Configuration testing Smittestopp v2.0 – report

21. December 2020

Methods

Configuration settings

Through experience from Denmark, we chose to use attenuation "buckets" to identify individuals who should receive a notification according to proximity and duration to someone who tested positive for COVID-19 (Tabell 1).

Tabell 1. Overview of configuration using in Smittestopp app for scenario-based testing

Bucket	Configuration 1	Configuration 2
Low	<57	<57
Middle	57-63	57-68
High	>63	>68

Testing set-up

For the testing of the configurations, we used a set of 40 phones with a mix of android and iOS operating systems as well as a mix of brands for the android phones. These phones represented the majority of phones used on the Norwegian market; an overview of the phones used can be found in the appendix. For configuration 1 we used build 37 for iOS and 19 for android, for configuration 2 we used build 52 and 33 respectively. In between all runs, all data from the phones were cleaned and the app reinstalled. To work around notifications not being send on phones on the same day as the app being installed, we used a debug mode on android or adjusted to date prior to notifying infection on iPhones.

Set-up scenario's

To test the configurations in the app, we set up simulations of two scenarios where people are likely to be nearby unknown individuals, namely a queue and in public transport. Each scenario was done several times, with a different mix of several phones (appendix). For each scenario we included ten participants who carried two phones with a development version of Smittestopp installed. They were asked to carry one phone in their hand and put one phone in their pocket. Of the ten participants, one person was identified as "infected" (ID=10), four people (ID= 1, 2, 3 and 9) fell under the definition used for "close contact" in manual contact tracing (≤2 meters for ≥15 min) and 5 people did not fit this definitions (either ≤2 meters for ≤15 min or >2 meters). At the start of each scenario all testers, expect the "infected" were asked to turn on the app and take their place. Once everyone was in their starting position, the "infected" turned on the app on his/her phones and the time started. When a tester left the scenario, the app was deactivated immediately. All testers were asked to disinfect hands before each run, wear a face mask and leave the room after they finished. In addition, all surfaces and phones were disinfected between runs.

Scenario 1 – queue

In the queue scenario, one tester was situated in the position of a cashier and all other testers were positioned 1 meter apart in a queue. After start of the scenario, everyone moved up one place closer to the cashier every 4 minutes and left the scenario after standing in front of the cashier (Figure 1). The total duration of this scenario was 20 min. For configuration 1 this scenario was done four times and for configuration 2 this scenario was done twice.

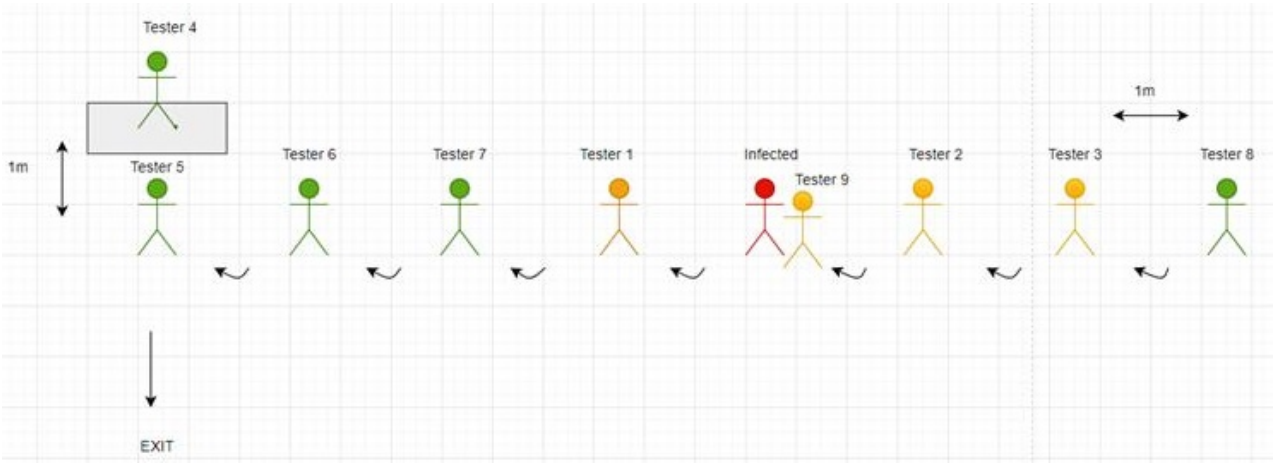


Figure 1. Schematic representation of the "queue scenario".

Red: "infected" tester, "orange" tester within the definition of "close contact" and "green" tester not according to definition of "close contact".

Scenario 2 – public transport

In the public transport scenario, we used the measurements of city buses as provided by ruter. The distance between two neighboring chairs was slightly wider as we did not have access to chairs that was as narrow as those used in the buses. In this simulation, testers were sitting in a bus and leaving the bus at "bus stops" every 4 minutes. The duration of the scenario was 20 minutes and the "infected" stayed in the bus during the whole scenario. Starting set-up and movements can be found in Figure 2.

FIGURE OF PUBLIC TRANSPORT SCENARIO

Figure 2 Schematic representation of the "public transport" scenario.

Red: "infected" tester, "orange" tester within the definition of "close contact" and "green" tester not according to definition of "close contact".

Data collection and analyses

After each run, the app on one of the phones of the "infected" tested was activated and infection was notified via the "mock" verification system. The keys of this notification were saved and checked with the keys received on the exposed phones. Via development tools, keys were pulled on each of the exposed phones (19 per run) and the exposure summary and information were collected in an excel sheet. After all data was entered, the phones were cleaned, and the app reinstalled for the next test run.

We calculated the notification rates using different weights for each of the buckets and time threshold. We chose weights between 100% and 250% for the low and middle (high bucket is always 0) and time thresholds between 10 and 15 minutes. Notification rates were calculated for individuals who did and did not fall within the definition of "close contact" in manual contact tracing. In addition, we determined differences in notification rates between phones held in hand or in pocket, android or iOS operating systems using $\chi 2$

Results

In total 13 phones had to be excluded due to errors (Tabell 2); 6 phones with iOS 13.6, 3 phones had the wrong date, 1 phone was not turned off after the scenario and 3 phones gave a technical error pulling data. Of these 3 were excluded with the 2nd configuration.

Tabell 2 Tabulation of scenario exclude

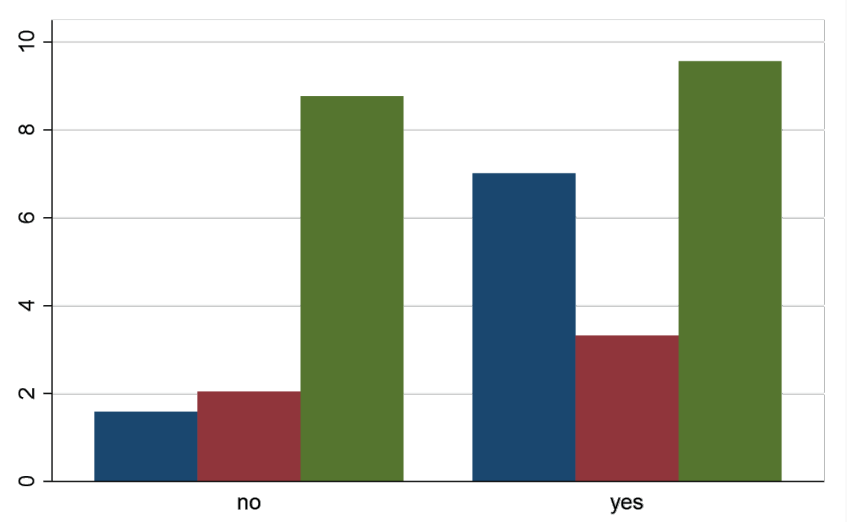
Scenario		Excluded		
		No	Yes	Total
Scenario 1 - queue	N	107	7	114
	%	93.86	6.14	100.00
Scenario 2 - bus	N	127	6	133
	%	95.49	4.51	100.00
Total	N	234	13	247
	%	94.74	5.26	100.00

Configuration 1.

In total we collected 161 data point for configuration 1; 78 among phones that were within 2 meters for over 15 minutes and 83 that were not (Tabell 3). Figur 1 shows the mean time registered in each bucket for those according to contact definition (yes) and not (no)

Tabell 3 Overview data from configuration 1

≤2 meters ≥15 min		**Location**		
		hand	**pocket**	**Total**
no	N	41	42	83
	%	49.40	50.60	100.00
yes	N	35	43	78
	%	44.87	55.13	100.00
Total	N	76	85	161
	%	47.20	52.80	100.00



Figur 1 Mean time spend in each of the buckets among people who are within contact definition of covid-19 (yes) and are not (no) using configuration 1. Blue: low, red: middle and green: high.

In total, 69% of contacts and 45% of others registered time in the low or middle bucket and could therefore theoretically receive an exposure notification. We adjusted the weights and times thresholds of the buckets to identify the best combination to increase the proportion of contacts who received a notification compared to others (Tabell 4). The highest notification rate among contact was 63% with weights of 250 on the low bucket, 200 on the middle bucket and a time threshold of 10 minutes. With this configuration, the exposure notification rate of close contacts was significantly lower among iOS phones (51% iOS and 73% android, p=0.046), whereas having the phone in the pocket only affected others significantly (49% phone in hand, 14% phone in pocket, p=0.001).

Tabell 4 Overview of exposure notifications among contacts and others using configuration setting 1 and diverse weights

Low bucket	**Middle bucket**	**Time threshold**	**Contacts (78)** (≤2 m AND ≥15 min) %	**Others (83)** (>2m or ≥15 min) %
250	100	10	60.26	20.48
		13	55.13	15.66
		15	51.28	13.25
250	150	10	61.54	22.89
		13	60.26	19.28
		15	55.13	16.87
250	200	10	62.82	31.33
		13	61.54	20.48
		15	60.26	19.28
200	100	10	60.26	19.28
		13	51.28	14.46
		15	48.72	12.05
200	150	10	61.54	22.89
		13	56.41	19.28
		15	53.85	13.25

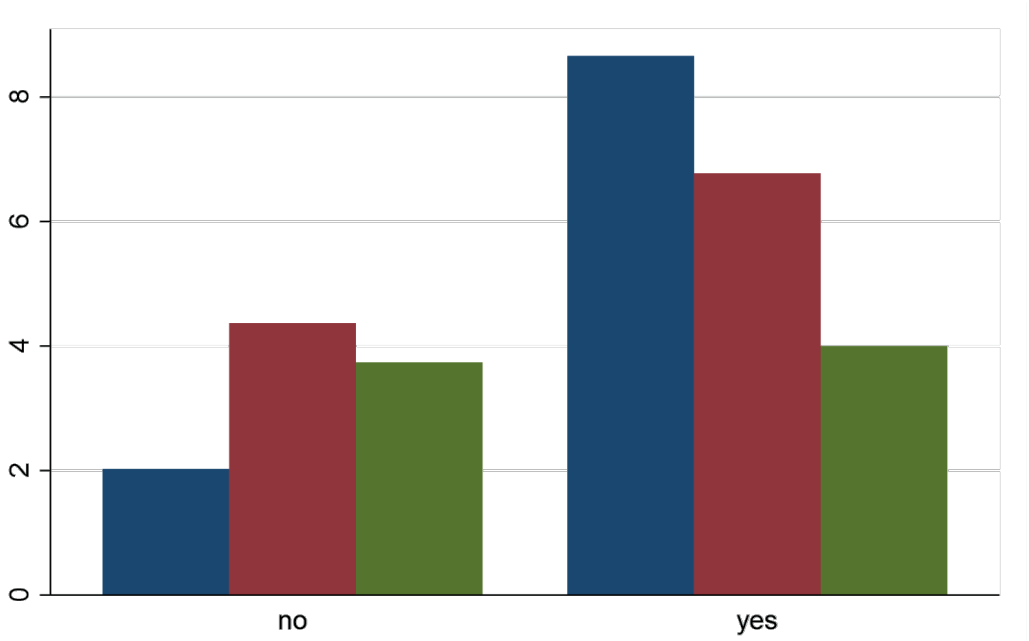
Based on these results, we adjusted the configuration settings to increase the notification rates among contacts (configuration 2; low<57, middle 57-68 and high >68).

Configuration 2.

In total, we collected 73 data points with configuration 2; 35 among contacts and 38 among others (Tabell 5). Figur 2 shows the mean time registered in each bucket for those according to contact definition (yes / no).

Tabell 5 Overview of data points collected with configuration 2.

≤2 meters ≥15 min		**Location**		
		hand	**pocket**	**Total**
no	N	18	20	38
	%	47.37	52.63	100.00
yes	N	17	18	35
	%	48.57	51.43	100.00
Total	N	35	38	73
	%	47.95	52.05	100.00



Figur 2 Mean time spend in each of the buckets among people who are within contact definition of covid-19 (yes) and are not (no) using configuration 2. Blue: low, red: middle and green: high.

In total 94% of contacts and 68% of others registered time in the low or middle buckets. We adjusted the weights and times thresholds of the buckets to identify the best combination to increase the proportion of contacts who received a notification compared to others (Tabell 6). The highest notification rate among contacts was 89% using weights of 250 for low and 200 for middle, with a time threshold of 10 min. However, this also resulted in exposure notification of 55% of others in our scenario. Based on the results, we chose to use weights of 200 for low and 150 for middle with a time threshold of 13 minutes, which resulted in exposure notifications of 80% of contacts and 34% of others. Below, more details of this configuration are shown.

Tabell 6 Overview of exposure notifications among contacts and others using configuration 2 and diverse weights

Low bucket	**Middle bucket**	**Time threshold**	**Contacts (78)** (≤2 m AND ≥15 min) %	**Others (93)** (>2m or ≥15 min) %
250	100	10	80.00	39.47
		13	74.29	26.32
		15	71.43	23.68
250	150	10	85.71	44.74
		13	80.00	34.21
		15	80.00	34.21
250	200	10	88.57	55.26
		13	85.71	39.47
		15	82.86	39.47
200	100	10	80.00	39.47
		13	71.43	26.32
		15	71.43	23.68
200	150	10	85.71	44.74
		13	80.00	34.21
		15	77.14	34.21

The notification rates among contacts were lower when the phone was in the pocket and if the phone was running on iOS (Tabell 7).

Tabell 7 Overview of notification rates between different settings among contacts and others. (p-value shows the difference in notification rates among contacts between the different settings)

Variable		**Contacts (78)** (≤2 m AND ≥15 min) %	**Others (93)** (>2m or ≥15 min) %	**p-value**
Scenario				
	Queue	76.47	31.58	
	Public transport	83.33	36.84	*0.612*
Location				
	Hand	94.12	44.44	
	Pocket	66.67	25.00	*0.042*
Type of operating system				
	iOS	68.42	21.05	
	Android	93.75	47.37	*0.062*

When looking at the notification among others, only 19% of others that were more than 2 meters from the infected phone were notified, compared to 66.7% of those within 2 meters for a shorter period of time (p=0.004).

Conclusion

On average, we manage identify 80% of phones who belong to people adhering to the contact definition (≤2 m for ≥15 min) and 34% of other contacts. Among the other contacts, especially people who are within 2 meters for a shorter period of time will also receive a notification.

Assuming risk is higher with closer proximity, the high notification rates among people who are within 2 meter is acceptable. In addition, the low notification rate (19%) of people between 2 and 4 meters indicate that people further than the measured distances will probably even less likely to receive a notification.

Taking this into account in combination with the current Norwegian recommendation of getting tested as soon as possible, we decided to use configuration 2 with weights of 200% for the low and 150% for the middle buckets and a time threshold of 13 minutes. Evaluation after launch will support the need of changing these thresholds.