Evaluation CoronaMelder

An overview after 9 months

Small but appreciable added value during lockdown, with greater potential benefit as society reopens

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Preface

CoronaMelder is technology's contribution to the battle against the coronavirus pandemic. Technology as it has never, or hardly ever, been used before by any government. Many people had a lot of questions about the CoronaMelder app, including us. We hope that this evaluation will contribute to a better understanding of the role that technology is playing and can play in the battle against coronavirus.

The many studies and findings of recent months have been discussed by the various advisory bodies: the Supervisory Committee for Digital Support in the Battle against Covid-19 (DOBC) and the Behavioural Science & DOBC Taskforce. We are grateful to all the members of the supervisory committee and the two taskforces, and of course also to the many researchers whose advice we have sought in recent months, for their feedback and cooperation regarding the different methods and analyses.

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Management summary

The Dutch contact tracing app CoronaMelder app is one of the tools used by the Dutch government to combat coronavirus. The app has two goals:

1. CoronaMelder is used as a supplement to regular contact tracing to reach more people who have been in contact with a person with a positive test result more quickly
2. Secondly, the CoronaMelder app is designed to prevent the spread of coronavirus by giving advice (‘options for action’) after users have received a notification, such as 'get tested' or 'go into quarantine'.

Right from the first trial of the app in the second half of August 2020, an ongoing evaluation was begun to ascertain whether CoronaMelder would achieve these two goals in practice and to what extent the app was leading to any unintended effects – negative or otherwise. This ongoing evaluation consists of several separate studies. The ongoing evaluation is not only about determining the extent to which these goals are being achieved. The results of the ongoing evaluation have also been used, where necessary, to propose changes to the app, the associated options for action, communication and policy.

Nine months after the evaluation of CoronaMelder started, a number of epidemiological impact studies have also been completed. This means that we are now able to bring together all the findings from the studies that have been part of the ongoing evaluation of the CoronaMelder app so far.

Complementing regular contact tracing
The extent to which CoronaMelder as a digital contact tracing tool complements regular contact tracing can be evaluated in four different ways.

First of all by investigating whether CoronaMelder can help identify cases that would otherwise have remained invisible with regular contact tracing. The question, then, is how many people requested a test after receiving a CoronaMelder exposure notification but were never contacted by the Dutch regional public health services called ‘GGD’ (Gemeentelijke Gezondheidsdiensten) to inform them that they had been in contact with someone who had tested positive. Based on an epidemiological impact study (a questionnaire study that looked at what people do after they received a notification from CoronaMelder), it is estimated that more than half of the people who scheduled a test after receiving a notification from CoronaMelder were never approached by the GGD. That means that without the CoronaMelder app, these people would not have got tested (or only if/when they experienced symptoms).

Secondly, by determining the percentage of people who tested positive after requesting a test following a CoronaMelder notification and who did not have symptoms at that time. If this percentage is higher than the percentage of positive tests that would be found through random screening, it would be a second indication that CoronaMelder is a valuable addition to regular contact screening and efficiently identifies more cases. This appears to be the case, as approximately 3% to 5% of people without symptoms who requested a test following a CoronaMelder notification tested positive every week. The detection rate of random screening over the same period is estimated to be lower, i.e. approximately 1% or lower.

Thirdly, by investigating whether CoronaMelder can detect cases more quickly than regular contact tracing. This often turns out to be the case. For example, at the end of May 2021, 77% of people who arranged a coronavirus test following a notification from CoronaMelder had not yet been approached through regular contact tracing at the time of arranging that test.

Finally, we examined how CoronaMelder relates to regular contact tracing, which was done by both an epidemiological analysis of contact tracing data[1] collected routinely (routine contact tracing data) conducted by the umbrella organization GGD GHOR[2] as well as a model study into the effects of CoronaMelder in relation including the regular contact tracing conducted by the Dutch National Institute for Public Health and the Environment (or RIVM).

- The epidemiological analysis of routine contact tracing data looked at the share of requests for a test generated jointly by regular contact tracing and the CoronaMelder app between the end of September 2020[3] and the end of April 2021. The picture is that contact tracing and CoronaMelder together accounted for fifteen percent of the total number of tests requested during that period[4]. If we take a closer look at this group of 15%, we can see that, in recent months, 1 in 10 test requests was prompted by CoronaMelder. If we then focus specifically on only the number of positive test results within that group of fifteen percent, we see that of the total number of positive tests, 1 in 20 were due to the CoronaMelder app.
- A similar picture emerges from RIVM's model study into the decrease of the reproduction rate (R number) as a result of testing, contact tracing and CoronaMelder. The decrease in question is a relative decrease compared to the R resulting from other measures, such as staying at home and keeping a distance of 1.5 metres, as well as closing restaurants and bars and vaccinating the population. The model study shows that testing, regular contact tracing and CoronaMelder together led to an estimated decrease in the R number of 12.7%, of which 6.0% was due to testing, 6.4% to contact tracing and 0.3% to CoronaMelder. Incidentally, the calculations also indicate that CoronaMelder prevented more than 15,000 infections and more than 200 hospital admissions in the period from December 2020 to March 2021.

Based on the answers to the question of 1) whether CoronaMelder leads to more infected people being identified, 2) whether those people are found more quickly, and 3) how the app compares to regular contact tracing, we can conclude that when it comes to the question of whether CoronaMelder complements regular contact tracing, there is a small but appreciable added value. This degree of added value has been achieved based on the estimated 2.9 million people who are currently using the CoronaMelder app (May 2021). Moreover, these results were achieved while there were many restrictive measures in place, resulting in limited social mobility. It is therefore not surprising that the added value during the so-called lockdown has been noticeable, but minor.

Counteracting the spread of coronavirus by providing advice

In order to answer the question of to what extent CoronaMelder succeeds in preventing the spread of coronavirus by providing users with advice (to the so-called options for action'), adherence was studied first. Adherence means the extent to which people follow guidelines. We looked at both intended adherence and actual adherence. Subsequently, the research results were included in the model study into the decrease in the R number caused by CoronaMelder. This led to the following insights:

1. The intention of users of CoronaMelder to follow the advice given in the app after they receive a notification was found to be high. For example, if they had symptoms, 95% of users said they would arrange a coronavirus test following a notification and over 97% would stay at home if the notification advised them to do so.
2. The extent to which CoronaMelder users actually follow this advice, such as 'get tested' and 'go into quarantine', clearly needs to be improved. For example, over the entire period studied, 41%[5] of people who received a notification requested a test, and 45% of people who received

[1] The GGD asks several questions when someone requests a test, including the question: 'Are you making an appointment following a notification from CoronaMelder?' The analysis is carried out based on the answers to these types of questions.
[2] GGD GHOR is the Association of GGD's (Regional Public Health Services) and GHOR-(Regional Medical Emergency Preparedness and Planning) offices in the Netherlands.
[3] At that time, CoronaMelder was already being used in five GGD regions.
[4] There are multiple reasons why people arrange a test. By far the most common reason is that they have symptoms.
[5] This 41% should be seen as a lower limit. The survey covered the period before 1 December, when people could not yet schedule a test if they had not developed any symptoms. Due to the research design, however, it was not possible to make a split between the periods before and after 1 December.

a notification in the period from October 2020 actually stayed at home for the whole period required after receiving that notification.

3. As well as the actual number of users, lower actual adherence was another factor that contributed to the fact that 0.3% of the estimated fall in the R number is attributable to the CoronaMelder app.

The potential of the CoronaMelder app

With further relaxations and the progress made in the vaccination effort, as well as the effectiveness of the vaccine, it may become more likely for more people to come into contact with infected people at a distance of less than 1.5 metres for more than 15 minutes. In this case, the added value of CoronaMelder is expected to increase, which also follows from the aforementioned epidemiological analysis of routine contact tracing data and the model study conducted by RIVM. The expected added value may increase even further if more people download and start using CoronaMelder. In addition, the time between the moment a person comes into contact with an infected person and the moment they have their test result should be reduced, especially if the person tests positive and can then self-isolate (the so-called delay). This would also help people to act on the advice given by CoronaMelder when notifying users that they may have been in contact with an infected person. This should be possible, because although the extent to which people act on the advice given by CoronaMelder could be improved, the intention of CoronaMelder users to follow that advice is high. Moreover, the research results show that users' intention to follow the advice has not decreased over time and that the intention to 'get tested without symptoms' has even increased.

Unintended effects

The ongoing evaluation also looked at potential unintended effects. For example, prior to the launch of the app, there were questions regarding the extent to which app users might feel 'protected' against the virus, causing them to take unnecessary risks, such as not adhering to restrictions such as keeping a distance of 1.5 metres. It does not seem likely that this so-called 'risk compensation' behaviour is occurring among users of the CoronaMelder app. Another unintended effect was a possible negative impact on the processes at the GGD or GP surgeries as a result of CoronaMelder. We have not been able to find any evidence of this either. There were indications that some users felt obliged to use the CoronaMelder app; however the vast majority of people in that group of users experienced a 'societal obligation'. Finally, when it comes to receiving incorrect notifications caused by bluetooth signals that pass through walls and floors, we have not been able to ascertain how often this happens, but a technical experiment has shown that this cannot be ruled out.

Conclusion

The conclusion is that CoronaMelder currently has a small but noticeable added value as an addition to regular contact tracing, especially in reaching close contacts after a positive test result. As society reopens, CoronaMelder could have greater potential than during a lockdown with little social interaction. Now that more and more restrictions are being lifted, people will meet up with others more often. Depending on how quickly the population is vaccinated and how well the vaccines protect society from the virus, the likelihood of more people having contact with infected people at a distance of less than 1.5 metres for more than 15 minutes may increase again.

If CoronaMelder continues to be used in the near future, we recommend doing the following in order to help the app realise its potential:

- Firstly, focus more on communication that is aimed at adoption, use and adherence. If more people download the CoronaMelder app and, for example, share their codes and adhere fully to the advice given, the app will be much more effective. There is still a great deal of room for improvement with regard to these three factors. Through better communication, such as a communication campaign or personalized communication, these potential benefits could actually be realized. Various factors are identified in this report that could promote adoption, use and adherence.
- Secondly, prioritize reducing the 'delay' between the time when someone comes into contact with an infected person, receives a notification in the CoronaMelder app, and then makes an

appointment for a test, gets tested and receives the test result. This will mean that users of CoronaMelder are notified earlier if they may have been at risk and can, in turn, warn other users of CoronaMelder more quickly if their test result is positive. The shorter this interval is, the more effective the CoronaMelder app will be.

Contents

1. Introduction

1.1 Rationale

The CoronaMelder app is one of the tools used to combat coronavirus. The app has two goals[6]:

1. Firstly, the CoronaMelder app is used to supplement regular contact tracing by improving the speed and accuracy with which contacts can be traced following a positive test result. As such, the app should contribute to preventing the spread of coronavirus.
2. CoronaMelder is also designed to counter the spread of SARS-Cov-2[7] by providing advice to its users in the form of notifications, in particular regarding the quarantine period and, since December 2020, arranging a test after receiving a notification.

Right from the first trial of the app in the second half of August 2020, an ongoing evaluation was started to ascertain whether CoronaMelder would achieve these two goals in practice and to what extent the app was leading to any unintended effects – negative or otherwise. This ongoing evaluation consists of several separate studies. The ongoing evaluation is not only about determining the extent to which the goals are being achieved. The results of the ongoing evaluation have also been used, where necessary, to propose changes to the app, the associated options for action, communication and policy.

Nine months after the evaluation of CoronaMelder started, a number of epidemiological impact studies have also been completed. This means that we are now able to bring together all the findings from the studies and analysis that have been part of the ongoing evaluation of the CoronaMelder app so far.

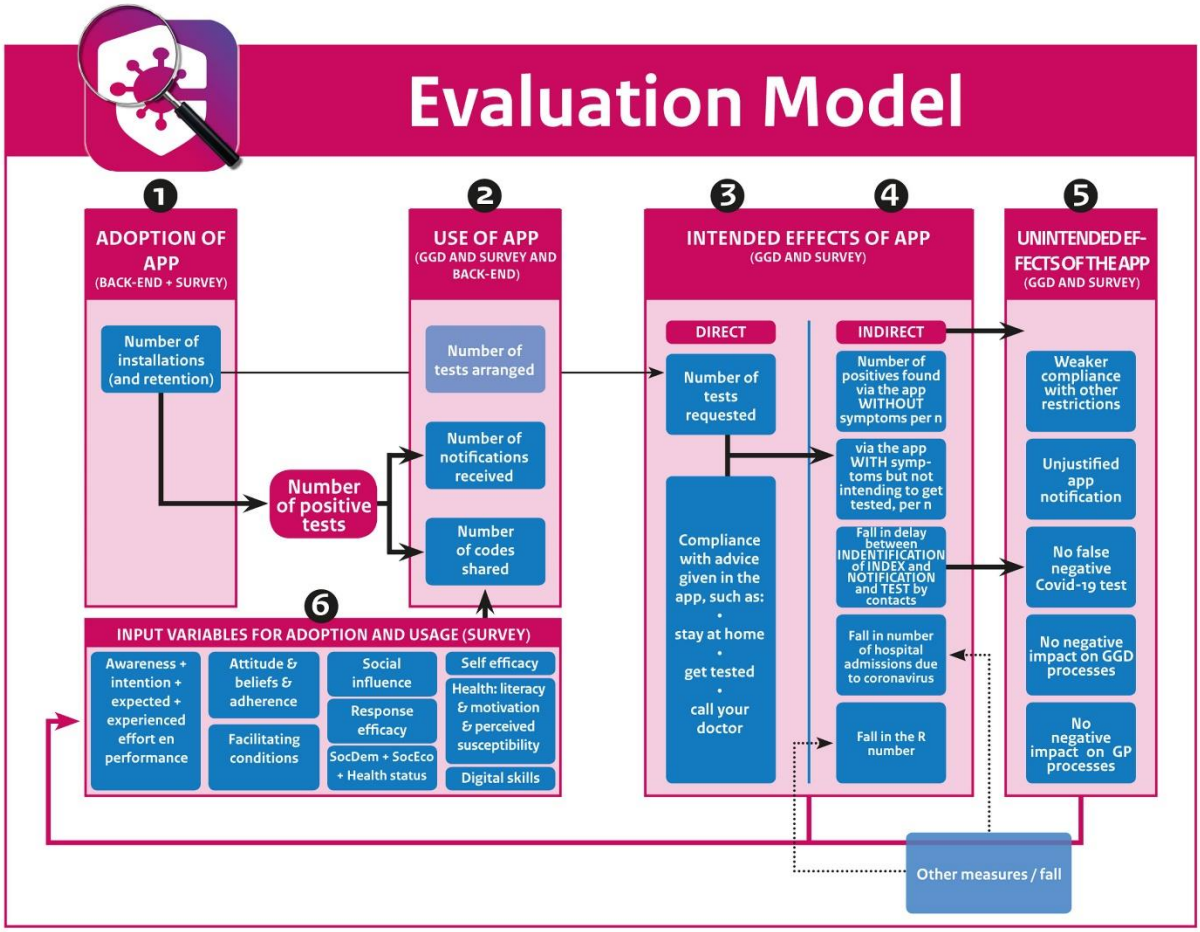
1.2 Evaluation model

The evaluation looks at six areas of investigation, as shown in Figure 1:

1. The **adoption** of the app, such as the number of downloads
2. The **usage** of the app, such as the number of codes shared
3. **Directly intended effects** (attributable to the use of the app), such as whether the options for action given by the app are followed up.
4. **Indirectly intended effects**, such as the contribution of the app to reducing the infection rate (or 'R' number)
5. **Unintended effects**; for instance, does the app lead to a weakening of compliance with other measures to combat coronavirus?[8]
6. **Characteristics** of users associated with adoption, usage and effects.

Figure 1
Evaluation model

[6] See https://www.rijksoverheid.nl/onderwerpen/coronavirus-app/doel-coronavirus-app van het Programma van Eisen versie 0.5 (!) via https://www.rijksoverheid.nl/onderwerpen/coronavirus-app/documenten/publicaties/2020/05/19/programma-van-eisen
[7] Also known as COVID-19 or coronavirus.
[8] To find out whether CoronaMelder leads to false negatives because people get tested too early after a notification, certain routine contact tracing data were needed. This data were only collected from April 2021 onwards. It was therefore not possible to investigate this question.


Evaluation Model
1
ADOPTION OF APP
(BACK-END + SURVEY)
Number of installations (and retention)
Number of positive tests
2
USE OF APP
(GGD AND SURVEY AND BACK-END)
Number of tests arranged
Number of notifications received
Number of codes shared
3
4
INTENDED EFFECTS OF APP
(GGD AND SURVEY)
DIRECT
Number of tests requested
Compliance with advice given in the app, such as:
• stay at home
• get tested
• call your doctor
INDIRECT
Number of positives found via the app WITHOUT symptoms per n
via the app WITH symptoms but not intending to get tested, per n
Fall in delay between INDENTIFICATION of INDEX and NOTIFICATION and TEST by contacts
Fall in number of hospital admissions due to coronavirus
Fall in the R number
5
UNINTENDED EFFECTS OF THE APP
(GGD AND SURVEY)
Weaker compliance with other restrictions
Unjustified app notification
No false negative Covid-19 test
No negative impact on GGD processes
No negative impact on GP processes
6
INPUT VARIABLES FOR ADOPTION AND USAGE (SURVEY)
Awareness + intention + expected + experienced effort en performance
Attitude & beliefs & adherence
Facilitating conditions
Social influence
Response efficacy
SocDem + SocEco + Health status
Self efficacy
Health: literacy & motivation & perceived susceptibility
Digital skills
Other measures / fall

1.3 Approach

The study was carried out by a team of scientists with specialist knowledge in the areas of epidemiology, behavioural science and the adoption of technological innovations, with a special interest in eHealth and eGovernment. The team is led by Professor Wolfgang Ebbers (Erasmus University Rotterdam) and also includes Professor Lotty Hooft (UMC Utrecht), Dr Nynke van der Laan (Tilburg University) and Dr Esther Metting (University of Groningen).

The evaluation consists of a large number of studies in which several different methods are combined to build up a picture, also known as methodical triangulation. The reason for the large scale of the study is that the impact of contact tracing is a new and complex area with a major societal impact, and it therefore involves major societal and behavioural issues. The studies ran in parallel to one another, and methodical triangulation was used to provide greater accuracy. The following studies were carried out as part of the evaluation, and the findings generated have all been incorporated into this report:

1. Behavioural study from the Lifelines Corona-barometer

Lifelines is a large cohort study based in the Northern Netherlands with 167,000 respondents. Since the pandemic, more than 50,000 of these respondents have been taking part in a monthly poll about coronavirus conducted using online questionnaires. This study is known as the Corona-barometer. Assistant Professor Esther Metting (University of Groningen) developed evaluation questions for the CoronaMelder app and added them to the coronavirus questionnaires on two occasions in order to find out about opinions regarding CoronaMelder and its usage in the Northern Netherlands.

2. Behavioural research in the LISS panel

Conducted by CentERdata in the LISS panel led by associate professor Nynke van der Laan (Tilburg University), involving 2000 participants located across the Netherlands. This study consists of taking four measurements within this representative group, whose behaviour is being tracked over an extended period. The purpose of this study is to investigate and explain the adoption of the CoronaMelder app and the (intended) adherence to the advice provided by the app. It also focused on unintended effects of the CoronaMelder app.

3. Research Behavioural Unit, RIVM

Conducted by the behavioural unit of the Dutch National Institute for Public Health and the Environment (RIVM), led by Associate Professor Nynke van der Laan (Tilburg University). This study includes a six-weekly questionnaire: what beliefs do people have about CoronaMelder and the use of the app?

4. Qualitative study into experiences with CoronaMelder

Conducted by the Centre for eHealth Research & Wellbeing of the University of Twente under the supervision of Professor Lisette van Gemert and Dr Jan Willem van het Klooster (University of Twente) in partnership with Professor Catherine Bolman of the Open University. Through 50 semi-structured interviews with respondents, the study aims to find out what the adherence of users is, focusing on notifications and code sharing in CoronaMelder, the contact tracing work of the GGD, which obstacles and difficulties are experienced and contact with GPs.

5. Study via GGD and GPs

Implementation in partnership with umbrella organization GGD-GHOR[9], the University of Groningen and the Dutch College of General Practitioners (NHG) under the leadership of Assistant Professor Esther Metting (University of Groningen). Questionnaires are distributed among GGD staff working in contact tracing and IT, managers, doctors, telephone operators and testers and the staff of GP practices. This part of the ongoing evaluation aims to investigate whether there have been any (unintended or undesirable) side effects as a result of the CoronaMelder app. In addition, GPs are distributing questionnaires to investigate the impact on people who receive a notification. It is also being investigated whether quantitative data from the backend of the GGD systems are available to demonstrate, among other things, how many people are being traced through the app.

6. Study via GGD among a sample of participants that tested positive for coronavirus

Implementation in collaboration with GGD-Gelderland-Midden and GGD Noord- and Oost-Gelderland under the supervision of Associate Professor Nynke van der Laan. All those who tested positive for coronavirus in 2020 between weeks 43 and 53 were contacted by GGD-Gelderland-Midden and the GGD Noord- and Oost-Gelderland by email within two weeks of their positive test, and were asked to take part in this questionnaire study. This study includes questions about the reason for arranging a coronavirus test and whether the advice provided in CoronaMelder were followed.

7. Literature review

A rapid review was conducted of the literature regarding the acceptance and effectiveness of contact tracing apps. These international research results are intended to clarify the results that emerged from the evaluation of CoronaMelder. This study is being overseen by Associate Professor Nynke van der Laan at Tilburg University from a behavioural science perspective, and by Professor Lotty Hooft from an epidemiological perspective at Cochrane Netherlands and Utrecht University.

8. RIVM Modelling

Carried out by the Dutch National Institute for Public Health and the Environment called RIVM. Various data – such as GGD contact data, the results of the LISS questionnaires and the study into what happens after a notification from CoronaMelder is received – were used by RIVM to investigate the effects of CoronaMelder on the reproduction rate (or R number). These models are already being used by RIVM to calculate the impact of other measures on the R number. In addition, RIVM has also estimated how many infections and hospital admissions CoronaMelder has prevented.

9. Epidemiological analysis of routine contact tracing data

Carried out by the GGD GHOR. The routinely collected contact tracing data focus on the CoronaMelder application and any associated variables such as symptoms. The data are from the end of September 2020 to 20 April 2021. This research clarifies how CoronaMelder contributes to regular contact tracing.

10. Study into what happens after an app user receives a notification from CoronaMelder
Carried out by Erasmus University Rotterdam under the direction of Professor Wolfgang Ebbers. This questionnaire study using the PanelClix panel looks at a specific aspect of the CoronaMelder process: what happens after a notification is sent. It singles out the subject of whether or not a test is arranged following a notification, and whether or not the recipient goes into quarantine.

11. Retest of Bluetooth Validation

[9] GGD GHOR is the Association of GGD's (Regional Public Health Services) and GHOR-(Regional Medical Emergency Preparedness and Planning) offices in the Netherlands.

Carried out by the Ministry of Health, Welfare and Sport. As part of the implementation of version 2 of the API of the Google/Apple Exposure Notification framework (GAEN) that CoronaMelder uses, retests were carried out in order to reassess the bluetooth exposure notification algorithm. The retest also looked at the extent to which the bluetooth signal passes through walls and floors.

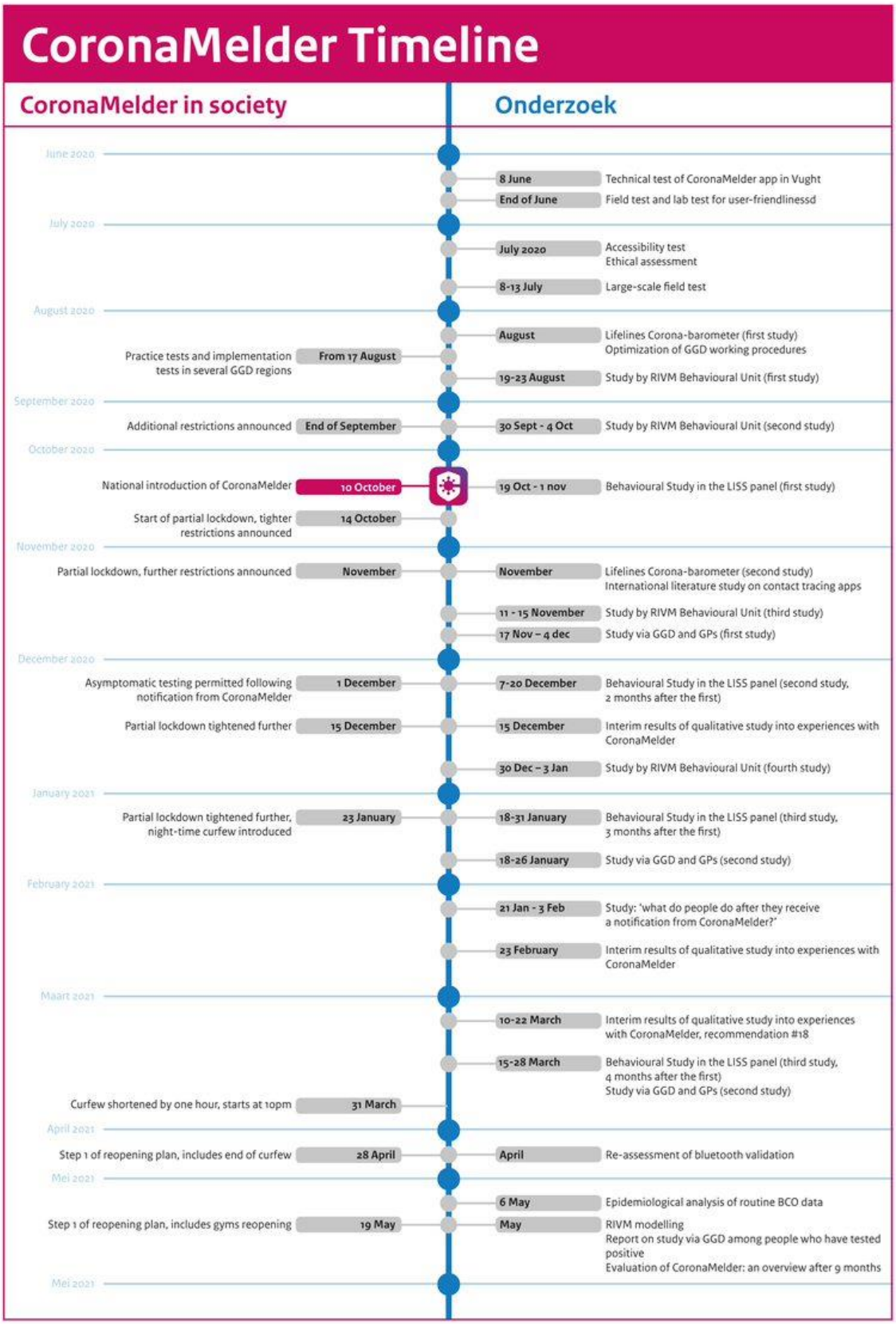
A complete list of sources, including the reports on studies above, is included in Appendix A.

1.4 Timeline

After a short pilot phase, the CoronaMelder app was officially launched on 10 October 2020. Several studies had already been carried out during the pilot phase, which was in June and July 2020. In the period from launch to the present, three changes that should be mentioned since they may have affected the usage of CoronaMelder:

1. Since 1 December 2020, it has been possible to get a coronavirus test receiving a notification from CoronaMelder even if the user has no symptoms (on day 5 after exposure); this was not possible before that date. Since the beginning of February 2021, it has been possible to have a test carried out as soon as the user receives a notification from CoronaMelder. In this case, the following applies: if the notification was received less than 5 days after exposure, the recipient must have two tests (one immediately upon receiving the notification and, in the case of a negative test, another test on day 5 after exposure). If the recipient receives the notification 5 days or more after the exposure, they only need to take one test.
2. In the last week of April 2021, it came to light that the CoronaMelder codes can be accessed by the apps that Google installs on Android phones by default. To protect users' privacy, the Ministry of Health, Welfare and Sport temporarily stopped notifications from CoronaMelder on the evening of Wednesday 28 April. This occurred after all questionnaire studies had been completed, so any impact that this event may have had on confidence in CoronaMelder would therefore not be included in this research period. However, the number of apps in active use up to and including this period was logged. The results are discussed in chapter 2.1.
3. CoronaMelder was launched at a time when various measures had been or were being taken to restrict social interaction. About two months after the launch, those measures were tightened further still. As a result of those stricter measures, it is probable that contact between people who did not know each other (such as another passenger on a train) would have been reduced during that period.

On the next page, we provide a short chronological overview of the restrictions on social interaction that would have greatly reduced the likelihood of contact lasting longer than 15 minutes with other close contacts. This overview also includes the various evaluation studies conducted over time.


CoronaMelder Timeline
CoronaMelder in society
Onderzoek
June 2020
8 June
Technical test of CoronaMelder app in Vught
End of June
Field test and lab test for user-friendlinessd
July 2020
July 2020
Accessibility test
Ethical assessment
8-13 July
Large-scale field test
August 2020
August
Lifelines Corona-barometer (first study)
Optimization of GGD working procedures
Practice tests and implementation tests in several GGD regions
From 17 August
19-23 August
Study by RIVM Behavioural Unit (first study)
September 2020
Additional restrictions announced
End of September
30 Sept - 4 Oct
Study by RIVM Behavioural Unit (second study)
October 2020
National introduction of CoronaMelder
10 October
19 Oct - 1 nov
Behavioural Study in the LISS panel (first study)
Start of partial lockdown, tighter restrictions announced
14 October
November 2020
Partial lockdown, further restrictions announced
November
November
Lifelines Corona-barometer (second study)
International literature study on contact tracing apps
11 - 15 November
Study by RIVM Behavioural Unit (third study)
17 Nov – 4 dec
Study via GGD and GPs (first study)
December 2020
Asymptomatic testing permitted following notification from CoronaMelder
1 December
7-20 December
Behavioural Study in the LISS panel (second study, 2 months after the first)
Partial lockdown tightened further
15 December
15 December
Interim results of qualitative study into experiences with CoronaMelder
30 Dec – 3 Jan
Study by RIVM Behavioural Unit (fourth study)
January 2021
Partial lockdown tightened further, night-time curfew introduced
23 January
18-31 January
Behavioural Study in the LISS panel (third study, 3 months after the first)
18-26 January
Study via GGD and GPs (second study)
February 2021
21 Jan - 3 Feb
Study: 'what do people do after they receive a notification from CoronaMelder?'
23 February
Interim results of qualitative study into experiences with CoronaMelder
Maart 2021
10-22 March
Interim results of qualitative study into experiences with CoronaMelder, recommendation #18
15-28 March
Behavioural Study in the LISS panel (third study, 4 months after the first)
Study via GGD and GPs (second study)
Curfew shortened by one hour, starts at 10pm
31 March
April 2021
Step 1 of reopening plan, includes end of curfew
28 April
April
Re-assessment of bluetooth validation
Mei 2021
6 May
Epidemiological analysis of routine BCO data
Step 1 of reopening plan, includes gyms reopening
19 May
May
RIVM modelling
Report on study via GGD among people who have tested positive
Evaluation of CoronaMelder: an overview after 9 months
Mei 2021

1.5 Structure of this report

Chapter 2 looks at the findings with regard to the research areas in the evaluation model. The structure of chapter 2 follows the evaluation model described in chapter 1.2 as closely as possible. Chapter 3 discusses the conclusions that can be drawn from the findings. For the sake of clarity, for each conclusion a reference is made to the relevant finding in chapter 2, which that conclusion is based on. Subsequently, some recommendations are made based on the studies. Finally, chapter 4 discusses some suggestions for additional research, if CoronaMelder continues to be used in future and is once again subject to ongoing evaluation.

2. Findings

2.1 Adoption

Since the nationwide introduction of the CoronaMelder app in October 2020, it has been downloaded a total of 4.9 million times (number up to 23 May 2021).[10] The *active usage* of the app has recently also been estimated in a privacy-friendly manner (see Appendix B for an explanation; in summary, this is an estimate of the daily number of mobile phones that make contact with the backend server). Currently (May 2021), the estimated percentage of active apps is around 60% of the total number of downloads (40% of installations never contact the server and have therefore been deactivated or uninstalled). In numerical terms, the estimated number of active apps is hovering at around 2.9 million. Before the incident involving Android phones in April 2020 (see introduction), the estimated number was higher than 2.9 million. Since the incident, the estimated number of active apps has been hovering at around 2.9 million[11].

The effectiveness of CoronaMelder depends on how often it is downloaded and on the number of active users. These are modifiable parameters, and could therefore be used as means of promoting adoption. In order to investigate which factors are related to the adoption of CoronaMelder, three explanatory models have been designed using the variables from the LISS panel as input. The models are the following[12]:

1. A model that uses the general adoption of technology variables based on the Unified Theory of Acceptance and Use of Technology (UTAUT). The UTAUT aims to explain the usage, intended usage and acceptance of technology.
2. A model that uses variables specific to interventions focusing on health, based on the Health Belief Model (HBM). The HBM aims to explain and predict health-related behaviours, particularly with respect to the usage of health services.
3. A model that uses variables for the specific context of the current pandemic and variables that are specific to the use of digital contact tracing applications.[13]

From these explanatory models for adoption, a number of factors emerged that significantly influence the adoption rate. The primary variables are explained in the subsequent sections. Users of

[10] See CoronaMelder Factsheet (the latest version is available at https://www.coronamelder.nl/media/Factsheet_Corona_latest.pdf. It is not possible to determine whether this number represents the number of unique users

[11] Since these are daily estimates, we have chosen not to provide the exact figures here.

[12] See LISS Wave 4 (Van der Laan, Van der Waal et al., 2021) for more about the explanatory models.

[13] Factors include beliefs around society, beliefs around privacy, concerns and anxieties, and beliefs around conspiracy theories; the variables are the adequacy of the technology, the likelihood of a person infecting other people, and the severity of infecting other people. (Van der Laan, Van der Waal et al., 2021)

CoronaMelder were compared with non-users in terms of their intentions, expectations and compliance with the advice.[14] In addition to these primary variables, users and non-users differ on numerous other variables. These are detailed in the full LISS report.

2.1.1 Demographic variables

People with a higher level of education (educated to at least university level) are more likely to use CoronaMelder than people with a lower level of education (educated to primary level or prevocational secondary/VMBO level). The same pattern can be seen with regard to monthly income (Van der Laan, Van der Waal, & De Wit, 2021). In addition, people aged 80 and older are the most positive about CoronaMelder, but the app is used the least among this group (users by age category: 18-39 years: 39%, 40-64 years: 45%, 65-79 years: 41%, over 79: 29%) (Metting, 2021c).

2.1.2 Performance expectancy

The expectation that CoronaMelder will contribute to the battle against coronavirus and help protect susceptible people is an important motivation for adoption. This expectation is higher among users of CoronaMelder (help to control virus: 89.1%; protect high-risk groups: 77.6%) than among non-users (help to control virus: 26%; protect high-risk groups: 33.5%). Over time, expectations regarding the effectiveness of the app have varied, but compared to the first measurement 1.5 weeks after the launch (53.4% agree) there has been a fall in the percentage of respondents who more or less agree with the statement that using CoronaMelder is helping to control coronavirus (LISS Wave 4.5 months after launch: 46.6% agree) (Van der Laan, Van der Waal et al., 2021).

2.1.3 Effort expectancy, self-efficacy and user-friendliness

Effort expectancy (i.e. how much time and energy people expect to have to put into using CoronaMelder, and how easy they expect this to be) and self-efficacy (i.e. the extent they expect to be capable of doing this) show a significant correlation with actual usage. A significant portion of those who do not currently use CoronaMelder believe that the app requires a lot of time and energy to start using it (21.9%). By contrast, of those people who are using CoronaMelder, only 3.2% indicated that this requires a lot of time and energy. In addition, 90.3% of users agreed with the statement that CoronaMelder is easy to use, compared to 48.5% of non-users. It also appears that users (98.6%) are more likely to view themselves as being able to use CoronaMelder than non-users (66.3%). So it seems that the app is easier to install and use in practice than non-users initially expect. With regard to facilitating circumstances, of those respondents who are not currently using CoronaMelder, 2 in 10 (21.1%) disagreed with the statement that they had a smartphone with internet connectivity suitable for using CoronaMelder. In addition, only 2 in 3 (68.4%) of non-users agreed with the statement that they expected to have adequate technological know-how to install CoronaMelder (Van der Laan, Van der Waal et al., 2021). Also, 24% of respondents from an Asian background and 26% of respondents from a Western or Eastern European background expected CoronaMelder to require a lot of time and energy, while some 40% of respondents from a Mediterranean or Arab background expected this (Metting, 2020a).

[14] For the breakdown by user status, a respondent was designated as a '*user*' if they answered the question 'Which situation applies to you?' with the option 'I am currently using the CoronaMelder app'. People were designated as a '*non-user*' if they gave the answer 'I have never used the CoronaMelder app' to this question.

2.1.4 Social influence

Most respondents (39.9%) believe that between a quarter and half of the population is using CoronaMelder. However, this contrasts with the extent to which people believe that CoronaMelder is widely used among people they know personally (agree: 15.6%; neutral: 35.8%). Respondents also estimated that people they know personally do not believe it is important for the respondent to use CoronaMelder (agree: 10.5%; neutral: 29.6%). The answers to these statements are stable and remained low over time. In addition, there is a large difference between users (descriptive norm: 40.2% agree; injunctive norm: 29.3% agree) and non-users (descriptive norm: 3.6% agree; injunctive norm: 1.2% agree). This indicates that the influence of people's immediate social circle is related to usage of the app, and that there may be room to improve social influence on non-users (Van der Laan, Van der Waal et al., 2021).

The fact that social influence plays a role in adoption is also reflected in the questionnaire study carried out through the Lifelines cohort. The Lifelines respondents who use CoronaMelder are more likely to know other people who also use the app and/or to advise other people to use the app if they are not already doing so (Metting, 2021c).

2.1.5 Personal benefits of using the app and barriers to using the app

Users are more likely to see the benefits of CoronaMelder than non-users (users: benefits 66.5%, barriers: 6.9% | non-users: benefits 9.1%, barriers 23.5%)[15]. There has been a very slight decline in the perceived personal benefits among respondents across the four measurements (especially between the first and second measurements) (Van der Laan, Van der Waal et al., 2021).

2.1.6 Social aspects

The explanatory models show that beliefs regarding societal aspects are related to app usage, such as feeling obliged to use the app – which can be viewed as a social obligation (also see the section on unintended effects), confidence in the government's approach to tackling coronavirus, and the extent to which using CoronaMelder is believed to make you a 'good citizen' and the extent to which CoronaMelder is thought to contribute to the Dutch economy. In total, 47.1% of users indicate that using CoronaMelder makes you a good citizen. In addition, around half of users (48.5%) believe that using the app will help the Dutch economy (Van der Laan, Van der Waal et al., 2021).

2.1.7 Privacy

Perceived barriers to usage include beliefs relating to privacy and reported concerns and anxieties regarding CoronaMelder. The explanatory models showed that beliefs about data security and privacy had a significant relationship with usage: the majority (85%) of those currently using CoronaMelder believe that the data in CoronaMelder app is kept strictly confidential, while among non-users fewer than 6 in 10 (55%) agreed with that statement. Across the population, the percentage who agreed with this statement had fallen very slightly between the current (65.9%) and previous, third, measurement (68.7%).

At the same time, there are also some misunderstandings regarding the technology used in CoronaMelder: almost 6 in 10 of current users (56.8%) believe that CoronaMelder keeps track of the user's location, while almost 7 in 10 (67.7%) of non-users believe this (Van der Laan, Van der Waal et

[15] The percentages do not add up to 100% because some of the respondents answered 'neutral'.

al., 2021). This picture is confirmed by the Lifelines survey (Metting, 2020a); according to that questionnaire, 68% of respondents believe that CoronaMelder keeps track of the user's location, even though this is not the case. It is also worth noting that more respondents with a higher level of education (73%) believe that the app logs the user's location than respondents with a lower level of education (59%). The number of people who hold these incorrect opinions remained fairly constant between the first and fourth measurements of the study used for this evaluation (Van der Laan, Van der Waal et al., 2021). An earlier study among the Dutch population also indicated that there are many misunderstandings about both how the app works and how data are collected and processed (Proszowska, Janssen, & De Vries, 2020).

These findings concerning privacy predate the news that broke at the end of April that CoronaMelder codes can be accessed by the apps that Google installs on Android phones by default[16] (see introduction). That means that we have no precise empirical information regarding the effect of that news on usage, but on the basis of our own empirical (see chapter 2.1) findings and theoretical insights, we assume that both the event itself and the media attention around it were noticeable and had a negative impact on the opinions described above regarding privacy and data security.

2.2 Usage

If a user tests positive for coronavirus, he or she can choose to notify other app users whom they have been around. They do this by giving the GGD code to a GGD staff member following a positive test result (referred to as 'usage').

By 23 May 2021, some 174.054 infected persons (approx. 12.6% of the total number of positive tests) had passed on a GGD code in CoronaMelder following a positive test result, and thereby warned other users that they may also have been infected.[17] The cross-sectional questionnaire survey in the PanelClix panel (Ebbers, 2021) showed that of those respondents who use CoronaMelder, 13% received at least one notification between October 2020 and the beginning of February 2021. (9% had received one notification; 4% had received several notifications). Some 86% of users had not received any notifications by the start of February 2021 (1% could not recall).

Intention to enter the GGD code
A previous study (Blom et al., 2020) found that 38% of respondents were willing to pass on the code if their coronavirus test was positive. In the current study (Van der Laan, Van der Waal et al., 2021), the level of intention is higher (97% among users of CoronaMelder only). The intention to pass on the GGD code is therefore in line with expectations. It should be remembered here that not everyone will convert this intention into action.

Sharing the GGD code
One of the studies asked whether respondents had shared a 'code' using the app together with the GGD (Van der Laan, Tenfelde, Raaijkmakers, & Van 't Hoff, 2021). Of the total of 3,098 people who answered this question, 75.5% (n = 2,339) indicated that they had done so and 24.1% (n = 748) indicated that they had not shared the code. 0.4% indicated that they preferred not to answer.

[16] https://www.rijksoverheid.nl/documenten/kamerstukken/2021/04/28/incident-google-en-apple-framework
[17] From the Factsheet CoronaMelder, via: https://www.coronamelder.nl/media/Factsheet_Corona_latest.pdf

The GGD questionnaire survey (Metting, 2021b) also shows that most, but not all, contact tracing staff ask about CoronaMelder during contact tracing (staff member always asks about CoronaMelder: measurement 2: 77%; measurement 3: 87%).

In addition, all the measurements show that contact tracing staff do not always ask about CoronaMelder (Metting, 2020b, 2021a, 2021b), 77% (second measurement) - 87% (third measurement) of contact tracing employees always ask about CoronaMelder. This picture is confirmed by the survey carried out after positive test results in Gelderland (Van der Laan, Tenfelde et al., 2021).

Examples of reasons for not asking about CoronaMelder according to contact tracing employees were: the person calling is elderly, or the contact tracing staff member forgets to ask because there is nowhere to record this information. Scaling down contact tracing due to the high infection rate was not mentioned as a reason (Metting, 2020b, 2021a, 2021b). The importance of sharing the GGD code and thereby warning other app users seems to be overlooked in the communication, and so users of CoronaMelder may not be aware of this (Van Gemert-Pijnen et al., 2021).

One remarkable finding was that older people over the age of 70 appeared to be more likely to say that the GGD did not ask for the code to be shared (Van der Laan, Tenfelde et al., 2021). This picture is confirmed by the qualitative research (Van Gemert-Pijnen et al., 2021) carried out for this evaluation and the questionnaire survey among GGD staff (Metting, 2020b, 2021a, 2021b).

2.3 Intended effects

2.3.1 Trace more people

By 23 May 2021, some 188.927 people had arranged a test for themselves after receiving a notification via CoronaMelder. Of these, 14.154 people tested positive[18]. There are two indicators that show whether CoronaMelder is able to find more people than regular contact tracing activities alone. Firstly, the proportion of people who arrange a test following a notification from the app, and who have no symptoms at that time but do test positive. If this proportion is higher than the percentage of positive tests that would be found in a random sample of the population, this is an indication that CoronaMelder is indeed helping to ‘trace more people’. Secondly, the proportion of people who were never contacted by the GGD as part of contact tracing, even after testing. We can state the following regarding these two indicators:

Proportion of asymptomatic people who arrange a test following a notification from the app, and then test positive

Since 1 December, it has been possible for people who have no symptoms to arrange a test if they receive a notification from CoronaMelder. They are advised to get tested on day 5 following exposure. From October 2020 to 23 May 2021, the total number of positive test results at GGD test centres in the Netherlands that were preceded by a notification from CoronaMelder was 14.154. Starting from the first week of December, testing was possible without symptoms if someone had received a notification from CoronaMelder. Since December, this has resulted in 11.022 positive test results, of which approx. 35.3% (absolute number 3.893) people had no symptoms when they asked for the test. The percentage of positive tests in random sample in the same period is estimated to be much lower, namely at or below 1% (see Appendix C)

[18]From the Factsheet CoronaMelder, via: https://www.coronamelder.nl/media/Factsheet_Corona_latest.pdf

Proportion of people who arranged a test following a notification from the app who were never contacted through regular contact tracing
Based on one of the epidemiological impact studies[19], of those people who arranged a test following a notification from CoronaMelder, we estimate that following the test around half were never approached by the GGD to notify them that they had been in contact with someone who had coronavirus. That means that without the CoronaMelder app, those people would not have been contacted in time.

Both the indicators thus show that CoronaMelder is able to notify more people earlier and to detect people who have the virus. In that sense, the app is an effective addition to regular contact tracing.

2.3.2 Tracing people more quickly

Data from GGD GHOR show that 77% of people who arranged a coronavirus test after receiving a notification from CoronaMelder had not yet been approached through regular contact tracing at the time when they arranged that test. This shows that CoronaMelder is able to trace these people faster than regular contact tracing. This is confirmed by the results of the questionnaire survey via the Lifelines cohort (Metting, 2021c), in which 81% of respondents indicated that contact tracing staff were not yet aware of them when they received the notification. It is also confirmed by the GGD survey of people who tested positive: there was little overlap between respondents who indicated that a notification from CoronaMelder was their reason for getting tested and those who said regular contact tracing. Of those who indicated that they had decided to get tested due to receiving a notification in CoronaMelder, only around 1 in 20 also indicated that they had also been contacted through regular contact tracing (Van der Laan, Tenfelde et al., 2021). This picture also suggests that CoronaMelder has added value when used alongside regular contact tracing.

However, there are signs that people could be traced even more quickly by reducing the interval between identifying the index patient and notifying and testing his or her contacts (Van Gemert-Pijnen et al., 2021).

2.3.3 CoronaMelder in relation to regular contact tracing

In order to determine the added value of the CoronaMelder app for contact tracing even more accurately, GGD GHOR carried out an analysis of routine contact tracing data (Dolman, 2021). These data were generated from the questions that people were asked when they were requesting a test, both by telephone and online. The data for that analysis were collected from the end of September onwards (CoronaMelder was already available in five pilot regions by then) until the end of April 2021[20].
The analysis revealed the following:

Throughout the entire period, from 26 September 2020 to 18 April 2021, 152,245 people (1.5% of the 9,853,035 test requests, σ=0.66%) answered that they were arranging a test after receiving a notification from CoronaMelder. Of those, 74,735 had symptoms when they were requesting the test (49% of the 152,245), compared to 7,563,191 (78% of the 9,700,790 test requests) with symptoms among those not requesting a test following a notification from CoronaMelder. Of the tests being requested following a notification from CoronaMelder, 26,008 (17% of 152,245 tests) were also in

[19] The cross-sectional questionnaire survey in the PanelClix panel (Ebbers, 2021)
[20] Because of the duration of this study, it has been decided to show and analyse the whole period rather than individual periods (also see chapter 4 Suggestions for additional research).

response to a notification from a GGD employee as part of regular contact tracing. Also see Table 1 below.

Table 1. Requests for tests, by category.
The number of test requests registered with the GGD between 26 September 2020 and 18 April 2021 which led to an actual test result, broken down by symptomatic, contacted by contact tracing staff, and notification from CoronaMelder (CM). Results are presented both in actual numbers and as a percentage of the total.

Category	Complaints	Regular contact tracing	App notification	Total (actual number)	Percentage
1	Yes	No	No	7.080.113	72%
2	Yes	Yes	Yes	9.786	0,1%
3	Yes	Yes	No	483.078	5%
4	Yes	No	Yes	64.949	1%
5	No	Yes	Yes	16.222	0,2%
6	No	Yes	No	880.645	9%
7	No	No	Yes	61.288	1%
8	No	No	No	1.256.954	13%
				9.853.035	

Broken down by positive and negative test results, there is a 1 in 4 chance that the test result is positive if the person was symptomatic and was contacted through some form of contact tracing (regular contact tracing and CoronaMelder or regular only). Also see Table 2 below.

Table 2. Test results by category.
The number of test requests registered with the GGD between 26 September 2020 and 18 April 2021 which led to an actual test result: broken down by symptomatic, contacted by contact tracing staff, and notification from CoronaMelder (CM). Results are shown in absolute numbers of positive tests, percentage of positive tests per category and numbers of negative tests

Category	Complaints	Regular contact tracing	App notification	Number of positives	Percentage of positives	Number of positive results
1	Yes	Yes	No	761.731	11%	6.318.382
2	Yes	Yes	Yes	2.540	26%	7.246
3	Yes	Yes	No	124.668	26%	358.410
4	Yes	Yes	Yes	7.076	11%	57.873
5	No	No	Yes	1.419	9%	14.803
6	No	No	No	99.348	11%	781.297
7	No	No	Yes	1.833	3%	59.455
8	No	No	No	120.208	10%	1.136.746

The eight categories above were merged into three new forms. Categories 1 and 8 were combined as ‘Spontaneous', categories 3, 6 and half of 1 and 5 were combined as ‘Following regular contact tracing' and categories 4 and 7 and half of 1 and 5 were combined as ‘Following notification from CM'. The total number of test requests that fall into these categories is shown. This reveals that the percentage of positive results is higher for 'contact tracing' than the category 'spontaneous' and the category 'CoronaMelder', see Table 3.

Table 3
Eight categories merged into spontaneous, contact tracing and CoronaMelder. Results in percentage of total tests leading to test result, percentage of positive tests per merged category and proportion of all positive tests, from 26 September 2020 to 18 April 2021.

	Proportion (%) of all tests	Tests arranged (#)	Percentage of positives	Proportion (%) of all tests	Positive tests (#)
Spontaneous	84,6%	8.337.067	10,2%	78,8%	881.939
Regular contact tracing	14,0%	1.376.727	18,1%	20,2%	225.996
App notification	1,4%	139.241	10,4%	1,0%	10.889

Table 4 shows the number of tests requested in response to regular contact tracing (1,376,727; 91% ± 0.05%) and CoronaMelder (139,241; 9% ± 0.05%). The number of positive tests based on the form of contact tracing used has also been broken down. This shows the proportion of positive test results following regular contact tracing (225,996; 95% ± 0.08%) and following a notification from CoronaMelder (10,889; 5% ± 0.08%).

Table 4
Within contact tracing, a distinction is made between regular contact tracing and CoronaMelder (CM). Results broken down by number of tests requested (#) and percentage of test requests per type of contact tracing and also the number of positive tests and percentage of test requests per type of contact tracing. A confidence interval was calculated based on this data, with a confidence level of 95%. The margins of error are shown in parentheses after the percentages.

	Number of positive results	Percentage from contact tracing	Number of positive results	Percentage from contact tracing
Regular contact tracing	1.376.727	90,8% (± 0,05%)	225.996	95% (± 0,08%)
CoronaMelder	139.241	9,2% (± 0,05%)	10.889	5% (± 0,08%)
Total	**1.515.968**		**236.884**	

From this we can conclude that of the total number of test results that result of some form of contact tracing (CoronaMelder or regular contact tracing), 1 in 10 test results (and 1 in 20 positive test results) were due to the CoronaMelder app. CoronaMelder thus has small but appreciable added value over and above regular contact tracing. This picture is confirmed by the study carried out after positive test results in Gelderland (Van der Laan, Tenfelde et al., 2021): among users of CoronaMelder, 6% indicate that a notification from CoronaMelder was their reason for getting tested.

2.3.4 Reducing the R number

Using model-based simulation, RIVM has calculated the percentage effect of CoronaMelder on the reproduction number (or R number) that is the result of regular contact tracing and the CoronaMelder app, respectively (RIVM, 2021). This shows a relative reduction compared to (the reduction in) the R number that is the result of other measures taken to limit the spread of the virus, such as maintaining a distance of 1.5 metres. Jointly, testing, regular contact tracing and the CoronaMelder app resulted in a simulated fall in the R number of 12.7%, of which 0.3% was due to CoronaMelder (6.0% was due to testing, 6.4% was due to regular contact tracing).

In addition, the model (RIVM, 2021) was also used to examine a scenario in which society comes out of lockdown and people therefore begin to have more frequent and/or prolonged exposure to people they do not know, and regular contact tracing becomes less effective as a result. In such a scenario, testing, contact tracing and CoronaMelder would lead to an estimated 8.8% fall in the R number, of which 0.4% is attributable to CoronaMelder.

RIVM (2021) has also considered a scenario in which all the recommendations provided are followed. Specifically, increasing the adoption rate of CoronaMelder, and adding an option for users to notify contacts themselves, without any need to involve the GGD. In this scenario, CoronaMelder becomes more effective still. If active usage rises to 30% and the need to involve the GGD is eliminated, CoronaMelder could result in a 2.0% reduction in the R number. If active usage rises to 40%, that

would translate to a reduction of 3.5%. Higher adherence to the advice given in the app following a notification would contribute even further to the effect of CoronaMelder on the R number.

The fact that the potential added value of CoronaMelder would increase in a society that is opening up is confirmed by comparing the data from the epidemiological analysis of routine contact tracing data regarding the sharing of GGD codes and the number of test requests with public mobility data from Google (Dolman, 2021). The number of people who get tested following a notification from one index increases in periods when people are likely to be exposed to a wider range of other people (see Table 5). Statistically, this is supported by public mobility data from Google. It is remarkable that, measured in 2021, the correlation between the code-test request factor[21] and average travel movements in the Netherlands based on Google data is significant[22]. This indicates that the code-test request factor increases in parallel with an increase in travel movements ($r=0.66$; $df=13$; $p<0.01$). Over the entire period in which CoronaMelder has been in use, the code-test request factor has been around 1, with the exception of the Christmas period. Starting in mid-February 2021, a clear increase in the number of test requests in response to a shared GGD code can be seen. This is an indication of the increasing effectiveness of CoronaMelder as travel movements increase (Dolman, 2021).

Table 5.
Number of codes shared, tests requested and the corresponding code-test request factor (with one week interval), shown per week number. This code-test request factor shows the number of test requests divided by the number of codes from the previous week. The higher this value, the more people have requested a test as a result of a code being shared.

Week number (2021)	Codes	Test requests based on CM notification	Code-test request factor
1	6.457	5.985	0,8
2	4.810	5.233	0,8
3	4.525	4.510	0,9
4	3.462	3.738	0,8
5	3.026	2.839	0,8
6	2.610	2.784	0,9
7	3.089	3.401	1,3
8	3.140	3.666	1,2
9	3.295	4.091	1,3
10	3.952	4.911	1,5
11	4.733	5.667	1,4
12	5.601	7.266	1,5
13	5.218	6.724	1,2
14	5.177	6.738	1,3
15	5.455	7.026	1,4

2.3.5 Preventing infections and hospital admissions

Based on the model study, RIVM has also estimated the number of infections and hospital admissions that have been prevented by the use of CoronaMelder. It is estimated that over 15,000 infections were

[21]When a person tests positive (index), they are asked to share a code with the relevant GGD using CoronaMelder (CM). This means that the possible contacts of this index can be notified through CoronaMelder: they are sent a notification in which they are advised to get tested. Given the lead time and the data available, as described above, an interval of one week between the code being shared and requesting a test is used as a rule of thumb. Based on this interval, we can look at the relationship between codes being shared and tests being requested due to CoronaMelder. This code-test request factor provides an indication of the impact of CoronaMelder. For example, a value of two would mean a doubling in the number of test requests from the number of codes shared in the previous week.
[22]Public Google mobility data, from: https://www.google.com/covid19/mobility/

prevented in the period December 2020 to March 2021. RIVM also estimates that CoronaMelder prevented more than 200 hospital admissions in the same period (RIVM, 2021).

2.3.6 Adherence

With regard to adherence (the extent to which people adhere to advice, such as ‘stay at home’ or ‘get tested’ following a notification), the ongoing evaluation highlights several points for attention.

2.3.6.1 Adherence to advice following CoronaMelder notifications

The cross-sectional PanelClix questionnaire survey (Ebbers, 2021) conducted in the period late January to early February 2021 shows that 45% of people who received a notification in the period since October 2020 had also stayed at home for the whole period required. And over that entire period, 41% of people who received a notification also requested a test. The latter finding involves some uncertainty, because the study includes the period prior to 1 December, when it was not yet possible to get tested without symptoms. Due to the design of the questionnaire, it was not possible to separate the research results from these two periods. The figure of 41% should therefore be seen as a lower limit. However, the same study by Ebbers (2021) did investigate the extent to which people with symptoms requested a test more often than those without symptoms. There appeared to be no significant difference. That would suggest that not everybody is fully following the advice given, in the sense that some people are not getting tested after receiving a notification, for example. At the same time, the periodic LISS panel questionnaires (Van der Laan, Van der Waal et al., 2021) show that users of CoronaMelder do intend to follow the advice given. Altogether, these findings suggest that there is a significant discrepancy between users’ intentions and their actual behaviour.

The second evaluation of the Lifelines questionnaire survey (Metting, 2021c) provides a similar picture to Ebbers (2021). Of the respondents in that survey, only 53% said they had gone into quarantine and 16% even said that they took no action at all following the notification. This picture is also confirmed by the periodic LISS panel questionnaires (Van der Laan, Van der Waal et al. 2021)[23]. Of the 46 respondents who had received a notification from CoronaMelder at some point, 50% indicated that they had arranged a test afterwards. In addition, 71.7% indicated that they often, usually or always stayed at home for as long as the notification advised them to. The number of 46 respondents is low, but the finding corresponds with the study by Van Gemert-Pijnen et al. (2021) which involved a higher number of observations. In that survey, too, respondents indicated that they acknowledged the advice given, but did not always follow it. The reasons given for this were the respondents’ own interpretation of the measures, that the measures were not considered applicable to the respondents’ own situation, or that measures were not considered useful or practical. As a reason in favour of acting on the advice given, people mentioned that since they had downloaded the app, they also felt obliged to act on the advice given.

2.3.6.2 Intention of acting on the advice given in the app among asymptomatic users (hypothetical)

It seems that CoronaMelder users who are, hypothetically, asymptomatic when they receive a notification would intend to follow all advice given by the app. They indicate that they would stay at

[23] Only a small number of respondents (n=46) from the LISS panel who had used CoronaMelder or were using it at the time of participating had ever actually received a notification from the app. This should be taken into account when interpreting the findings regarding reported behaviour below.

home (90.3%), not receive visitors (90.5%), and/or get tested (78.3%) (Van der Laan, Van der Waal et al., 2021). The percentage of respondents who would get tested if they were asymptomatic has increased significantly in successive LISS waves. This may be a result of the change in the testing policy since 1 December, when it became possible for people without symptoms to get tested.

2.3.6.3 Intention of acting on the advice given in the app among symptomatic users (hypothetical)

Among users who have symptoms (hypothetically), 95.2% would arrange a test, 97.5% would also stay at home for as long as the notification advised, and 97.2% would not receive visitors. Users therefore seem to have the good intentions when it comes to following the advice given in the app. These intentions are high and stable over time (Van der Laan, Van der Waal et al., 2021).

In a previous study conducted in the US, France, the UK and Italy, 9 out of 10 respondents said they intended to stay at home if an app notification advised them to do so (Altmann et al., 2020). However, in another study among German respondents, that percentage was much lower: only a third would quarantine if the app advised them to do so (Blom et al., 2020). There seem to be differences between countries, but these differences could also be explained by when the question was asked (i.e. at the start of the pandemic in the case of Altmann et al. (2020), or after the first peak of infections in the case of Blom et al. (2020)). Data from RIVM indeed show that support changed when the restrictions were extended, but also when the number of infections was falling, as was the case in June 2020[24]. But given the stability of intentions over time, this does not seem to be the case here.

2.3.6.4 Factors associated with intention to follow the advice given

The explanatory models for the intention to follow the advice in a hypothetical situation both with and without symptoms showed that self-efficacy is an important explanatory factor. The vast majority already reported high self-efficacy: they considered themselves capable of arranging a test (88.4%), staying at home for as long as recommended (87.8%), and not receiving visitors (90.1%). So there was relatively little room for improvement here. In the explanatory model for follow the advice from the app in a hypothetical asymptomatic situation, the degree to which respondents considered themselves to be susceptible to coronavirus infection also played a role: those who agreed more with the statement that there was a risk of infection had a stronger intention of acting on the advice. In the model for a hypothetical situation in which the respondent was symptomatic, the perceived severity of an infection for that respondent played a role: the more severe infection with coronavirus was seen as, the more likely that respondent would be to act on the advice (Van der Laan, Van der Waal et al., 2021).

Other reasons for people not to to follow the advice given, and thus potential explanations for the apparent discrepancy between good intentions and actual behaviour, may relate to the personal inconvenience that is expected to result. The percentage of those agreeing that the consequences would be negative was the highest for staying at home (24.7%) and not being able to receive visitors (22.6%), while this was lower with respect to arranging a test (10.8%). It appears that about half of the respondents see personal benefits to acting on the advice (arranging a test: 55.5%; staying at home for as long as advised: 53.8%; no visitors: 54.8%) (Van der Laan, Van der Waal et al., 2021).

[24] https://www.rivm.nl/gedragsonderzoek/maatregelen-welbevinden/draagvlak

In addition, people with a higher level of education are more likely than people with a lower level of education to indicate that they expect to act on the advice given in CoronaMelder (higher educated: 68% vs. lower educated: 52%). Adults younger than 30 (63% of this age group) and adults between 60 and 80 years of age (65% of this age group) were the most likely to say they would act on the advice (Metting, 2020a).

2.3.7 Wider / International picture of how effective contact tracing apps are

The model-based international studies into the effectiveness of the use of contact tracing apps show that using the app can be more effective than – and can therefore be a useful complement to – regular contact tracing methods. The use of an app can also lead to a fall in the R number, the total number of infections, and the total mortality rate. These reductions may be greater when the adoption rate for the app is higher, but they may also be seen at a relatively low adoption rate (20%). The effects may be greater when the time between receiving a notification from the app and testing is shorter. The current evidence from the international literature on the effectiveness of contact tracing apps is largely based on model-based studies (Jenniskens et al., 2020). Until now, therefore, it is mainly the predicted rather than actual effects of contact tracing apps that are available at the European level[25]. Currently, no thorough empirical comparison with other digital contact tracing apps in Europe is possible.

2.4 Unintended effects

2.4.1 Impact on GGD processes

CoronaMelder should not negatively affect GGD processes, e.g. by increasing employees' workload. The potential impact of CoronaMelder on GGD processes was evaluated with three questionnaires sent out in December 2020, February 2021 and March 2021 (Metting, 2020b, 2021a, 2021b). Branches from all GGD regions participated in one or more questionnaires and participating branches were spread more or less evenly across the various regions. The first questionnaire was completed by 147 GGD employees, the second by 107 employees and the last questionnaire was completed by 79 GGD employees. Several questions were of a qualitative nature, allowing staff to share comments and make suggestions. Many of the respondents are new hires, with about half of them having joined the GGD after the summer. Most respondents were so-called Contact Tracers.

CoronaMelder affects the work of 22% of the employees, and this is especially true for Contact Tracers. Almost all employees in the study indicated that they were familiar, to some extent, with their duties with regard to CoronaMelder, while two employees (1x IT and 1x contact tracing) reported being unclear as to what their tasks entailed (Metting, 2021b).

Employees are taught about CoronaMelder by means of an e-learning module and a webinar. Approximately half of the employees have completed the e-learning module (first survey 50%, second survey 49%, third survey 54%). The webinar was less popular than the e-learning course: at the time of the third survey, 20% of GGD employees watched the webinar, marking an increase compared to the first and second survey, when the webinar was watched by 17% and 15% of employees, respectively. The fact that so many respondents were new employees may explain why not everyone completed the webinar and e-learning module. Employees are generally satisfied with the information given, even though respondents reported being less satisfied at the time of the first survey and final

[25] Also see: https://investigativedesk.com/nl/een-op-de-tien-besmette-europeanen-meldt-dit-via-een-corona-app/

survey than at the time of the second survey. There is no clear reason for this (Metting, 2020b, 2021a, 2021b).

This study does not show that CoronaMelder hampered GGD processes during this time. Most employees are well informed and know what to do. The results of the qualitative study (Van Gemert-Pijnen et al., 2021) only partly confirm the results of Metting's study (2020, 2021a, 2021b). The qualitative study conducted by Van Gemert-Pijnen et al. (2021) suggest that integration between CoronaMelder and TT processes is frequently poor, which means that employees have to register data in different systems and that it can take a considerable amount of time to process the GGD code, resulting in a delay between registration and notification via CoronaMelder. Moreover, the qualitative study shows that encouraging Contact Tracers to consistently use CoronaMelder as part of the contact tracing process also needs more attention.

2.4.2 Impact on general practice processes

Just like GGD processes, GP processes should also not be affected negatively by CoronaMelder. The impact of CoronaMelder on GP processes was evaluated through an online survey held among GP surgeries (Metting, 2020b, 2021a). This survey was conducted twice, in December 2020 and in February 2021. The questionnaire was completed by 100 employees at GP surgeries in December and by 67 employees in February. At the time of the first survey, 76% of respondents had been given information about CoronaMelder, before dropping to 38% at the time of the second survey. The most commonly cited sources of information about the app were GP cooperatives, COVID-19 webinars and regional crisis meetings. The percentage of healthcare professionals who reported needing more information decreased from 21% to 13% between the first and second survey. In both surveys, 55% of respondents reported being aware of the information on CoronaMelder on Thuisarts.nl.

In February, the percentage of patients contacting practices with questions about CoronaMelder had decreased from 12% to 8%. This may be because patients became more familiar with the app, learned where to find information about the app, or stopped using the app as much (Metting, 2021a).

During the second survey, some of the respondents working in GP surgeries (14%) reported having little faith in CoronaMelder, with several of them indicating that they were never notified that they had been in the vicinity of infected patients for 15 minutes or longer (Metting, 2021a).

It can be concluded that more employees working in GP surgeries are familiar with the options for action given by CoronaMelder and that the application has hardly any effects on GP processes. However, the information about CoronaMelder on Thuisarts.nl could be communicated more actively and providing information in waiting rooms (slides/posters/brochures) could also help patients and professionals. Information about the results of the CoronaMelder survey could also be shared through front-line channels to increase trust in CoronaMelder.

Research (Van der Laan, Van der Waal et al., 2021) shows that 25.4% of CoronaMelder users intend to call their GP when they get a notification in a hypothetical situation, even if they do not have symptoms. In order to prevent the app from increasing the impact of the pandemic on GP surgeries, it is advisable to continue to communicate emphatically that patients should not call their GP after a CoronaMelder notification if they have no or only mild complaints.

2.4.3 Risk compensation behaviour

There have been concerns that the CoronaMelder may inspire a false sense of security, which could lead to other measures being considered less necessary. These concerns have been expressed in relation to various corona measures, such as wearing face masks: people using CoronaMelder may believe that they do not need to adhere to other important measures. In general, however, the theory (risk compensation theory) fuelling this expectation has been debunked several times (e.g. by Pless, (2016)). A literature review conducted by RIVM has also shown that this type of behaviour seems unlikely to occur in the wearing of face masks (RIVM, 2020).

Only a small percentage of respondents believed that using CoronaMelder may make people more lax in following other measures, with 4.3% of respondents responding to this question with ‘certainly true’ or ‘maybe true’ (Van der Laan, Van der Waal et al., 2021).

In addition, almost three in ten (29.8%) respondents believed the statement that CoronaMelder reduces the risk of being infected to be ‘certainly true’ or ‘maybe true’. There is currently no evidence to show that CoronaMelder users are less inclined to follow the basic rules. There was little if any difference between the self-reported adherence to the basic rules between users and non-users, with users reporting frequently washing their hands marginally more often. Moreover, users more often have the intention to follow the basic rules than non-users. These findings suggest that risk compensation is unlikely to occur (Van der Laan, Van der Waal et al., 2021). However, it remains an important point of concern and it is advisable to communicate clearly that using CoronaMelder does not reduce the risk of infection with coronavirus.

2.4.4 Social obligation

The sense of obligation to use CoronaMelder is an important point in the evaluation. At the moment, 58% of current users report feeling more or less obliged to use the app, whereas only 3.3% of non-users reported feeling obliged. Across the population as a whole, the sense of obligation has decreased slightly from 26.1% in early November, 1.5 weeks after the launch of CoronaMelder, to 21.1% based on the latest survey results (Van der Laan, Van der Waal et al., 2021).

Further questions were then asked to investigate the nature and source of these feelings of obligation. Few users agreed with the statement that they do not feel free to choose whether to use the app or not (7.9%). In addition, users were also less likely to agree with the statements that the insistence to use CoronaMelder annoys them (2.8%) or angers them (2.1%), compared to non-users (37.7% annoyance, 25% anger). It therefore seems that users either do not feel that they are being urged to use the app, or that this insistence does not annoy them (Van der Laan, Van der Waal et al., 2021).

A possible explanation for feelings of obligation is that using CoronaMelder feels like a social obligation. Of those who reported feeling obliged to use CoronaMelder, 86.8% said that using CoronaMelder is seen as a social obligation. Furthermore, 47.1% of users believed that using CoronaMelder makes you a good citizen, and 77.6% of users agreed with the statement that CoronaMelder helps to protect susceptible people. In addition, about half of the users (48.5%) expected that using CoronaMelder would help the Dutch economy. Non-users agreed with all these statements (good citizen, protecting susceptible people, helping the economy) to a much lesser degree than users, which suggests that there seems to be an overarching social interest that probably played a role in the users' decision to use CoronaMelder (Van der Laan, Van der Waal et al., 2021).

Those who indicated that they more or less agreed with the statement that they felt obliged to use CoronaMelder were also asked what they believed to be the source of this obligation. A relatively low percentage of respondents indicated that they agreed to some extent that employers/clients (7.9%), schools/educational institutions (9.4%) or the government (11.6%) required them to use CoronaMelder (Van der Laan, Van der Waal et al., 2021).

2.4.5 Unjustified CoronaMelder notifications

Large numbers of people have got tested, prompted by symptoms, contact tracing and CoronaMelder notifications. Of all tests conducted by the GGD so far (as of May 2021), an average of 10.2% was positive. On average, 8% of tests taken after a CoronaMelder notification turned out to be positive. As such, negative test results greatly outnumber positive test results, and it is therefore conceivable that individuals might experience testing as being unjustified in those cases. From a societal point of view, however, ensuring easy access to testing can help monitor the spread of the virus.

Although the large number of negative test results following a CoronaMelder notification may indicate that some notifications are unjustified, we believe that this issue mainly revolves around the suspicion that some notifications are not caused by risky contact but are triggered by bluetooth signals passing through walls and floors instead, even though the users in question might not have been less than 1.5 metres apart for more than 15 minutes in any meaningful way, such as residents of apartment buildings or users of multi-tenant offices.

Determining how many unjustified notifications were caused by signals passing through walls and floors would require, among other things, extensive research. As such, we did not investigate this for reasons of proportionality. However, partly at the request of the evaluation team, the Ministry of Health, Welfare and Sport conducted an experiment to find out whether it was possible for the bluetooth signal to pass through walls and thus trigger a false notification, which showed that an erroneous notification, triggered by the bluetooth signal passing through walls and floors, cannot be ruled out (Ministry of HWS, 2021).

3. Conclusions and recommendations

3.1 Main conclusion on the added value of CoronaMelder

CoronaMelder has a dual purpose:

1. CoronaMelder is used as a supplement to regular contact tracing, helping to contact more people who have been exposed to the virus more quickly. As such, the app should contribute to preventing the spread of coronavirus.
2. CoronaMelder counters the spread of SARS-Cov-2 by giving advice to its users after an exposure notification, especially about the quarantine period and, since December 2020, by helping them request a test after a notification.

With regard to the first goal, there are four ways to answer the question of whether CoronaMelder is actually a valuable addition to regular contact tracing.

First of all by investigating whether CoronaMelder can help identify cases that would otherwise have remained invisible with regular contact tracing. The question, then, is how many people requested a test after receiving a CoronaMelder notification but were never contacted by the GGD to inform them

that they had been exposed to the virus. Based on an epidemiological impact study[26], it is estimated that more than half of the people who requested a test after receiving a CoronaMelder notification were never contacted by the GGD. Without CoronaMelder, this group of people would have remained invisible, or at least until they developed symptoms (see chapter 2.3.1).

Secondly, by determining the percentage of people who tested positive after requesting a test following a CoronaMelder notification and who did not have symptoms at the time. If this percentage is higher than the percentage of positive tests that would be found through random screening, it would be a second indication that CoronaMelder is a valuable addition to regular contact screening and efficiently identifies more cases. This appears to be the case, as approximately 3% to 5% of people without symptoms who requested a test following a CoronaMelder notification tested positive every week. The detection rate from random screening over the same period is estimated to be lower, i.e. approximately 1% or lower.
(see chapter 2.3.1).

Thirdly, by investigating whether CoronaMelder can detect cases more quickly than regular contact tracing. This often turns out to be the case. By the end of May 2021, 77% of people requesting a test after a CoronaMelder notification had not yet been approached as part of regular contact tracing at the time of the request (see chapter 2.3.2.).

Finally, by investigating how CoronaMelder compares to regular contact tracing, with the GGD GHOR performing an epidemiological analysis of routinely collected contact tracing data[27] (routine contact tracing data) and RIVM conducting a model study into the effects of CoronaMelder compared to regular contact tracing, among other tracing methods.

- The epidemiological analysis of routine contact tracing data looked at the share of requests for a test generated jointly by regular contact tracing and the CoronaMelder app between the end of September 2020[28] and the end of April 2021. The picture is that contact tracing and CoronaMelder together accounted for fifteen percent of the total number of tests requested during that period[29]. If we take a closer look at this group of 15%, we can see that, in recent months, 1 in 10 test requests were prompted by CoronaMelder. Zooming in a bit further still on the number of positive test results within this 15% group, we can see that CoronaMelder was behind 1 in every 20 positive test results (chapter 2.3.3).
- A similar picture emerges from RIVM's model study into the decrease of the reproduction rate (or R number) as a result of testing, contact tracing and CoronaMelder. The decrease in question is a relative decrease compared to the fall in the R number resulting from other measures, such as staying at home and social distancing, as well as closing restaurants and bars and vaccinating the population. The model study shows that testing, regular contact tracing and CoronaMelder combined led to an estimated decrease in the R number of 12.7%, of which 6.0% was due to testing, 6.4% to contact tracing and 0.3% to CoronaMelder. Moreover, the models also show that CoronaMelder prevented more than 15,000 infections and more than 200 hospital admissions in the period from December 2020 to March 2021 (see chapters 2.3.4 and 2.3.5).

Based on the answers to the questions above of whether CoronaMelder helps to detect more cases, whether it detects cases more quickly and how it compares to the regular contact tracing, it is clear that CoronaMelder has limited but noticeable added value in addition to regular contact tracing. Incidentally, it should also be noted that this is based on CoronaMelder's current (May 2021) user base of approximately 2.9 million users (see Appendix B). Moreover, these results were achieved while there were many restrictive measures in place, resulting in limited social mobility. It is therefore not surprising that the added value during the so-called lockdown has been noticeable, but minor.

[26] The cross-sectional survey with the PanelClix panel (Ebbers, 2021)
[27]When a test is requested, the GGD asks multiple questions, including: 'Are you making an appointment following a notification from CoronaMelder?' The analysis is carried out based on the answers to these types of questions.
[28] CoronaMelder had already been launched in five GGD regions at that time.
[29] People can request tests for various different reasons. By far the most common reason is that they have symptoms.

In order to answer the question of to what extent CoronaMelder succeeds in preventing the spread of coronavirus by drawing attention to advice (the so-called options for action), adherence was studied first. Adherence means the extent to which people follow the guidelines. We looked at both intended adherence and actual adherence. Subsequently, the research results were included in the model study into the decrease in the R number caused by CoronaMelder. This led to the following insights:

1. CoronaMelder users intend to and are highly inclined to follow the advice given by the app following a notification. For example, if users were to have symptoms, 95% of them would schedule a coronavirus test if they received a notification and over 97% would self-isolate as long as the notification advised (see chapter 2.3.6.).
2. The extent to which CoronaMelder users actually follow this advice, such as 'get tested' and 'go into quarantine', clearly needs to be improved. For example, over the entire period under review, only 41%[30] of people who received a notification requested a test. Furthermore, 45% of the people who received a notification from October 2020 onwards also self-isolated after the notification (see chapter 2.3.6.).
3. The lower actual adherence, in addition to the actual number of users, also contributes to the fact that 0.3% of the estimated decrease in the R number can be attributed to CoronaMelder (see chapter 2.3.4.).

As the restrictions are relaxed further and depending on the progress made in the vaccination effort, as well as the effectiveness of the vaccine, people may become more likely to come into contact with infected people at a distance of less than 1.5 metres for more than 15 minutes. In this case, the added value of CoronaMelder is expected to increase, which also follows from the aforementioned epidemiological analysis of routine contact tracing data and the model study conducted by RIVM. The expected added value may increase even further if more people download and start using CoronaMelder. In addition, the time between the moment when a person is exposed to the virus and the moment when they have their test result (known as the ‘delay’) should be reduced, especially if the person tests positive and can then self-isolate. This would also help people to to follow the advice given by CoronaMelder when notifying users that they may have been exposed to the virus. This should be possible, because although the actual extent to which people follow CoronaMelder’s advice could be improved, the intention of CoronaMelder users to follow said advice is high. Moreover, the research results show that users’ intention to act on the advice given has not decreased over time and that the intention to ‘get tested without symptoms' has even increased.

The ongoing evaluation also looked at potential unintended effects. In the run-up to the launch, for example, questions were asked about whether CoronaMelder would cause people to feel protected against the virus, causing them to behave in a needlessly risky manner, e.g. by not following social distancing rules. It seems unlikely that CoronaMelder users would display this so-called risk-compensation behaviour. Another unintended effect was a possible negative impact on the processes at the GGD or GP surgeries as a result of CoronaMelder. We have not been able to find any evidence of this either. However, there are indications that some users feel obliged to use CoronaMelder. The vast majority of people in that user group, though, felt a so-called social obligation. Finally, we have not been able to show how often users are sent erroneous notifications caused by bluetooth signals passing through walls and floors, but a technical experiment did show that such errors cannot be ruled out (see chapter 2.4).

The conclusion is that CoronaMelder currently has a small but noticeable added value as an addition to regular contact tracing, especially in reaching close contacts after a positive test result. As society reopens, CoronaMelder could have greater potential than during the lockdown, when there was little social interaction. Now that more and more restrictions are being lifted, people will meet more often. Depending on how quickly the population is vaccinated and how well the vaccines protect society from

[30] This 41% should therefore be seen as a lower limit. The survey covered the period before 1 December, when people could not yet schedule a test if they had not developed any symptoms. Due to the research design, however, it was not possible to make a split between the periods before and after 1 December.

the virus, the likelihood of more people having contact with infected people at a distance of less than 1.5 metres for more than 15 minutes may increase again.

If CoronaMelder continues to be used in the near future, we recommend doing the following in order to help the app realise its potential:

1. place greater emphasis on communication aimed at adoption, usage and adherence,
2. reduce the so-called delay.

We will elaborate on these recommendations in the following chapters.

3.2 Adoption

The effectiveness of CoronaMelder depends on how often it is downloaded and on the number of active users. If 30%-40% of the entire population were to be active users, CoronaMelder would be more effective at reducing the R number (RIVM, 2021). With a higher adoption rate, CoronaMelder therefore becomes more effective. This means that more people should download CoronaMelder. Moreover, current users of the app should be encouraged to continue using CoronaMelder (retention). It should be noted in this respect that the surveys (Van der Laan, Van der Waal et al., 2021) show that people generally believe that a (very) high adoption rate is necessary in order for CoronaMelder to contribute to preventing the spread of coronavirus (adoption rate of 76-90%). While it is true that CoronaMelder's effectiveness depends on how many people install it, it also contributes to slowing the spread of the virus at lower adoption rates. Communicating this message more clearly may convince more people to install the app. In addition, app users should be encouraged to continue using CoronaMelder (retention), which is rare at the moment.

We suggest increasing adoption and retention by doing the following:

Emphasise perceived benefits of use and provide reassurance regarding perceived barriers:
The study identified various (direct or indirect) perceived personal benefits. There are two conceivable approaches for these variables.
The first option is to influence the perceived benefits of and barriers to use through communication campaigns. Previous research has identified several (direct or indirect) perceived personal benefits. These include, for example, keeping yourself and others safe, reducing the likelihood of risky behaviour, helping the economy recover, and the potential relaxation of other measures as the reproduction rate falls (Biddle et al., 2020; Rheault, & Musulan, 2020). There are also various barriers to using CoronaMelder, such as the privacy concerns mentioned below, the long-term social and ethical consequences, and fear. Communication campaigns could emphasise the perceived benefits and seek to reassure people about the perceived barriers.
A second option would be to make actual changes to the app that would add to and improve the benefits for users. For example, the various corona applications that are currently available (CoronaMelder, CoronaCheck and GGD Contact) could refer to each other where relevant, following the example of the corona apps in the United Kingdom and Germany.

Strengthening social influence
Using CoronaMelder is relatively invisible compared to other measures, such as wearing a face mask. As a result, people only find out that others are using the app by talking about it or through usage statistics (e.g. the Factsheet published by the Ministry of Health, Welfare and Sport). People are unlikely to bring up the app in conversation unless they have a clear reason to do so, such as media attention or getting a notification. Thus, people may believe that few others in their social group are

using CoronaMelder, even if this is not actually the case. Communication strategies could focus on improving the social norm. CoronaMelder studies found that descriptive norms play a role in adoption intention. If people are under the impression that people close to them have installed CoronaMelder, they will be inclined to also do so themselves (Proszowska et al., 2020; Strycharz, Bol, Buijzen, Helberger, & De Vresse, 2020). Conversely, research has also shown that not believing that others will install the app is also a barrier to adoption (Proszowska et al., 2020; Zhang, Kreps, & McMurry, 2020). Improving both the descriptive and the injunctive norm (that the people around you appreciate you using CoronaMelder) deserves attention. One way of doing this is by featuring CoronaMelder more often in campaigns and media, so that it becomes a topic of conversation again.

Increasing self-efficacy
Previous research shows that intended adoption is higher when people feel they know how to use the app (high self-efficacy), (Walrave, Waeterloos, & Ponnet, 2020). Among non-users, lower self-efficacy can be a barrier to installing the app. In communicating with non-users, it is therefore a good idea to focus on how easy it is to install and use CoronaMelder. Another option would be to help people install and use the app, preferably in physical locations such as libraries or community centres.

Improving expected effectiveness
Over time, it can be seen that the expected contribution of CoronaMelder to combating coronavirus is decreasing (Van der Laan, Van der Waal et al., 2021). Given the importance of the expected effectiveness factor and the downward trend, it is important to (continue to) communicate how effective CoronaMelder is, as well as highlighting essential benefits of the app, such as earlier and faster risk detection. The advice is to emphasise success stories, e.g. people discovering that they have been infected with coronavirus thanks to CoronaMelder and to stress the increasing relevance of CoronaMelder now society is opening up once more.

The extent to which CoronaMelder can protect risk groups depends on the adoption rate (Van der Laan, Van der Waal et al., 2021). Moreover, survey results on risk perception show that respondents are more concerned about infecting others than about being infected themselves. A promising approach could therefore be for communication strategies to take an altruistic approach. However, people may become less inclined to use CoronaMelder to ‘protect others’ as vaccination coverage increases. At the time of writing this report, it is not yet clear when the required vaccination coverage will be achieved, how long vaccinations will be effective and whether they also protect against mutations of coronavirus. It is therefore impossible to determine whether 'protecting others' will become a less popular reason for using CoronaMelder.

Correcting general misconceptions
Communication can also help to correct the general misconception that CoronaMelder keeps track of personal and location data.

3.3 Usage

Not all users pass on the GGD code following a CoronaMelder notification, even though most users are highly inclined to share the GGD code after a real or hypothetical positive test result. Based on the GGD survey conducted among people who have tested positive (Van der Laan, Tenfelde et al., 2021), the GGD study (Metting, 2020b, 2021a, 2021b) and the qualitative user survey entitled 'Grip op CoronaMelder' (Van Gemert-Pijnen et al., 2021), we make the following recommendations to improve the use of CoronaMelder:

- Communications to people who test positive for coronavirus should stress the importance of passing on the GGD code, both through a national communication campaign and by the GGD.
- Elderly people should also always be asked to share their GGD code.
- Pay attention to CoronaMelder in training sessions, work procedures and protocols, both in the written instructions and in the implementation of the contact tracing procedure (including registration in the GGD systems). Support and encourage contact tracing staff to share codes and IDs properly and register CoronaMelder app usage efficiently.

3.4 Adherence

Although the studies suggest that intention to adhere is high, the actual adherence after receiving a notification appears to be lower than intended adherence. There is an gap between intentions and actual behaviour. The studies show that simply reading the latest advice does not lead to behavioural change (following the advice), so the message shown in CoronaMelder after a notification will have to be fine-tuned, addressing both psychological aspects (intention commitment) and practical aspects. This could possibly be done using a message in the CoronaMelder app, or referral from the app to another app or website. In its current form, CoronaMelder is approached as a standalone app, but enriching it may help promote adherence to the advice givengiven. To this end, based on the survey conducted for this evaluation with the LISS panel (Van der Laan, Van der Waal et al., 2021) and the qualitative user study entitled 'Grip op CoronaMelder' (Van Gemert-Pijnen et al., 2021), we make the following recommendations for appropriate interventions to increase self-efficacy and to increase the motivation to convert intention into actual behaviour:

- Explain the rules of quarantine and self-isolation better and more clearly in the app itself and in the communication surrounding the app (e.g. on the Coronamelder.nl website and in brochures).
- Add more features to CoronaMelder that encourage users to act on the advice given.
- Improve the support of the self-efficacy of users who have received a notification to help them act on the advice given.
  Update the app so that it can be used actively (useful features) or so that users receive useful information via the app after a notification.
  Let people formulate their own intentions and let them think about situations in which they struggle to convert their intention into actual behaviour. This will help users internalise their intentions, making them more likely to convert them into behaviour (Sheeran, & Webb, 2016).
- Repeat the advice regularly. The current messages sent in the CoronaMelder app need to be strengthened.

A possible effect of enriching the information provided by the app is that it would emphasize the personal benefits and thus increase adoption as well as adherence.

3.5 Delay

Based on the model study (RIVM, 2021) and in line with the qualitative user study entitled 'Grip op CoronaMelder' (Van Gemert-Pijnen et al., 2021) conducted for this evaluation, we recommend that the delay be reduced where possible. In other words, the time between the moment when a user is exposed to the virus, receives a CoronaMelder notification and requests a test and the moment when the test result is available, should be reduced. By reducing this delay, CoronaMelder users will be notified of risky contacts at an earlier stage, so that they can also notify other app users more quickly if they end up testing positive. We also reiterate the advice to investigate whether it would be possible

for CoronaMelder users to enter their GGD code themselves after testing positive, so that close contacts can be notified automatically after the GGD has activated the code.

4. Suggestions for additional research

Should CoronaMelder also be deployed in the future and be evaluated again on an ongoing basis, we would like to make some suggestions regarding this evaluation.

Firstly, it makes sense to conduct a fifth and perhaps sixth wave with the LISS panel, so that we can monitor adoption, adherence and unintended effects such as risk-compensation behaviour or feelings of obligation to use the app. It also makes sense to continue to communicate CoronaMelder data and information via CoronaMelder.nl, as has already been done with the weekly Factsheet. This will benefit transparency. Also, now that we have the estimation method in place, regularly publishing the estimated number of active apps would be an obvious move.

In addition, the evaluation itself could be improved in certain respects. After discussions within the evaluation team and discussions with and reactions from the Supervising Committee on Digital Support for Contact Tracing (DOBC) as well as the DOBC Taskforce and the Behavioural Sciences Taskforce to the evaluation, we envisage taking the following steps, at minimum:

- **An analysis of GGD contact data broken down by region over time**.
  There was little time between the moment GGD contact data were made available and the publication of the analyses. As such, it was only possible to perform a detailed epidemiological analysis. There was no time left for a thorough epidemiological analysis broken down by region over time, for example per month. Such an analysis may provide more precise insights, e.g. into the added value of CoronaMelder in the event that contact tracing is scaled down in a certain region.

- **An international comparison**
  So far, there is a lot of information on the predicted effects of similar contact and tracing apps at the European level, but not on the actual effects. It has not yet been possible to carry out a thorough empirical comparison of the real epidemiological, behavioural, organisational and societal effects of the various digital contact tracing apps in Europe (see chapter 2.3.7). It is worth looking into the options for doing this at the European level, although it must also be noted that the data collected may differ from one country to the next.

- **Improving registrations**
  During the various analyses of GGD contact data, which were mainly of an epidemiological nature, we were struck by the fact that there were frequently differences and ambiguities in the datasets used by GGD GHOR and RIVM to evaluate CoronaMelder. Ultimately, all these differences could be explained and ambiguities could be resolved, but it did slow down the analysis process. Eliminating these differences and ambiguities by improving registration methods would greatly benefit the evaluation process.

- **Strengthening the mixed methods approach**
  The evaluation was deliberately based on methodical triangulation of quantitative and qualitative research, as this allowed the researchers to interpret and explain the effects and results of CoronaMelder from as many perspectives as possible. If the evaluation were to continue, the mixed methods approach could be improved by introducing data triangulation. By linking all the quantitative and qualitative datasets, we could obtain an even more thorough understanding of the current effects of CoronaMelder, which in turn would help us to achieve the intended effects of the app.

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Appendix 2. (Active) CoronaMelder usage

In developing the CoronaMelder app, user privacy has the highest priority. This has also meant that, until recently, it was not possible to gauge the app's active user base. A privacy-friendly solution has been now found, which means that it is now possible to see how many downloaded apps are still in use. For example, on page 7 of this report you can read that at the moment (May 2021) about 60% of the 4.8 million downloaded apps are active. We have outlined the method used to count active users below.

Insight into active use
After testing positive for COVID-19, people can voluntarily report this in CoronaMelder, together with a GGD employee by using the GGD code. Every time a GGD code is shared, several codes are uploaded, which are added to a list. These lists are published to the server several times a day.

All CoronaMelder apps check for new lists several times a day. If a new list is found, the app will download it and compare the codes on the list the codes on the user's phone. If a code on the list matches a code on the user's phone, the user is sent a notification.

Counting lists
Each app downloads each list only once. This approach allows us to count how often each list is downloaded without registering who they are download by or when they are downloaded. This figure can in no way be traced back to individual users.

Not all apps download all new lists every day. Some apps will download new lists less frequently, especially on older phones or if users press the pause button. We therefore look at the total number of times each list is downloaded over a two-week period and calculate an average.

Appendix 3. Explanation of the detection rate of random testing

The detection rate in a sample corresponds to the estimated percentage of infectious people in the total population of the Netherlands. Every day, RIVM reports the absolute numbers including margins of uncertainty, with a delay of about 7 days. See the table below as an example.

Table 6 Numbers and percentages of COVID-19 infectious people in the Netherlands from 30 November 2020 to 13 May 2021, based on RIVM data of 24 May 2021.

	Uncertainty margin low*	Number of infected people*	Uncertainty margin high*	Population at the end of Jan 2021**	% low	% of Dutch population	% high
Week 49							
30-11-2020	74.157	102.019	130.306	17.475.908	0,4%	**0,6%**	0,7%
1-12-2020	75.261	103.103	131.218	17.475.908	0,4%	**0,6%**	0,8%
2-12-2020	76.728	104.128	132.250	17.475.908	0,4%	**0,6%**	0,8%
3-12-2020	77.836	105.156	133.079	17.475.908	0,4%	**0,6%**	0,8%
4-12-2020	79.251	106.481	134.181	17.475.908	0,5%	**0,6%**	0,8%
5-12-2020	80.955	108.339	135.706	17.475.908	0,5%	**0,6%**	0,8%
6-12-2020	82.692	110.479	138.377	17.475.908	0,5%	**0,6%**	0,8%
Week 50							
7-12-2020	83.542	112.366	140.755	17.475.908	0,5%	**0,6%**	0,8%
8-12-2020	85.932	115.217	144.102	17.475.908	0,5%	**0,7%**	0,8%
9-12-2020	88.863	118.565	148.097	17.475.908	0,5%	**0,7%**	0,8%
10-12-2020	92.336	122.353	152.673	17.475.908	0,5%	**0,7%**	0,9%
11-12-2020	96.720	127.301	157.674	17.475.908	0,6%	**0,7%**	0,9%
12-12-2020	101.570	133.029	163.902	17.475.908	0,6%	**0,8%**	0,9%
13-12-2020	106.250	138.395	169.943	17.475.908	0,6%	**0,8%**	1,0%
Week 50							
7-12-2020	83.542	112.366	140.755	17.475.908	0,5%	**0,6%**	0,8%
8-12-2020	85.932	115.217	144.102	17.475.908	0,5%	**0,7%**	0,8%
9-12-2020	88.863	118.565	148.097	17.475.908	0,5%	**0,7%**	0,8%
10-12-2020	92.336	122.353	152.673	17.475.908	0,5%	**0,7%**	0,9%
11-12-2020	96.720	127.301	157.674	17.475.908	0,6%	**0,7%**	0,9%
12-12-2020	101.570	133.029	163.902	17.475.908	0,6%	**0,8%**	0,9%
13-12-2020	106.250	138.395	169.943	17.475.908	0,6%	**0,8%**	1,0%
Week 51							
14-12-2020	110.552	144.059	176.495	17.475.908	0,6%	**0,8%**	1,0%
15-12-2020	113.839	148.706	182.248	17.475.908	0,7%	**0,9%**	1,0%
16-12-2020	117.218	153.407	188.189	17.475.908	0,7%	**0,9%**	1,1%
17-12-2020	118.862	157.163	194.027	17.475.908	0,7%	**0,9%**	1,1%
18-12-2020	120.659	160.920	199.418	17.475.908	0,7%	**0,9%**	1,1%
19-12-2020	122.369	163.909	204.167	17.475.908	0,7%	**0,9%**	1,2%
20-12-2020	122.530	165.266	207.612	17.475.908	0,7%	**0,9%**	1,2%
Week 52							
21-12-2020	123.206	166.255	209.391	17.475.908	0,7%	**1,0%**	1,2%
22-12-2020	122.204	165.796	209.114	17.475.908	0,7%	**0,9%**	1,2%
23-12-2020	120.778	164.589	208.601	17.475.908	0,7%	**0,9%**	1,2%
24-12-2020	117.313	161.998	206.198	17.475.908	0,7%	**0,9%**	1,2%
25-12-2020	113.498	158.663	203.808	17.475.908	0,6%	**0,9%**	1,2%
26-12-2020	110.338	155.145	200.319	17.475.908	0,6%	**0,9%**	1,1%
27-12-2020	106.068	150.530	196.177	17.475.908	0,6%	**0,9%**	1,1%
Week 53							
28-12-2020	102.661	145.883	190.893	17.475.908	0,6%	**0,8%**	0,8%
29-12-2020	99.628	141.469	185.086	17.475.908	0,6%	**0,8%**	0,8%
30-12-2020	96.284	136.692	179.233	17.475.908	0,6%	**0,8%**	0,8%
31-12-2020	93.849	132.424	173.050	17.475.908	0,5%	**0,8%**	0,8%
1-1-2021	91.050	128.953	168.262	17.475.908	0,5%	**0,7%**	0,7%
2-1-2021	90.421	126.945	164.750	17.475.908	0,5%	**0,7%**	0,7%
3-1-2021	89.470	124.991	161.953	17.475.908	0,5%	**0,7%**	0,7%

	Uncertainty margin low*	Number of infected people*	Uncertainty margin high*	Population at the end of Jan 2021**	% low	% of Dutch population	% high
Week 1							
4-1-2021	88.622	123.425	159.507	17.475.908	0,5%	**0,7%**	0,9%
5-1-2021	88.908	122.461	157.252	17.475.908	0,5%	**0,7%**	0,9%
6-1-2021	88.914	121.564	155.730	17.475.908	0,5%	**0,7%**	0,9%
7-1-2021	88.498	120.650	153.898	17.475.908	0,5%	**0,7%**	0,9%
8-1-2021	87.500	120.251	152.806	17.475.908	0,5%	**0,7%**	0,9%
9-1-2021	87.655	120.473	153.091	17.475.908	0,5%	**0,7%**	0,9%
10-1-2021	86.725	119.530	152.649	17.475.908	0,5%	**0,7%**	0,9%
Week 2							
11-1-2021	85.119	118.018	151.407	17.475.908	0,5%	**0,7%**	0,5%
12-1-2021	84.206	116.549	149.367	17.475.908	0,5%	**0,7%**	0,5%
13-1-2021	83.970	115.862	148.524	17.475.908	0,5%	**0,7%**	0,5%
14-1-2021	83.435	115.238	147.587	17.475.908	0,5%	**0,7%**	0,5%
15-1-2021	82.532	114.624	146.837	17.475.908	0,5%	**0,7%**	0,5%
16-1-2021	82.705	114.309	146.532	17.475.908	0,5%	**0,7%**	0,5%
17-1-2021	82.915	113.720	145.963	17.475.908	0,5%	**0,7%**	0,5%
Week 3							
18-1-2021	82.361	112.457	144.002	17.475.908	0,5%	**0,6%**	0,8%
19-1-2021	81.041	111.391	141.859	17.475.908	0,5%	**0,6%**	0,8%
20-1-2021	79.812	110.212	140.647	17.475.908	0,5%	**0,6%**	0,8%
21-1-2021	77.957	108.715	139.367	17.475.908	0,4%	**0,6%**	0,8%
22-1-2021	76.330	107.330	138.574	17.475.908	0,4%	**0,6%**	0,8%
23-1-2021	75.670	106.312	137.422	17.475.908	0,4%	**0,6%**	0,8%
24-1-2021	75.404	105.102	135.959	17.475.908	0,4%	**0,6%**	0,8%
Week 4							
25-1-2021	75.164	104.283	134.576	17.475.908	0,4%	**0,6%**	0,8%
26-1-2021	75.101	103.381	132.747	17.475.908	0,4%	**0,6%**	0,8%
27-1-2021	74.830	102.610	131.239	17.475.908	0,4%	**0,6%**	0,8%
28-1-2021	73.515	101.234	129.570	17.475.908	0,4%	**0,6%**	0,7%
29-1-2021	71.808	99.775	127.646	17.475.908	0,4%	**0,6%**	0,7%
30-1-2021	70.858	98.670	126.510	17.475.908	0,4%	**0,6%**	0,7%
31-1-2021	69.095	97.085	125.265	17.475.908	0,4%	**0,6%**	0,7%
Week 5							
1-2-2021	67.950	95.593	123.946	17.475.908	0,4%	**0,5%**	0,7%
2-2-2021	66.945	94.243	122.162	17.475.908	0,4%	**0,5%**	0,7%
3-2-2021	67.275	93.523	120.953	17.475.908	0,4%	**0,5%**	0,7%
4-2-2021	67.563	93.112	119.827	17.475.908	0,4%	**0,5%**	0,7%
5-2-2021	67.816	93.215	119.382	17.475.908	0,4%	**0,5%**	0,7%
6-2-2021	69.097	94.088	119.481	17.475.908	0,4%	**0,5%**	0,7%
7-2-2021	69.919	94.873	120.131	17.475.908	0,4%	**0,5%**	0,7%
Week 6							
8-2-2021	70.354	95.317	120.498	17.475.908	0,4%	**0,5%**	0,7%
9-2-2021	70.945	95.964	121.054	17.475.908	0,4%	**0,5%**	0,7%
10-2-2021	71.040	96.370	121.589	17.475.908	0,4%	**0,6%**	0,7%
11-2-2021	70.396	96.168	121.838	17.475.908	0,4%	**0,6%**	0,7%
12-2-2021	69.834	96.138	122.155	17.475.908	0,4%	**0,6%**	0,7%
13-2-2021	69.929	96.394	122.722	17.475.908	0,4%	**0,6%**	0,7%
14-2-2021	69.793	96.232	123.014	17.475.908	0,4%	**0,6%**	0,7%

Page Break

	Uncertainty margin low*	Number of infected people*	Uncertainty margin high*	Population at the end of Jan 2021**	% low	% of Dutch population	% high
Week 7							
15-2-2021	69.407	95.883	122.794	17.475.908	0,4%	**0,5%**	0,7%
16-2-2021	69.080	95.326	121.793	17.475.908	0,4%	**0,5%**	0,7%
17-2-2021	69.176	94.872	121.064	17.475.908	0,4%	**0,5%**	0,7%
18-2-2021	69.009	94.638	120.777	17.475.908	0,4%	**0,5%**	0,7%
19-2-2021	68.553	94.529	120.478	17.475.908	0,4%	**0,5%**	0,7%
20-2-2021	68.788	94.748	120.593	17.475.908	0,4%	**0,5%**	0,7%
21-2-2021	68.507	94.496	120.903	17.475.908	0,4%	**0,5%**	0,7%
Week 8							
22-2-2021	68.566	94.279	120.574	17.475.908	0,4%	**0,5%**	0,7%
23-2-2021	68.267	93.720	119.582	17.475.908	0,4%	**0,5%**	0,7%
24-2-2021	68.437	93.662	119.242	17.475.908	0,4%	**0,5%**	0,7%
25-2-2021	68.676	94.151	119.647	17.475.908	0,4%	**0,5%**	0,7%
26-2-2021	68.974	94.826	120.560	17.475.908	0,4%	**0,5%**	0,7%
27-2-2021	70.135	95.893	121.884	17.475.908	0,4%	**0,5%**	0,7%
28-2-2021	71.140	96.809	122.825	17.475.908	0,4%	**0,6%**	0,7%
Week 9							
1-3-2021	72.609	97.833	123.825	17.475.908	0,4%	**0,6%**	0,7%
2-3-2021	73.957	99.222	124.729	17.475.908	0,4%	**0,6%**	0,7%
3-3-2021	74.805	100.586	126.179	17.475.908	0,4%	**0,6%**	0,7%
4-3-2021	74.947	101.310	127.167	17.475.908	0,4%	**0,6%**	0,7%
5-3-2021	75.051	102.101	128.734	17.475.908	0,4%	**0,6%**	0,7%
6-3-2021	75.461	102.927	130.272	17.475.908	0,4%	**0,6%**	0,7%
7-3-2021	76.236	103.776	131.625	17.475.908	0,4%	**0,6%**	0,8%
Week 10							
8-3-2021	76.972	104.809	132.855	17.475.908	0,4%	**0,6%**	0,8%
9-3-2021	78.274	106.335	134.527	17.475.908	0,4%	**0,6%**	0,8%
10-3-2021	80.231	108.220	136.593	17.475.908	0,5%	**0,6%**	0,8%
11-3-2021	81.908	109.798	138.274	17.475.908	0,5%	**0,6%**	0,8%
12-3-2021	83.672	111.823	140.109	17.475.908	0,5%	**0,6%**	0,8%
13-3-2021	85.643	114.237	142.303	17.475.908	0,5%	**0,7%**	0,8%
14-3-2021	87.287	116.461	145.269	17.475.908	0,5%	**0,7%**	0,8%
Week 11							
15-3-2021	88.490	118.601	148.063	17.475.908	0,5%	**0,7%**	0,8%
16-3-2021	90.054	121.010	151.346	17.475.908	0,5%	**0,7%**	0,9%
17-3-2021	91.915	123.131	154.125	17.475.908	0,5%	**0,7%**	0,9%
18-3-2021	93.507	125.403	157.222	17.475.908	0,5%	**0,7%**	0,9%
19-3-2021	95.847	128.292	160.404	17.475.908	0,5%	**0,7%**	0,9%
20-3-2021	98.905	131.894	164.303	17.475.908	0,6%	**0,8%**	0,9%
21-3-2021	101.570	135.143	168.412	17.475.908	0,6%	**0,8%**	1,0%
Week 12							
22-3-2021	103.741	138.096	172.077	17.475.908	0,6%	**0,8%**	1,0%
23-3-2021	106.329	140.959	175.387	17.475.908	0,6%	**0,8%**	1,0%
24-3-2021	108.328	143.760	178.880	17.475.908	0,6%	**0,8%**	1,0%
25-3-2021	108.873	145.585	181.545	17.475.908	0,6%	**0,8%**	1,0%
26-3-2021	109.555	147.722	184.527	17.475.908	0,6%	**0,8%**	1,1%
27-3-2021	111.711	150.586	188.619	17.475.908	0,6%	**0,9%**	1,1%
28-3-2021	112.362	151.850	191.260	17.475.908	0,6%	**0,9%**	1,1%

	Uncertainty margin low*	Number of infected people*	Uncertainty margin high*	Population at the end of Jan 2021**	% low	% of Dutch population	% high
Week 13							
29-3-2021	113.039	152.979	193.138	17.475.908	0,6%	**0,9%**	1,1%
30-3-2021	114.011	154.100	194.269	17.475.908	0,7%	**0,9%**	1,1%
31-3-2021	115.418	155.476	195.974	17.475.908	0,7%	**0,9%**	1,1%
1-4-2021	115.667	156.320	197.084	17.475.908	0,7%	**0,9%**	1,1%
2-4-2021	115.949	157.775	198.969	17.475.908	0,7%	**0,9%**	1,1%
3-4-2021	117.679	159.680	201.329	17.475.908	0,7%	**0,9%**	1,2%
4-4-2021	119.443	161.608	204.289	17.475.908	0,7%	**0,9%**	1,2%
Week 14							
5-4-2021	120.600	162.953	205.892	17.475.908	0,7%	**0,9%**	1,2%
6-4-2021	121.581	163.984	206.145	17.475.908	0,7%	**0,9%**	1,2%
7-4-2021	123.150	165.619	208.239	17.475.908	0,7%	**0,9%**	1,2%
8-4-2021	123.894	166.988	210.111	17.475.908	0,7%	**1,0%**	1,2%
9-4-2021	124.635	168.789	212.411	17.475.908	0,7%	**1,0%**	1,2%
10-4-2021	125.805	170.685	215.076	17.475.908	0,7%	**1,0%**	1,2%
11-4-2021	127.474	172.581	218.054	17.475.908	0,7%	**1,0%**	1,2%
Week 15							
12-4-2021	129.651	174.855	220.708	17.475.908	0,7%	**1,0%**	1,3%
13-4-2021	131.485	176.692	222.508	17.475.908	0,8%	**1,0%**	1,3%
14-4-2021	133.337	178.601	224.313	17.475.908	0,8%	**1,0%**	1,3%
15-4-2021	133.940	180.343	226.189	17.475.908	0,8%	**1,0%**	1,3%
16-4-2021	134.528	181.722	228.484	17.475.908	0,8%	**1,0%**	1,3%
17-4-2021	135.169	183.308	230.658	17.475.908	0,8%	**1,0%**	1,3%
18-4-2021	134.943	183.771	232.153	17.475.908	0,8%	**1,1%**	1,3%
Week 16							
19-4-2021	134.297	183.568	232.726	17.475.908	0,8%	**1,1%**	1,3%
20-4-2021	133.567	182.830	232.484	17.475.908	0,8%	**1,0%**	1,3%
21-4-2021	132.844	181.999	231.950	17.475.908	0,8%	**1,0%**	1,3%
22-4-2021	130.969	180.117	229.702	17.475.908	0,7%	**1,0%**	1,3%
23-4-2021	128.692	178.161	228.069	17.475.908	0,7%	**1,0%**	1,3%
24-4-2021	126.995	176.154	225.963	17.475.908	0,7%	**1,0%**	1,3%
25-4-2021	124.440	173.121	222.662	17.475.908	0,7%	**1,0%**	1,3%
Week 17							
26-4-2021	122.095	170.164	219.615	17.475.908	0,7%	**1,0%**	1,3%
27-4-2021	118.739	166.191	214.728	17.475.908	0,7%	**1,0%**	1,2%
28-4-2021	115.740	162.067	209.866	17.475.908	0,7%	**0,9%**	1,2%
29-4-2021	111.902	157.574	204.810	17.475.908	0,6%	**0,9%**	1,2%
30-4-2021	109.067	154.047	200.673	17.475.908	0,6%	**0,9%**	1,1%
1-5-2021	106.387	150.588	195.959	17.475.908	0,6%	**0,9%**	1,1%
2-5-2021	104.016	147.338	192.135	17.475.908	0,6%	**0,8%**	1,1%
Week 18							
3-5-2021	102.340	144.096	187.681	17.475.908	0,6%	**0,8%**	1,1%
4-5-2021	101.444	141.711	183.647	17.475.908	0,6%	**0,8%**	1,1%
5-5-2021	101.311	140.131	180.942	17.475.908	0,6%	**0,8%**	1,0%
6-5-2021	99.283	137.931	177.266	17.475.908	0,6%	**0,8%**	1,0%
7-5-2021	97.883	136.267	174.876	17.475.908	0,6%	**0,8%**	1,0%
8-5-2021	97.078	135.338	173.710	17.475.908	0,6%	**0,8%**	1,0%
9-5-2021	96.325	133.770	172.104	17.475.908	0,6%	**0,8%**	1,0%
Week 19							
10-5-2021	95.021	1132.115	170.070	17.475.908	0,5%	**0,8%**	1,0%
11-5-2021	92.995	130.398	168.027	17.475.908	0,5%	**0,7%**	1,0%
12-5-2021	92.884	129.666	166.874	17.475.908	0,5%	**0,7%**	1,0%
13-5-2021	91.346	127.836	164.957	17.475.908	0,5%	**0,7%**	0,9%