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Interim report 1 of recruitment and preliminary results related to the SwissCovid app from the Zurich SARS-CoV-2 Cohort study (ZSAC)

Version 02.11.2020:
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Executive Summary:

The SwissCovid digital proximity tracing (DPT) app was released on 25 June 2020 and currently has around 1.86 Mio. active users. DPT has three potential advantages over MCT:

1. DPT notification of exposed users is automatized once the infected index case has triggered the notification. This gives DPT a speed advantage over MCT (which often requires informing contacts individually).
2. DPT still works when manual contact tracing is reaching or exceeding capacity due to large numbers of infections.
3. DPT has a wider reach than MCT because it does not rely on an infected person's recollection of contact exposures.

The present study is based on data from the Zurich SARS-CoV-2 Cohort (ZSAC). By 30 September 2020, ZSAC had enrolled 327 index cases, 261 close contacts, and 75 index cases that converted from originally being traced as a close contact. Baseline socio-demographic characteristics of both index cases and close contacts were comparable with a median age of 35 and 38 years for close contacts and index cases, respectively. Approximately 50% of participants in both populations were female.

We first assessed app usage by both index cases and close contacts. Compared with other studies, self-reported use of the SwissCovid app was high with 72% of close contacts, 66% of converted persons, and 61% of index cases reporting permanent or occasional use of the app. It is possible that participants in the ZSAC study were generally better informed about Covid-19 and preventive measures, or more compliant with public health guidance. Reasons for non-use of the app were almost evenly distributed across the three pre-defined answer options "perception of uselessness" (23% and 28%), "technical problems" (25% and 17%), and "privacy concerns and data protection" (28% and 21%) for both close contacts and index cases.

Second, we evaluated whether recommended actions were followed by index cases after receiving a positive test result and by close contacts after receiving an app warning. Overall, 92% (n=232) of the index cases reported to have received the CovidCode; out of those, 96% (n=214) reported to have uploaded the code into their smartphone, thus triggering a warning to potentially exposed close contacts. Of 192 app users among close contacts, 73 (38%) received an app warning within 7 days of being contacted by manual contact tracers. Of those 73 warned app users, 9 (12%) persons received the app warning before being reached by manual contact tracing. After receiving the app warning, 14% of close contacts called the SwissCovid infoline, whilst the remainder undertook different (19%) or no actions (67%).

Third, we explored from the viewpoint of close contacts, whether app notifications led to a faster quarantine. More than 50% of same-household contacts entered quarantine on the same day (median 0 days for app users) or the day after (median 1 day for app non-user). Close contacts with a risk exposure outside the same household were notified substantially later: app non-users after a median of 2.5 days, users without a warning after 3 days and app users with a warning after 2 days.

In conclusion, our study points to a small benefit of SwissCovid by alarming non-household contacts 0.5 to 1 days earlier than manual contact tracing. If confirmed, this finding could be interpreted as first evidence for one of the postulated main advantages of DPT: to notify users faster than classic, manual contact tracing.

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Background

The rationale for digital proximity tracing

The SwissCovid digital proximity tracing (DPT) app was released on 25 June 2020 and currently has around 1.86 Mio. active users.(1) SwissCovid belongs to a new type of health technologies currently employed by several countries : decentralized, privacy-preserving proximity tracing (DP-3T).(2) Apps modelled after the DP-3T architecture allow users to remain anonymous and share only essential, non-identifiable data. They are a warning tool built on the premise of anonymity and voluntariness and are not designed as an epidemiological monitoring tool.

The SwissCovid app intends to break SARS-CoV-2 transmission chains as early as possible by informing persons with a proximity contact with a confirmed index case about the risk exposure.(3) DPT apps like SwissCovid are intended to complement manual contact tracing (MCT).(4) However, DPT has three potential advantages over MCT.(5) First, DPT notification of exposed users is automatized once the infected index case has triggered the notification. This gives DPT a speed advantage over MCT (which often requires informing contacts individually), by allowing rapid quarantine of exposed individuals to interrupt chains of transmission. Second, and along the same lines, DPT still works when manual contact tracing is reaching or exceeding capacity due to large numbers of infections. Third, DPT has a wider reach than MCT because it does not rely on an infected person's recollection of contact exposures.

What is known about use and effectiveness of SwissCovid?

Because DPT apps are a very novel health technology, its features and possible impact on pandemic mitigation are understood only partially.(5) In particular, it remains uncertain whether SwissCovid can deliver on its potential advantages over MCT. Preliminary results from several studies in Switzerland, posted as pre-prints, shed some light on factors associated with app uptake, reasons for non-use of the app (6), challenges to the non-technical implementation of SwissCovid (7), as well as the process efficiency of the SwissCovid notification cascade. Salathé and colleagues analyzed publicly available SwissCovid key performance indicators (including number of all app downloads and notification codes entered) and demonstrated proof of principle for app functioning, based on observations of persons tested positive for SARS-CoV-2 after app notification. (8) Their analysis also includes preliminary data from the study described in this report (Zurich SARS-CoV-2 Cohort Study; Annex 3). Furthermore, a very recent analysis of the SwissCovid notification cascade in September 2020 for the Canton of Zurich provides an even more detailed quantification of the different cascade steps (bit.ly/3mxgQF9, Annex 4). Based on triangulation of and simulations using aggregated data, the preliminary results suggest that DPT may lead to additional quarantine recommendations in the equivalent of up to 5% of all manually traced and quarantined close contacts.

The present study is based on data from the Zurich SARS-CoV-2 Cohort (ZSAC) and has the following three aims. First, we investigated the use of the SwissCovid app as well as reasons for non-use among index cases and close contacts in the Canton of Zurich. Second, we evaluated whether both populations followed the recommended actions; i.e., whether index cases uploaded notification codes (CovidCodes) to trigger warnings and whether close contacts called the SwissCovid infoline upon receipt of an app warning. Third, we explored from the viewpoint of close contacts, whether the time from exposure to quarantine was different between those receiving a warning by the app compared to app non-users.

Methods

Study design and participant recruitment

The Zurich Sars-CoV-2 Cohort Study (ZSAC) is an ongoing population-based longitudinal cohort study of individuals infected with SARS-CoV-2 and their close contacts in the Canton of Zurich. The cohort was established in collaboration with the health directorate of the Canton of Zurich (Gesundheitsdirektion; GD ZH) and aims to characterize clinical outcomes and immunological responses of index cases and examine patterns of transmission among index cases and their close contacts.

Individuals diagnosed with SARS-CoV-2 infection in the Canton of Zurich are identified through mandatory reporting of positive cases by the diagnostic laboratories to the GD ZH. Their close contacts are identified as part of routine contact tracing. All identified index cases and close contacts are screened for eligibility at the GD ZH. Index cases and close contacts are considered eligible if they are aged 18 years or older, residing in the Canton of Zurich, have sufficient knowledge of the German language and are cognitively able to follow the study procedures. Due to the high number of index cases and close contacts, adaptive random subsampling of the two populations is performed on a daily basis to ensure representativeness while maintaining feasibility of the project. Selected individuals are invited to participate in the study and informed consent is obtained. Enrolment into the cohort study began on 07.08.2020 and is planned to continue until February 2021. As of 31.10.2020, 593 individuals newly diagnosed with SARS-CoV-2 infection and 333 close contacts have been enrolled. In this analysis, we used data from 402 index cases and 261 close contacts enrolled between 07.08.2020 and 30.09.2020, when conditions changed due to the sharp increase in case numbers.

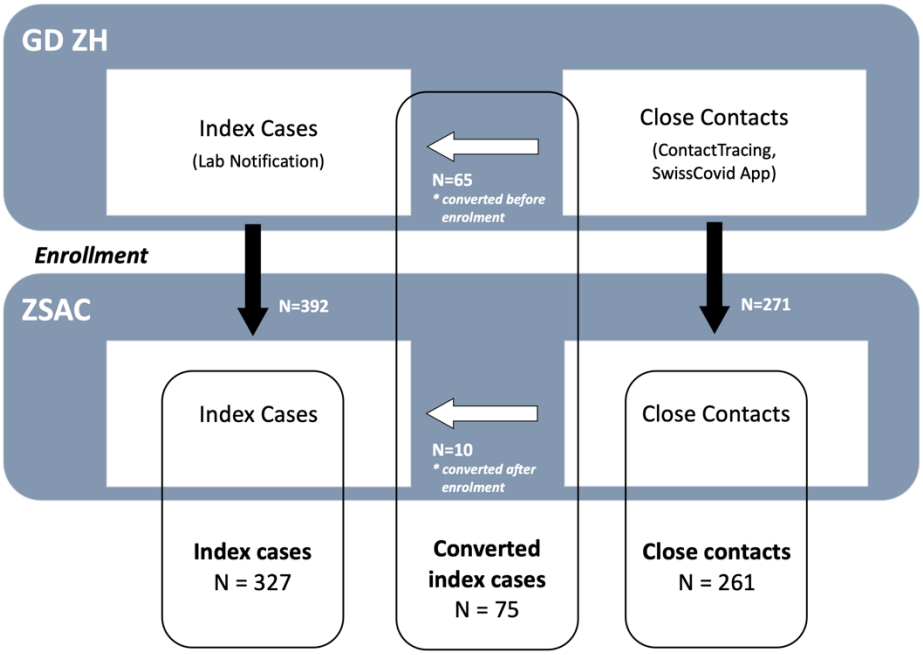
The study protocol was approved by the responsible ethics committee of the Canton of Zurich (Kantonale Ethik-Kommission Zürich; BASEC-Nr. 2020-01739) and prospectively registered on the International Standard Randomised Controlled Trial Number Registry (ISRCTN14990068).

Data collection

All data is collected and managed through the online survey system Research Electronic Data Capture (REDCap). Questionnaires for index cases include questions regarding socio-demographics, self-reported comorbidities, reason for SARS-CoV-2 testing and details on the suspected contact leading to SARS-CoV-2 transmission, as well as on symptoms, disease severity and burden. Similarly, questionnaires for close contacts elicit information regarding socio-demographics, symptoms, experiences with quarantine, and details on their contact with the index case (i.e., exposure setting, timing, type of contact). Both questionnaires include specific questions related to the use of the SwissCovid app, receipt and uploading of the CovidCode by index cases and app warnings received by close contacts (see Appendix 1 and 2). The questions were jointly developed by epidemiologists, public health and infectious disease experts.

Data both as a close contact and as an index case was available for 10 individuals that were initially enrolled as a close contact and later converted to an index case (i.e., tested positive after enrolment). Individuals originally identified by contact tracing as close contacts that converted before study enrollment were directly enrolled as index cases and thus only provided data as an index case (n=65; see Figure 1). Individuals pertaining to either of these groups were considered “converted index cases” in the analysis and contributed data on the level of both close contacts and index cases, where appropriate.

Figure 1: Study enrollment and populations in the Zurich SARS-CoV-2 Cohort study.



Outcomes and definitions

The outcomes of interest in this analysis are the following:

1. Use of the SwissCovid app in both index cases and close contacts and reasons for non-use. Participants were considered app users if they reported using the app permanently or occasionally. Those who reported not using the app, regardless of whether they intended to in the future or not, were considered app non-users.
2. Frequency of index cases who stated a SwissCovid app notification as the initial reason for SARS-CoV-2 testing.
3. Frequency of index cases who received and uploaded the CovidCode, thereby triggering a notification.
4. Frequency of close contacts who received an app warning and among those, the frequency of close contacts who received the warning before being contacted by the contact tracing team.
5. Time between exposure date to start of quarantine in close contacts across different exposure settings. Exposure date refers to the last day of relevant exposure of the close contact with the index case. This was estimated as 10 days prior to the last day of quarantine, as was determined by contact tracers and self-reported by participants. Exposure settings were described as reported by participants and classified into household and non-household settings, if known. Settings were classified as household if the participant reported living in the same household as the index case. Non-household settings include workplace, private settings (e.g. private events, friend's house), public settings (e.g. restaurant, supermarket, gym), healthcare facility, school or university, shared accommodation (e.g. nursing homes or assisted living facilities) and military or civil service.

Statistical methods

Descriptive analyses were performed on the full dataset containing information from all index cases and close contacts. Continuous variables are presented as median and interquartile ranges (IQR) and categorical variables are described using frequencies (N) and percentages (%), unless stated otherwise. Free text responses regarding reasons for non-use of the app, not uploading the CovidCode by index cases and steps taken by close contacts after receiving a warning, were reviewed. Based on their context, responses were coded without a preconceived categorization and reported in frequency and percentage. Based on app use and exposure setting, close contacts were stratified into 1) app non-users, 2) app users that received a warning and 3) app users that did not receive a warning. Descriptive analyses were used to compare baseline characteristics and the outcomes of interest across these groups. In an exploratory analysis, Kaplan meier curves were constructed to analyze the time between the exposure (i.e., the last relevant contact with the index case) and the beginning of quarantine (as self-reported by the participants) across different exposure settings and app use. We assumed an intrinsically faster notification time in household settings. All analyses were performed using R version 3.6.1.

Results

Baseline characteristics of the study population

By 30 September 2020, ZSAC had enrolled 327 index cases, 75 index cases that converted from originally being traced as a close contact and 261 close contacts (**Table 1).** The close contact and index case populations were largely similar with respect to socio-demographic characteristics. Median age of close contacts and index cases was 35 and 38 years, respectively. Approximately 50% of participants in both populations were female. Other characteristics such as Swiss nationality (84% and 79%), highest level of education reached (33% and 32% with a university degree), employment status (72% and 69% employed), and self-reported comorbidities (23% and 22% with at least one chronic comorbidity) were also comparable in close contacts and index cases. On the other hand, the baseline characteristics of converted index cases were slightly different compared to the other two populations, in which 55% were females, 24% had a university degree and 93% were of a Swiss nationality. More pronounced differences were observed with respect to epidemiological parameters. While 98% of close contacts and 93% of converted index cases had knowledge or a strong suspicion about the exposure setting, only 46% of index cases knew or suspected the setting in which SARS-CoV-2 transmission occurred. Among those with knowledge or suspicion regarding their exposure, the two most frequently reported settings were household and private settings for close contacts (29% and 26%, respectively) and converted index cases (53% and 26%, respectively). By contrast, public spaces (28%) and private settings (28%) were more frequently stated by index cases.

SwissCovid App use

Self-reported use of the SwissCovid app was high across groups, with 72% of close contacts, 66% of converted persons, and 61% of index cases reporting permanent or occasional use of the app. Reasons for non-use of the app were almost evenly distributed across the three pre-defined answer options “perception of uselessness” (23% and 28%), “technical problems” (25% and 17%), and “privacy concerns and data protection” (28% and 21%) for both close contacts and index cases. In the smaller group of converted index cases, privacy concerns were more dominant (32%). Lacking knowledge of the SwissCovid app was a negligible reason across all three groups. Around one in four non-users mentioned other reasons (Annex 5).

Compliance with recommended actions for SwissCovid users

Table 2 illustrates how app users among the index cases (n=242, including data from 49 converted index cases) followed the recommended actions after receiving the positive SARS-CoV-2 test results. Overall, 92% (n=232) reported to have received the CovidCode; out of those, 96% (n=214) reported to have uploaded the code into their smartphone, thus triggering a warning to potentially exposed close contacts. Reasons for not uploading the code included having received the code too late or their close contacts already being in quarantine.
Table 3 shows the app warning status and actions taken by close contacts (n=192, including data from 7 converted index cases). Of 192 app users, 73 (38%) received an app warning within 7 days of being contacted by manual contact tracers. Of those 73 warned app users, 9 (12%) persons received the app warning before being reached by manual contact tracing. After receiving the app warning, 14% of close contacts called the SwissCovid infoline, whilst the remainder undertook different (19%) or no actions (67%). Some among the ones not taking action reported to already have been reached by manual contact tracing.

Time from exposure to quarantine for exposed contacts

One advantage of SwissCovid pertains to a potentially faster notification of close contacts. As shown in **Table 4**, the time from risk exposure to quarantine differed substantially across exposure settings. More than 50% of same-household contacts entered quarantine on the same day (median 0 days for app users) or the day after (median 1 day for app non-user). Close contacts with a risk exposure outside the same household were notified substantially later: app non-users after a median of 2.5 days, users without a warning after 3 days and app users with a warning after 2 days.
The distribution of exposure times are visualized in a Kaplan-Meier plot (Figure 2). The figure confirms the shorter notification duration for same household contacts, without a discernible duration difference for app users. For non-household users, however, the app seemed to provide some advantage in terms of earlier time to quarantine.

Discussion

This study of 261 close contacts and 402 index cases (including 75 converted index cases) recruited through contact tracing in the Canton of Zurich provides important insights on SwissCovid app usage and sheds some first light on whether the app provides a speed advantage over manual contact tracing; a key aspect to demonstrate effectiveness. In this study, 71% of close contacts and 61% of all index cases reported to be using the SwissCovid app. Overall, the vast majority (89%; n=216) of app users among the index cases reported to have received and uploaded the SwissCovid code, thus completing all necessary steps to trigger the warning of close contacts.

Among the close contacts using the app, 38% (n=73) of all app users received a warning at a time that is compatible with the risk exposure determined by manual contact tracing (i.e. within 7 days of contact by manual contact tracing). Of those, 61% reported a non-household exposure and 39% a household exposure. However, only 9 of the 73 notified contacts received the app warning before being reached by the contact tracing team.

For close contacts, median times from exposure to start of quarantine were very fast for contacts from the same household. In this setting, most entered quarantine either on the same day or the day after exposure to an index case. This was expected, as household members are easier to identify and inform. By contrast, informing non-household members is commonly more time-consuming, which may be indicated by the longer median times from exposure to quarantine, ranging from 2 to 3 days across our analysis groups. Of note, the group of close contacts with non-household exposures who received app notifications nominally had the shortest median time to

quarantine (2 days), followed by app non-users (2.5 days) and users without notification (3 days). If confirmed in more detailed analyses (in progress), the time difference may indeed by relevant. For instance, the modelling study by Ferretti illustrates that bringing down the time to quarantine from 3 to 2 days has a large impact on the app having an effect. (3) By contrast, there was no discernible speed advantage between app non-users and users with or without a warning among persons reporting same-household exposure. However, this finding is not surprising due to the faster information flow within households.

Our finding of a possible speed advantage by warnings issued through the SwissCovid app requires more detailed analyses and further confirmation, also because only 12% of close contacts warned by the app reported to have received the notification before being reached by manual contact tracing. While this percentage may seem small, our study also emphasizes that effectiveness evaluations of DPT should focus on specific subgroups, for example by distinguishing by risk exposure setting. The biggest effect is expected to be seen for risk exposures where the index case and close contact do not know each other or when there are no frequent interactions, such as in non-household settings.

In our study, app usage was very high and exceeding estimates based on official counts of active app users (1) or surveys (6). This discrepancy with other studies is not easy to reconcile. But it is possible that the group of index cases and close contacts who agreed to participate in the ZSAC study were generally better informed about Covid-19 and preventive measures, more concerned about the health impacts of Covid-19, or more compliant with public health guidance. Therefore, the data presented here may reflect rather favorable circumstances for app usage. Delivery of CovidCodes seemed efficient in our study sample, and most index cases who were app users chose to upload the code, thus contrasting with the reported gap between generated and entered CovidCodes of nearly 30%.(8) However, some of the participants also reported significant delays with the issuing of the CovidCodes, which may point towards a potential for improvement in the necessary processes.

A further limitation of the ZSAC study is that it is unable to collect information on persons warned by the app who never come onto the radar of manual contact tracing (i.e., because they were never named as close contacts). To study DPT effectiveness regarding the goal of reaching more close contacts will require different sources of DPT, it cannot be addressed using the ZSAC data, which relies on contacts identified by manual contact tracing. Furthermore, the ZSAC study was conducted during a time period when SARS-CoV-2 incidence was comparatively low, and contact tracing was not yet operating at capacity limits. As manual contact tracing comes under strain with increasing SARS-CoV-2 incidence, it is possible that the percentage of persons first informed by DPT may also increase. DPT has the potential to act as a second line of defense if manual contact tracing no longer works optimally. However, it remains to be seen whether this potential benefit also materializes in the ZSAC study. The currently high case loads in the canton of Zurich also affect the ability of contact tracers to identify exposed close contacts, thus also affecting ZSAC recruitment of new close contacts. In light of these developments, the ZSAC study has adapted the questionnaire for index cases to collect further data on app usage and app warnings.

In conclusion, our study points to a small benefit of SwissCovid by alarming non-household contacts 0.5 to 1 days earlier than manual contact tracing. If confirmed, this finding could be interpreted as first evidence for one of the postulated main advantages of DPT: to notify users faster than classic, manual contact tracing. Further steps in the assessment of SwissCovid app effectiveness include a closer and more detailed inspection of the actual sequence and timing of different steps in the notification cascade through the analysis of data within pairs of close contacts and their respective index cases.

Table 1- Baseline characteristics of the study population

Variable	Close contact, N = 261[1]	Converted index case, N = 75[1, 2]	Index case, N = 327[1]
Age, years	35 (28, 51)	39 (28, 55)	38 (29, 51)
Gender			
Female	128/261 (49%)	41/75 (55%)	163/327 (50%)
Male	133/261 (51%)	34/75 (45%)	164/327 (50%)
Education			
None	1/257 (0.4%)	2/75 (2.7%)	3/323 (0.9%)
Only mandatory school	8/257 (3.1%)	2/75 (2.7%)	10/323 (3.1%)
Vocational training	58/257 (23%)	14/75 (19%)	89/323 (28%)
Vocational/specialized baccalaureate	31/257 (12%)	11/75 (15%)	42/323 (13%)
Higher technical school or technical college	74/257 (29%)	28/75 (37%)	76/323 (24%)
University studies (including applied sciences)	85/257 (33%)	18/75 (24%)	103/323 (32%)
(Missing)	4	0	4
Employment status			
Employed	185/256 (72%)	55/74 (74%)	222/323 (69%)
Self-employed	12/256 (4.7%)	5/74 (6.8%)	35/323 (11%)
Student	32/256 (12%)	7/74 (9.5%)	27/323 (8.4%)
Retired	10/256 (3.9%)	5/74 (6.8%)	18/323 (5.6%)
Unemployed	6/256 (2.3%)	0/74 (0%)	8/323 (2.5%)
Other	11/256 (4.3%)	2/74 (2.7%)	13/323 (4.0%)
(Missing)	5	1	4
Monthly household income			
<6000 CHF	87/247 (35%)	25/72 (35%)	110/310 (35%)
6000-12000 CHF	101/247 (41%)	38/72 (53%)	117/310 (38%)
>12000 CHF	59/247 (24%)	9/72 (12%)	83/310 (27%)
(Missing)	14	3	17
Nationality			
Swiss	220/261 (84%)	70/75 (93%)	257/327 (79%)
Non-Swiss	41/261 (16%)	5/75 (6.7%)	70/327 (21%)
Chronic comorbidity			
At least one self-reported comorbid condition	57/252 (23%)	15/71 (21%)	69/315 (22%)
No self-reported comorbid conditions	195/252 (77%)	56/71 (79%)	246/315 (78%)
(Missing)	9	4	12
Known exposure setting			
Knows or has strong suspicion	253/257 (98%)	70/75 (93%)	150/325 (46%)

Variable	**Close contact**, N = 261[1]	**Converted index case**, N = 75[1, 2]	**Index case**, N = 327[1]
No	4/257 (1.6%)	5/75 (6.7%)	175/325 (54%)
(Missing)	4	0	2
Exposure setting (among those with known/suspected exposure)			
Household	72/252 (29%)	37/70 (53%)	20/148 (14%)
Workplace	43/252 (17%)	2/70 (2.9%)	23/148 (16%)
Private setting	66/252 (26%)	18/70 (26%)	42/148 (28%)
Public space	45/252 (18%)	9/70 (13%)	43/148 (29%)
School/University	8/252 (3.2%)	0/70 (0%)	1/148 (0.7%)
Other	18/252 (7.1%)	4/70 (5.7%)	19/148 (13%)
Healthcare facility	0/252 (0%)	0/70 (0%)	0/148 (0%)
(Missing)	1	0	2
SwissCovid app use			
App non-user	73/258 (28%)	25/74 (34%)	125/324 (39%)
App user	185/258 (72%)	49/74 (66%)	199/324 (61%)
(Missing)	3	1	3
Reasons for non-use of the app			
No knowledge of the app	1/57 (1.8%)	2/19 (11%)	6/103 (5.8%)
Perception of uselessness	13/57 (23%)	3/19 (16%)	29/103 (28%)
Technical problems	14/57 (25%)	3/19 (16%)	17/103 (17%)
Privacy and data protection	16/57 (28%)	6/19 (32%)	22/103 (21%)
Other	13/57 (23%)	5/19 (26%)	29/103 (28%)
(Missing)	16	6	22

[1] Statistics presented: Median (IQR); n/N (%)

[2] Converted refers to those identified as close contacts by contact tracing and that have tested positive either before or after enrolment

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Table 2: CovidCodes received and uploaded by index cases who are app users

Variable	Index cases; N = 249[1,2]
Received CovidCode	223/242 (92%)
(Missing)	7
Uploaded CovidCode	214/223 (96%)
Reasons for not uploading the CovidCode	
Did not work/Code invalid	3/8 (38%)
Received the code too late/Had already informed their contacts	2/8 (25%)
Believed data has already been deleted	1/8 (12%)
Close contacts already in quarantine	1/8 (12%)
Not yet received	1/8 (12%)
(Missing)	1

[1] Statistics presented: n/N (%)
[2] Includes «Converted» cases

Table 3: App warnings received and steps taken by close contacts who are app users

Variable	Close contacts; N = 192[1,2]
Received a warning by the app	
Yes, in the last 7 days probably because of the current contact	73/192 (38%)
Yes, more than 7 days ago	2/192 (1.0%)
No warning	117/192 (61%)
Warned by the app before the cantonal medical service	9/73 (12%)
(Missing)	2
Steps taken after receiving an app warning	
Called SwissCovid infoline	10/72 (14%)
Other steps taken	14/72 (19%)
No steps taken	48/72 (67%)
(Missing)	3
Other steps taken	
Had already taken measures[3] after being traced by contact tracing	6/16 (38%)
Had already taken measures[3] following family/friend's advice	6/16 (38%)
Called cantonal medical service	1/16 (6.2%)
Testing	1/16 (6.2%)

[1] Statistics presented: n/N (%)

[2] Includes "Converted" cases for whom data as a close contact was available (i.e. converted after enrolment)

[3] Includes SARS-CoV-2 testing and quarantine

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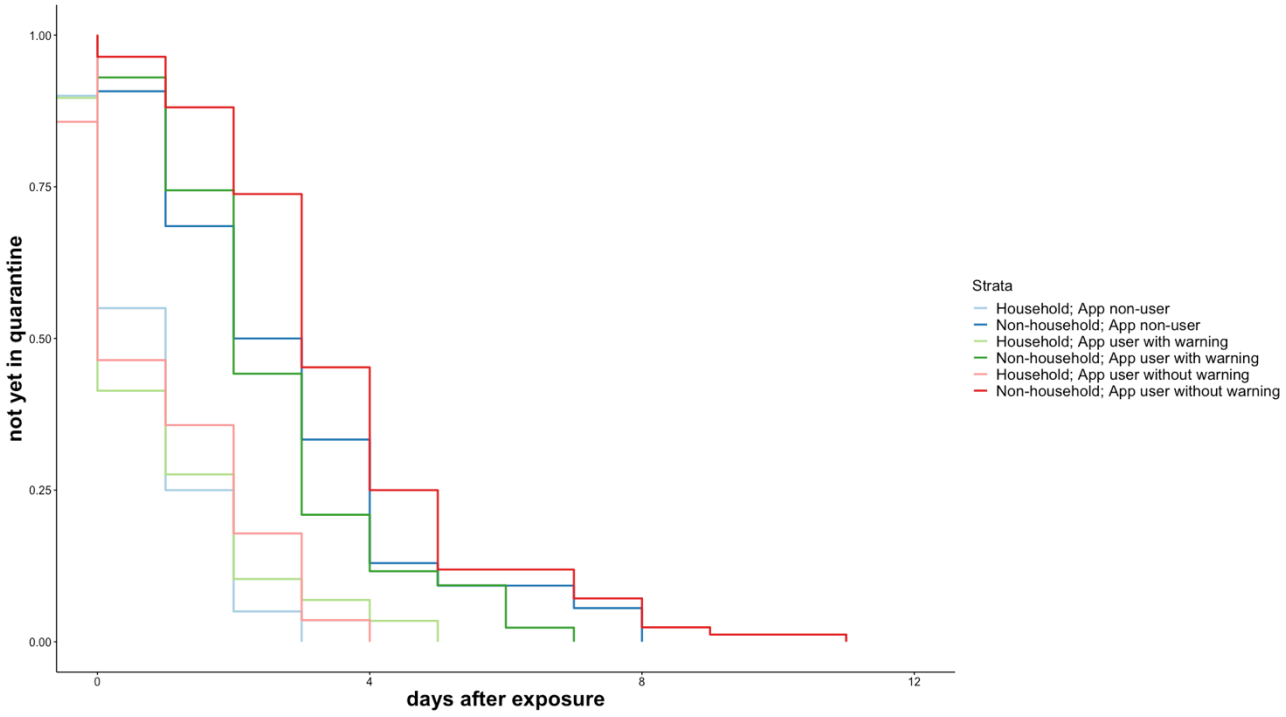
Table 4: Time between exposure and initiation of quarantine among close contacts, stratified by app use and receipt of app warning.

Variable	App non-user		App user with no warning		App user and received a warning	
	Household, N = 20[1]	**Non-household**, N = 54[1]	**Household**, N = 28[1]	**Non-household**, N = 87[1]	**Household**, N = 29[1]	**Non-household**, N = 44[1]
Time from exposure to quarantine, days[2]	1.0 (0.0, 1.2)	2.5 (1.0, 4.0)	0.0 (0.0, 2.0)	3.0 (2.0, 4.2)	0.0 (0.0, 2.0)	2.0 (1.5, 3.0)
Warned by the app before MCT	-	-	-	-	1/29 (3.4%)	8/42 (19%)

[1] Statistics presented: n/N (%); Median (IQR)
[2] Exposure date considered end of quarantine – 10 days
[3]GD contact date considered 1 day before enrolment

Figure 2: Time from exposure to quarantine for close contacts (N=261), stratified by app use and app warning status



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Annex 1: Questions related to the SwissCovid app for index cases

Gebrauch der SwissCovid App

Die SwissCovid App wird vom Bundesamt für Gesundheit herausgegeben, um Personen per Smartphone vor möglichen Ansteckungsrisiken zu warnen. Die App merkt sich, wenn ein Kontakt länger als 15 Minuten und näher als 1.5 Meter bestand. Wird bei einer Person mit der App das neue Coronavirus festgestellt, kann diese Person anonym andere App-Nutzerinnen/-Nutzer warnen, die sich während der Ansteckungsphase in ihrer Nähe aufgehalten haben.

1. Verwenden Sie die SwissCovid App?
- Ja, ständig
- Ja, aber manchmal schalte ich Bluetooth aus, um die Funktion der SwissCovid App zu unterbrechen
- Nein, ich habe die App wieder deinstalliert
- Nein, aber ich plane Sie zu verwenden
- Nein

2. Wenn 1=Nein
Weshalb verwenden Sie die SwissCovid App gegenwärtig nicht?
- Ich kenne die App nicht
- Ich denke nicht, dass die App für mich nützlich ist
- Ich kann die App nicht installieren (z.B. wegen technischer Probleme, weil ich kein Android oder iOS Smartphone habe)
- Ich fürchte um meine Privatsphäre und den Datenschutz
- Andere Gründe (bitte angeben)

3. Wenn 1=Ja
Hat die SwissCovid App schon mal eine Warnung ausgegeben, dass Sie mit einer mit dem Coronavirus infizierten Person in Kontakt waren?
- Ja, vermutlich wegen dem aktuellen Kontakt (d.h. in den letzten 7 Tagen)
- Ja, zu einem früheren Zeitpunkt (d.h. vor mehr als 7 Tagen)
- Ja, sowohl vermutlich wegen dem aktuellen Kontakt, wie auch schon einmal zu einem früheren Zeitpunkt
- Nein, ich hatte bisher keine Warnung

4. Wenn 3="Ja, aktuell" (Option 1 & 3)
Haben Sie eine Warnung durch die SwissCovid App erhalten, bevor Sie vom kantonsärztlichen Dienst kontaktiert wurden?
- Ja
- Nein

5. Wenn 4="Ja" (Options 1-3)
Welche Schritte haben Sie unternommen, nachdem Sie von der App gewarnt wurden?
- Ich habe die empfohlene Infoline SwissCovid angerufen
- Ich habe andere Schritte unternommen, und zwar Folgende (bitte angeben)
- Ich habe keine weiteren Schritte unternommen

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Annex 2: Questions related to the SwissCovid app for closed contacts

Gebrauch der SwissCovid App

Die SwissCovid App wird vom Bundesamt für Gesundheit herausgegeben, um Personen per Smartphone vor möglichen Ansteckungsrisiken zu warnen. Die App merkt sich, wenn ein Kontakt länger als 15 Minuten und näher als 1.5 Meter bestand. Wird bei einer Person mit der App das neue Coronavirus festgestellt, kann diese Person anonym andere App-Nutzerinnen/-Nutzer warnen, die sich während der Ansteckungsphase in ihrer Nähe aufgehalten haben.

1.	Verwenden Sie die SwissCovid App?	• Ja, ständig • Ja, aber manchmal schalte ich Bluetooth aus, um die Funktion der SwissCovid App zu unterbrechen • Nein, ich habe die App wieder deinstalliert • Nein, aber ich plane Sie zu verwenden • Nein
2.	Wenn 1=Nein Weshalb verwenden Sie die SwissCovid App gegenwärtig nicht?	• Ich kenne die App nicht • Ich denke nicht, dass die App für mich nützlich ist • Ich kann die App nicht installieren (z.B. wegen technischer Probleme, weil ich kein Android oder iOS Smartphone habe) • Ich fürchte um meine Privatsphäre und den Datenschutz • Andere Gründe (bitte angeben)
3.	Wenn 1=Ja Haben Sie einen CovidCode erhalten (Freigabecode, den Sie von den kantonalen Behörden aufgrund des positiven Coronavirus-Tests bekommen, um über die App andere Personen zu warnen)?	• Ja • Nein
4.	Wenn 3=Ja Haben Sie den CovidCode in der SwissCovid App eingegeben, um die anonyme Benachrichtigung anderer App-Nutzer/-Nutzerinnen zu aktivieren?	• Ja • Nein
5.	Wenn 4=Nein Können Sie den Grund angeben, warum Sie den CovidCode nicht aktiviert haben bzw. nicht aktivieren konnten?	Freitext

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Annex 3: Working Paper "Early Evidence of Effectiveness of Digital Contact Tracing for SARS-CoV-2 in Switzerland" (including aggregated data from ZSAC; https://www.medrxiv.org/content/10.1101/2020.09.07.20189274v3), see separate PDF.

Annex 4: Working Paper "The contribution of the SwissCovid digital proximity tracing app to pandemic mitigation in the Canton of Zurich" (including aggregated data from ZSAC; https://bit.ly/3mxgQF9), see separate PDF.

Annex 5: Other reasons for non-use of the SwissCovid app, as reported by participants.

Characteristic	**Close contact**, N = 261[1]	**Converted index case**, N = 75[1]	**Index case**, N = 327[1]
Consumes too much battery	2/57 (3.5%)	2/19 (11%)	5/103 (4.9%)
Not the right phone	0/57 (0%)	0/19 (0%)	5/103 (4.9%)
Data costs	1/57 (1.8%)	0/19 (0%)	0/103 (0%)
Does not always have internet or doesn't carry a cell phone often	2/57 (3.5%)	0/19 (0%)	3/103 (2.9%)
Almost always has bluetooth off	1/57 (1.8%)	0/19 (0%)	1/103 (1.0%)
Uncertainty of the Bluetooth connection	1/57 (1.8%)	0/19 (0%)	0/103 (0%)
App not working correctly	1/57 (1.8%)	0/19 (0%)	0/103 (0%)
No confidence in the app	1/57 (1.8%)	0/19 (0%)	0/103 (0%)
Privacy and worries about false reports	2/57 (3.5%)	0/19 (0%)	0/103 (0%)
Does not believe infected persons report their infection	0/57 (0%)	1/19 (5.3%)	0/103 (0%)
Worried about the consequences of getting a notification (i.e. quarantine)	0/57 (0%)	0/19 (0%)	2/103 (1.9%)
Feels constant stresss/panic with the app	0/57 (0%)	1/19 (5.3%)	2/103 (1.9%)
Believes it is no longer recommended by the health department	0/57 (0%)	0/19 (0%)	1/103 (1.0%)
Has to turn it off at work	0/57 (0%)	0/19 (0%)	2/103 (1.9%)
Uses German corona app (border crosser)	0/57 (0%)	0/19 (0%)	1/103 (1.0%)
Personal decision/No specific reason	1/57 (1.8%)	0/19 (0%)	4/103 (3.9%)

[1] Statistics presented: n/N (%)