Content Analysis and Review of Mobile Health Applications on COVID-19

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Abstract

It could be difficult for health care professional to recommend a suitable app for COVID-19 education and self-monitoring purposes. In this study, we have systematically evaluated the contents and features of COVID-19 mobile health applications (apps) available in android-based Play Store and iOS-based App Store. The inclusion criteria were apps that are related to COVID-19 with no restriction in language type. The basic features assessment criteria used for comparison were the requirement for free subscription, Internet connection, education/advisory content, size of app, ability to export data and automated data entry. The functionality of the apps was assessed according to: (1) knowledge (information on COVID-19), (2) tracing/mapping of COVID-19 cases, (3) home monitoring surveillance, (4) online consultation with a health authority, and (5) official apps run by health authorities. Of 223 COVID-19 related mobile apps, only 56 (35%) found in App Store and 54 (85.7%) in Play Store matched the inclusion criteria. In the basic features assessment, most App Store (33.3%) and Play Store (35.7%) apps scored 4 out of 7 points. Meanwhile, the outcome of the functionality assessment for most App Store apps (43.3%) was a score of 3, compared to android-based apps (35.7%), which scored 2 (out of maximum point 5). Most iOS-based apps incorporate infographic mapping of COVID-19 cases while most android-based apps incorporate home-monitoring surveillance features, instead of providing focused educational content on COVID-19. From this study, it is anticipated that existing or future designs of COVID-19 mobile apps can further be improved.

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Research paper

Content Analysis and Review of Mobile Health Applications on COVID-19

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Abstract

It could be difficult for health care professional to recommend a suitable app for COVID-19 education and self-monitoring purposes. In this study, we have systematically evaluated the contents

and features of COVID-19 mobile health applications (apps) available in android-based Play Store and iOS-based App Store. The inclusion criteria were apps that are related to COVID-19 with no restriction in language type. The basic features assessment criteria used for comparison were the requirement for free subscription, Internet connection, education/advisory content, size of app, ability to export data and automated data entry. The functionality of the apps was assessed according to: (1) knowledge (information on COVID-19), (2) tracing/mapping of COVID-19 cases, (3) home monitoring surveillance, (4) online consultation with a health authority, and (5) official apps run by health authorities. Of 223 COVID-19 related mobile apps, only 56 (35%) found in App Store and 54 (85.7%) in Play Store matched the inclusion criteria. In the basic features assessment, most App Store (33.3%) and Play Store (35.7%) apps scored 4 out of 7 points. Meanwhile, the outcome of the functionality assessment for most App Store apps (43.3%) was a score of 3, compared to android-based apps (35.7%), which scored 2 (out of maximum point 5). Most iOS-based apps incorporate infographic mapping of COVID-19 cases while most android-based apps incorporate home-monitoring surveillance features, instead of providing focused educational content on COVID-19. From this study, it is anticipated that existing or future designs of COVID-19 mobile apps can further be improved.

Keywords: coronavirus; mobile medical application; self-care; mHealth; health education

Background

Coronavirus disease 2019 (COVID-19), caused by Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) has received global attention. At the time of writing (April 2020), the number of confirmed cases across the world continues to rise. The World Health Organization (WHO) announced the COVID-19 disease as a pandemic on 11th March 2020.[1] While the SARS-CoV-2 pandemic has wrecked huge havoc in term of lockdown and mortality, the public has become more

eager to obtain information about the spread of the infection.[2] Their efforts in keeping themselves up-to-date with the latest information about COVID-19 could involve existing technologies such as watching the national bulletin on the television or listening to the news on the radio. However, a majority of people may not like the idea of waiting for a live broadcast at a fixed schedule. Reading digital news articles and scrolling through reliable official websites seems to be the main option for tech-savvy individuals.[3]

This opens up a golden opportunity for web or mobile medical application (app) developers to create a platform for the public to provide them with the information they are looking for. There is still ongoing research on the role of mobile health, also known as mHealth in healthcare services. The use of mHealth apps has made healthcare and health information easily accessible.[4] The use of mHealth apps at the user's convenience also helps to reduce the frequency of unnecessary hospital visits by stable patients, thus reducing the mobility of immunocompromised patients to high-risk areas.[5,6]

The implementation of strategic features in mHealth that can help in diagnosis or symptom reporting has great potential in the management of infections. Additionally, the integration of relevant epidemiological data and geographical information of transmittable disease prevalence in a region will allow the tracing of cases, which can be utilized as an effective tool to control the spread of infection.[7] It is more effective to deliver health-related information through mHealth apps as information can be exchanged rapidly and updated dynamically.[8] Mobile apps can potentially prevent the occurrence of a particular disease as exchanged texts through a mobile app can promote communication, storage of information and message delivery that drives users to make healthy lifestyle changes.[9,10]

Recently the US Food and Drug Administration issued guidance and policy for mHealth apps to

ensure their safety and effectiveness.[11] Meanwhile, other challenges revolve around information-sharing and transparency of services offered that could compromise the privacy of the app's user.[12,13] mHealth app use is also a major concern among healthcare professionals because of the possible dissemination of misinformation that could harm the users or readers, as some information and services provided are not aligned with medical guidelines.[14]

This study aimed to analyse and evaluate the contents as well as features of COVID-19 mobile apps. The findings are instrumental in helping healthcare professionals to identify suitable mobile apps for COVID-19 self-monitoring and education. The results of the mobile apps assessment can potentially help mobile app developers improve or modify their existing mobile app designs to achieve optimal outcomes.

Methodology

A systematic review, comparison and functionality assessment of selected mobile apps for COVID-19 was performed. Firstly, a search for COVID-19 mobile apps was performed in two digital platforms: App Store on the Apple iPhone 8 Plus and Google Play Store on Oppo R9s and Vivo V9 smartphones. The search was conducted from March 4th, 2020 to March 24th, 2020. The inclusion criteria to obtain relevant mHealth apps included apps launched for smartphone users and apps that are related to COVID-19 with no restriction in language type. The exclusion criteria include mobile apps that are launched on other devices, such as iPads, tablets and laptops, apps designed to provide quarantined users with their grocery or pharmacy supplies in response to containing the virus, and entrepreneurship apps designed to collect funds in support of organizations affected by COVID-19.

The keywords “Covid19”, “Coronavirus”, “Corona” and “COVID-19” were used to find COVID-19 mobile apps in the App Store and Play Store. In order to ensure that all relevant mobile apps were

included, an online search on Google using the key terms “mobile app”, “mHealth”, “Covid19”, “Coronavirus”, “Corona” and “COVID-19” was also conducted. Then, all mobile apps were filtered according to the COVID-19 relevance and were further filtered according to the inclusion and exclusion criteria. The authors are mainly proficient in the English language, so only apps that support an English language user interface were assessed and reviewed. The summaries of the processes involved in selecting the relevant mobile apps from the App Store and Play Store are illustrated in **Figure 1**.

The included mobile apps were assessed based on their (I) basic features and (II) functionalities. (I) The basic features were modified from the outline of developed classification of mHealth apps evaluation criteria proposed by Nouri, S [15] and literature [9,10,16]. The included seven basic features were: (1) no internet requirement, (2) size of app less than 50MB, (3) no subscription needed (i.e., free), (4) educational content (COVID-19 teaching), (5) export data (sharing of user’s data with other platforms), (6) automated data entry (automatic update of data without user interference) and (7) advisory function. (II) Once the assessment of basic features was completed, the researchers convened again to categorise the apps into different groups according to their purpose and functionality, by reading the summary and explanation given by the developers of each included app. The categorized five functionalities of mobile apps were: (1) knowledge (information on COVID-19), (2) tracing/mapping of COVID-19 cases, (3) home monitoring surveillance, (4) online consultation with a health authority, and (5) official mobile apps run by a health authority.

The basic features of all included mobile apps were screened individually by two researchers. Any disagreement was discussed until consensus was achieved. The full content of included mobile apps were then individually examined by the same researchers. Any ambiguity was resolved by two senior researchers to confirm the functionality classification of all included mobile apps. One point was

assigned to items that were fully satisfied. No point was given for each item that was partly satisfied or did not apply. A maximum of seven and five points for the basic features and functionalities, respectively. Descriptive statistics (frequencies) were used to describe the characteristics of the apps according to the basic features and functionalities.

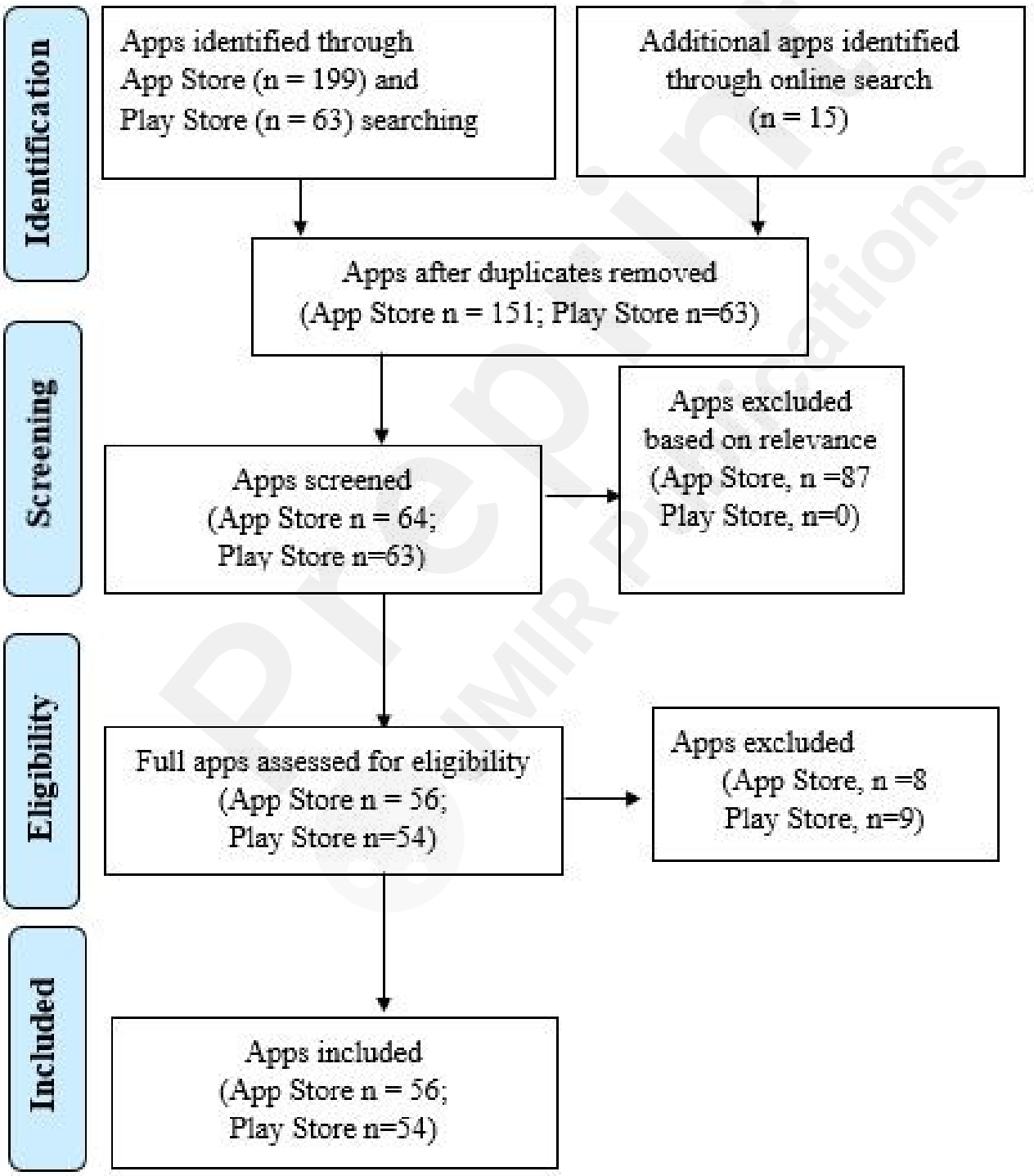

Figure 1: Selection process of mHealth apps in iOS-based App Store and android-based Play Store.

Results

The keywords used to search for mobile apps related to COVID-19 in Apple's App Store and Google Play Store gave a total of 160 and 63 apps, respectively. The apps were filtered according to the inclusion and exclusion criteria giving a total of 56 (35%) mobile apps from App Store and 54 (85.7%) mobile apps from Play Store. The available mobile apps are grouped according to (a) universal COVID-19 apps; (b) country-specific apps and (c) non-English language apps, as illustrated in **Supplementary Information 1** for Apple App Store and **Supplementary Information 2** for Google Play Store.

Out of all the total number of mobile apps available with relevance to COVID-19, only 30 (53.6%) that were found in the Apple App Store and 28 (51.9%) in Google Play Store were assessed. Selected mobile apps were assessed according to their basic features **(Table 1, Table 2 and Table 3)** and functionality **(Table 4, Table 5 and Table 6).** The results of the assessment follow a scoring system whereby the app was given a score of one for every criterion that it satisfied.

The criteria assessed under basic features include the requirement of internet connectivity to utilize the app, storage capacity, subscription requirement, educational content, ability to export data, automated data entry support and an advisory feature. According to the results obtained from the assessment of basic features of mobile apps as illustrated in **Figure 2a**, a majority of apps from App Store (96.7%) and Google Play (92.9%) require internet connectivity to be accessed. There is a higher proportion of mobile apps from Apple (56.7 - 76.7%) that can be accessed without any subscription while providing educational content and advice than Android mobile apps (32.1 -

75.0%). Meanwhile, there are slightly more COVID-19 mobile apps (64.3 - 96.4%) from Google that are less than 50MB in capacity, with the ability to export data and allow automated data entry in comparison to Apple (36.7 - 76.7%).

Apart from assessing the basic features, the mobile apps were also assessed based on the functionality as illustrated in **Figure 2b**. The criteria assessed under functionality includes the availability of COVID-19 related information, tracing/mapping of COVID-19 cases, home monitoring surveillance, online consultation with a health authority, and whether or not the mobile apps are maintained by a Health Authority. Most of the mHealth apps (23.3 - 80.0%) in the App Store on an iPhone provide better functionality than mHealth apps in Play Store on an Android smartphone. However, a higher proportion of Android mobile apps (42.9%) offer home monitoring surveillance related to COVID-19 than Apple (20.0%).

When assessing the basic features of the mobile apps, none of the apps from Apple App Store scored 1, 6 or 7, as shown in **Figure 3a**. There are six apps (20.0%) that scored 2 and 3, ten apps (33.3%) that scored 4, and eight apps that scored 5 (26.7%). Meanwhile, for apps downloaded from the Google Play Store, none of the apps scored 1 or 7. There are two apps (7.1%) that scored 2, seven apps (25.0%) that scored 3, ten apps (35.7%) that scored 4, seven apps (25%) that scored 5 and the remaining two apps (7.2%) scored 6. In **Figure 3b**, when assessing the functionality of the mobile apps, none of the apps from Apple App Store scored 5. One app (3.3%) scored 0, two apps (6.7%) scored 1, eleven apps (36.7%) scored 2, three apps (10%) scored 4, and the majority (43.3%) scored 3. From the Google Play Store, none of the apps scored 5. Two apps (7.1%) scored 0, four apps (14.3%) scored 1, nine apps (32.1%) scored 3, three apps (10.7%) scored 4, and the majority (35.7%) scored 2.

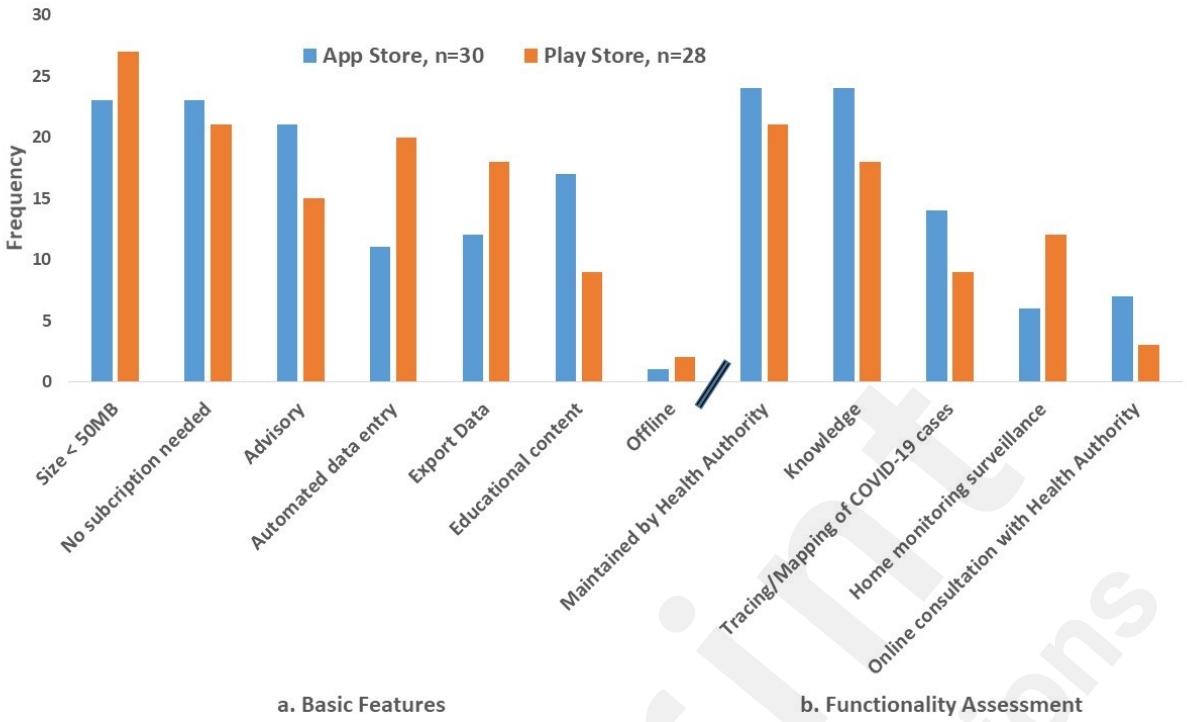

Figure 2. Assessment of iOS and android-based mobile apps (2a: Basic features; 2b: Functionality assessment)

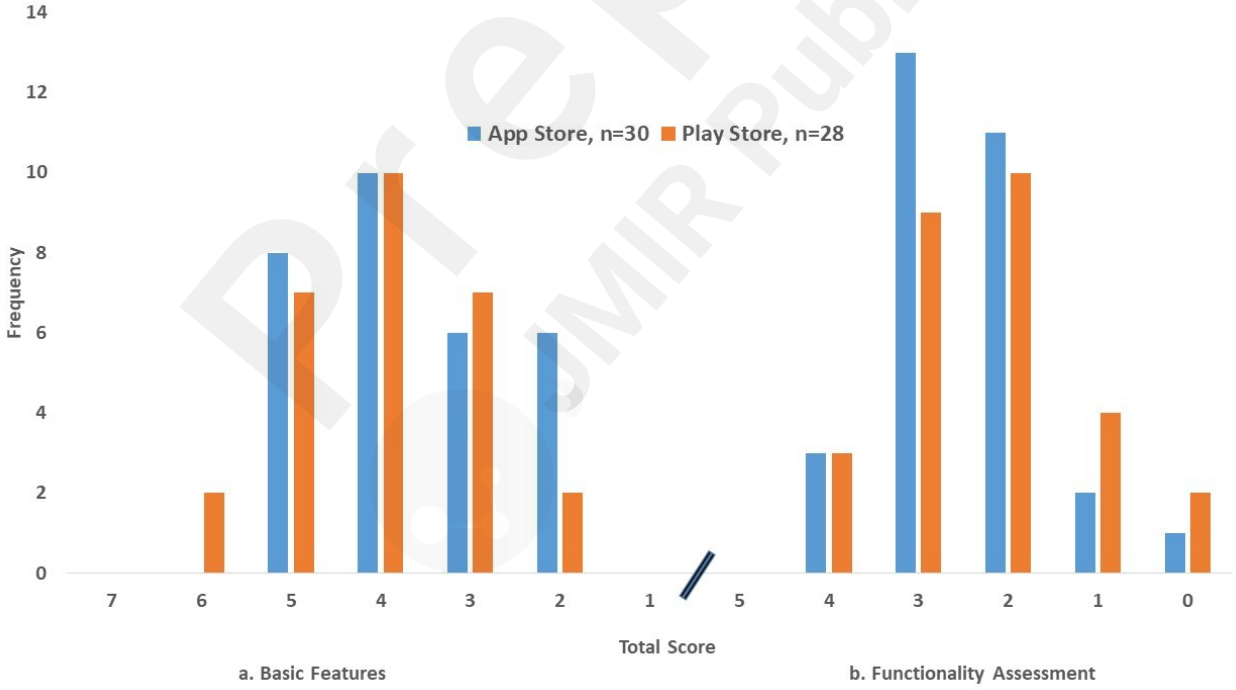

Figure 3. Total assessment score of iOS and android-based mobile apps (3a: Basic features; 3b: Functionality assessment)

Table 1. Basic features assessment of mobile medical apps (iOS and android-based)

Table 1a. Universal COVID-19 apps

No.	Name of mobile applications	Basic Features (/ or X)							
		No internet requirement	Size of application <50	No subscription requirement (i.e. Free)	Educational content	Export Data	Automated data entry	Advisory	Total score
1	COVID Symptom Tracker	X	/	/	X	/	/	/	5

Table 1b. Country-specific apps

No.	Name of mobile applications	Basic Features (/ or X)							
		No internet requirement	Size of application <50	No subscription requirement (i.e. Free)	Educational content	Export Data	Automated data entry	Advisory	Total score
2	BC COVID-19	X	/	/	/	X	/	/	5
3	Canada COVID-19	X	/	/	/	X	/	/	5
4	Coronavirus Australia	X	/	/	/	/	X	/	5
5	COVA Punjab	X	/	X	N/A	/	/	/	4
6	HSE COVID-19	X	/	X	X	/	/	X	3
7	NCOVI	N/A	/	/	/	N/A	N/A	/	4
8	TraceTogether	X	/	/	X	/	/	/	5
9	□□□□□ □□□□ (Self-Isolator Safety & Protection)	N/A	/	/	/	N/A	N/A	/	4
10	□□□□□ □□□□□ (Self-isolating Government Officials)	N/A	/	/	/	N/A	N/A	/	4

Table 2. Basic features assessment of mobile medical apps (iOS and android-based)

Table 2a. Universal COVID-19 apps

No.	Name of mobile applications	Basic Features (/ or X)							
		No internet requirement	Size of application <50	No subscription requirement (i.e. Free)	Educational content	Export Data	Automated data entry	Advisory	Total score
1	APPLE COVID-19	/	/	/	/	X	X	X	4
2	CDC	X	/	/	/	X	X	X	3
3	CoronaFACTS	X	/	/	/	X	/	X	4
4	Corona Checker	X	/	/	X	X	X	/	3
5	COVID-19!	X	X	/	/	X	X	/	3
6	HEALTHLYNKED COVID-19 TRACKER	X	/	/	/	X	X	/	4
7	RELIEF CENTRAL	X	/	/	/	X	/	/	5
8	Patient Sphere COVID-19	X	/	/	X	/	X	X	3
9	PreMedicus®	N/A	X	X	X	/	X	/	2
10	Mobile Angel Cancer Telemed	X	X	/	X	/	X	X	2

Table 2b. Country-specific apps

No.	Name of mobile applications	Basic features (/ or X)							
		No internet requirement	Size of application <50	No subscription requirement	Educational content	Export Data	Automated data entry	Advisory	Total score

				(i.e. Free)					
11	**BMC Combat Covid19**	X	/	/	X	X	X	X	2
12	**Corona-Care**	X	X	X	X	/	/	/	3
13	**COVID-19 Gov PK**	X	/	/	/	X	/	/	5
14	**Covidom Patient**	X	X	X	X	/	X	/	2
15	**COVI QATAR**	X	/	/	/	X	X	/	4
16	**COVID-19 UAE**	X	X	/	/	X	/	/	4
17	**CUREiTT**	X	X	X	X	/	/	X	2
18	**NJ COVID 19**	X	/	/	/	X	X	/	4
19	**STOP COVID19 CAT**	X	/	X	N/A	/	N/A	N/A	2
20	**Tarussud**	X	/	/	/	X	/	/	5

Table 3. Basic features assessment of mobile medical apps (android-based)

Table 3a. Universal COVID-19 apps

No.	Name of mobile applications	Basic Features (/ or X)							
		No internet requirement	**Size of application <50**	**No subscription requirement (i.e. Free)**	**Educational content**	**Export Data**	**Automated data entry**	**Advisory**	**Total score**

1	**Test Yourself Goa**	X	/	/	X	/	X	/	4

Table 3b. Country-specific apps

No.	Name of mobile applications	Basic Features (/ or X)							
		No internet requirement	**Size of application <50**	**No subscription requirement (i.e. Free)**	**Educational content**	**Export Data**	**Automated data entry**	**Advisory**	**Total score**
2	**Aarogya Setu**	X	/	/	X	/	/	/	5
3	**CoBuddy – Covid19 Tool**	X	/	X	X	/	/	X	3
4	**Corona Watch**	X	/	/	X	X	/	/	4
5	**COVI**	X	/	/	/	X	/	/	5
6	**Covid-19**	X	/	X	X	/	/	X	3
7	**COVID-19 NI**	/	/	/	/	X	/	/	6
8	**COVID19 Feedback**	X	/	/	X	/	/	X	4
9	**COVID-19 Quarantine Monitor Tamil Nadu (official)**	X	/	/	X	/	/	X	4
10	**COVID-19 West Bengal Government**	X	/	/	X	/	/	X	4
11	**GCC -Corona Monitoring**	X	/	/	X	X	/	X	3
12	**GoK – Direct Kerala**	X	/	/	X	X	X	X	2
13	**Home Quarantine (Kwarantanna domowa)**	X	X	/	X	/	/	X	3
14	**Mahakavach**	X	/	X	X	/	/	N/A	3

15	**MP COVID RESPONSE APP**	X	/	/	N/A	/	N/A	N/A	3
16	**Quarantine Watch**	X	/	X	N/A	/	N/A	N/A	2
17	**StayHomeSafe**	/	/	X	N/A	/	/	N/A	4
18	**Test Yourself Puducherry**	X	/	/	/	/	/	/	6

Table 4. Functionality assessment of mobile medical apps (iOS and android-based)

Table 4a. Universal COVID-19 apps

No.	Name of mobile applications	Advanced features related to COVID-19 (/ or X)					
		Knowledge	**Tracing/Mapping of COVID-19 cases**	**Home monitoring surveillance**	**Online consultation with Health Authority**	**Official mobile application maintained by Health Authority**	**Total score**
1	**COVID Symptom Tracker**	/	/	X	X	/	3

Table 4b. Country-specific apps

No.	Name of mobile applications	Advanced features related to COVID-19 (/ or X)					
		Knowledge	Tracing/Mapping of COVID-19 cases	Home monitoring surveillance	Online consultation with Health Authority	Official mobile application maintained by Health Authority	Total score
2	BC COVID-19	/	X	X	X	/	2
3	Canada COVID-19	/	/	X	X	/	3
4	Coronavirus Australia	/	/	X	X	/	3
5	COVA Punjab	/	/	N/A	/	/	4
6	HSE COVID-19	/	X	/	X	/	3
7	NCOVI	/	/	N/A	N/A	/	3
8	TraceTogether	/	/	X	/	/	4
9	□□□□□ □□□□ (Self-Isolator Safety & Protection)	/	N/A	/	N/A	/	3
10	□□□□□ □□□□□ (Self-isolating Government Officials)	/	N/A	/	N/A	/	3

Table 5.0 . Functionality assessment of mobile medical apps (iOS-based)

Table 5a. Universal COVID-19 apps

No.	Name of mobile applications	Advanced features related to COVID-19 (/ or X)					
		Knowledge	Tracing/Mapping of COVID-19 cases	Home monitoring surveillance	Online consultation with Health Authority	Official mobile application maintained by Health Authority	Total score
1	Apple COVID-19	/	X	X	X	/	2
2	CDC	/	X	X	X	/	2

3	**CoronaFACTS**	/	/	X	X	/	3
4	**Corona Checker**	X	X	X	X	X	0
5	**COVID-19!**	/	/	X	X	X	2
6	**HEALTHLYNKED COVID-19 TRACKER**	/	/	X	X	/	3
7	**RELIEF CENTRAL**	/	/	X	X	X	2
8	**Patient Sphere for COVID-19**	X	X	/	X	X	1
9	**PreMedicus® ER**	/	X	X	/	X	2
10	**Mobile Angel Telemed**	X	X	/	/	/	3

Table 5b. Country-specific apps

No.	Name of mobile applications	Advanced features related to COVID-19 (/ or X)					
		Knowledge	Tracing/Mapping of COVID-19 cases	Home monitoring surveillance	Online consultation with Health Authority	Official mobile application maintained by Health Authority	Total score
11	BMC Combat Covid19	X	X	/	/	/	3
12	Corona-Care	/	/	X	X	/	3
13	COVID-19 Gov PK	/	X	X	X	/	2
14	Covidom Patient	X	X	X	/	/	2
15	COVI QATAR	/	X	X	X	/	2
16	COVID-19 UAE	/	X	X	X	/	2
17	CUREiTT	/	X	X	X	X	1
18	NJ COVID 19	/	/	X	X	/	3
19	STOP COVID19 CAT	N/A	/	N/A	N/A	/	2
20	Tarassud	/	/	X	/	/	4

Table 6.0. Functionality assessment of mobile medical apps (android-based)

Table 6a. Universal COVID-19 apps

No.	Name of mobile applications	Advanced features related to COVID-19 (/ or X)					
		Knowledge	Tracing/Mapping of COVID-19 cases	Home monitoring surveillance	Online consultation with Health Authority	Official mobile application maintained by Health Authority	Total score
1	Test Yourself Goa	/	X	X	X	/	2

Table 6b. Country-specific apps

No.	Name of mobile applications	Advanced features related to COVID-19 (/ or X)					
		Knowledge	Tracing/Mapping of COVID-19 cases	Home monitoring surveillance	Online consultation with Health Authority	Official mobile application maintained by Health Authority	Total score
2	Aarogya Setu	X	/	X	X	/	2
3	CoBuddy – Covid19 Tool	X	X	/	X	X	1
4	Corona Watch	/	/	X	X	X	2
5	COVI	/	X	X	X	/	2
6	Covid-19	X	X	/	/	/	3
7	COVID-19 NI	/	X	X	X	/	2
8	COVID19 Feedback	X	X	X	X	X	0
9	COVID-19 Quarantine Monitor Tamil Nadu (official)	X	X	/	X	X	1
10	COVID-19 West Bengal Government	X	X	/	X	X	1

11	**GCC -Corona Monitoring**	X	/	/	X	X	2
12	**GoK – Direct Kerala**	/	X	X	X	/	2
13	**Home Quarantine (Kwarantanna domowa)**	/	X	/	X	/	3
14	**Mahakavach**	/	/	/	N/A	/	4
15	**MP COVID RESPONSE APP**	N/A					N/A
16	**Quarantine Watch**	N/A		/	N/A	/	2
17	**StayHomeSafe**	N/A		/	N/A	/	2
18	**Test Yourself Puducherry**	/	X	X	X	/	2

Discussion

According to the assessment that has been conducted, the mobile apps vary in terms of basic features and functionality. Basic features consist of trivial characteristics that may or may not be of significant importance to users who would like to utilize COVID-19 mobile apps for COVID-19-related education or self-monitoring purposes with no existing issue with internet access or low mobile storage capacity. Another assessment was conducted based on the advanced features found in the apps. The advanced features touch on the type of content that the app offers on COVID-19, which are used as a measure of the quality of the mobile app. In terms of the basic features, most of the apps from App Store and Play Store require no subscriptions and have a storage size of less than 50MB. There are some apps that need to be paid for as they need the revenue for advertisements and data mining.[17]

People could mistakenly assume that paid mHealth apps have better content or app design. Their value should be assessed in relation to their overall strengths and limitations.[15,18] It is recommended for mHealth apps to have a small storage size, as taking up a lot of phone storage space can result in reduced performance of the mobile phone. [19] Moreover, App Store offers more apps that provide educational content and advice on COVID-19 than Google Play. This shows the potential of mHealth apps in transforming the delivery of health care services.[20] On the other hand, there are more mobile apps from Google Play Store that enable data to be exported and offer automated data entry in comparison to App Store. The availability of data export will allow users to share health reports with their healthcare providers. Automated data entry can provide greater efficiency in inputting data to the app system, while streamlining the user's experience.[21,22]

There are two COVID-19 mobile apps from Play Store that had the highest score of 6 in the assessment of basic features (COVID-19 NI and Test Yourself Puducherry) and eight COVID-19 mobile apps from the App Store that had the highest score of 5 (BC COVID-19, COVID Symptom Tracker, Canada COVID-19, Coronavirus Australia, COVID-19 Gov PK, Relief Central, Tarassud and TraceTogether).

When assessing the functionality of the mobile apps, there are three COVID-19 mobile apps from App Store and Play Store that had the highest score of 4: COVA Punjab and TraceTogether from both App Store and Play Store, Tarassud from App Store, and Mavakavach from Play Store.

A detailed review of mobile apps in Apple App Store

Amongst apps meant for universal use with an Apple device, APPLE COVID-19 app ranked first in the category of health and fitness with the second-highest user rating of 4.4 while HEALTHLYNKED COVID-19 TRACKER ranked second in the medical category with a slightly higher user rating of 4.6 - rated by thousands of mobile users. Though other apps rated more than 4.5, including CoronaFACTS, Corona Checker and COVID-19!, there is no strong support that the operating performance of these apps is better than APPLE COVID-19 or HEALTHLYNKED COVID-19 TRACKER because of the low number of users who rated the apps.

APPLE COVID-19 and HEALTHLYNKED COVID-19 TRACKER achieved a score of 4 in the basic feature assessment. One main difference is the ability to access APPLE COVID-19 without requiring any internet or data usage, unlike HEALTHYLYNKED COVID-19 TRACKER.

However, HEALTHLYNKED COVID-19 TRACKER allows mapping of COVID-19 cases to provide users with an up-to-date statistic on the number of COVID-19 infections worldwide; a feature which APPLE COVID-19 does not offer. Both apps are run by the health authorities in the United States as APPLE COVID-19 was developed in collaboration with the Control Disease Centre (CDC) while HEALTHLYNKED COVID-19 TRACKER was developed by a company of medical professionals. It is recommended for a developer of health-related apps to collaborate with healthcare professionals to provide up-to-date content that can be easily trusted by the public.[23]

Both APPLE COVID-19 and Relief Central apps scored 2 in the functionality assessment but Relief Central scored an extra point (5) than APPLE COVID-19 (4) in the basic feature assessment as it supports automated data entry. However, disseminated information in the Relief Central app is not aimed for the general public but those with a background in the medical field, for instance, health care professionals and (e.g. pharmacy, medical, nursing and allied health) students, as the profession of the user is inquired before the someone can proceed further in using the app. Thus, the content in this app cannot be accessed for the public's perusal.

Both CoronaFACTS and HEALTHLYNKED COVID-19 TRACKER scored the same in both assessments: 4 points in the basic feature assessment and 3 points in the functionality assessment. Both offer the same advanced features of providing information on COVID-19, mapping of COVID-19 cases and are maintained by the health authority of their country. The differences between the two apps is that there is no advisory content in CoronaFACTS, unlike HEALTHLYNKED COVID-19 TRACKER, and CoronaFACTS is another app that supports

automated data entry which HEALTHYLYNKED COVID-19 does not support it. CoronaFACTS functions by collecting COVID-19 related newspaper articles from trusted sources based on the region chosen by the user, and directs the user to the official site of the article.

Applications with Country-specific apps from both stores were also assessed. From the Apple App Store, apps named COVID-19 PK Gov and Tarassud scored the highest (5) in their basic features assessment with limitations including that users have to be online to operate the app and the absence of a data exportation feature. Other limiting factors of COVID-19 Gov PK in its content are the absence of mapping of COVID-19 cases, home monitoring surveillance and online consultation with a health authority. Tarassud has better functionality as it scored 4 out of 5 in the functionality assessment, with only one limitation whereby there is an absence of a home monitoring surveillance feature. Tarassud also includes information on the updated number of cases around the world with guidelines on COVID-19, for those in isolation and quarantine. Of note, using electronically collected influenza data at a Swedish county as an example, prediction of influenza virus activity using retrospective surveillance data were successfully integrated into local healthcare management system.[24]

A detailed review of mobile apps in Google Play Store

An app named Test Yourself Goa is available for universal use on an Android device. It is an app used to determine if an individual is at high risk of getting COVID-19 based on the symptom-checking feature. After the completion of the symptom checking test, a piece of advice will be given that is aligned with the guidelines proposed by the Centers for Disease Control and Prevention. For patients who are just learning to manage their disease, mHealth can be of help thanks to its ability to provide advice based on the aggregation of data.[25] In our assessment, it

satisfied almost all of the favorable basic features except it requires an internet connection, has no educational content on the disease and no automated data entry feature. Test Yourself Goa also allows the health authority to collect the user's details such as full name, mobile number, zip code and address. In the functionality assessment, this mobile app only scored 2 out of 5 as it provides information on COVID-19 and is an official app maintained by health authorities.

Meanwhile, amongst apps with a Country-specific apps from the Play Store, COVID-19 NI and Test Yourself Puducherry scored the highest in their basic feature assessment with scores of 6 each. The differences between the two apps are that COVID-19 NI does not require internet connectivity and there is an absence of data exportation in comparison to Test Yourself Puducherry. Both apps also got the same score in their functionality assessment with a considerably low score of 2, proving that they contain COVID-19 information and are maintained by a health authority. The mobile apps can provide disease-specific information to patients, the general public or healthcare professionals, which can raise the awareness of users to the signs, causes and effects of the disease with a view to containing the disease.[26]

A detailed review of mobile apps available in both Apple App Store and Google Play Store

The only app that is available in both App Store and Play Store for universal use is COVID Symptom Tracker. This COVID-19 mobile app enables users to report any symptoms daily. The users need to fill in their personal information such as age, sex, height, weight and postcode. Additionally, the user's data will be collected by the health authority. Based on the findings in the basic feature assessment, COVID Symptom Tracker requires internet access to operate the app and it does not provide any educational content. In the Functionality assessment, the app

scored 3 out of 5 due to the unavailability of several features including home monitoring surveillance and online consultation with a healthcare professional.

An app named COVA Punjab scored the second-highest in the basic feature assessment with a restriction of the app requiring the internet to work. Most of the mHealth apps in Apple App Store and Google Play Store require an internet connection, as it is an important feature for the developers to enable real-time data synchronization with the app to prevent the display of outdated information.[27,28]

However, the reviewer was not able to access the app, as user registration requires a local phone number. Hence, there is no information about whether or not the app has any educational content on COVID-19. In the Functionality assessment, both COVA Punjab and Tracetogether scored 4 out of 5. TraceTogether does not have a home monitoring surveillance feature while there is no information on the feature in the COVA Punjab app. However, TraceTogether scored more (5) than COVA Punjab (4) in its basic feature assessment with similar limitations. While TraceTogether is confirmed to have no educational content, there is a lack of information regarding this feature in COVA Punjab.

Not only does TraceTogether have the highest score in the basic feature assessment, but it also has the highest score in the functionality assessment in both the App Store and Play Store. It is an app used mainly for contact tracing of COVID-19 cases in Singapore to enable users to be notified of people who had close contacts with COVID-19 positive cases. Although contact tracing initially could be done manually, the number of confirmed cases of COVID-19 continues

to rise across the world and it has become difficult to do. Therefore, there are a lot of countries that have used different methods of contact tracing.[29] For example, Taiwan has given health institutions access to patients' travel history and allows relevant authorities to monitor anyone under quarantine by tracking the location of their mobile phone.[29] Meanwhile, in South Korea, the government has maintained a public database of the personal data of COVID-19 patients including their age, gender, profession and travel routes .[29] In the case of TraceTogether, if the user is suspected to be infected with COVID-19, the user's data from the app will also be collected by the health authority for contact tracing purposes. TraceTogether also gives information on the functions of the app for a first time user. As the app is being maintained by the health authority, it also allows users to interact with the health authority in addition to allowing users to upload relevant files such as images and documents.

There are also a number of apps that scored low in the functionality assessment. In the Apple AppStore, CoronaChecker was identified as a low-scoring app with a score of 0. CoronaChecker is an app intended to provide suggestions on the requirement of a COVID-19 test for the user. Using artificial intelligence, a conversation is initiated with the user upon opening the app. During the interaction, closed questions are generated to ask the user about any clinical symptoms that they may be manifesting to check for any possible viral infection. Despite the low-functionality offered by this app, it was rated 5 out of 5 by 298 users. This could be an indication that the users were satisfied by the operating performance of the app, as CoronaChecker is only designed for users to confirm their health status and not as an educational tool for COVID-19.

COVID19 Feedback obtained the lowest score (0) in the functionality assessment from the

Google Play Store. The mobile app only requests feedback from individuals who have done the coronavirus test in India. The feedback received from the public will be used to improve the efficiency and processes related to the coronavirus test. Hence, COVID19 Feedback does not support any of the advanced features related to COVID-19.

In the Apple App Store, CUREiTT scored the lowest in both assessments. It scored two in the basic assessment as it is only available in exporting data and it supports automated data entry. The app also collects the user's personal information such as phone number, year of birth and gender. Although CUREiTT only scored one in the functionality assessment, it has a unique function of displaying appropriate clinical trials in the geographical area of individuals diagnosed with cancer or coronavirus.

GoK – Direct Kerala app has the lowest score in both assessments for Google Play Store. The two scores from the basic feature assessment are due to the storage size of less than 50MB and the absence of a subscription requirement. However, the app does provide national news reports about the government’s actions to manage COVID-19 cases. Moreover, it is an official mobile app maintained by a health authority. Quarantine Watch also has the same score as GoK – Direct Kerala but most of the assessments were not assessed, as a national phone number was required for mandatory registration.

Recommendation on COVID-19 mobile apps

Every app has a specific goal and a target audience. We have carefully assessed the available apps, which has shown that only a few apps can be used globally for COVID-19 education and

self-monitoring. From the results above, a high-quality mobile app that can be globally used is COVID Symptom Tracker which can be installed on both Apple and Android devices. With the aim of slowing the outbreak of the virus, a symptom tracker is useful in identifying high-risk areas in the country, speed of viral transmission in an area and individuals who are at risk the most in relation to their health conditions.[30]

Based on our study, Mahakavasch and Home Quarantine are the only two apps from Google Play Store that contain both important features for users: provision of information related to COVID-19 with home monitoring features. The home monitoring features are only available for the purpose of monitoring those in quarantine. Home Quarantine, as the name suggests, is designed for those who were assigned to be quarantined at their homes for 14 days. If the users suspect they have been exposed to COVID-19 during their quarantine, they can simply contact the number stated in the app. Mahakavasch has a similar concept as Home Quarantine but it differs slightly as the users of Mahakavasch will need to take a self-portrait and upload it in the app to enable their location during their quarantine period to be detected.

Self-monitoring apps

The use of apps on smartphones to conduct self-assessments for COVID-19 can help to notify the user of his/her health status. It is also known that technology can promote rapid identification of potential COVID-19 cases for timely interventions to be carried out.[31] This is because COVID-19 is a communicable viral disease in which infected people may appear asymptomatic.[30] With the availability of self-monitoring apps, the user can continue to perform their daily activities at home without going to the hospital for a check-up (21). Other advantages

of self-monitoring apps are the ability to observe a patient's condition at any time, increased efficiency of the healthcare services with the use of modern technology and reduced burden of immobilized patients who cannot regularly visit a hospital.[32]

Altogether, from both stores, there are six apps that offer COVID-19 home-monitoring features. Three apps from the App Store are BMC Combat COVID19, Patient Sphere for Covid-19 and Mobile Angel. BMC Combat Covid19 is the only app that is specific to citizens of British Columbia, while the other two apps are aimed for universal use. BMC Combat Covid19 and Mobile Angel Cancer Telemed scored 2 while Patient Sphere for COVID-19 scored 3 in the basic feature assessment. Patient Sphere for Covid-19 functions similarly as a health record system for a registered individual. Registration can be made through email or phone number. It allows users to manually enter their data in the symptom diary after monitoring themselves. The monitoring parameters that can be recorded are related to common symptoms of COVID-19, such as a stuffy nose, cough, shortness of breath and chills. However, Mobile Angel app is only restricted to patients from a healthcare facility that has been registered in the app.

The other three apps that offer home-monitoring features are from the Play Store: CoBuddy - Covid19 Tool, COVID-19 Quarantine Monitor Tamil Nadu (official) and COVID-19 West Bengal Government. Unfortunately, the apps are only available for use in specific regions. COVID-19 West Bengal Government and COVID-19 Quarantine Monitor Tamil Nadu (official) scored 4 and CoBuddy - Covid19 Tool scored 3 in basic features. COVID-19 Quarantine Monitor Tamil Nadu (official) and COVID-19 West Bengal Government provide similar contents. A toggle switch should be enabled in the apps to allow the user’s daily condition to be

monitored.

Quality Improvement of mobile apps

Based on the research, there are several recommendations that mobile app developers can consider to improve their existing COVID-19 apps or create a high-quality COVID-19 mobile app in the future.

Firstly, it is recommended that a health-related app is to be maintained by a health authority to avoid the spread of misleading information to the public. A collaboration with the health authorities to create a mHealth app can increase the reliability of the app which will encourage more users to be engaged in its usage. Otherwise, the user can be informed of the source of the shared information provided in the app. Secondly, to increase the engagement rate of the public with the mobile app, it should also contain background information on COVID-19, guidelines and preventive measures instead of only a focused feature related to COVID-19 (e.g. symptom tracking feature). Moreover, the app should be available for universal use instead of only for residents in a specific country. Thirdly, it is suggested that the apps should be made available without requiring any payment in both Apple App Store and Google Play Store to make them more accessible.

Fourthly, including real-time or near real-time updates of statistical analytics with geographical information of positive cases, recovered cases and a death toll is highly recommended to allow users to be readily informed about the COVID-19 situation worldwide. Fifthly, to ensure that users can safely share their personal details, the app should be secure and able to provide

assurance to the user that all shared information is kept confidential.

Furthermore, there are other advanced features that can greatly improve the quality of an mobile app including the addition of a feature that can report crowded places to alert users about places to be avoided to allow them to practice social distancing, as well as a quarantine attendance status, online consultation with healthcare professionals, and tracing of the whereabouts of positively-infected app users to alert their close contacts to undergo contact tracing for COVID-19. It is also crucial to categorize mobile apps into appropriate categories to enable users to find an app easily, and thus improve its user engagement rate.

Many COVID-19 mobile apps are appropriately placed under Health & Fitness and Medical. Examples of categories that do not correspond to COVID-19 mobile apps are reference, news, utilities and tools, as these terms lack specificity in the content they display. Last but not least, an advanced integration of a mHealth app with a health device that can monitor a user's health such as a digital thermometer which can automatically record the user's body temperature reading in the app will also enhance the self-monitoring feature of the app.

Limitations

Several limitations were found throughout the study conducted. Firstly, our findings on the available mobile apps in Google Play Store were limited as the search for any COVID-19 related keyword has been disabled by Google to avoid any misinformation on the disease. Secondly, after this research has been completed, it is likely that there will be more updated features in the

assessed mobile apps. Moreover, new COVID-19 mobile apps may be launched which could not be included in this review. Thirdly, there are gaps in our research as some apps were inaccessible to the reviewers. This is due to the strict verification process using either a local phone number especially for apps designed with country-specific functionalities or restricted access for specific users only. One app also required payment before the installation of the app could begin. Therefore, some apps were marked with 'N/A' in the assessment results, which indicated the absence of information regarding a certain feature in the app. Fourthly, no usability study has been conducted to test for users' responses to COVID-19 mobile apps, so the authors could not conduct a systematic review of literature regarding COVID-19 mobile apps.

Conclusions

It is important to evaluate the contents and features of COVID-19 mobile apps to guide users in choosing the suitable mobile app based on their requirements and help developers to improve the designs of their existing or future mobile apps to further enhance quality. Evaluation of basic functions showed that 88% of included mobile apps do not require subscription, 62% provide symptom advice, and 45% have educational content. In term of the specific functions, more than half of the included mobile apps are official mobile apps maintained by a health authority for COVID-19 information provision. Around 40% and 31% of the mobile apps have tracing/mapping and home monitoring surveillance functions, respectively, with only 17% of mobile apps equipped with an online consultation function. Quality-wise, 60% of the included mobile apps scored 4 or 5 points out of 7, proving that during the time constraint of a few weeks, the mobile app developers did not manage to create a full comprehensive mobile app. Our study paves the way for future work to determine the role of mobile apps in controlling the rate of

transmission of COVID-19.

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Data sharing statement: All data have been reported in this manuscript.

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List of Captions:

Figure 1. Selection process of mHealth apps in Apple's App Store and Google Play Store.

Figure 2. Assessment of iOS and android-based mobile apps (2a: Basic features; 2b: Functionality assessment)

Figure 3. Total assessment score of iOS and android-based mobile apps (3a: Basic features; 3b: Functionality assessment)

Table 1. Basic features assessment of mobile medical apps (iOS and android-based) (1a. Universal COVID-19 apps; 1b. Country-specific apps)

Table 2. Basic features assessment of mobile medical apps (iOS and android-based) (2a. Universal COVID-19 apps; 2b. Country-specific apps)

Table 3. Basic features assessment of mobile medical apps (android-based) (3a. Universal COVID-19 apps; 3b. Country-specific apps)

Table 4. Functionality assessment of mobile medical apps (iOS and android-based) (4a. Universal COVID-19 apps; 4b. Country-specific apps)

Table 5. Functionality assessment of mobile medical apps (iOS-based) (5a. Universal COVID-19 apps; 5b. Country-specific apps)

Table 6. Functionality assessment of mobile medical apps (android-based) (6a. Universal COVID-19 apps; 6b. Country-specific apps)

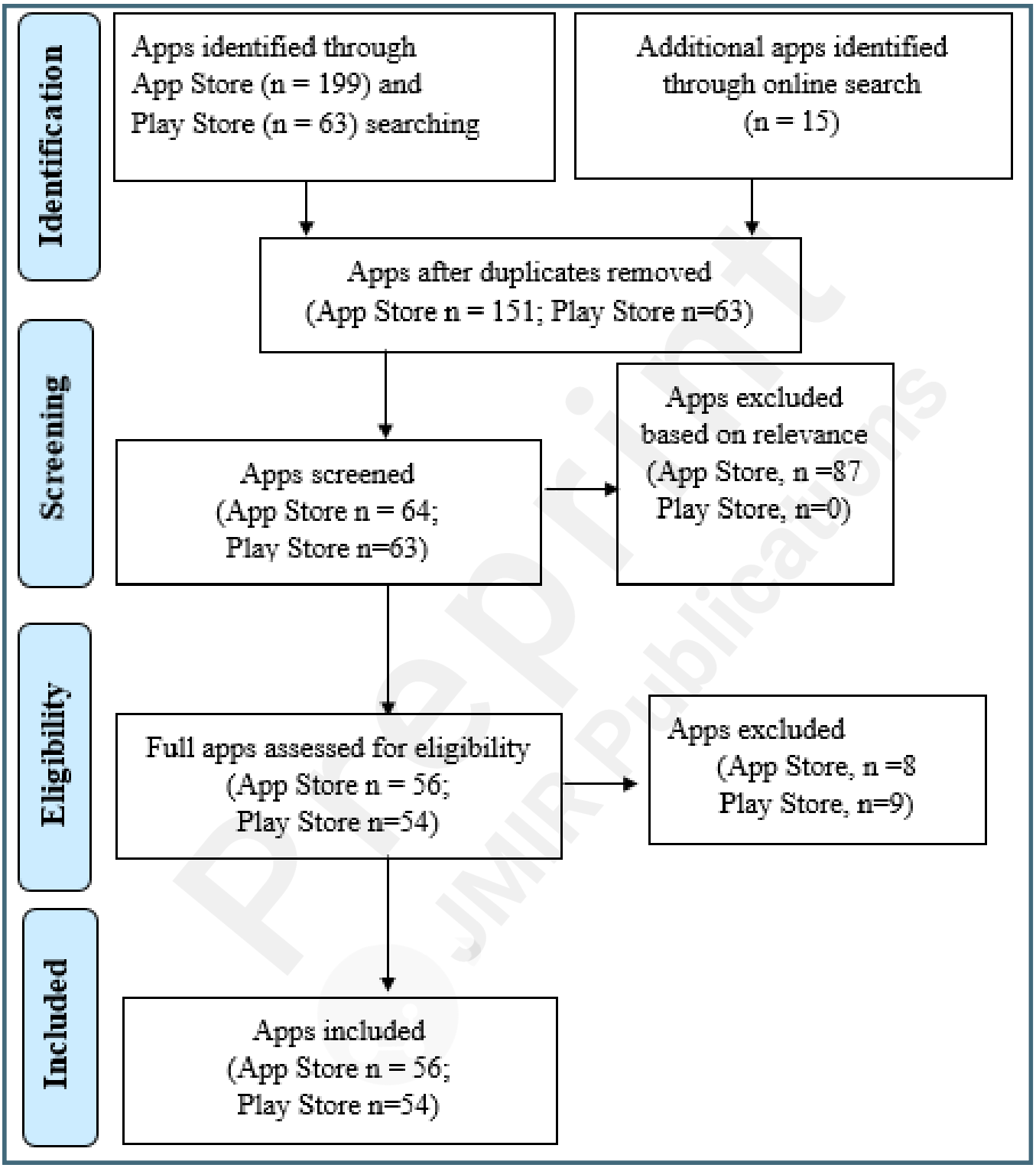
Supplementary Information 1. Characteristic of mobile medical apps (iOS-based)

Supplementary Information 2. Characteristic of mobile medical apps (android-based)

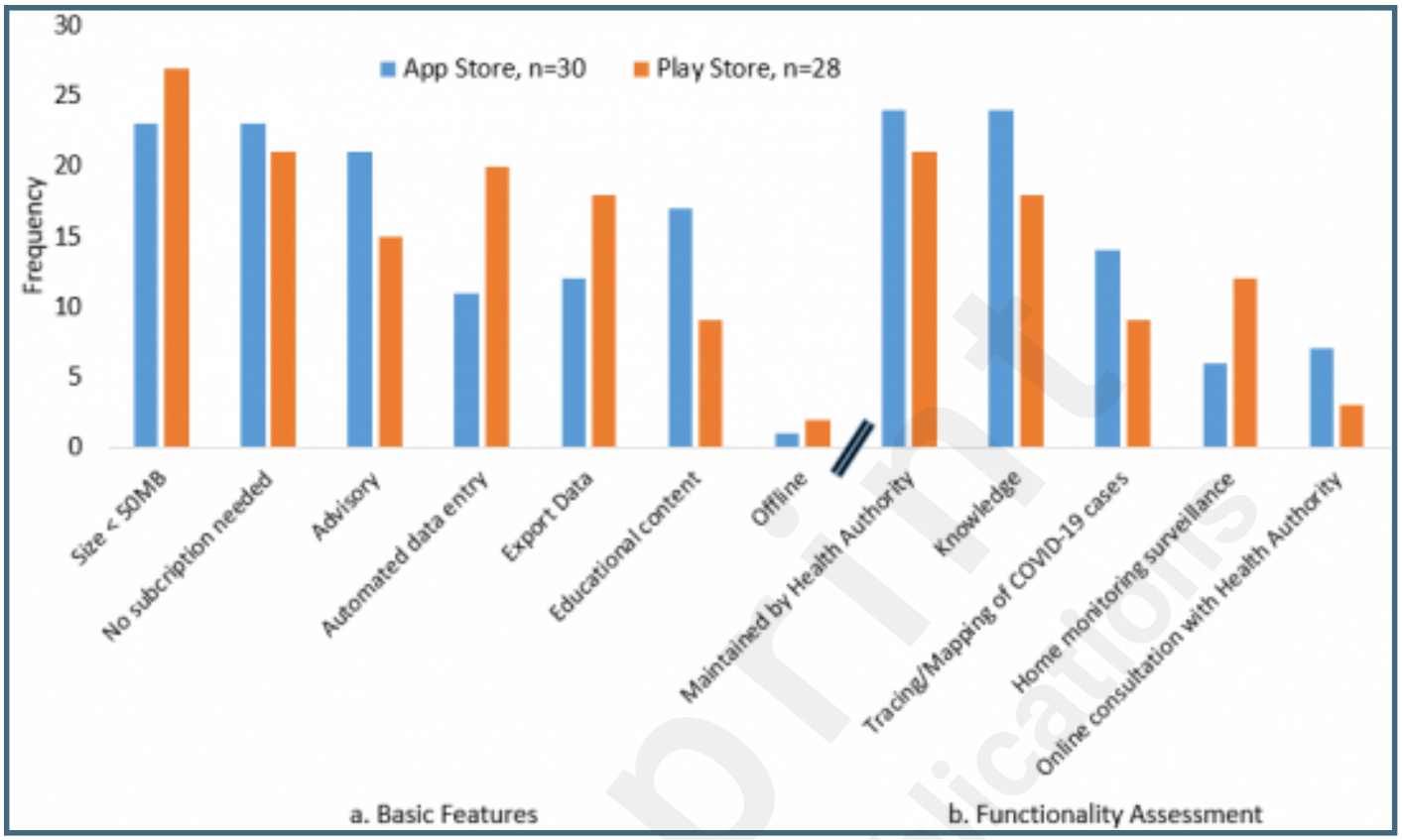
Supplementary Files

Figures

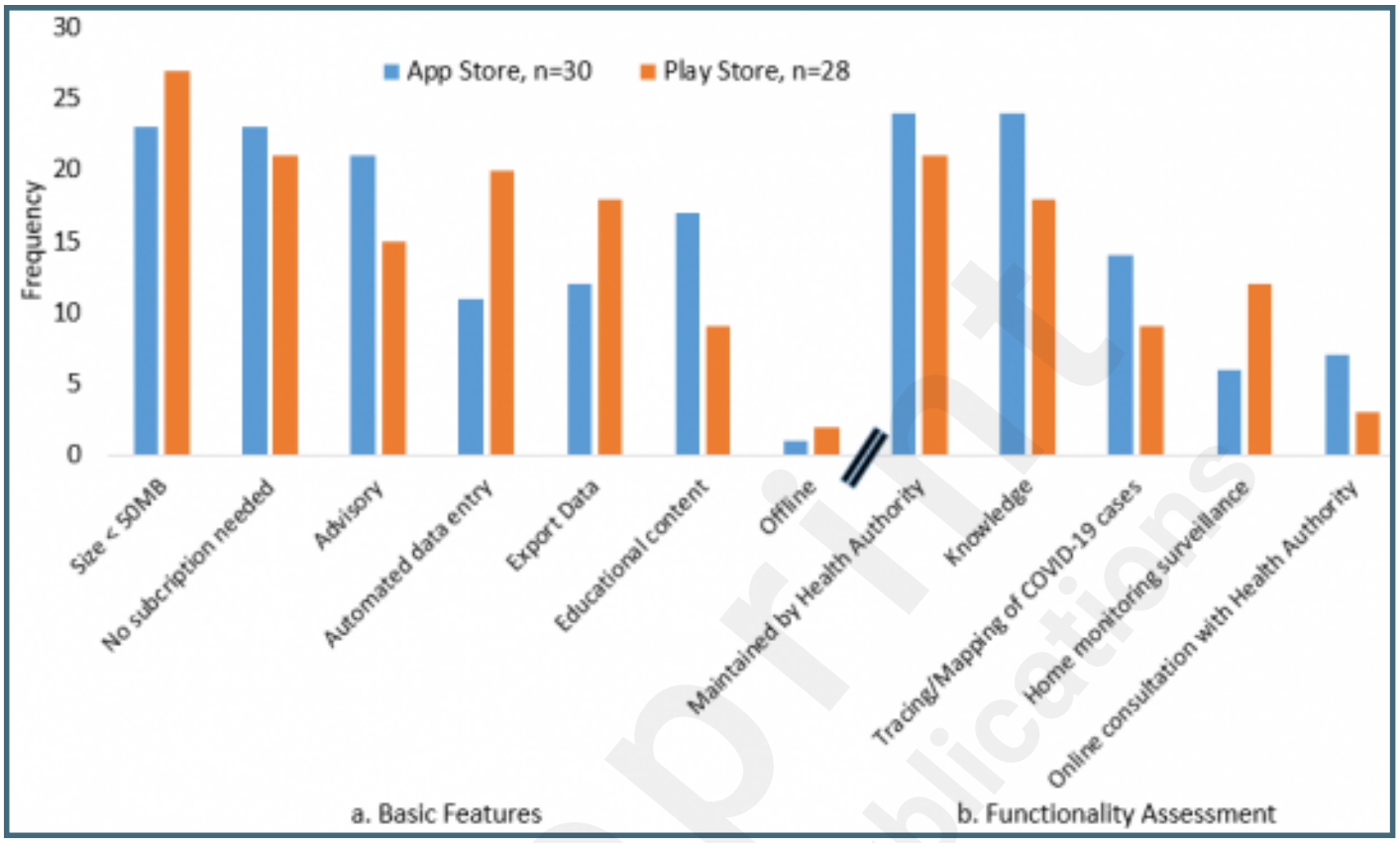
Selection process of mHealth apps in Apple's App Store and Google Play Store.



Assessment of iOS and android-based mobile apps (2a: Basic features; 2b: Functionality assessment).



Total assessment score of iOS and android-based mobile apps (3a: Basic features; 3b: Functionality assessment).



Multimedia Appendixes

Characteristic of mobile medical apps (iOS-based).
URL: http://asset.jmir.pub/assets/73b7db6322793aaa8d7132582d26d23c.docx

Characteristic of mobile medical apps (android-based).
URL: http://asset.jmir.pub/assets/1cc49c0755b4c8160664ed76dac88afd.pdf