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White Paper

Predicted Adoption Rates of Contact Tracing App Configurations

Insights from a choice-based conjoint study with a representative sample of the UK population

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"What features the contact tracing app has is an important element in how well the public accepts it and uses it. It should have minimal intrusion to a person's life but has what is essential for contact tracing to be effective."

- Anonymous Survey Respondent

Executive Summary

Widespread adoption of a contact tracing app by the UK public is an important part of safely easing or lifting the lockdown. In this context, **it is essential to understand how adoption rates are influenced by different configurations of a proposed contact tracing app.** There are many implementation options that can impact app adoption. For example, which institution should be responsible for and have oversight of the app? What type of data is collected? Does it matter how long it is stored? This whitepaper provides data-driven insights into these and other questions to guide app implementation choices.

We conducted a choice-based conjoint study with a UK-wide representative sample (n=2061). Choice-based conjoint uses realistic choice scenarios (rather than less reliable attitude surveys) to measure preferences for product features, and to simulate the likely acceptance of a product. This allows us to estimate the adoption rate for various app configurations.

We would like to highlight the following **main findings**:

- It is possible to implement a contact tracing app that can achieve widespread adoption.

- Adoption rates increase significantly if the NHS (as opposed to the government) has ownership and oversight of the contact tracing app.

- Adoption rates increase significantly if app use is linked to priority testing for COVID-19 when in self-isolation.

Based on simulations of adoption rates for different app configurations, we recommend a contact tracing app with the following configuration:
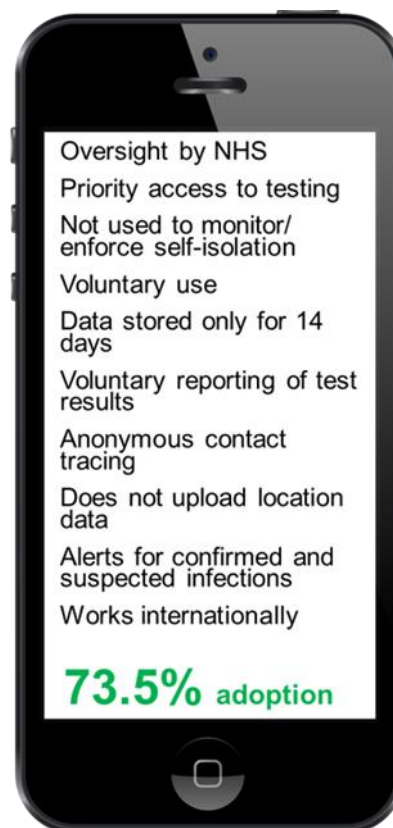
This suggested configuration strikes a balance between maximizing the uptake of the app while protecting privacy and civil liberties. We estimate that **this configuration is likely to increase adoption by 22.4 percentage points over the NHSX app currently under development** (based on our interpretation of limited information available in the public domain).

This whitepaper discusses key findings from our study in detail.

Introduction

In this whitepaper, we focus on understanding how the UK public views the introduction of a contact tracing app and how likely it is to adopt different configurations of such an app. This understanding is critical because a contact tracing app would not be effective unless there is significant public uptake — no matter how technologically sophisticated or superior the app is. This is illustrated well by a recent study which suggests that approximately 60% of the adult population have to adopt the app to contain the pandemic (Ferretti et al., 2020). Achieving this adoption rate is not only essential to the app's effectiveness, but also very challenging: Singapore's TraceTogether app, often viewed as a success story, has only achieved 19.3% uptake to date (www.tracetogether.gov.sg).

One particularly sensitive challenge for the successful implementation of a contact tracing app is navigating the potential privacy and civil liberty issues inherent in these apps. The UK government faces critical decisions — ranging from who will oversee the app, to what type of data will be collected and for how long it will be stored — that have privacy and civil liberty implications. This research provides data-driven insights into the impact of these decisions on app adoption.

Methodology

We use a choice-based conjoint design to study how people trade-off different attributes of a contact tracing app when making adoption decisions. This method derives individual preference functions for each respondent, so that we can estimate how changing one attribute of the app will affect uptake. This allows us to run simulations to estimate the likely adoption of different app configurations if brought to market.

Based on contact-tracing app functionalities that currently exist or are being considered to varying degrees by governments around the world (including the NHSX/UK government), we identified ten potential app attributes and various sub-options of these attributes that could be relevant for a UK contact tracing app (see Table 1 on p. 10 for a complete list). A UK wide representative sample of 2061 respondents was then asked to give their preferences using a partial profile choice-based conjoint design with a dual response/none option (Wlömert & Eggers, 2016). More information about our sample can be found in Appendix I. Further information of the research design and detailed analyses are available from the authors, or publicly at the Open Science Framework.

Simulations of App Adoption Rates

Based on the individual preference functions of respondents for the different app attributes and attribute options, we can simulate adoption rates for various app configurations.

We ran simulations for four potential apps: **1) an "Expected NHSX" app** that the NHSX/UK government have announced (based on our interpretation of press coverage and NHSX blogs), **2) a "Big Brother" app** that does not respect privacy and civil liberties, **3) a "Maximum Adoption" app** that would reach the highest adoption, regardless of implications for privacy and civil liberties, and **4) a "Recommended" app** that would reach the highest adoption while safeguarding privacy and civil liberties.

In Figure 1, we list all ten app attribute options that were used to simulate the different configurations in order of their importance for adoption choice .

It should be noted that these are "ideal" adoption rates, since 100% of our respondents were informed about the app and made considered adoption choices. Real-life adoption rates would be expected to be lower.

Figure 1 shows the adoption rates that the four app configurations can achieve (reminder: 60% adoption is need for the app to be effective, see Ferretti et al., 2020):

Fig 1: Adoption rate simulation for different app configurations

App 1: "Expected NHSX"

Oversight by government*

No additional functionalities

Not used to monitor/ enforce self-isolation

Voluntary use

Data stored only as long as necessary*

Voluntary reporting of test results

Anonymous contact tracing

Does not upload location data

Alerts for confirmed and suspected infections

Works internationally

51.1% adoption

*Perception based on press coverage

App 2: "Big Brother"

Oversight by government

Priority access to testing

Used to enforce self-isolation with punitive means

Compulsory use

Data stored only as long as necessary

Compulsory reporting of test results

Identifiable contact tracing

Uploads location data

Alerts for confirmed and suspected infections

Does not work internationally

54.6% adoption

App 3: "Maximum Adoption"

Oversight by NHS

Priority access to testing

Used to monitor self-isolation by sending alerts

Voluntary use

Data stored only until end of pandemic

Voluntary reporting of test results

Anonymous contact tracing

Uploads location data

Alerts for confirmed and suspected infections

Works internationally

77.6% adoption

App 4: "Recommended"

Oversight by NHS

Priority access to testing

Not used to monitor/ enforce self-isolation

Voluntary use

Data stored only for 14 days

Voluntary reporting of test results

Anonymous contact tracing

Does not upload location data

Alerts for confirmed and suspected infections

Works internationally

73.5% adoption

App 1: "Expected NHSX"

The "Expected NHSX" app achieves the **lowest adoption rate with 51.1%**. This is primarily due to two factors. Our analysis found that there are two attributes that are most important in determining respondents' choice for an app configuration. First, it is very important who is responsible for the app and has oversight. Current news reports create the perception that the UK's contact tracing app development is spearheaded by the government. The Secretary of State for Health and Social Care is the primary spokesperson for the app in the media and the government's healthtech blog publishes updates about the app. However, our **respondents show a clear preference for the NHS to be fully in charge**. Second, **respondents want the app to be linked to testing**, so that those in self-isolation get priority access to testing for COVID-19. Currently, no plans to link the app to priority testing have been announced.

App 2: "Big Brother"

The authoritarian "Big Brother" app achieves **a slightly higher adoption rate with 54.6%.** This is due to the assumption that testing for suspected COVID-19 cases would be provided, which respondents seem to value more than protecting their privacy and civil liberties.

App 3: "Maximum Adoption"

The **maximum adoption rate that any app could reach in our simulation is 77.6%.** However, this configuration potentially infringes upon civil liberties by using the app for monitoring purposes, as well as privacy by uploading location data and storing data for longer than necessary. Therefore, we would not recommend the implementation of these options, even though they would slightly increase app adoption.

App 4: "Recommended"

Our "Recommended" app, unlike the "Maximum Adoption" app, is not used to monitor or enforce self-isolation, stores data for only 14 days, and does not upload any location data. **This privacy and civil liberties respecting app can reach 73.5% adoption.**

Key Findings and Recommendations

We studied the impact of ten potential attributes that could be relevant for a UK contact tracing app on adoption likelihood. The results are summarized in Table 1**. Our analysis shows that some attributes are significantly more important than others in determining respondents' app adoption choices.** The order of attribute importance is remarkably robust and stable for different segments of the UK population (see detailed results by segment here).

Within each attribute, we investigated a range of implementation options. Some options impact choice positively, others negatively. Please note that the impact of the different options is relative to each other within each attribute (i.e., in Table 1, changing the oversight from the NHS to an independent oversight body would reduce adoption; but changing it from the government to an independent oversight body would increase adoption).

Table 1: App Attributes and Attribute Options

Attribute Importance for App Adoption	App Attribute	Attribute Options	Relative Impact on adoption
23.61%	**Responsibility and Oversight** Who is responsible for the app project and has oversight?	The NHS	++
		An independent oversight body	+
		The government	-
		A large tech company	--
14.83%	**Additional Benefits of App Use** What additional benefits does the app offer to users?	Priority to get tested for COVID-19 when in self-isolation	++
		Priority to book food delivery slots when in self-isolation	+
		Information about how busy local shops and parks are	-
		No additional benefits	--
11.33%	**Monitoring and/or Enforcing of Self-Isolation** Is the app used for monitoring and/or enforcing self-isolation?	Used to monitor self-isolation by sending alerts	++
		Not used for these purposes	-
		Used to enforce self-isolation with punitive means	--
10.38%	**Freedom of Movement** To what extent is freedom of movement linked to app use?	Entirely optional (no link to freedom of movement)	+
		Required for any movement	+/-
		Required to return to work	--
8.80%	**Reporting of COVID-19 Test Result** Is the reporting of COVID-19 test result through the app voluntary or compulsory?	Voluntary	+
		Compulsory	-
8.63%	**Length of Data Storage** How long will data be stored?	Only until the COVID-19 crisis is over	+
		Only for as long as necessary	-
		Only for the necessary 14 days	--
7.27%	**Anonymity** What kind of contact tracing does the app use?	Anonymous contact tracing	+
		Identifiable contact tracing	-
5.88%	**Data Type** Does the app share location data?	Yes	+
		No	-
5.24%	**Infection Alerts** What kind of infection alerts does the app send you?	Alerts for confirmed and suspected cases	+
		Alerts for confirmed cases	-
4.01%	**International Use** Can the app be used in other countries?	Yes	+
		No	-

As can be seen from Table 1, **the top four attributes collectively explain 60.1% of respondents' app adoption choices.** We will focus the remainder of this whitepaper on these top four attributes and discuss the implications of the relative importance of different attribute options in more detail. A full analysis of all attributes is available by contacting the authors.

Attribute 1: Responsibility and Oversight

Table 2: Who is responsible for the app project and has oversight?	Relative Impact on Adoption
The NHS	++
An independent oversight body	+
The government	-
A large tech company	--

As shown in Table 2, **respondents are most likely to adopt a contact tracing app if the NHS is responsible and has oversight.** They also respond positively to an independent oversight body, but do not want the government or a private tech firm in charge.

The impact of these attribute options on app adoption does not change for different segments of the population (see detailed results by segment here).

It is noteworthy that less people will adopt the contact tracing app if the government is seen to be in charge. This view is also reflected in the open comments by respondents:

"If [this app] is truly used for the purpose identified then I have no problem. But - and it is a big but - I do not trust the Government to play by their own stated rules. They are all adept at not telling the truth and using personal data for other purposes." (Anonymous Survey Respondent)

> **Recommendation 1:** The governance of the app should be clearly set out, with a view to putting the NHS in charge and possibly involving an independent oversight body. Importantly, the government should not be, nor perceived to be, in control of the app.
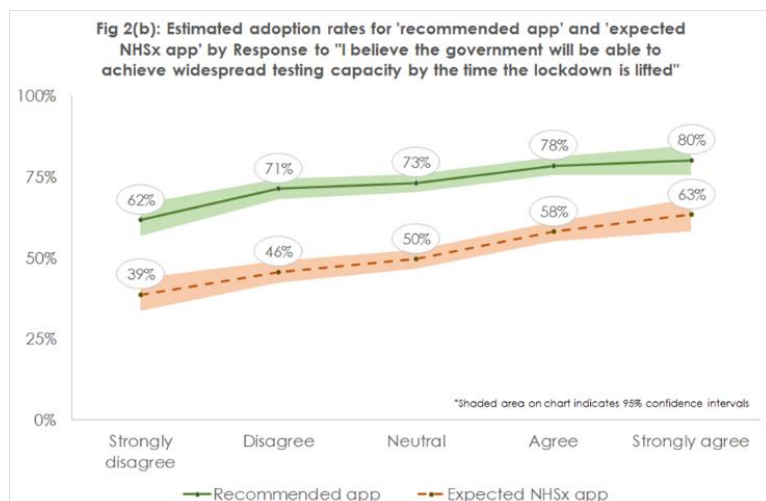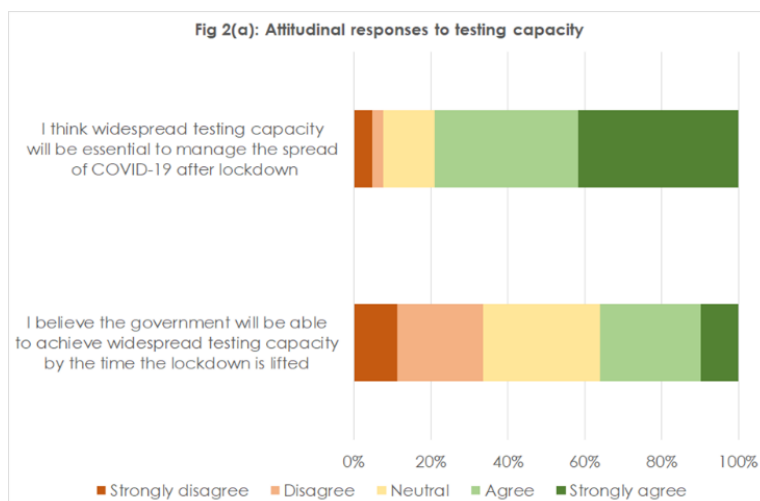
Attribute 2: Additional Benefits of App Use

Table 3: What additional benefits does the app offer to users?	Relative Impact on Adoption
Priority to get tested for COVID-19 when in self-isolation	++
Priority to book food delivery slots when in self-isolation	+
Information about how busy local shops and parks are	-
No additional benefits	--

The likelihood of app adoption significantly increases if the app offered additional relevant benefits. As shown in Table 3, not offering any additional benefits reduces adoption. However, it is also clear that not all benefits are created equal in terms of driving adoption. For example, the possibility of receiving information about how busy local amenities are does not seem to interest respondents and reduces app adoption. In contrast, **respondents are most likely to adopt the app if it facilitated priority access to testing during self-isolation.**

Respondents seem aware that mass contact tracing can only work in conjunction with mass testing, as suggested by researchers (Ferretti et al., 2020; Salathé et al., 2020). As illustrated in Figure 2(a), 79% of respondents agree or strongly agree that "testing capacity will be essential to manage the spread of COVID-19 after lockdown." However, respondents are not confident that "the government will be able to achieve widespread testing by the time the lockdown is lifted," since only 36% of respondents agree or strongly agree with this statement.

Fig 2(a): Attitudinal responses to testing capacity

Fig 2(b): Estimated adoption rates for 'recommended app' and 'expected NHSx app' by Response to "I believe the government will be able to achieve widespread testing capacity by the time the lockdown is lifted"

The belief in whether the government will be able to achieve widespread testing strongly impacts respondents' app adoption choices: **Respondents who do not believe that widespread testing can be achieved by the time the lockdown is lifted are less likely to adopt a contact tracing app** than those who are neutral or do believe that it can be achieved. This difference is illustrated in Figure 2(b).

Apart from testing, respondents' adoption of the app would also increase if it facilitated booking food delivery slots for those in self-isolation.

The impact of these attribute options on app adoption does not change for different segments of the population (see detailed results by segment here).

Recommendation 2: The app should be linked to testing, so that those in self-isolation (because they are symptomatic or have been alerted by the app of a possible infection) can get tested quickly. In addition, it is important to convince the public that this testing capacity is in fact achieved and functional. Providing priority booking for food delivery slots when in self-isolation would also support app adoption.

Attribute 3: Monitoring and/or Enforcing of Self-Isolation

Table 4: Is the app used for monitoring and/or enforcing self-isolation?	Relative Impact on Adoption
Used to monitor self-isolation by sending alerts	+
Not used for these purposes	-
Used to enforce self-isolation with punitive means	--

A somewhat unexpected finding is that **app adoption increases if the app is used to monitor self-isolation by sending alerts** (e.g., push notifications). As shown in Table 4, respondents' app adoption slightly decreases if the app does not provide any monitoring, and strongly decreases if the app is used to enforce self-isolation with punitive means. The impact of these attribute options on app adoption does not change for different segments of the population (see detailed results by segment here).

A possible explanation for this finding is that respondents think of monitoring others rather than themselves when judging this attribute. Respondents' open comments indicate that they do not have much faith in other people observing COVID-19 guidance, for example:

"In fact, I think it would be a good idea to monitor people's movements as I know loads of people who are blatantly flouting the guidelines set out by the government." (Anonymous Survey Respondent)

Thus, some form of light-handed monitoring through technology seems to be acceptable, whereas heavy-handed enforcement with punitive means is not accepted. We know from prior literature that citizens are generally more willing to relinquish civil liberties in times of crisis (e.g., Murray & Wunsch, 2002). This presents a dilemma for decision makers: while monitoring self-isolation brings about marginal benefits in terms of app adoption, it potentially comes at the expense of infringing upon civil liberties. In light of this, we consider opting for safeguarding civil liberties a better strategy.

Recommendation 3: The app should not be used for monitoring or enforcement purposes.

Attribute 4: Freedom of Movement

Table 5: To what extent is freedom of movement linked to app use?	Relative Impact on Adoption
Entirely optional (no link to freedom of movement)	+
Required for any movement	-/+
Required to return to work	--

Table 5 indicates that respondents do not support requiring app use for returning to work, and this finding is stable across all segments. However, the picture is more nuanced when it comes to making app use entirely optional or making it compulsory for any movement. Overall, **respondents are slightly more likely to choose an app that is voluntary, but the impact of requiring the app for any movement on app choice is neutral.**

Respondents' open comments show that this is a particularly polarizing issue, with some strongly advocating for compulsory app use and others strongly opposing it. For example:

"I think this is a unique situation and we need to take drastic measures at this time, the app should be compulsory, and people should be required to use it if they want to leave the house. People clearly cannot be trusted to follow the rules that are laid out for everyone's safety, so we need to take away the right for them to choose and make it compulsory." (Anonymous Survey Respondent)

"The whole idea is a complete invasion of privacy, it is "Big Brother" monitoring citizens & is outrageous. Luckily, I don't have a smartphone, so even if it became compulsory, I don't care!" (Anonymous Survey Respondent)

For this attribute, the impact of the different attribute options on app adoption changes for different segments of the population. Specifically, those with primary education, those with an extremely conservative political orientation, and women have a preference for compulsory app use. But even more than demographic variables, preference for optional versus compulsory app use is driven by attitude (see Figure 3). Compulsory app use is preferred by respondents who strongly agree that "widespread

Fig 3: Attitudinal responses to digital contact tracing and fear of COVID-19
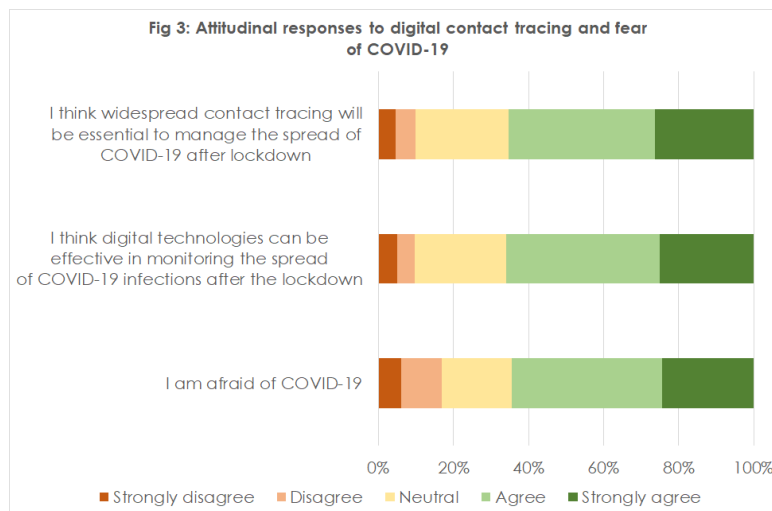
contact tracing will be essential to manage the spread of COVID-19 after lockdown" and "digital technologies can be effective in monitoring the spread of COVID-19 infections after the lockdown," as well as respondents who strongly agree that they are "afraid of COVID-19."

Even though some segments support compulsory app use and the effect of this option on adoption is neutral, making app use entirely optional is the preferred implementation option and increases adoption.

Recommendation 4: App use should be voluntary and not linked to freedom of movement.

Remaining Attributes

Table 1 shows the relative importance of the remaining six attributes and respondents' preferences for the different attribute options. We would like to briefly highlight two unexpected findings.

First, we find that respondents choose to share their data longer than the necessary 14 days (the incubation period of COVID-19). Instead, they expressed a preference for their data to be stored until the COVID-19 pandemic is over. This indicates that **respondents are willing to share their data in a way they perceive useful in fighting the pandemic. However, they also want to have a clear end point**, as they did not support their data being stored "for as long as necessary."

Second, respondents are more likely to choose an app that uploads their location data than one that does not. This is surprising because the collection of location data is the more invasive option. From our analysis of the open comments of respondents, one possible explanation for this finding is that **respondents do not fully understand Bluetooth-enabled contact tracing**. Instead, they believe that location data is necessary for the app to function effectively.

Further Insights

We also observe some general differences in adoption likelihood for a contact tracing app – regardless of its configuration – among different segments of the population.

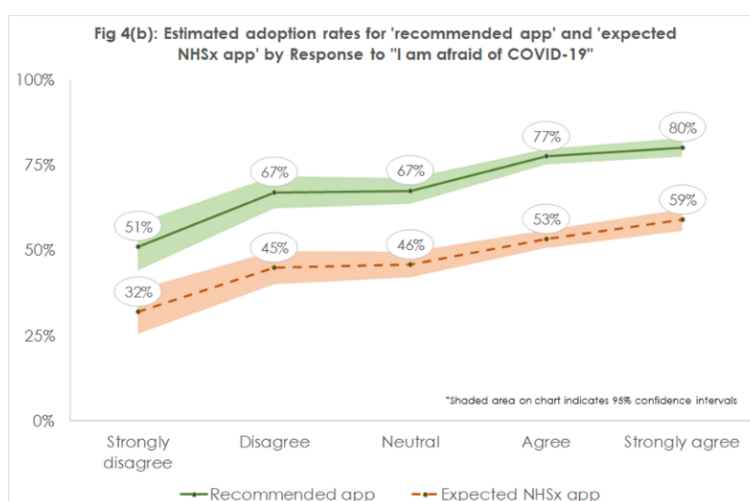## Demographic Differences in Adoption

In terms of **age**, preference for adopting an app goes down for respondents aged 50-64, and respondents aged 65+ are least likely to adopt any app at all. Those aged 25-34 have the highest preference for app adoption (see Figure 4(a)). In terms of **household income**, preference for app adoption increases with higher levels of income. It is important to note that people with lower incomes and older people are less likely to own a smartphone, and that older people might feel technologically challenged using apps. In terms of **gender**, women have stronger preferences for the

Fig 4(a): Estimated adoption rates for 'recommended app' and 'expected NHSx app' by Age
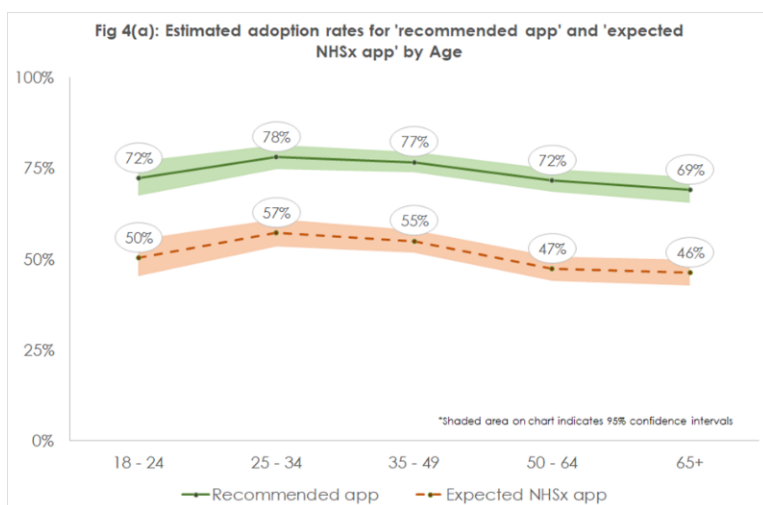
app than men. In terms of **ethnicity**, Black people and Asian people have stronger preferences for the app than White people. This finding is only tentative as sample sizes are small for Black people (n=66) and Asian people (n=115). Finally, respondents who live in **London** have a stronger preference for adopting the app than respondents living in the rest of England, Wales, Scotland and Northern Ireland. This is likely an indication that the app appeals more to residents of densely populated areas.

Attitudinal Differences in Adoption

Preference for adopting a contact tracing app is positively correlated with **fear of COVID-19** (see Figure 4(b)), and also higher for respondents who have either themselves or whose family and friends have been **diagnosed with or experienced symptoms of COVID-19**. Likewise, people who lost someone to COVID-19 also strongly prefer the adoption of a contact tracing app. Moreover, preference for the app goes up for respondents who self-report **financial losses** and those who self-report a **negative impact on their mental health** due to the lockdown.

Fig 4(b): Estimated adoption rates for 'recommended app' and 'expected NHSx app' by Response to "I am afraid of COVID-19"

Respondents who strongly disagree or disagree with the statement "I trust the information I receive about COVID-19 from the government" are less likely to adopt an app, as are those who strongly disagree or disagree with the statement that "the government's priority is saving lives." Finally, respondents who strongly disagree or disagree that "widespread contact tracing will be essential to manage the spread of COVID-19 after lockdown" and that "digital technologies can be effective in monitoring the spread of COVID-19 infections after the lockdown" are less likely to adopt any app. As mentioned previously, this is also true for respondents who strongly disagree or disagree that "the government will be able to achieve widespread testing capacity by the time the lock down is lifted."

> **Recommendation 5:** These demographic and attitudinal differences should inform the communication strategy surrounding the launch of the app.

Other concerns

An analysis of the open comments left by respondents shows that many people worry about either **not owning a smartphone** themselves, or about what will happen to those who do not own a smartphone. In addition, despite having received a clear explanation about Bluetooth-enabled contact tracing, many respondents were wondering if the app would **work without wifi or 4G**. These are important concerns to address when introducing a contact tracing app in the UK.

Concluding Thoughts

In times of crisis, we are often willing to compromise on some aspects of privacy and civil liberties for the greater good. This study indeed finds that our respondents are willing to share more data and accept more invasive measures than would be imaginable in "normal" times. This is why decision-makers involved in the design and launch of a contact tracing app have an enormous responsibility to get it right. **They must strike a fine balance in designing and implementing a contact-tracing app that on the one hand relies on our cooperation and personal data to be effective, but on the other hand does not overreach into our willingness to make sacrifices and share personal data to combat this pandemic.** This whitepaper presents the summary of key insights and recommendations on how to strike this balance. Based on our analysis, **we recommend a specific contact tracing app configuration that can achieve sufficient widespread adoption to be effective while protecting privacy and civil liberties.**

We, the authors, are available to discuss the details of our study and full recommendations.

Acknowledgements

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Appendix I: Demographic Characteristics of the Sample (n = 2061)

Demographic Variable	Groups	% Representation in Sample
Age	18 - 24	9.5%
	25 - 34	17.4%
	35 - 49	27.2%
	50 - 64	24.0%
	65+	21.4%
	Prefer not to say	0.4%
Gender	Female	48.0%
	Male	51.3%
	Non-binary	0.3%
	Prefer not to say	0.4%
Ethnicity	White	88.0%
	Black	3.2%
	Asian	5.6%
	Multiple	1.9%
	Other	0.7%
	Prefer not to say	0.6%
Location	England (London)	21.2%
	England (outside London)	64.6%
	Scotland	7.6%
	Wales	4.6%
	Northern Ireland	1.5%
	Prefer not to say	0.6%
Education	Primary education	4.2%
	Secondary education (upto A-Levels)	51.1%
	Bachelor degree	21.5%
	Master degree	12.5%
	Doctoral degree	3.5%
	Other professional qualification or certification	6.1%
	Prefer not to say	1.1%
Household income	Below £20,000	27.6%
	£20,001 to £40,000	34.7%
	£40,001 to £60,000	18.8%
	£60,001 to £80,000	7.6%
	Above £80,000	6.4%
	Prefer not to say	5.0%
Smartphone Owners	Owns	89.8%
	Does not own	10.2%

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