Typology-Based Analysis of Covid-19 Mobile Applications: Implications for Patient Empowerment

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Abstract. During COVID-19 pandemic, mobile technology is seen as potential tool for epidemic control and citizens' empowerment. Based on literature, we explore, which are the currently known types of the mobile apps and what implications do the apps have for patient empowerment. There is a need for evidence and an assessment framework to ensure that COVID-19 apps deliver on their promises.

Keywords. COVID-19, mobile application, tracing, remote technologies, empowerment

1. Introduction

During COVID-19 pandemic, mobile technology is being envisioned as potential and ubiquitous tool for authorities' epidemic control. At the same time, mobile technology has potential to provide easily accessible information for the citizens. Targeting those goals, COVID-19-related smartphone, and web-based health applications (*later apps*) are being rapidly developed, leading to a multitude of options, raising ethical and legal challenges and potentially confusing end users. [1, 2]

The increasing presence of technology in health care has created new opportunities for patient engagement and with this, an emerging exploration of patient empowerment within the digital health context. Research gives evidence that there is a linkage between digital health solutions, and patient empowerment, but measurable health outcomes remains yet elusive [3]. Alarmingly, there is currently a lack of real-world evidence for potentially beneficial mobile applications used by citizens and patients during the COVID-19 pandemic for their need of information and support for coping. Health literacy and - in this context - the digital divide are important aspects of empowerment but remaining challenges in this are less discussed even though they may hinder maximizing the potential of mobile tools [4, 5].

Due to a diversity of COVID-19 apps with abundant objectives, it is important to support professionals and the public in identifying the varied types and functionalities of the apps. Additionally, taken that apps promote health-care intervention it is substantive to outline their impact on patient empowerment. Therefore, our research

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questions are: (1) What are the functionalities of currently known types of COVID-19 mobile apps? (2) What implications do the apps have in regard of patient empowerment?

2. Methods

In   this paper, we apply approach of typologies, similar to classifications as useful tools to classify and organise items based on common variables (attribute such as *colour*), where the types are mutually exclusive (e.g., *red* type) and the typology system complete, although in the real world, people tend to disagree of their nature. [6, 7] European Commission (*later EC*) identifies four types of COVID-19 applications based on their services: symptom checkers and self-diagnosis apps, apps for tracking the spread of the coronavirus, apps for delivering trustworthy information and guidelines to public, and apps for supporting homebound patients and enabling self-management. [2] Alternative typology is suggested based on the outcomes of the apps: whether their goal is in societal impact, in personal impact or in density dependence [1].While there is yet little evidence of the apps' outcomes, in this paper, we concentrate on the EC typology based exploration of the COVID-19 apps. Terms for literature searches were composed according to the typology: "Covid-19", "apps", "guideline", "information", "self-diagnosis", "symptom checker", "symptom", "tracking", "tracing", "home", "self-management", "triage", "coping".

In this context, we conceptualize patient empowerment to cover situations where citizens are encouraged to take an active role in the management of their own health [5, 9]. Patient empowerment is a meta-paradigm and it is a broader concept than patient participation and patient-centeredness. [8]

PubMed search in the middle of July 2020 resulted in 28 peer-reviewed papers. When the concept of empowerment was composed with other search terms, it did not result in added papers. After removing duplicates and the first exclusion round based on two researcher reading the abstracts (out of scope, e.g., focus on professionals, not relevant e.g., focus on dark net activities, language) 20 papers were selected for further reading. After full paper reading, additional five of the research papers were excluded as they were out of scope, or focused on professionals. Total of 15 papers were analysed using the EC typology.

3. Results

The first results based on PubMed searches indicate that there is yet little evidence for research of COVID-19 apps and that the terms describing these apps are not well established. Of the types, symptom checkers and self-diagnosis apps resulted in 3 papers, tracing apps 7, apps for information and guidelines 2, and monitoring apps 5 papers, when two papers covered several types of apps.

Results of the apps for symptom checking and triage show that evidence on these kinds of apps is scarce. While numerous apps are available for professionals, patients' perspective remains understudied. [10]. Devising personalized self-testing kits for COVID-19 virus is important because providing real-time testing will facilitate speedy prediagnosis to a large population [11]. Smartphone embedded software and high-performance computing have the potential to be deployed as self-test breathing

monitoring apps. Those with higher risks of severe illness can check their breathing sound pattern frequently through the app [11]. Communication of health needs is of paramount importance when patients are isolated. Usage of alternative digital mental health options such as smartphone apps has increased, thus providing support for empowerment. The wide availability of these resources may promote resilience and well-being on a wider community level as mental health information is disseminated widely and potentially destigmatizes illness while promoting acceptance of digital tools. On turn, developing digital mental health resources without an evidence-based framework might be harmful. [12]

Results of the tracing apps give evidence of potentially useful tools that may be employed to limit disease transmission [1, 13]. Several countries have now started to deploy apps capable of supporting COVID-19 contact tracing, but the efficacy of such apps has yet to be proved. Key functionalities include that apps inform people that they have spent a specific time near someone with the virus. The contacts should then respond according to local rules, for example by self-quarantining themselves immediately [1, 13-17]. These apps are not without concerns from a user perspective and consequently, they may cause limitations for patient empowerment. The topic of user adoption is presented align with privacy concerns, where some users may not be comfortable with an app that tracks their location or has otherwise negative effects on individual privacy. Users may become fatigued from procedures, e.g., scanning QR code, and choose to discontinue. [13, 17] False negative alarms could spur a false sense of safety in others. Moreover, many apps work only with certain phones causing uncertainties for availability. [15]. In turn, an emerging evidence suggests also the app may enable some patients to return more quickly to their lives [18]. In summary, literature evidences that these apps can contribute towards a more general, population level goal but a personal benefit and impact on empowerment is not as evident [1].

Results of the apps for information and guidance illustrate that during the pandemic people have a need for timely information and guidance when they seek for the latest news of the pandemic, check facts when encountering uncertainties, and want to obtain informational guidance for health management. [19] Typically information and guidance can be received autonomously, which supports citizens' self-determination and control, which are close coupled with empowerment. The information content in an app should be reliable and based on current data. [1]

Results of the apps for coping and monitoring at home emphasize necessity to avoid traditional face-to-face visits especially for patients with higher risks, such as elderly, without hampering the quality of care. During COVID-19 pandemic especially outpatient visits have been cancelled or postpone and digital technologies have become a way for accessing remote care. Advances in remote care and monitoring, e.g., via apps enable variety of possibilities for virtual visits, follow-ups, monitoring and consultation. [12, 20-23] At the same time, remote technologies, such as videoconferences, video monitoring and wearable devices, can provide electronic reminders and support in daily activities. Reported advantages of these kinds of apps are improved access and quality of care regardless of location or time, thus prompting full potential of empowerment. [12, 20-21] Reported limitations are technical issues, patients' and caregivers' skills with technology, and ethical concerns related to data privacy. [20] Consequently, while apps can increase agency in self-care and improvement in health, ability to share data captured with the devices back to caregivers remains a challenge, therefore limiting potential patient participation. [22]

4. Discussion

Having applied a structured approach of a typology-based analysis, four types of COVID-19 apps and related functions were identified. Our results show that current development concentrates on two types of apps, namely the apps for tracing and for remote care and monitoring. Taken that the development of the apps has been exceptionally rapid due to pressure set by the ongoing pandemic some compromising ways in developing these apps have inevitably been applied. It should be noted that when developing apps, methods should be backed by scientific evidence. [1] An in-depth analysis of comparison and consideration of the relative benefits and possible harms is required. [18] Structured assessment of already deployed apps is needed [1]. As most apps' use is still at initial stages, their full impact is yet unknown but scientific evidence and assessment would support recognizing their potential. This would illustrate which of the apps are effective and applicable for wider use which is a prerequisite for e.g., tracing apps [1,12,15,16]. To sum up our results, it is obvious that future evidence of COVID-19 digital interventions is urgently needed [19].

Plausible evidence of the types of apps and their implications to empowerment are yet scarce. Although empowerment is being articulated, structures emerging and supporting it are yet mostly unanalyzed. [9]. Research may give evidence how apps advance an emerging view of patient empowerment. Considering the nature of the pandemic as public health threat, we suggest exploring apps' impact on preventive behaviour and empowerment. [19] Especially, as a result of our analysis, the apps as ubiquitous technology supporting equity in care needs further evidence [18]. In the context of empowerment, it is critical to raise the fact that the introduction of new technologies can cause discrimination. This can take the form of bias where technology is available to some but not all. Thus, it is crucial to recognize the importance of equity when deploying apps if patient empowerment is one of the goals. [1,18]

Our approach is subject to some limitations. We wish to highlight a number of factors affecting reliability and validity of research, which deserve attention: the number of apps, the purpose of apps including a possible collection of functions, and an analysis framework for data should be clearly stated also in seminal research. Due to the ongoing situation, preliminary reporting is descriptive and may be selective or biased data. [23] While we applied EC typology for the current apps, different types of apps may dominate when the pandemic situation evolves. Moreover, no established frameworks or terminology is available for analyzing COVID-19 apps and patient empowerment, which is among the recognized development aims in the future.

To conclude, there is a need for evidence of apps' outcomes and their impact on empowerment. An assessment framework to evaluate how COVID-19 apps deliver on their promises should be established. Collaborative initiatives should harness both conventional and novel evidence-based tools to provide an effective and timely response to the COVID-19 pandemic on the global stage. [1, 2, 23]

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