The contribution of the SwissCovid digital proximity tracing app to pandemic mitigation in the Canton of Zurich

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Abstract

Background: Digital proximity tracing (DPT) apps were released in several countries to help mitigate the Sars-Cov-2 pandemic. Specifically, DPT complements manual contact tracing (MCT) by warning exposed contacts earlier, by reaching contacts that may be missed by MCT, and by providing a second line of defense if MCT gets overwhelmed. The impact of DPT on pandemic mitigation still awaits demonstration, however.

Objective: To estimate app user flow and outcomes of DPT app notification cascade in a clearly defined regional (Canton of Zurich) and temporal context (September).

Data sources: Aggregated administrative and research data, including DPT key performance indicators, test results statistics, infoline call statistics, and anonymized information on a close contact sample.

Methods: A schematic model for the DPT notification cascade was developed and populated with estimates for specific cascade step subgroup sizes using data triangulation techniques. Resulting estimates were systematically checked for internal consistency, consistency with other upstream or downstream estimates in the cascade, as well as consistency with nationally available data.

Results: We estimate that 429 app users received a positive Sars-CoV-2 test, of whom 344 received and uploaded a CovidCode. This triggered an app notification for an estimated 1’415 proximity contacts and led to 756 infoline calls. In total, 166 callers received a quarantine recommendation, and 30 notified app users tested positive for Sars-CoV-2 after an app notification.

SwissCovid triggered quarantine recommendations in the equivalent of 5% of all exposed contacts placed in quarantine by manual contact tracing. Per 10 uploaded Covidcodes, we estimate that approximately 1 contact tested positive for Sars-CoV-2 after an app notification.

Conclusion: Although requiring further confirmation, the estimated numbers of app-notified persons receiving quarantine recommendations or testing positive after notification suggest relevant contributions to pandemic mitigation. Increasing SwissCovid app uptake will further enhance this contribution.
Background

Digital proximity tracing (DPT) apps are a novel health technology to complement manual contact tracing in the current Sars-CoV-2 pandemic.\(^1\)\(^2\) DPT apps measure proximity using Low Energy Bluetooth. If an app user is tested positive for Sars-CoV-2, she/he can notify proximity contacts in a privacy-preserving manner. The contribution of the app to pandemic mitigation is dependent on notified app users preventing possible transmissions to other contacts, for example through self-quarantine.\(^2\)\(^,\)\(^3\)

Apps following the decentralized, privacy-preserving proximity tracing (DP-3T) architecture maintain the anonymity of app users.\(^4\) The SwissCovid app, released nationwide on June 25, 2020, is one of the first incarnations of DP-3T-style apps.\(^5\)

However, four months after its release, the contribution of SwissCovid to pandemic mitigation is still unclear. A recent research report from Switzerland provided first indications that persons who received app notifications later tested positive for Sars-CoV-2.\(^6\) The current report builds on these observations and attempts at describing the flow of app users in the notification cascade for a clearly defined regional and temporal context.

Methods

Setting:

The functioning of the SwissCovid app is described in detail elsewhere.\(^1\)\(^,\)\(^7\) This study was performed for the Canton of Zurich with 1.54 Million inhabitants. The analysis time frame was from September 1 to 30, 2020. This canton was selected because of the availability of several, relevant data sources from administration and research (see section “Data Sources”). In September 2020, the Sars-CoV-2 incidence was relatively stable around 300-600 new cases nationally.\(^8\) In the canton Zurich, 1715 persons were tested positive for Sars-CoV-2 in September, out of 65'000 tests performed during that month (percentage of positive tests 2.7%).\(^9\) Approximately 3’000 persons were placed in quarantine by manual contact tracing following exposure to an index case (that is, a person who tested positive for Sars-CoV-2).\(^9\)

Calculation Methods:

This study employed data triangulation of information from different sources.\(^10\) The triangulation process followed the framework of Kaufmann et al.\(^11\) Key outcome measures were defined, a list of possible administrative and research data sources was compiled, screened for relevant information, and suitable parameter data was extracted.

A schematic model for the flow of users and information in the notification cascade was developed (Figure 1), analogous to the model shown in (6). For each notification cascade step, the number of persons was estimated based on known, measured data and estimated parameters from different databases (Table 1). The triangulation centered around two key measures, for which relatively accurate measures were available: the number of infoline calls from Zurich (parameter 4) and the number of positive tests following an app notification in Zurich (parameter 7). The triangulation process consisted of estimating the size of the remaining five (out of the seven) subpopulations in the notification cascade. To this end, different sets of extracted parameters were selected, the size of...
different subpopulations was calculated and systematically checked for consistency based on the following criteria (in descending priority order):

1) Is the estimate consistent with an independently collected, analogous measure?
2) Is the estimate contradicting for other up- or downstream estimates?
3) Are the Zurich estimates largely consistent with national estimates if available?
4) Are the estimates largely consistent with qualitative information if available?

Parameter selection and consistency checks were performed manually. Calculations were performed in R version 3.6.2 (www.r-project.org).

Data sources and relevant parameters (also see table 1):

1. Gesundheitsdirektion Zürich: Number of positive cases in the canton of Zurich; ratio of quarantined and isolated persons; number of tests performed in Zurich; test positivity
2. Medgate: Number of infoline calls from Zurich; percentage of infoline calls pertaining to app notifications; percentage of infoline calls leading to quarantine recommendation
3. Covid-19 Social Monitor: Coverage of app usage in the Canton of Zurich; percentage of app users not calling the infoline after notification
4. Federal Office of Public Health: Number of positive tests performed in ZH after a SwissCovid notification (FOPH)
5. Zurich Sars-CoV-2 Cohort Study: Percent notified app users who called infoline and/or entered quarantine, number of app users who received the app notification before being informed by MCT; number of positive tests after app notification
6. Federal Office of Statistics: Number of active users; number of entered notification codes (CovidCodes); fraction of CovidCode generator software logins from Zurich

Key outcomes of interest

The following outcome measures were calculated and put in context to total outcome numbers (total of positive tests, persons in quarantine) in the canton of Zurich (cited in the “Setting” section):

- Number of cases testing positive for Sars-CoV-2 after an app notification
- Number contacts who called the infoline and received a quarantine recommendation
- Ratio of number of infoline callers with quarantine recommendations over number of all quarantined persons
- Ratio of number of persons with a positive Sars-CoV-2 test after app notification over number of entered CovidCodes
## Table 1: Parameter definitions

<table>
<thead>
<tr>
<th>#)</th>
<th>Sub-population</th>
<th>Estimation</th>
<th>Parameter description</th>
<th>Range (Main analysis)</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>Number of app users who test positive for Sars-CoV-2 in Zurich</td>
<td>Number of positive cases in Zurich * [Number of active app users / number of persons aged 20 to 79 years in Switzerland]</td>
<td>Number of positive tests in Zurich Number of active app users, divided by number of persons aged 20 to 79 years in Switzerland</td>
<td>1715 positive tests 1.6 Mio. 6.4 Mio.</td>
<td>ZHHD FoS</td>
</tr>
<tr>
<td>2)</td>
<td>Number of entered Covidcodes in Zurich</td>
<td>Number of total Covidcodes entered in Switzerland * Percentage of codes generated by Zurich Health Directorate Alternative: Number of positive app users in Zurich * Percentage of positive app users who upload and enter Covidcodes</td>
<td>Total number of CovidCodes Percentage of logins into CovidCode generation software by Zurich (proxy for code generation) Number of positive app users in Zurich Percentage estimates from Zurich Sars-CoV-2 Study</td>
<td>1867 codes 18.4% Based on 1), n=429 93% CovidCodes received, 96% entered</td>
<td>FoS FoS ZSAC</td>
</tr>
<tr>
<td>3)</td>
<td>Number of app-notified persons in ZH</td>
<td>Number of infoline callers / Percentage of persons calling the infoline Alternative: (Number of CovidCodes entered * Number of calls per CovidCode) / Percentage of app notified persons calling infoline</td>
<td>Number of calls to infoline from Zurich, Percentage of app notified persons calling infoline</td>
<td>estimated in 4); n=756 53.3%</td>
<td>Medgate SocMon</td>
</tr>
<tr>
<td>4)</td>
<td>Number of infoline calls from ZH and related to app notifications</td>
<td>Number of infoline calls from Zurich * Percentage of calls related to app notifications</td>
<td>Number of calls from Zurich (n=900) Percentage of calls related to app notifications (only available for all of Switzerland)</td>
<td>900 calls 84%</td>
<td>Medgate Medgate</td>
</tr>
<tr>
<td>5)</td>
<td>Number of tests performed after app notification</td>
<td>Number of pos. tests after app notification / positivity Percentage of all tests performed in Zurich</td>
<td>Number of positive tests after app notification Percentage of positive tests among all tests performed in Zurich</td>
<td>Estimated in 7), n=30 2.6% †</td>
<td>FOPH ZHHD</td>
</tr>
<tr>
<td>6)</td>
<td>Number of infoline calls leading to quarantine</td>
<td>Number of infoline calls from Zurich * Percentage of calls leading to quarantine recommendation</td>
<td>Number of ZH calls 4) Percentage of calls leading to quarantine recommendation</td>
<td>Estimated in 4), n=756 22% for Switzerland</td>
<td>Medgate Medgate</td>
</tr>
<tr>
<td>quarantine recommendation</td>
<td>Number of positive test results from Zurich where test was performed after app notification</td>
<td>Number of positive tests indicating of SwissCovid app alert as a reason for testing</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>7) Number of positive tests after app notification</td>
<td>Number of positive tests from Zurich * Percentage of persons with positive test who got tested after an app notification</td>
<td>N=30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative: Number of positive tests from Zurich * Percentage of persons with positive test who got tested after an app notification</td>
<td>Number of positive tests Percentage infected persons who reported to seek testing after app notification</td>
<td>1715 positive tests 1.9%</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

| | | FOPH |
| | | ZHHD |
| | | ZSAC |

Footnote: § The overall test positivity rate is likely an underestimation of the true positivity for persons with digital proximity contact exposure.

Abbreviation: FOPH, Federal Office of Public Health; ZHHD, Health Directorate of the Canton of Zurich; FOS, Federal Office of Statistics; SocMon, Covid-19 Social Monitor study; ZSAC, Zurich Sars-CoV-2 Cohort Study
Results:

Figure 1: Steps in the notification cascade of digital proximity tracing. An infected person A gets tested positive for Sars-CoV-2, is referred to manual contact tracing (MCT) and receives and uploads a CovidCode to warn other app users. Person B was in close proximity. This person receives the app notification, upon which she has several options: calling an infoline (#1, recommended option), receiving a free test (#2), and/or staying home voluntarily (#3).

The estimation of different sub-populations is described in Table 1. Numbers in [square brackets] reflect estimates obtained through alternate calculation methods for parameters 2, 3, 4 & 7.

Abbreviations: MCT, manual contact tracing.

Figure 1 illustrates the app notification cascade. The numbers represent estimates obtained through the triangulation process. The calculations suggest that 429 of 1715 persons testing positive for Sars-CoV were app users. Of the 429 app users, 344 received and entered a CovidCode, which triggered notifications in an estimated 1’418 exposed contacts. These notifications led to 756 calls to the infoline, of which 166 callers received a quarantine recommendation. Furthermore, 30 app users tested positive for Sars-CoV-2 after notification; this estimate was corroborated by an alternative data source and calculation method (Table 1). The total number of persons getting tested after an app notification could not be estimated with good precision and are therefore not shown.

Overall, the 166 quarantine recommendations correspond to the equivalent of 5% of all exposed contacts placed in quarantine by manual contact tracing (n=3000). Per 10 uploaded Covidcodes (n=344), we estimate that almost 1 contact tested positive for Sars-CoV-2 after an app notification (n=30).
Discussion

The triangulation analysis for the Canton of Zurich has provided, for the first time, an estimation of the contribution of SwissCovid to pandemic mitigation at the population level. We estimate that app notifications may have contributed to (and in some instances triggered) actions to prevent further viral transmission in 30 infected persons who received testing after app notifications. Furthermore, we estimated that SwissCovid notifications led to self-quarantine recommendations in 166 persons. Overall, this estimate implies that the app could have led, at most, to an additional 5% of persons entering quarantine. Also noteworthy, the effort to identify these 166 persons likely was less labor- and resource-intensive than contact identification through manual contact tracing.

Apart from presumably lower personnel time requirements, DPT also offers potential benefits in notification speed and greater contact reach over manual contact tracing. (3) The present analysis is not directly informative regarding the realization of these potential advantages. But information from the Zurich Sars-CoV-2 Cohort, which was also used for the triangulation, suggests that 12.3% app-notified contacts received the notification before being reached by manual contact tracing. (6) The large increase in Sars-CoV-2 case-loads since mid-October may further accentuate the speed advantage, as manual contact tracing increasingly comes under strain and may suffer from delays.

A rising incidence of Sars-CoV-2 may also change other aspects of the DPT notification cascade in relevant ways. In September 2020, uptake of the app was steady at around 25% in the adult population. Data from a panel survey indicate that a perceived lack of effectiveness of SwissCovid may be a major reason for not using the app; cited by almost 30% of non-users in the survey. (7) The large increase of Sars-CoV-2 incidence may change this perception, as indicated by rising numbers of active app users (200’000 additional users in October (12)) and strengthened public appeals for app usage by health authorities since Mid-October. Increased SwissCovid app uptake will also increase the overall contribution of DPT to pandemic mitigation efforts. This prediction is supported by a simulation using data from the present analysis. Had all positive cases received and entered CovidCodes, the number of quarantine recommendations would have risen five-fold relative to the status quo (other parameters held equal).

A strength of our study is the systematic triangulation approach and the integration of different data sources. Reassuringly, independent, alternative calculation approaches for three parameters (table 1, parameters 2, 4, and 7) yielded similar results to the main analysis. Nevertheless, some limitations should be noted. Some of the parameters were derived from studies with limited sample sizes and follow-up (e.g. from the Zurich Sars-CoV-2 cohort study including 241 index cases in 169 close contacts by the end of September 2020). Other parameters were only available on a national level, therefore possibly not reflecting canton-specific differences adequately (e.g. regarding process efficiency of CovidCode generation or manual contact tracing). Moreover, the level of granularity for most parameters was limited. For example, it is unclear whether quarantine recommendations were followed or whether app-notified contacts were also identified by manual contact tracing. Further research studies are needed to examine these additional aspects, but also to corroborate the main findings from this analysis.

To conclude, by re-creating the user flow in the app notification cascade for the canton of Zurich, our analysis provides a first estimation of the public health contribution of SwissCovid. Our data suggest that the equivalent of 5% of all quarantined contacts may have additionally received a quarantine recommendation after app notification. Promoting app usage is expected to further increase the public health impact of SwissCovid.
References


