Contact Tracing Mobile Applications in New York: A Qualitative Study on the Use and Privacy Perceptions

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ABSTRACT

Contact tracing mobile applications were used in several countries as the exclusive means of reducing the spread of the COVID-19 virus. In the United States (US), such mobile applications were not nationwide; several states adopted and developed mobile applications for use by the local citizenry. Previous research indicated that the use and adoption of such applications might be correlated to individual demographics. Using the Antecedent Privacy Concerns and Outcomes (APCO), this study assesses individuals' use, adoption, and privacy considerations when using the contact tracing mobile application in New York State. **F**ocus group participants were interviewed to determine if age or race/ethnicity were confounding factors related to their use of these mobile applications. This qualitative study will contribute to the body of knowledge by operationalizing and expanding on the APCO model to further understand the service, privacy, and perception of mobile apps used during COVID-19.

Keywords

COVID-19, race and ethnicity, age, contract tracing, mobile apps

INTRODUCTION

Contact tracing is heralded as one of the most important means of mitigating the spread of infectious diseases. During the COVID-19 global pandemic, contact tracing became an immense undertaking requiring data from every region, country, and local municipality. One of the technological innovations developed during COVID was mobile application-based (or app-based) contact tracing. However, the use of mobile applications involves a level of buy-in from the public. It is only as useful as the number of people willing to download the app and use it appropriately. In some countries, use was mandated and enforced. In the United States, the use of app-based contact tracing was largely voluntary. Previous research indicated several concerns regarding adoption, use, and privacy at the personal level, which was correlated to individual demographics (especially in countries where use was not mandatory). The United States has some of the most diverse populations of any country and places constitutional value on personal rights. This dynamic likely had an impact on the adoption, use, and privacy concerns of app-based contact tracing in the United States. This study aims to assess the use, adoption, and privacy considerations individuals had in one of the states that deployed app-based contact tracing, New York. A qualitative approach, focus group interviews, was undertaken to gather an in-depth exploration of the acceptance of app-based contact tracing.

BACKGROUND

Countries and corporations developed mobile applications to assist (or primarily for SARS-CoV-2 contact tracing). SARS-CoV-2 stands for severe acute respiratory syndrome coronavirus 2; it was the virus responsible for the infectious disease during the COVID-19 pandemic (Zoppi 2020). For example, Singapore, China, and

Switzerland have developed apps to track the spread in their countries (Cho et al. 2020; Glauser et al. 2022; Villius Zetterholm et al. 2021). In some cases, regional apps were developed for use in several countries, such as the United Kingdom and the Pan-European initiative (Kaya 2020; Kolasa et al. 2021). Corporations such as Google and Apple collaborated to create the Exposure Notification App, which was available for use on Apple and Android phones. However, in the United States, no such app existed nationwide through the government system. Instead, certain states took on such initiatives alone and promoted the apps within their borders. At least 19 states, and three territories, developed contact tracing apps (Sato 2020). Not all the state-developed apps are connected with each other, nor do they all work the same way. Some, however, did connect with the Google/Apple collaborative app Exposure Notification.

Contact tracing apps

From previous research, many of the concerns about app-based contact tracing were related to the privacy of sensitive personal data (Boudreaux et al. 2020; Cho et al. 2020; Colizza et al. 2021; Fox et al. 2021; Kolasa et al. 2021; Villius Zetterholm et al. 2021). These concerns may have resulted in the reduction of contact tracing effectiveness. Spreading awareness about privacy-protected mobile applications could help to make these apps effective (Andreoletti et al. 2021). The efficacy of these apps was directly related to widespread use, and privacy measures help boost the use of these apps. Location-based technology, like GPS, was shown to be more epidemiologically effective over Bluetooth to contact-trace infected and exposed individuals (Kaya 2020).

Contact tracing apps were a vital aspect of informing individuals of exposure and notifying them of a need to test or quarantine, but the frequency and accuracy of their use depend heavily on public acceptance and perception (Villius Zetterholm et al. 2021). An effective contact tracing application is defined by one simple concept: the proper balance between data protection and public health interests. Users of the app needed to feel that their data was secure and protected, but the app also needed a substantial amount of information regarding exposure to ensure that the contact tracing application would benefit public health (Kolasa et al. 2021). Proper epidemiological evaluation of contact tracing relied on five factors: integration with local health policy, higher user uptake and adherence, quarantine of infectious people as accurately as possible, rapid notification, and the ability to evaluate effectiveness transparently (Colizza et al. 2021). A sociological analysis of contact tracing apps in Ireland found that there were three main stages to acceptance: adoption intention, willingness to use, and usage intention (Fox et al. 2021). At least one study found that declined use of contact tracing apps related to the refusal of COVID vaccination (Caserotti et al. 2022).

Apps like these often involve the exchange of mobile phone numbers between infected and exposed individuals, which is not protective of personal data (Cho et al. 2020). Societal perception and culture play a role in the data models used. North American and European apps tend to be more decentralized, while they tend to be more centralized in Eastern and Asian nations due to the culture around privacy (Kaya 2020). Privacy measures also prevent the government from using personal information obtained from contact tracing apps as a means to coerce people, especially racial, religious, and ethnic minorities who already suffer from public health events like COVID at disproportionate rates (Boudreaux et al. 2020).

Marginalized racial groups are more situationally prone to contract COVID-19, meaning that these people often find themselves in more hazardous situations at a higher rate (such as being "essential" workers or in overcrowded low-income housing), which increases their chances of catching the virus (Hendl et al. 2020). Studies have shown that racialized groups are more prone to scrutiny and have greater consequences when it comes to the adaptation of digital technologies (Hendl et al. 2020). The potential danger of tracking COVID status by social or demographic groups by unwanted entities (government agencies, law enforcement, or private corporations) could increase the marginalization of underrepresented groups (who have already been proven to suffer from COVID at disproportionate rates) (Redmiles 2020). It was proposed that developers investigate the usability of technology across different groups, their effectiveness, and how that could potentially help eliminate or perpetuate social inequalities (Redmiles, 2020).

However, younger, more educated, and wealthier individuals seemed to accept contact tracing apps at a higher rate which deepens the existing health disparities among populations. Overall trust in the government, privacy concerns, social responsibility, perceived health threat, experience with technologies, performance expectancy, and perceived benefits, understanding, and intention-action gap all factored into the different rates of acceptance of contact tracing applications based on demographics (Villius Zetterholm et al. 2021).

Reviews of CTAs of many different countries on the Apple App Store and the Google Play Store have shown that tech malfunctions and battery drainage have discouraged the use of contact tracing apps. Although, privacy concerns were reported across all 13 apps steadily at 2% for each (Elkhodr et al. 2021).

This study focuses on the use, perception, and privacy considerations of the New York State COVID AlertNY contact tracing app by individual age and race. Based on previous studies, our research questions were:

RQ1: How does the perceived usefulness of mobile apps for COVID-19 contact tracing differ by age? Race?

RQ2: How do privacy and security concerns influence the adoption of COVID-19-related mobile apps? Are there differences in age? Race?

To investigate these questions, this qualitative study developed semi-structured focus group interviews using the antecedent privacy concerns and outcomes (APCO) framework as a guide for the study instrument.

Antecedent Privacy Concerns and Outcomes (APCO) Model

The APCO macro model by Smith, Dinev, and Xu (2011) introduced relationships among privacy factors, categorized as antecedents, privacy concerns, and outcomes at various levels of analysis. Privacy concern measures individuals' perceptions, attitudes, and beliefs concerning the disclosure of their personal information (Smith et al. 2011). Antecedents are personal characteristics or factors that arise from situations involving the disclosure of personal information (Smith et al. 2011). Individual-level APCO antecedents are privacy experiences, privacy awareness, personality, and demographic differences. In at least one case, the APCO was expanded to include cultural values (Buck et al. 2022). The APCO framework captures individual-level outcomes as behavioral reactions, including willingness to disclose personal information (Bansal et al. 2016). Other individual-level outcomes are trust and the privacy calculus theory, which examines individuals' cost-benefit analysis decision-making process involving personal information disclosure (Li 2012; Xu et al. 2009). Where trust is often found as one of the most important considerations (Buck et al. 2022). Figure 1 offers a high-level view of relevant individual-level APCO factors.

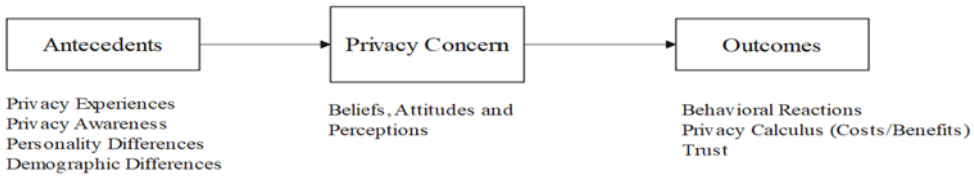

Figure 1. High-level Overview of Individual-level APCO Macro Model Factors [source: Jia et al., 2015]

The paper is organized to include the methodology of the study (including participant recruitment, interview guide, and analysis procedure). The findings from the focus group interviews are presented to highlight the privacy concerns and outcomes (behavioral intentions, trust, and privacy calculus) of the participants. Where recruitment was segmented by their demographic differences, and their private experiences and awareness were gleaned from responses. The implications of the findings are discussed to explain answers to our research questions and highlight other interesting results. Finally, the conclusion of this paper acknowledges the contribution to science.

METHODOLOGY

Focus groups have been used throughout social science and applied fields (Morgan and Krueger 1993; Stewart and Shamdasani 2014) and have been defined as the research technique by which data is collected from group interaction on a topic determined by the investigator (Stewart and Shamdasani 2014).The structured discussions tend to consist of between 6 to 10 participants (Morgan and Krueger, 1993). This size gives each participant more time to discuss her or his views and experiences on topics and makes it easier for moderators to manage active discussions. Focus groups have been used for needs assessment and strategic planning, where studies have used this technique to better understand knowledge, attitude, and practice with regard to a specific topic. The discussion in focus groups is more than the sum of separate individual interviews; it is the fact that the participants both query each other and explain themselves to each other. Segmenting the focus group participants builds a comparative dimension and facilitates discussion among more similar participants. Segmentation is a long-standing practice to capture conscious variation among the compositions of the groups; participants have been segmented by age, sex, marital status, geographic location, job title, or something specific to the research topic (Freeman 2006).

Given previous study findings about perceived usefulness and privacy concerns related to mobile applications, the focus groups will be segmented by age and self-identified racial and ethnic background, see Table 1. Each focus group will consist of 6-8 participants, and we had a total of 16 focus groups (separated by age and self-identified racial/ethnic group). The small size of the group gives each participant more time to discuss, making it easier for the moderator to manage active discussions. All interviews took place virtually using Zoom video conferencing software.

Table 1: Focus group participants by race and age segmentation

	Age Ranges					
	18-24	25-34	35-44	45-54	55 +	Total
Asian	8	1	2	1		12
Black/AA	6	4	7		5	22
H/L*	7	6	2	1		16
White	6	1	6			13
Other	1	1				2
Total	29	13	16	2	5	65

In Table 1, the Hispanic/Latino population is included as a separate category and is only included in the count once. Some people in this category may also self-identify as another race; however, they would have been included only in the Hispanic/Latino category.

This study was approved by the University at Albany, SUNY, Institutional Review Board (IRB). An IRB is an administrative group that reviews research study proposals to assess protections for the rights of participating human subjects. IRBs are convened in most institutes of higher learning (IHEs) and in some government facilities. The IRB approval number for this exempt research is 22X036.

Participants

It is sometimes impossible to obtain data or information from the entire population while undertaking research that targets specific demographics (Etikan et al. 2016; Stratton 2021). Convenience sampling is a non-probability sampling technique in which people of the target population are chosen for the study's purpose based on specific practical characteristics such as geographical closeness, availability at a specified time, ease of access, or desire to volunteer (Bujang et al. 2012; Dornyei 2007; Taherdoost 2016). It also describes population study subjects conveniently available to the researcher (Bujang et al. 2012; Given 2008). The primary goal of convenience sampling is to obtain information from participants freely accessible to the researcher (Etikan et al. 2016). sampling is widespread because it is less expensive, takes less time than other sampling procedures, and is simple. It helps generate a prospective hypothesis or study objective. (Farrokhi and Mahmoudi-Hamidabad 2012; Sedgwick 2013; Taherdoost 2016).

Investigators used this sampling method to ask colleagues to share the recruitment flyer at NY state universities, including The City University of New York (CUNY), the University at Buffalo, the State University of New York, the University at Albany, SUNY, and Syracuse. Additionally, the recruitment flyer was shared with partnering research centers and community partners such as the Center for the Elimination of Health Disparities (CEMHD), The Center for Social and Demographic Analysis (CDSA), and EAD & Associates. Furthermore, a few social media platform groups, including Black Ladies in Public Health, Center for Social and Demographic Analysis (CDSA), and Twitter contacted by investigators. Participants also shared information about recruitment, extending to a snowball method.

The snowball sampling method is a recruitment approach in which researchers ask participants who have already been sampled to recommend other prospective participants for a study (Johnson 2014; “Snowball Sampling” 2012). This unique approach of convenience sampling is frequently employed when a researcher foresees challenges in reaching, assembling, and engaging study participants of an often hard-to-reach population because of its networking properties and recommendation (Cohen and Arieli 2011; Handcock and Gile 2011; Johnson 2014; Valdez and Kaplan 1998). Therefore, snowball sampling is beneficial when conducting research in underserved social groups and increases the researcher's pool of potential participants by utilizing the social networks of interviewees (Cohen and Arieli 2011).

The recruitment flyer specified eligibility criteria for prospective participants for the focus groups. Participants were required to be at least 18 years of age or older, live, work, or attend school in New York State, and have English language fluency. All applicants who did not satisfy any of the eligibility criteria were automatically excluded from being potential participants in the study. Prior to the focus group interviews, participants were asked to fill out an optional demographic questionnaire, in which we captured their gender. The demographic information of our participants is included in Table 2.

Table 2: Demographic information for participants

		N	%
Race/Ethnicity	Asian	12	18%

	Black/African American	29	45%
	Hispanic/Latino*	15	25%
	White	18	27%
	Other	5	8%
Gender	Female	26	40%
	Male	25	38.5%
	Other	2	3%
	Did not respond	12	18.5%

As shown, our participants included nearly an equal amount of male and female participants (~40%), as determined by those who filled out the demographic questionnaire. This table also shows the true distribution of participants according to their race and ethnicity. The Hispanic/Latino category is noted with an asterisk because individuals who self-identified as a race and an ethnicity were counted twice here. For example, some may have identified as Black and Hispanic or White and Hispanic. Where this occurred, the numbers for the race categories will be higher than in Table 1 for the focus group segmentation.

Interview Guide

A semi-structured interview was employed during the focus group discussions. A semi-structured interview consists of predetermined, open-ended questions that stimulate interviewees' candid and in-depth answers (Ryan et al. 2009). As a data collection strategy, a semi-structured interview consists of several steps, including creating an interview guide, conducting the interview, and analyzing the interview data (Bloomberg and Volpe 2018; Rubin and Rubin 2011). An interview guide, a diagrammatic presentation of issues or questions that the interviewer should examine, is the basis for semi-structured interviews. The questions in an interview guide include a core question and other general guiding questions. Pilot testing improves these questions (Baumbusch 2010; Jamshed 2014). Instead of having the researcher lead the conversation, the interview guide encourages participants to describe their real-life experiences and promotes a more focused examination of a specific topic (Creswell and Poth 2016).

The questions for this study were developed using the APCO as a guide to determine likely variables, see Table 3 (Alashoor et al. 2017; Dinev and Hart 2006; Lankton and Tripp 2013). Experience and demographics have varied based on the technology or population studied.

Table 3: Study variables based on the APCO framework [adapted and modified from (Alashoor et al. 2017; Dinev and Hart 2006; Lankton and Tripp 2013)]

Variable (This Study)	APCO variable	Definition
Experience	Privacy Experiences	Use of other Mobile Applications
Contact Tracing App		Use of a contact tracing app
Gender	Demographic Differences	Gender
Age		Age range
Race		Race/ethnicity
Privacy Concerns	Privacy Concerns	Concerns about opportunistic behavior related to personal information that is disclosed by the respondent in particular
Perceived Privacy Risk	Risk/Costs	Concerns about opportunistic behavior related to personal information that is disclosed by the app
Activity Engagement	Benefits	Ability to engage in specific activities
Health Interest in App		The app provides benefits to community health
Contact tracing	Trust	Belief in contact tracing to minimize the spread of the virus

Trust in App		Being willing to depend on the app.
Trust in Organization		Willingness to believe information from the organization
Change Privacy Settings	Behavioral Reactions	Whether vendor privacy has been changed
Continuance Intention		Intentions to use the app

For this study, experience is viewed through the lens of the participants' experiences with mobile applications in general, their experiences with other contact tracing applications, and their general experience during COVID. Their general experience during COVID was added given the late release of the contact tracing applications in New York State, whereby an individual's perception about the event may influence their use (or avoidance) of the app. Similarly, given the focus of this study, we asked questions about the participant's gender, age, and race.

Below are the study questions used in the focus group sessions.

1. How do you feel about the pandemic?
    a. How effective do you think contact tracing is in minimizing the spread of the virus?
    b. How effective do you think the vaccines are in ending the pandemic?
2. How familiar are you with mobile applications?
    a. Have you had previous concerns about privacy while using mobile applications?
    b. Does it matter what organization created the application? Why or why not?
    c. Have you ever changed the permissions of any application on your mobile phone?
3. How familiar are you with the NY contact tracing application?
    a. How often have you used the application? What scenarios would make you use this application (or continue using it)?
    b. Do you have any concerns about privacy while using the application?
    c. Do you trust the application? Why or why not?
    d. Do you think this application is needed to protect the health of the community? Why or why not?
    e. Are there any benefits to using this mobile application? Why or why not?
    f. Are there any risks to using this mobile application?

Procedure

Participants contacted investigators, per the recruitment flyer, to express interest in the study. Their interest was collected in a Qualtrics survey. Seven hundred ninety-five (795) responses were obtained from the survey. After the study team contacted the participants, those selected were asked to complete general demographics questions via Qualtrics to establish study eligibility. After determining eligibility, all selected participants were asked to fill out a demographic questionnaire on Qualtrics. The demographics questionnaire answered additional questions related to race/ethnicity and specific age to determine their focus group placement. Focus groups were segmented by race and age. The decision to place individuals in particular groups was met when more than four individuals can fill the segmented focus group. Additional groups were added to reach saturation. For example, once we determined there were more than 4 participants who self-identified as White non-Hispanic and between the ages of 18-34, a group was formed. A similar structure for Black non-Hispanic, between the ages of 18-34, and Asian non-Hispanic, between the ages of 18-34.

A subsequent email was sent to all participants and alternated with an in-depth demographic questionnaire and a link to the virtual focus group using Zoom. In total, 129 participants, each with a unique identification number, were divided into nineteen focus groups with an average of five participants and at least one individual as an alternate. Three focus groups were eliminated due to nonattendance by participants; therefore, sixteen focus group interviews were conducted. Sixteen focus group interviews were conducted between March and April 2022. Not all participants scheduled attended each session, leaving us with a total of 65 participants interviewed. At the start of each virtual focus group session, the narrative consent form was read to the focus group participants. The focus group session was guided by a semi-structured interview based on the questions in the focus group instrument. The focus groups lasted approximately 1 hour, though in some cases, the discussions exceeded the one-hour limit with the participants' permission. Each participant received a $30 electronic gift card as an incentive.

The risks of participating in the study were anticipated to be minimal. The primary risk would be a breach of

confidentiality. Through the mitigation factors, this risk was anticipated to be no greater than those present while the subject was participating in a phone call with their peers. Participants were cautioned that study staff would maintain their confidentiality; however, other participants in the focus group with them could inadvertently reveal their identities. During the focus groups, participants were referred to by their first names only. Focus groups were digitally recorded and transcribed verbatim. Project staff and investigators converted participant names to pseudonyms in the transcripts, as well as redacted any identifying information the participant may have mentioned about themselves.

Each focus group was constituted of interviewees and a team of researchers. The interview moderator mediated the focus group discussions, while another investigator was responsible for notetaking. Another investigator performed as a Zoom moderator and assisted in typing out questions in zoom chats and showing images of the COVID-19 mobile and vaccination applications. The members of the research team, except the moderator, turned off cameras and remained muted in order not to cause distractions.

Interview Moderator responsibility

Typically, only two members of the research team are present during focus group interviews. However, given the use of Zoom, an additional moderator was used to monitor the video conferencing activity. The interview moderator steered the discussion. Before the discussions, the interview moderator introduced the objective of the interview and secured the participants' verbal consent and their approval to be recorded per the University at Albany, State University of New York (UAlbany) Institutional Review Board (IRB). The interview moderator also commenced the discussion and asked questions based on the interview guide. The interview moderator ended the interview after the discussion and prompted any last-minute questions or concerns from the participants. The interview was concluded by thanking the participants and releasing them from zoom.

Notetaker responsibility

A researcher from the team was assigned the duty of notetaking—relevant issues and concerns raised by the interviewees during the discussion. Notetaking extends beyond the larger context to capture the focus group discussions and the non-verbal contextual communication that took place during the conversations.

Zoom moderator responsibility

A research team member was tasked with moderating the zoom interview. Questions were typed in the chat column to aid participants with hearing problems due to network connectivity. The Zoom moderator also assisted participants and monitored the chat. In addition, the zoom moderator aided the discussions by showing images of the NY COVID Alert and Exposure Notifications application.

Data Analysis

The video-conferenced focus group interviews were recorded for the purposes of data collection and to create a transcript of participant responses. The research team used Otter.ai to develop an initial transcript of the conversation for each session, with approval from the IRB. The initial transcript was checked and edited by investigators to account for inaccuracies due to the tone, pitch, or accent of the participants or errors from the transcription service. Investigators also edited the transcripts to include pseudonyms for all the participants, removing any references to their real names.

The edited final version of the transcript was uploaded to NVivo (release 1.6.2), a qualitative software, for the purposes of coding the data. The anonymized transcripts allowed for a larger group to code the data. At least three coders thematically coded each focus group session's transcript using a codebook developed from the APCO framework (Table 4). Through our initial pass, we used the predetermined codes. However, one theme arose outside of the APCO framework: issues related to mental health.

Table 4: Codebook developed from APCO framework

Name	Description
Attitudes	Describes the attitude expressed by the participant. It may be positive, negative, neutral, or mixed
Mixed	A person's statement that they are indecisive as to whether their attitude is positive or negative. If a person states two different views, such as that they are positive about one aspect and negative

	about another, this is not mixed, but rather multiple feelings.
Negative	A negative opinion or a disagreement where an opinion is not shared with someone or with a group.
Neutral	Person's statement that they are neutral as to whether their attitude (not mixed). Neither positive nor negative
Positive	specifying positive opinions or agreements with other stakeholders or with an idea. A shared opinion
Behavioral Reactions	Related to the participant's willingness to change permissions or intentions on using the app.
Continuation Intention	Participant willingness to continue or begin using the app
Privacy permissions	Whether vendor privacy has been changed purposefully by the participant.
Beliefs	These are comments made that indicate a person's beliefs can vary from strongly believing to do not believe
Disbelief	Indicates a person does not believe in something
Strong belief	Indicates a person strongly believes in something
Benefits	Benefits of using the app related to specific activities or health
Activity Engagement	Benefits of using the app related to the ability to engage in specific activities
Health	Benefits of using the apps related to community health
Pandemic Experiences	Participant's experiences during the pandemic, including how they think the pandemic was handled by governments
Privacy Concerns	Concerns about opportunistic behavior related to personal information that is disclosed by the app or outside forces, in particular
Privacy Experiences	Describes the experiences the participants have had regarding privacy concerns. Using general mobile applications, contact tracing apps, or vaccination apps.
Contact Tracing Application Privacy	Specific privacy experiences with contact tracing mobile applications
General Mobile Application Privacy	General privacy experiences with mobile applications
Risks - Costs	Risks or costs of using the mobile application
Trust	Descriptions identifying the participant's trust. As related to COVID, contact tracing, vaccination, mobile apps, or organizations disseminating the app.
Contact Tracing	Belief in contact tracing to minimize the spread of the virus
Mobile Application	Being willing to depend on the app
Organization	Willingness to believe in the information from the organization that disseminates the app
Vaccination	Belief in the vaccination to fight the pandemic
Values	Comments that suggest the values held by the participants range from unconcerned -to seriously concerned.
Concerned	Responses from participants that indicate they are concerned about a specific topic
Unconcerned	Comments from participants that indicate they are generally not concerned about a topic.
Mental Health	Describes experiences while using the apps in relation to their mental health.

Thematic analysis identified common themes within the group discussions. These themes will be presented as aggregate and individual concerns using pseudonyms in the findings section below.

FINDINGS

Several interesting themes were identified through the coding analysis. In particular, the themes of trust, privacy,

participant behavioral intentions, and mental health had among the highest intercoder validity, as reported through NVivo, see Table 5.

Table 5: Table of intercoder reliability, by references coded

	Trust	Privacy Concerns	Behavioral Intentions	Mental Health
References coded	304	133	229	80
Percent agreement	93.65	97.33	95.73	99.88

Contact Tracing App Experiences

The majority of our participants were unaware of the COVID-19 apps for NYS. This was across all races and ages. In each one of our focus groups, most had not heard of or seen the app before. We nearly reached saturation, where we could predict that most participants did not have an experience with the contact tracing app.

This is the first, I am ever seeing it [Charlie, 18-24 years old, African American]

I've never seen it before. [Gretchen, 18-24 years old, White]

Yeah, I would say I don't I don't really know much. I know that you can get an alert. It's like someone in your neighborhood. Or in your I think it's in your building or something gets it, you might get an alert that you might have been exposed to it… Yeah, I don't really know much. [Ursula, 25-34 years old, Hispanic/Latino]

I personally don't know any of these as far as I know. Yeah. [Quist, 18-24 years old, Hispanic/Latino]

Um I haven't heard that there was an app. But I feel like at some point at time, I heard that there was something in your settings that um, I couldn't like, I never really like, looked at it or like, tried to figure it out. But I thought there was something in your settings that would tell you. But yeah, I haven't heard about the app really. [Yasmeen, 18-24 years old, Asian]

I haven't used it. And again I'm I don't go out that often because I just don't want to be in large groups of people…. [Nancy, 65- 84 years old, African American]

I can start I have used CDC ... But I have not ever downloaded a specific application for COVID. [Zilla, 35-44 years old, African American]

I have not used this app before. [Umar, 45-54 years old, White]

Well, I would say I don't really know much about these [contact tracing] apps. But definitely, I would love to use it. If it will be as effective as the description here says, I would love to use it. [Yuvan, 25 - 34 years old, African American]

Only a few people were aware of the app. Of those that were aware of the app, most saw it on their family members' phones but were otherwise unaware. One was a previous member of the contact tracing team for the state:

Yeah…I was actually a contact tracer for the state. And this is something they would that the Department of Health, and PCG leadership would constantly push at us want us to push to our clients. So we'd ask, were you tested because of the COVID exposure notification? Or were later on in the initiative when I was moved up to case investigation, basically. So the help we discussed the contact tracing schematic yet or are people familiar? [Finn, 18-24 years old, White]

Yes, yes, this is the app I use Well, I yeah, this is the app but I've used this app in the past just Yeah. Last year I used it. [John, 18-24 years old, African American]

Okay, my family uses it often times whenever we go to social gatherings [Betty, 18-24

years, African American]

I have seen Covid Alert New York because it was on my grandma's phone… But uh, I'll be honest, other than that, I've never used or seen them. I only, like seeing the image of this one on my grandmother's phone. Thank you. [Iris, 18-24 years, African American]

I'm not quite conversant with this app, but I've had family members who have used the app…[Emmanuel, 35-44 years old, African American]

The Apple-Google collaboration COVID Exposure app was off-putting to at least one who was aware of the app. Again, as mentioned above, very few were aware of the contact tracing apps.

No, I opted out, I didn't want to do it, it felt like weird because they just kind of put it on my phone without me knowing kind of it just popped up and I had people tell me, so it kind of bothered me a little bit [Dennis, 18-24 yrs. old, White]

Trust

Younger interview participants were unconcerned with trusting government agencies collecting data through the contact tracing application because they felt private companies or the government already had so much information about them. This sentiment was felt almost universally among younger participants:

... I mean, we give Google and YouTube so much information. We're gonna worry about the government at this point? I don't think so. [Charlie, 18-24 yrs. old, African American]

For me, it's the same as any other app like Snapchat and stuff like that. Just wondering and worrying about them tracking what I'm doing. [Tiana, 18-24 yrs. old, Other race]

I would trust it because it sounds like New York State Department of Health, so I would just like think like its affiliated. [Gretchen, 18-24 yrs. old, White]

... you know, if they wanted to track us or like us or information for malicious purposes, they would have done that already. Really? So, like, we use phones every single day. Like, they could track us do anything. [Angela, 18-24 yrs. old, African American]

Among older participants, trust was focused on the application, privacy, and effectiveness.

I think trust is a very loaded word. As I said, at this point, I, you know, I certainly don't feel comfortable with the level of privacy that we have with our phones and our other electronic devices. Anyway, the fact that these are manmade and subject to whatever is whatever data is already in there. So yeah, trust would be a hard word for me. [Mavis, 65-84 yrs. old, African American]

Personally. During my first use of the application, I had some basic issues trusting the application because it has to do with contact tracing and obviously contact tracing is a barge into someone's privacy. But subsequently, a had to understand that the use for this contact tracing is beyond personal purposes. So, yeah, it's okay now I know to understand why it's fine by me. [Quincy, 25-34 yrs. old, African American]

Yeah, I never used them as well. I don't trust it. I don't think it's effective. I concerned about the usage of data, data collection, all kinds of stuff, so I don't trust them. And I don't use them at all. [Xavier, 35-44 yrs. old, Asian]

Privacy

However, the sentiment changed among older participants. Privacy concerns regarding the actual data collected by the mobile contact tracing application varied based on how the individual understood what information was being provided and how much they trusted mobile applications in general.

Some were less concerned about privacy, given the pandemic, across all ages and races:

I don't have a problem with it. I'm more focused on just having everybody feel safe and to

lower the number of people who become sick. [Nancy, 64-84 yrs. old, African American

Okay, to me, I would say there is no need for privacy because maybe the people around you should know if you contacted a virus so that they can maybe take their precautions [Abigail, 25-34 yrs. old, Hispanic/Latino]

But I do feel I mean, for the benefit of the greater good to sacrifice a certain level of privacy is certainly it is fine. [Vince, 45-54 yrs. old, Asian]

I don't have any additional concerns about privacy, because I think that we have very little of it at this point anyway. [Mavis, 64-84 yrs. old, African American]

Others were concerned about data privacy and security while using the app. This was primarily among the older adults (>35 years old), African American participants:

Yeah, I'm concerned about the safety of using the app. I would have to think a little bit longer and kind of more about it. But I would not say, no, definitely no, not to it, but not to using it. [Ophelia, 55-64 yrs. old, African American]

Yes. Because even you know, even though like I just said even though it doesn't track my location, I'm still mindful that it's on my phone. So, it's connected to me. And I'm entering my information in it. So that makes me feel like my private information is still being monitored [Zilla, 35-44 yrs. old, African American]

Yeah, I always have concerns about my personal information being in the hands of people who might use it in a bad way or so about any application, not only about COVID apps. I always have reservations about letting my personal information on any mobile applications, and website. So, it's more like a general no no-trust thing for me. I don't really trust online stuffs done like that. [Felix, 35-44 yrs. old, African American]

Behavioral Intention

Not all participants were aware of the contact tracing applications or had used them before. For those not previously aware of the mobile application, there were mixed results about using the app. Most participants were not aware of the app and had never used the app before but thought that it would be helpful. Several people decided to download the app during and following the interview.

I haven't used any of these apps, but from what I'm hearing from my fellow participants, I'm really considering umm, using the app. If it can actually notify me of someone who has contracted the virus. I mean, that will go a long way in helping me. Am I planning to stay safe. [Yosef, 25-34 yrs. old, Asian]

I haven't used the apps but with the positive reviews I'm getting I'm actually try. I think, after this focus group, I will actually probably download these apps and see how it works. [Yosef, 25-34 yrs. old, Asian]

So, I didn't have the COVID Alert app before this, but I do downloaded it tonight, just to check it out. And I saw, one benefit I see is I'm always going to like forward.ny.gov website to look at data because I'm a nerd, and it has it right on there. So, I might use it now to look at that more easily. [Wilma, 35-44 yrs. old, White]

A few participants did not really understand contact tracing nor the need for the app, finding it redundant.

If I didn't ever get COVID Like I knew proper, what do you call them proper actions could be taken by my family and my doctor. It's just it kind of does kind of seem redundant the app? Because there's like so many other avenues in which to like test for COVID and alert people to having COVID. [Betty, 18-34 yrs. old, African American]

I think in a scenario where I start having symptoms that is related to COVID maybe the constant cough and all of that I think that's the best time to use the app although I've no used it before but then I think if I'm starting to have symptoms that is related to COVID, I think I will use the app. [Tiffany, 35-44 yrs. old, White]

Um I'll be honest; I haven't had to deal with contact tracing at all. So, I have nothing to really say on it. Like, I don't really know if it's effective, or if it isn't, because like, never literally never had to use it or had it like, uh, affect me, I guess. [Iris, 18-24 yrs. old, Hispanic/Latino]

The efficacy of the app was discussed as well, given the lack of usage (and awareness) of the participants.

I think they could be really helpful. But I don't know. I don't know how robust they are. I know that that back in September, I was in the same house as my sister who tested positive for COVID, and I never got any alerts that I had been around her. So that speaks to their effective efficacy. I don't know if she had opted out opted out of it. That's possible. But I don't I just don't know if they work really well, then I think they could do a lot to help stop the spread. [Victor, 35-44 yrs. old, White]

I think again, it just comes back to whether or not it's being used the right way. If it's being you know, there's enough people using it. And if it's correct I, as of right now, I'm skeptical if it's bringing as much value as they would like. Or even that I would like I am not. I'm not really super convinced, right now. [Thelma, 35 -44 yrs. old, White]

Mental Health

A few participants connected using the app to their personal mental health and the way they generally felt about the pandemic. In these instances, use and adoption of the app would only occur when mandated:

... would probably only get [the contact tracing app] if the school required me to get it. Or if I was required by some outside information, if like outside information outside organization that they needed that information, then I would like to download it. But otherwise, no. Like, it's really it really has depressed me this whole pandemic, just keeping track of like the numbers, how many people get, like disease, I probably avoid, like even learning more information, even if it will be to my own benefit, just because my mental health has suffered. [Betty, 18-24 yrs. old, African American]

Yeah, I would add probably like anxiety. There's probably a point where you're checking the app too much or you're relying on that, and it can be maybe a little debilitating or paralyzing like Heather said depression is a mental health issue. [Kenya, 18-24 yrs. old, Hispanic/Latino]

DISCUSSION

The use of the Antecedent Privacy Concerns and Outcomes (APCO) Model provided guidance for the predetermined codes in this study. The antecedents included privacy experiences (with mobile apps and with COVID-19 apps) and demographic information (age, race, and gender), similar to previous studies using the APCO framework. Throughout this discussion, the antecedents are mentioned, except for personality differences, which were not included in this study.

Awareness

Nearly all of our participants were familiar with the use of mobile apps on their phones. However, the majority of our 65 respondents were unaware the app existed. Indicated a possible need for a proper education campaign surrounding the rollout of the contact tracing application. Of those that were aware, nearly all of them were African American and knew someone with the app but had not used it themselves. One of our participants was a contact tracer for the state and learned about the app through their job. Therefore, the focus group served as an educational experience for most respondents. Several of the participants were interested in downloading the application after the 1-hour session. This indicated that many of the participants would have used the application if they had been better informed about it. This likely impacted our focus on RQ1: How does the perceived usefulness of mobile apps for COVID-19 contact tracing and vaccination status differ by age? Race?

There were mixed results about the perceived usefulness of the apps, without apparent differences by age or race. Some participants did not understand the usefulness of the app, finding it redundant. The consideration here was that actively testing for the virus, especially when sick, would make the app useless. Conversely, the usefulness of the apps was connected to the requirements or mandates for use. While many did not know about the apps prior

to the focus group study, they were intrigued and wondered why the apps were not promoted. Additionally, they noted the efficacy of the app was based on robust usage. Furthermore, the potential use of the apps was outweighed by the mental health considerations.

Trust and Privacy

Much like previous studies, we found a variation in the trust and privacy expectations of New Yorkers regarding contact tracing applications based on demographics, specifically in age (Villius Zetterholm et al. 2021). However, trust was not necessarily a factor in the consideration for use; because of both apathy and belief that the government already has access to all of their information. Trust in general mobile applications and in contact tracing apps were broadly universal among younger adult participants (<34 yrs. old). This trust extended to non-government apps as well.

Regarding RQ2: How do privacy and security concerns influence the adoption of COVID-19-related mobile apps? Are there differences in age? Race? We found indications that there are differences regarding age, but it was not clear among different race and ethnic groups.

Younger adults in this study were less concerned with privacy considerations than adults older than 34. This is in line with previous studies (Redmiles 2020). Adults over 34 in this study (across race/ethnicity) generally indicated that privacy was either extremely important to them or a luxury that should not be afforded to us because of the pandemic. For the use of contact tracing applications may be connected to privacy, much like what was found in previous studies (Boudreaux et al. 2020; Cho et al. 2020; Colizza et al. 2021; Fox et al. 2021; Kolasa et al. 2021; Villius Zetterholm et al. 2021).

However, there was an indication that privacy and security concerns shifted when accounting for the intersectionality of race and age, particularly among Black adults over 55 years of age. Where there was more specific distrust of mobile apps in general and the data collected on mobile phones, this was in comparison to the Black adults younger than 55. These findings are similar to previous research, except that the intersectionality of race and age should be considered (Hendl et al. 2020). Unfortunately, this study was restrained because of the challenge in reaching out to older adult participants (55 and older) from other races. Therefore, comparison among older adults is not possible.

Mental Health

Unlike previous studies, the use of contact tracing applications was also found to connect with mental health concerns. This was especially true for those 54 years older and under. Interestingly, the timing of this study is a factor of the variable of the study that should be considered. Many of the COVID-related restrictions were being lifted in the state of New York when the interviews were conducted. This likely influenced many of the answers from the participants and could be considered a limitation of the study. However, as identified by the participants, awareness of the COVID Alert NY app was not high, and this particular app was not mandated, and therefore many people did not use it.

APCO Framework

Our findings indicated that the particular situation (or event) in which the mobile application is used might also be a concerning factor, in this case, the pandemic. Experiences with the pandemic (or with contact tracing) may factor into beliefs, attitudes, perceptions, and concerns related to the use of technology and privacy considerations.

Additionally, the privacy calculus related to the perceived use of the mobile app contributing to mental health issues seemed to be a bigger consideration among participants than the app's usefulness or trustworthiness. This unique type of privacy calculus was more prevalent among adults younger than 55. This finding, in particular differs from other studies, where trust is often the bigger concern (Buck et al. 2022).

Limitations

This focus group study is not representative of the entire NYS populous; however, it does provide some context regarding the use, adoption, and privacy considerations among different segments of the population. This study was restrained because of the challenge of reaching out to older adult participants (55 and older) and participants from races outside of Black, White, or Asian. Additionally, a majority of the participants are aged between 18 and 34 years old. Finally, personality differences among the participants were not collected in demographic information or the interview sessions.

CONCLUSION

This innovative study contributes to the body of knowledge by operationalizing and expanding on the APCO model to further understand the use, privacy, and perception of mobile apps used for COVID-19 mitigation by age groups. Although, the findings from this focus group are not representative, the conversations among participants provide important context for future studies. The findings indicate age and race may influence trust and privacy perception. The findings also indicate that mental health concerns may be related to the event (especially for adults younger than 55), which could be an additional factor in the decision of individuals to use the app. Furthermore, the study contributes to the base of knowledge surrounding the use of technology during a pandemic, which may need to consider the impact the pandemic had on the users themselves. The results of this study provide insights into the privacy and technology acceptance concerns that motivate or prevent individuals from engaging in COVID-19 mobile apps used for mitigation.

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