JMIR Publications
The Leading eHealth Publisher

Including the Public in Public eHealth: The Need for Community Participation in the Development of State-Sponsored COVID-related Mobile Apps

Muhammed Yassin Idris, Maya Korin, Faven Araya, Sayeeda Chowdhury, Patty Medina, Larissa Cruz, Trey Hawkins, Humberto Brown, Luz Claudio

Submitted to: JMIR mHealth and uHealth
on: June 01, 2021

Disclaimer: © The authors. All rights reserved. This is a privileged document currently under peer-review/community review. Authors have provided JMIR Publications with an exclusive license to publish this preprint on it's website for review purposes only. While the final peer-reviewed paper may be licensed under a CC BY license on publication, at this stage authors and publisher expressively prohibit redistribution of this draft paper other than for review purposes.

Table of Contents

Preprint JMIR Publications

Including the Public in Public eHealth: The Need for Community Participation in the Development of State-Sponsored COVID-related Mobile Apps

Muhammed Yassin Idris[1, 2] PhD; Maya Korin[1] PhD, MSc; Faven Araya[3] MPH; Sayeeda Chowdhury[1] BA; Patty Medina[1] MPH; Larissa Cruz[1] MPH; Trey Hawkins[1] BS; Humberto Brown[3]; Luz Claudio[1] PhD

[1]Icahn School of Medicine at Mount Sinai New York US
[2]Morehouse School of Medicine Atlanta US
[3]Arthur Ashe Institute for Urban Health New York US

Corresponding Author:
Muhammed Yassin Idris PhD
Morehouse School of Medicine
720 Westview Dr SW
Atlanta
US

Abstract

The rate and scale of transmission of COVID-19 overwhelmed healthcare systems worldwide, particularly in under-resourced communities of color that already faced a high prevalence of pre-existing health conditions. One way the health ecosystem has tried to address the pandemic is by creating mobile apps for telemedicine, dissemination of medical information, and disease tracking. As these new mobile health tools continue to be a primary format for healthcare, more attention needs to be given to their equitable distribution, usage, and accessibility. In this viewpoint collaboratively written by a community-based organization and a health app development research team, we present results of our systematic search and analysis of community engagement in mobile apps released between February and December 2020 to address the COVID-19 pandemic. We provide an overview of apps' features and functionalities but could not find any publicly available information regarding whether these apps incorporated participation from communities of color disproportionately impacted by the pandemic. We argue that while mobile health technologies are a form of intellectual property, app developers should make public the steps taken to include community participation in app development. These steps could include community needs assessment, community feedback solicited and incorporated, and community participation in evaluation. These are factors that community-based organizations look for when assessing whether to promote digital health tools among the communities they serve. Transparency about the participation of community organizations in the process of app development would increase buy-in, trust, and usage of mobile health apps in communities where they are needed most.

(JMIR Preprints 01/06/2021:30872)
DOI: https://doi.org/10.2196/preprints.30872

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**
Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.
Only make the preprint title and abstract visible.
No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**
Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain v
Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <a href="http

Original Manuscript

Preprint
JMIR Publications

Viewpoint

Muhammed Idris, PhD[1, *]; Maya Korin, PhD, MS[1]; Faven Araya, MPH[2] ; Sayeeda Chowdhury, MPH[1]; Patty Medina [1]; Larissa Cruz [1]; Trey Hawkins [1]; Humberto Brown[2]; Luz Claudio, PhD[1]

1. Department of Environmental Medicine and Public Health, Icahn School of Medicine at Mount Sinai, New York, NY 10029
2. Arthur Ashe Institute for Urban Health, Brooklyn, NY, 11203

Including the Public in Public eHealth: The Need for Community Participation in the Development of State-Sponsored COVID-related Mobile Apps

Abstract

The COVID-19 pandemic has overwhelmed healthcare systems worldwide, particularly in under-resourced communities of color with a high prevalence of pre-existing health conditions. Many state governments and healthcare entities responded by increasing their capacity for telemedicine, creating mobile apps for dissemination of medical information, and disease tracking. Our experiences with state-sponsored apps suggest that because many of these eHealth tools did not include community participation, they inadvertently contributed to the widening digital health disparities. We propose that, as eHealth tools continue to expand as a form of healthcare, more attention needs to be given to their equitable distribution, accessibility, and usage. In this Viewpoint collaboratively written by a minority-serving community-based organization and an eHealth academic research team, we present our experience participating in a Community Advisory Board working on the dissemination of the COVID Alert NY mobile app to illustrate the importance of public participation in app development. We also provide practical recommendations on how to involve community representatives in the app development process. We propose that transparency and community-involvement in the process of app development ultimately increases buy-in, trust, and usage of digital technology in communities where they are needed most.

Keywords: mobile apps; COVID-19; CBPR; digital health; eHealth; community health; health disparities

Introduction

Since the start of the COVID-19 outbreak, eHealth tools have been rapidly deployed, including telemedicine, mobile health apps, and wearable technologies [1,2]. These eHealth tools can be used to reduce and monitor disease. However, they may inadvertently resulted in

increasing underlying inequalities by unevenly benefiting individuals who are better able to access new information, adopt technologies early on, and have more resources to pay for these new innovations [3]. As Crawford and Serhal (2020) highlight, "Digital health technologies interact with social, cultural, and economic realities and with social determinants of health to indirectly contribute to health inequity" [2]. Barriers to using eHealth technologies in underserved communities also include a lack of perceived value, limited digital and health literacy, and a lack of relevance [4,5].

Community-based partnerships are key to addressing these social determinants that serve as barriers to closing the digital divide and using technology to promote health equity [6]. In this this Viewpoint, when we refer to community we are distinguishing between a “user” community defined as the client or consumer of a particular technology, platform, or service and the communities (of color) as defined by the collective sector of the public that is disproportionately impacted by health disparities and stand to benefit most affected by use of this technology. The latter is characterized by a shared sense of identity, understanding, or geographical distribution, but may or may not self-select into a user community [7]. As with the adoption of any new product or innovation, involvement of communities throughout the eHealth development process influences awareness of need in underserved communities as well as decisions around initial use, adoption, rejection, and continued use of eHealth innovations [8].

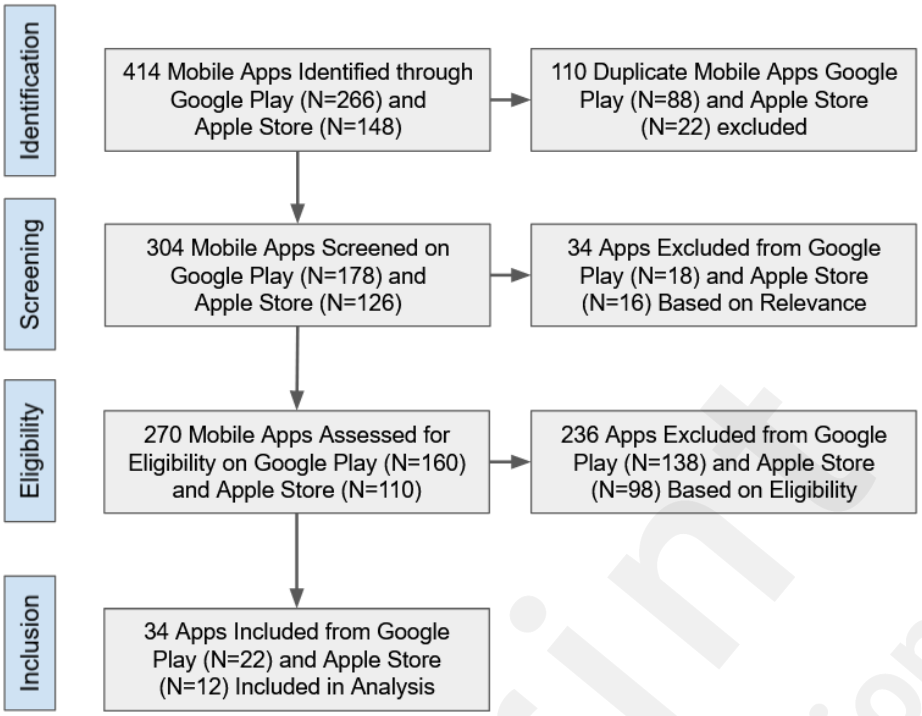
The goal of this Viewpoint is to illustrate the importance of community involvement throughout the development of state-sponsored eHealth apps. We have chosen to focus on state-funded eHealth apps because these are funded by taxpayer dollars and should be responsive to public health needs. In what follows, we first present preliminary data on the proliferation of state-sponsored COVID-19 related Contact Tracing apps between February 26,

2020 and December 31, 2020. We then speak to our experience on the NYC Health and Hospitals' Community Advisory Board during the roll out of the COVID Alert NY mobile app. Our experience shows how community involvement has practical implications on trust and buy-in from community-based organizations and by extension, from communities disproportionately impacted by health inequities. We also provide some practical recommendations for developers for when and how to involve community representatives in their development process.

The Proliferation of State-Sponsored COVID-19 Contact Tracing Mobile Apps

We conducted a systematic search of state-sponsored COVID-19 apps on the Apple App and Google Play stores. We examined all COVID-19 related health apps released between February 26, 2020 and December 31, 2020. Following the methods outlined by Davalbhakta et al. [11], we relied on the following keywords in the Apple App and Google Play Stores: "Covid", "Corona", "Pandemic", "Covid-19", "SARSCOV2", "coronavirus", "2019-nCoV", "Covid-19 tracker", "Stop COVID", "c-19". Two reviewers (TH and SC) screened apps for relevance and eligibility for inclusion, including whether the apps were state-sponsored. Where there was ambiguity or disagreement around relevance and eligibility, review of the app was escalated to the lead investigator (MYI) for adjudication. Figure 1 provides a flowchart outlining our search and selection process.

Figure 1. Selection process of COVID-19 apps from Apple App and Google Play Stores



Following the three most common categories in schemas used in previous publications of COVID-19 apps [10–12], we categorized the apps in our search based on three distinct functionalities: 1) contact tracing/ exposure notification, 2) symptom checking, and 3) information dissemination. Contact tracing and exposure notification functionality allows users to turn on exposure notifications and be alerted when users encounter (anonymous) others who tested positive in their location. Symptom checking allows users to enter symptoms along with some simple answers to questions and reveals options for next steps regarding the likelihood of COVID-19 infection. Information dissemination functionality in eHealth apps focuses on providing facts about the coronavirus disease, good hygiene practices, and guidelines to follow, like social distancing and the importance of wearing facemasks, how to access resources and other types of relevant information.

Thirty-four apps (Apple = 12, Google = 22) met the inclusion criteria. Of them, 12% (N=4) only provided information to users (e.g., suggested resources, updates, and public service announcements delivered through push notifications), 3% (N=1) only collected data from users (e.g., symptom tracker that will determine whether a person may need further

assessment or testing for COVID-19), and 85% (N=29) of apps provided both information and collected data. Forty one percent (N=14) of all apps reviewed included at least one feature for checking COVID-19-related symptoms, 77% (N=26) included functionality around contact tracing and exposure notification, and 50% (N=17) provided some information dissemination functionality. Table 1 shows the apps by category (e.g., checking symptoms, contact tracing/exposure notification, and information dissemination) and Figure 2 provides a visualization of the number of COVID-19 apps released by category between February 2020 and December 2020.

Table 1. List of State-Sponsored COVID-19 Apps by Category

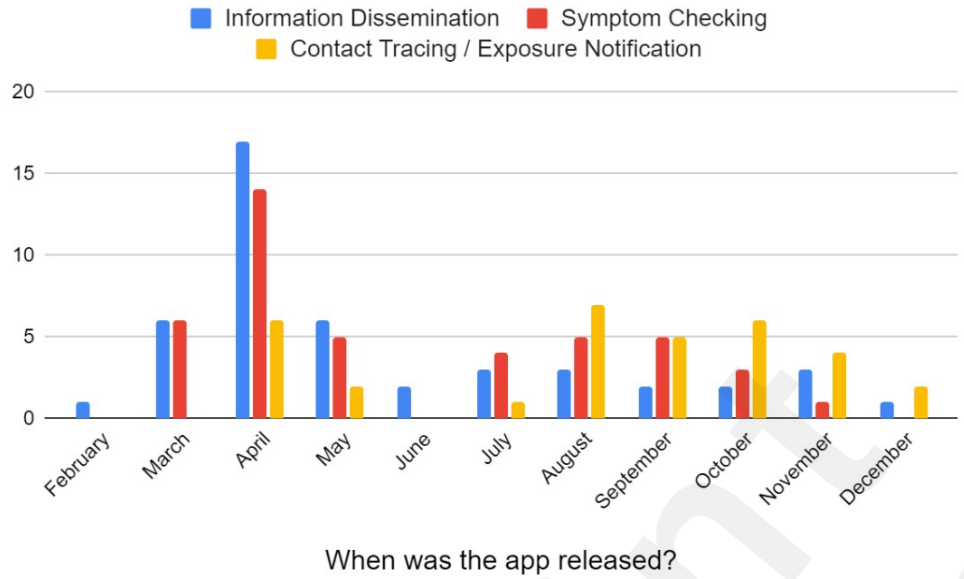
Name of Application	(Approximate) Date Released	iOS/ Android	Contact Tracing/ Exposure Notification	Symptom Checking	Information Dissemination
ABTrace Together	4/1/2020	iOS	✓		
AlohaSafe Alert	11/10/2020	iOS	✓		✓
ArriveCAN	4/21/2020	iOS		✓	
BC COVID-19 Support	5/21/2020	iOS		✓	✓
CA Notify	12/11/2020	Android	✓		
Canada COVID-19 (COVID Alert)	7/30/2020	iOS		✓	✓
Care19 Alert	8/10/2020	Both	✓		
Care19 Diary	4/19/2020	Android	✓	✓	✓
CO Exposure Notification	10/23/2020	Android	✓		
CombatCOVID MDC	8/20/2020	Both	✓		✓
COVID Alert	7/28/2020	Both	✓		
Covid Alert CT	10/30/2020	Android	✓		
Covid Alert DE	9/8/2020	Both	✓	✓	
Covid Alert NJ	9/30/2020	Both	✓	✓	✓
Covid Alert NY	9/30/2020	Both	✓	✓	
Covid Alert PA	9/11/2020	Both	✓	✓	✓
Covid Trace Nevada	8/17/2020	Both	✓	✓	✓
Covid View	12/29/2020	iOS			✓
Covid Watch Arizona	08/17/2020	Both	✓		
COVID-19 Virginia Resources	4/27/2020	Both			✓
Covid-19 Wisconsin Connect	5/14/2020	iOS			✓

Preprint JMIR Publications

Covidaware MN	11/16/2020	Both	✓		✓
CovidWise	8/7/2020	Both	✓		✓
Crush Covid RI	5/15/2020	Both	✓	✓	✓
DC Can	10/23/2020	Android	✓		
GuideSafe	8/11/2020	Both	✓	✓	
Healthy Together	4/1/2020	Both	✓	✓	✓
MD Covid Alert	11/5/2020	Android	✓		
MI Covid Alert	10/1/2020	Both	✓	✓	
NJ COVID 19	3/31/2020	iOS			✓
SlowCovidNC	9/16/2020	Both	✓		
Stronger than C19	4/25/2020	Both		✓	✓
WA Notify	11/25/2020	Android	✓		
WI Exposure Notification	12/20/2020	Android	✓		

Preprint JMIR Publications

Figure 2. Count of Apps Released Overtime by Category



A clear trend emerges where most apps released early in the pandemic were primarily focused on symptom checking and information dissemination. Starting in August 2020, however, we see fewer apps being released overall, but more activity around contact tracing apps. This trend corresponds with the release of many apps by local and national governments utilizing Bluetooth-based exposure notification incorporating a system co-developed by Google and Apple [13]. The technology allows users to turn on exposure notifications and be alerted when users encounter (anonymous) others who tested positive in their location. This collaboration between high tech and public health organizations has been hailed as an exemplar of technology partnership for social good [14]. Yet, little is publicly known about who is using these state-sponsored contact tracing apps.

COVID Alert NY Mobile App as a Case In Point

In New York City there were three entities who played a significant role in the development and dissemination of the COVID Alert NY mobile app: the NY State Department of Health (DOH), NYC Department of Health and Mental Hygiene (DOHMH), and NYC Health + Hospitals (HH), the largest municipal healthcare system in the United States serving almost

500,000 uninsured NYC residents. Despite caution by community-based organizations and advocates early in the pandemic, there was not enough data to document health disparities related to COVID-19 morbidity and mortality [15]. It was clear on the ground that COVID-19 testing sites were not accessible to NYC communities of color [16]. Hesitancy around testing was further amplified by inadequate care where patients of color would, despite showing symptoms, be told that they were fine and sent home on multiple occasions.

Once the data was collected and racial and ethnic disparities became apparent, a NYC Test and Trace community advisory board (CAB) was organized to provide input on COVID-related efforts in New York City in May 2020. The CAB, which meets weekly with city health officials, was organized under the auspices of HH and consisted of 71 members representing a broad range of organizations across all 5 boroughs [17]. The CAB was instrumental in directing where testing sites should be deployed and providing guidance on effective strategies for communicating critical information to community members while addressing language barriers and concerns around health literacy. The CAB also played a vital role in sharing lived experiences of community members to inform and reinforce community-based recommendations.

While the DOHMH and HH were responsive to the CAB's questions, concerns, and counsel around testing, there was no CAB input into the design, development, and dissemination of the COVID Alert NY mobile app for contact tracing and exposure notification which was presented to the CAB in September 2020. Given the government's responsibility for public health, state and local authorities must be responsive to the best interest of their constituents and the public. Recognizing this responsibility, it is therefore essential to establish and implement community-driven processes that incorporate and prioritize the needs and concerns of disproportionately impacted and underserved communities. Our experience at the

grassroots suggests that when there is proper community consultation, what follows is more engagement, usage, and penetration of government-led interventions.

As the epicenter of the pandemic in early 2020, New York City's response to the COVID pandemic was positioned to model community engaged practices that combat health disparities and promote health equity. Community-based organizations and advocates on the CAB expressed concerns around the digital divide and trust in state-sponsored apps within communities of color early in the pandemic. It is important to note here that the release of the Alert NY mobile app was coming off the heal of Public Charge, in which public officials could deny applications for lawful immigration if they determined the applicant has used or will depend on public benefits [18]. The app was developed by the DOH and shared with the CAB to disseminate by DOHMH and HH. Despite expressing concerns around privacy and confidentiality, the CAB were given an app that was developed without community input and being asked to disseminate it without having the ability to incorporate community feedback. As a result of this lack of community-involvement, the CAB was reluctant to endorse or share the COVID Alert NY mobile app within our communities.

A Community-based Participatory Research Approach to Health App Development in with Underserved Communities

COVID-19 mobile app developers must address impediments to eHealth tool utilization among underserved and disproportionately impacted communities, including access, privacy, and confidentiality, poor eHealth literacy, and language barriers [2,19]. There are numerous frameworks for incorporating community input into the research and development of programs to tackle COVID-19 health disparities. One relevant framework is participatory app design, which involves affected stakeholders from the inception of the project in designing solutions that identify and incorporate the community's unique needs into the app

development [20]. Similarly, user-centered designs provide a framework to better understand who users are, their goals, experiences, and expectations to ensure users are kept at the center of the design process [21].

Our work focuses on using a community-based participatory research (CBPR) lens to involve community representatives in eHealth app development. CBPR is a collaborative approach that emphasizes long-term partnerships between communities and academics to ensure equity in each aspect of the research and development process [22,23]. For mobile apps to be able to address health disparities, development should include incorporating communities in the problem definition and design, technical and content development, deployment, evaluation, and dissemination of results to stakeholders.

Unlike participatory and user-centered design, a CBPR approach extends beyond incorporating a community perspective into technology design and aims to ensure equity throughout the entire process of design, development, and deployment [24–28]. These principles include understanding communities' resources and technical capacity, defining interactive processes that are responsive to community needs, equitable decision-making, and building collaboration in the design, development, deployment, and transparency around technology-related outputs, ownership, and maintenance [28]. We expand the principle around technology-related outputs to also include transparency around data collection and use. The goal of CBPR is not only to build something useful, but rather to improve public health through an iterative and sustainable process where communities of color are kept front and center.

Practical Recommendations on When and How to Get Community Involved

Our experience serving on the New York City Test and Trace Community Advisory Board

illustrates how transparency and community-involvement in COVID-19 related apps has practical implications for buy-in from community-based organizations and by extension, from communities disproportionately impacted by COVID-19. Community-based organizations that have the public's trust due to years of work at the grassroots level, especially those representing and serving communities of color, rely on information about the extent to which the communities they serve were involved in the development of eHealth tools to assess whether to promote these solutions within the communities they serve. We recommend that developers work closely with community-based organizations who can serve as trusted public brokers and can help facilitate community involvement in all phases of app development. In the design phase of development process, we recommend that app developers work alongside community-based organizations to:

1. Complete a need-based assessment before/while designing the app.
2. Solicit regular community feedback on low and high-fidelity prototypes.
3. Clearly identify and attribute where community feedback was incorporated

During the development phase, we recommend that developers:

4. Involve community members in the technical development/testing of the app
5. Involve community members in the development/review of content.
6. Conduct a focus group of community members and leaders to demo a prototype and discuss deployment of app.

Finally, for deployment, we recommend:

7. Before the app is deployed, co-create an evaluation plan (with a corresponding logic model) with CBO partner.
8. Once an app is deployed, complete evaluation with involvement of CBO partner involved and present results publicly (i.e., published, presentations).

We also recommend (9) incentivizing involvement by compensating community members for

the opportunity cost of participating in needs-based assessments, focus groups, and program evaluation.

Discussion and Conclusions

While other publications have reviewed COVID-19 related mobile apps, no reviews have considered community-involvement in their design, development, and dissemination. Ming et al provided an overview of features and functionality of 223 mobile health apps released in the early days of the pandemic on public app stores [29]. Salehinejad et al utilized the Mobile App Rating Scale (MARS) to assess the acceptability of quality, content, and functionality of COVID-19 related apps found on the Google Play and Apple App stores [30]. Two other studies reviewed literature to identify COVID-19 apps and reviewed apps ranging from information dissemination and risk/symptom assessment to contact tracing [10,31]. In line with the studies outlined above, we found that the majority of COVID-19 apps focused on symptom tracking, followed by information dissemination, and then contact tracing and exposure notification. Almalki and Giannicchi [32] provide an overview and taxonomy of the COVID-19 apps through September 2020 and found that the majority of app they reviewed were contact tracing and exposure notification apps developed by governments or national authorities. Unlike previous studies, we focused on state-sponsored apps and provided the first comprehensive search of apps through December 2021.

In this Viewpoint we argue that COVID-19-related eHealth tools funded by taxpayer dollars should involve community-based organizations and advocates in the design, development, and dissemination given the government's responsibility for the entire public's health. Community-based organizations assess whether to promote eHealth tools among the communities they serve. In this way, our experiences suggest that transparency and community-involvement in the process of app development increases buy-in, trust, and usage.

As our personal experience illustrates, when affected communities are not included this can lead to a lack of buy-in, trust, and lack of community participation in the diffusion of eHealth innovations among constituents of those communities [21].

López et al [31] argue that in order to "harness its true potential and make the greatest difference, [health information technologies] need to be (1) designed with components that focus on the identification and eliminations of disparities...and (2) tailored to the needs of diverse populations." The authors point to user-centered design as a framework for incorporating communities of color into the design, development, and deployment of mobile health apps to reach more equitable and better health outcomes. However, we encourage researchers and practitioners to use a community-based participatory research (CBPR) lens to incorporate communities of color who are often disproportionately impacted by the COVID-19 pandemic because this approach goes beyond involving individual "users." Rather, this CBPR approach includes the broader community with the goal of improving public health and enhancing community capacity by supporting participation and establishing sustainable programs.

A lack of input at every step of the eHealth tool development process by communities of color contributes to bias. That is, small choices made throughout design, development, dissemination have a large collective impact on perceptions of adopters in underserved communities of the relative advantage, compatibility with values and experiences, complexity of use, and the extent which eHealth tools can be tested or provides tangible benefits [33]. When technology is not designed around the needs, expectations, values, and experiences of individual users this can lead to a lack of adoption. Within the context of eHealth, this lack of inclusive design results in a lack of diffusion of these innovations within underserved communities, which ultimately exacerbates health disparities [34]. If we truly recognize that

health disparities exist, we must prioritize ensuring that underserved communities feel comfortable with eHealth apps in order realize their full potential.

Acknowledgments

This work was supported by the Institute for Exposomic Research and pilot funding from the Transdisciplinary Center on Early Environmental Exposures's (TCEEE) Pilot Project Program Grant P30ES023515. It was also funded by grants 5R25HL108857 and 5T37MD001452. Thank you also to Walter Ramos for expert administrative support.

Conflicts of Interest

None declared.

References Cited

1. Keesara S, Jonas A, Schulman K. Covid-19 and Health Care's Digital Revolution. New England Journal of Medicine Massachusetts Medical Society; 2020 Jun 4;382(23):e82. PMID:32240581
2. Crawford A, Serhal E. Digital health equity and COVID-19: The innovation curve cannot reinforce the social gradient of health [Internet]. Journal of Medical Internet Research. JMIR Publications; 2020 [cited 2020 Dec 13]. p. e19361. PMID:32452816
3. Timmermans S, Kaufman R. Technologies and Health Inequities. https://doi.org/101146/annurev-soc-121919-054802 [Internet] Annual Reviews ; 2020 Jul 30 [cited 2021 Aug 27];46:583–602. [doi: 10.1146/ANNUREV-SOC-121919-054802]
4. Christopher Gibbons M. Use of health information technology among racial and ethnic underserved communities. Perspectives in health information management / AHIMA, American Health Information Management Association [Internet] Perspect Health Inf Manag; 2011 [cited 2021 May 9];8(Winter). PMID:21307989
5. WH P, L F. When does personalized feedback make a difference? A narrative review of recent findings and their implications for promoting better diabetes self-care. Current diabetes reports [Internet] Curr Diab Rep; 2015 Aug 17 [cited 2021 Aug 17];15(8). PMID:26077015
6. Ginossar T, Nelson S. Reducing the health and digital divides: A model for using community-based participatory research approach to e-health interventions in low-income hispanic communities. Journal of Computer-Mediated Communication [Internet] John Wiley & Sons, Ltd; 2010 Jul 1 [cited 2021 May 31];15(4):530–551. [doi: 10.1111/j.1083-6101.2009.01513.x]
7. Hiller ET. The Community as a Social Group. American Sociological Review SAGE Publications; 1941 Apr;6(2):189. [doi: 10.2307/2085549]
8. Robertson TS. The Process of Innovation and the Diffusion of Innovation. Journal of Marketing SAGE Publications; 1967 Jan;31(1):14. [doi: 10.2307/1249295]
9. Davalbhakta S, Advani S, Kumar S, Agarwal V, Bhoyar S, Fedirko E, Misra DP, Goel A, Gupta L, Agarwal V. A Systematic Review of Smartphone Applications Available for Corona Virus Disease 2019 (COVID19) and the Assessment of their Quality Using the Mobile Application Rating Scale (MARS). Journal of Medical Systems [Internet] Springer; 2020 Sep 10 [cited 2021 Apr 20];44(9):164. [doi: 10.1007/s10916-020-01633-3]
10. Kondylakis H, Katehakis DG, Kouroubali A, Logothetidis F, Triantafyllidis A, Kalamaras I, Votis K, Tzovaras D. COVID-19 Mobile Apps: A Systematic Review of the Literature. Journal of Medical

Internet Research [Internet] JMIR Publications Inc.; 2020 Dec 1 [cited 2021 Aug 27];22(12). PMID:33197234
11. LC M, N U, NA A, N O, N K, CS T, KW G, PW N, YM A-W, KS L, HP G. Mobile Health Apps on COVID-19 Launched in the Early Days of the Pandemic: Content Analysis and Review. JMIR mHealth and uHealth [Internet] JMIR Mhealth Uhealth; 2020 Sep 1 [cited 2021 Aug 27];8(9). PMID:32609622
12. H JLS, D C, K Y. Mobile Health Apps That Help With COVID-19 Management: Scoping Review. JMIR nursing [Internet] JMIR Nurs; 2020 Aug 6 [cited 2021 Aug 27];3(1):e20596. PMID:32897271
13. Privacy-Preserving Contact Tracing [Internet]. [cited 2021 Aug 23]. Available from: https://covid19.apple.com/contacttracing
14. Google and Apple Change Tactics on Contact Tracing Tech | WIRED [Internet]. [cited 2021 Aug 23]. Available from: https://www.wired.com/story/google-apple-change-tactics-contact-tracing-tech/
15. Opinion | The Pandemic's Missing Data - The New York Times [Internet]. [cited 2021 Aug 24]. Available from: https://www.nytimes.com/2020/04/07/opinion/coronavirus-blacks.html
16. Grigsby-Toussaint DS, Shin JC, Jones A. Disparities in the distribution of COVID-19 testing sites in black and Latino areas in new York City. Preventive Medicine Academic Press; 2021 Jun 1;147:106463. [doi: 10.1016/J.YPMED.2021.106463]
17. Test & Trace Corps – Community Partnerships | NYC Health + Hospitals [Internet]. [cited 2021 Aug 24]. Available from: https://www.nychealthandhospitals.org/test-and-trace/community-partnerships/
18. KM P, H Y, J O. A New Threat to Immigrants' Health - The Public-Charge Rule. The New England journal of medicine [Internet] N Engl J Med; 2018 Sep 6 [cited 2021 Aug 24];379(10):901–903. PMID:30067441
19. Vonholtz LAH, Hypolite KA, Carr BG, Shofer FS, Winston FK, Hanson CW, Merchant RM. Use of mobile apps: A patient-centered approach. Academic Emergency Medicine Blackwell Publishing Inc.; 2015 Jun 1;22(6):765–768. PMID:25998446
20. Spinuzzi C. The Methodology of Participatory Design. Society for Technical Communication;
21. Abras C, Abras C, Maloney-krichmar D, Preece J. User-Centered Design. IN BAINBRIDGE, W ENCYCLOPEDIA OF HUMAN-COMPUTER INTERACTION THOUSAND OAKS: SAGE PUBLICATIONS [Internet] 2004 [cited 2021 Apr 27]; Available from: http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.94.381
22. Community-Based Participatory Research for Health: Advancing Social and Health Equity, 3rd Edition | Wiley [Internet]. [cited 2021 Apr 27]. Available from: https://www.wiley.com/en-us/Community+Based+Participatory+Research+for+Health%3A+Advancing+Social+and+Health+Equity%2C+3rd+Edition-p-9781119258872
23. Wallerstein NB, Duran B. Using Community-Based Participatory Research to Address Health Disparities. Health Promotion Practice [Internet] Health Promot Pract; 2006 [cited 2021 Apr 27];7(3):312–323. PMID:16760238
24. Israel BA, Schulz AJ, Parker EA, Becker AB. Review of community-based research: Assessing partnership approaches to improve public health [Internet]. Annual Review of Public Health. Annual Reviews 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, USA ; 1998 [cited 2021 Mar 29]. p. 173–202. PMID:9611617
25. Doty JL, Brady SS, Popelka JM, Rietveld L, Garcia-Huidobro D, Doty MJ, Linares R, Svetaz MV, Allen ML. Designing a mobile app to enhance parenting skills of latinx parents: a community-based participatory approach. JMIR Formative Research [Internet] JMIR Publications; 2020 Jan 1 [cited 2021 Mar 29];4(1):e12618. [doi: 10.2196/12618]
26. Vangeepuram N, Mayer V, Fei K, Hanlen-Rosado E, Andrade C, Wright S, Horowitz C. Smartphone ownership and perspectives on health apps among a vulnerable population in East Harlem, New York. mHealth 2018; [doi: 10.21037/mhealth.2018.07.02]
27. Brewer LPC, Hayes SN, Caron AR, Derby DA, Breutzman NS, Wicks A, Raman J, Smith CM, Schaepe KS, Sheets RE, Jenkins SM, Lackore KA, Johnson J, Jones C, Breitkopf CR, Cooper LA,

Patten CA. Promoting cardiovascular health and wellness among African-Americans: Community participatory approach to design an innovative mobile-health intervention. PLoS ONE [Internet] Public Library of Science; 2019 Aug 1 [cited 2021 Apr 27];14(8). PMID:31430294

28. Unertl KM, Schaefbauer CL, Campbell TR, Senteio C, Siek KA, Bakken S, Veinot TC. Integrating community-based participatory research and informatics approaches to improve the engagement and health of underserved populations. Journal of the American Medical Informatics Association [Internet] Oxford University Press; 2016 Jan 1 [cited 2021 Apr 27];23(1):60–73. PMID:26228766
29. Ming LC, Untong N, Aliudin NA, Osili N, Kifli N, Tan CS, Goh KW, Ng PW, Al-Worafi YM, Lee KS, Goh HP. Mobile health apps on COVID-19 launched in the early days of the pandemic: Content analysis and review [Internet]. JMIR mHealth and uHealth. JMIR Publications Inc.; 2020 [cited 2021 Apr 27]. PMID:32609622
30. S S, SR NK, S HG, K B, F F. A review and content analysis of national apps for COVID-19 management using Mobile Application Rating Scale (MARS). Informatics for health & social care [Internet] Inform Health Soc Care; 2021 [cited 2021 Aug 27];46(1):42–55. PMID:33164594
31. John Leon Singh H, Couch D, Yap K. Mobile Health Apps That Help With COVID-19 Management: Scoping Review. JMIR Nursing [Internet] JMIR Publications Inc.; 2020 Aug 6 [cited 2021 Apr 27];3(1):e20596. [doi: 10.2196/20596]
32. M A, A G. Health Apps for Combating COVID-19: Descriptive Review and Taxonomy. JMIR mHealth and uHealth [Internet] JMIR Mhealth Uhealth; 2021 Mar 1 [cited 2021 Aug 27];9(3). PMID:33626017
33. Kaminski J. Diffusion of Innovation Theory [Internet]. Canadian Journal of Nursing Informatics. 2011 [cited 2021 Aug 23]. Available from: https://cjni.net/journal/?p=1444
34. A. Moore G. Crossing the Chasm, 3rd Edition: Marketing and Selling Disruptive Products to Mainstream Customers. Harper Business [Internet] HarperCollins; 2014 [cited 2021 Aug 23];288. Available from: https://www.degruyter.com/document/doi/10.1515/9780824891831-001/html

Preprint JMIR Publications

Supplementary Files

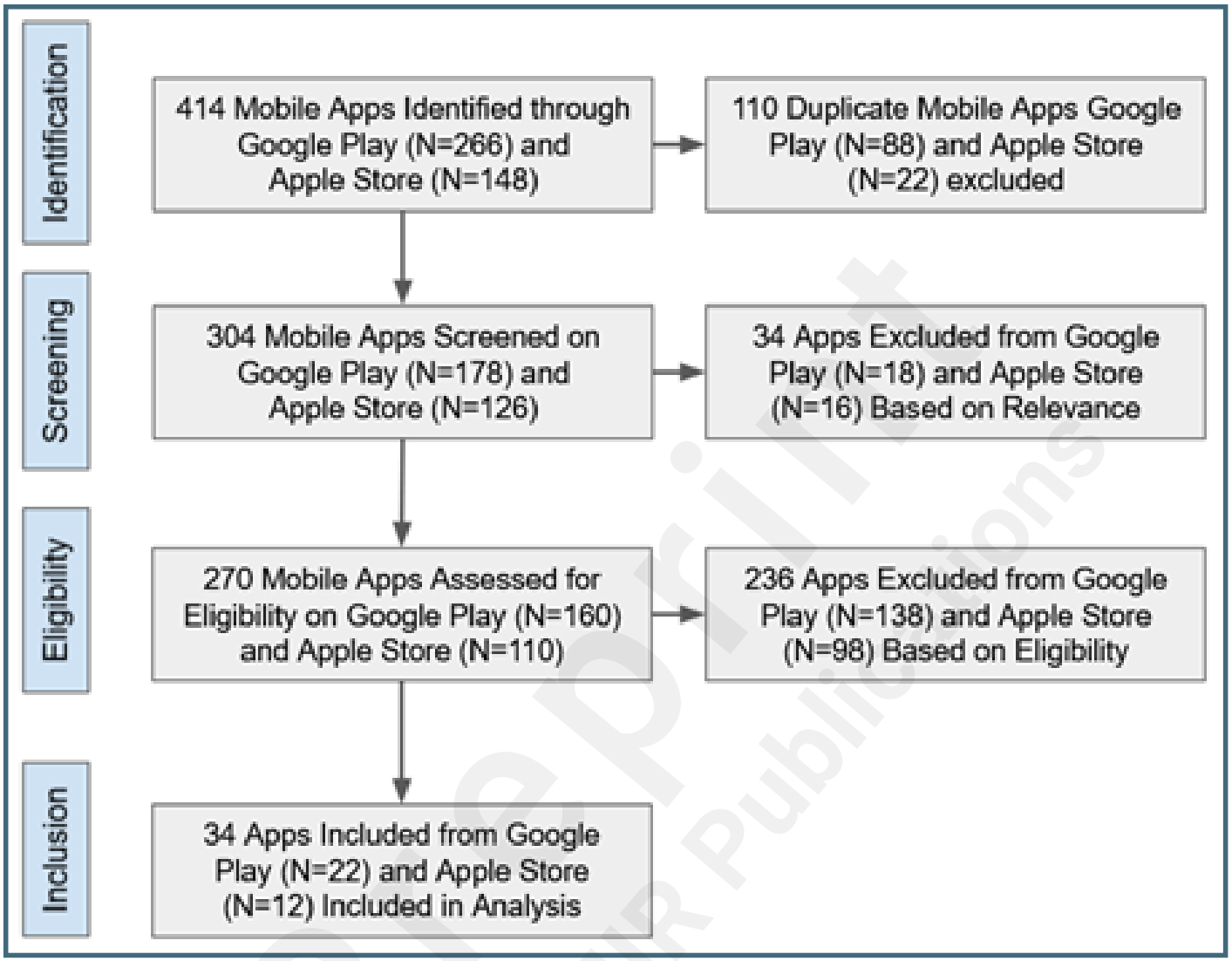
Responses to Reviewer Comments.
URL: http://asset.jmir.pub/assets/84042453090bdf92a830b281615edbcf.docx

Preprint JMIR Publications

Figures

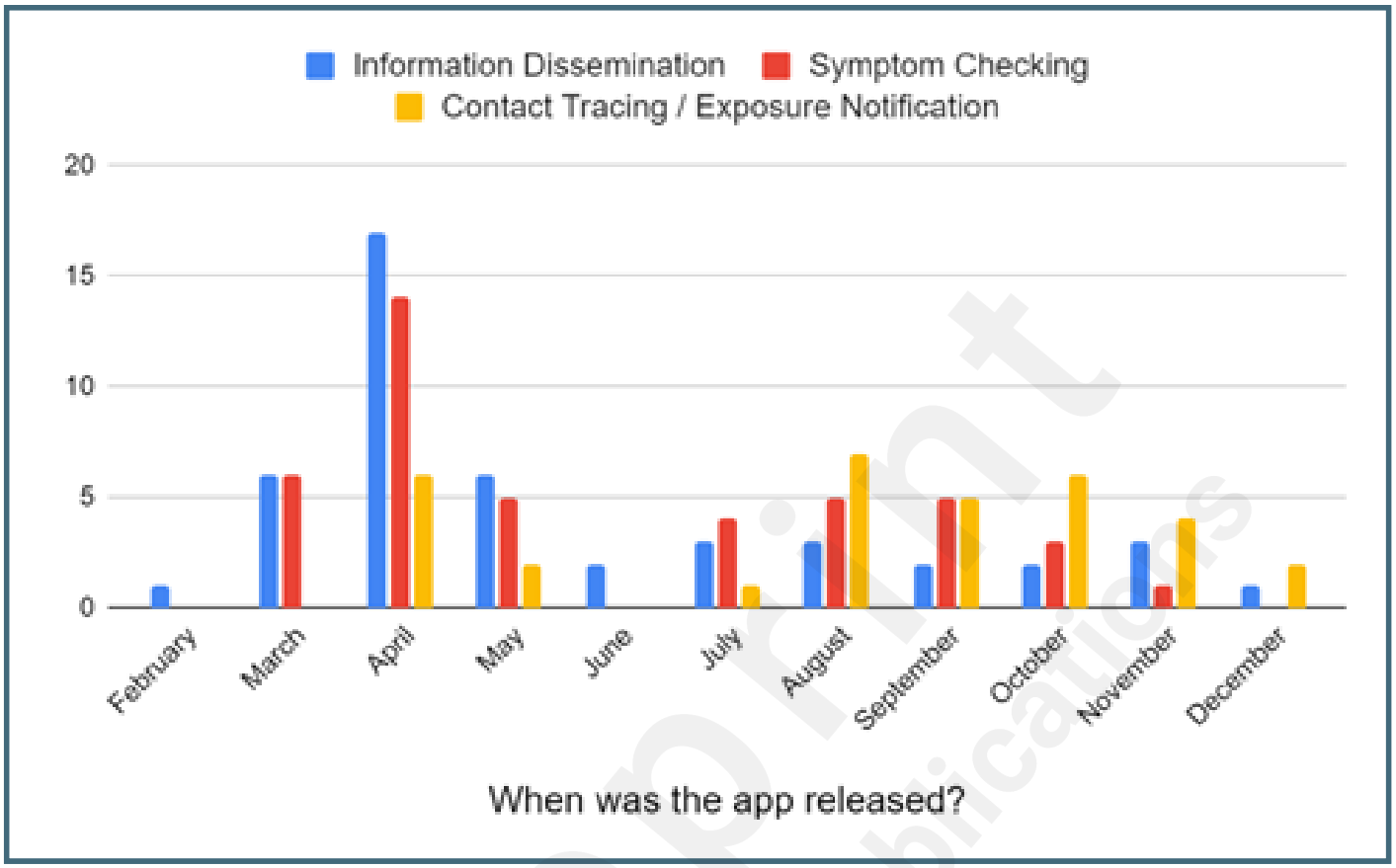
Preprint JMIR Publications

Untitled.



Preprint JMIR Publications

Untitled.



Preprint JMIR Publications

Multimedia Appendixes

Preprint JMIR Publications

List of State-Sponsored COVID-19 Apps by Category.
URL: http://asset.jmir.pub/assets/8c1357ffd79c0ee5c356011190627388.xlsx

Preprint JMIR Publications