National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

RIVM response to the scientific audit report on RIVM COVID-19 data analytics and modelling for scientific advice to policy makers

RIVM

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General response

The staff and management of RIVM would like to express sincere gratitude to the international audit committee (AC) for their time and effort in performing the audit, and for sharing their insights, reflections and recommendations. Here we reflect on these findings and indicate how we will address the recommendations provided in the evaluation report.

We are pleased that the AC concluded that RIVM's COVID-19 data analytics and modelling (DAM) work was of excellent scientific quality, with high societal relevance, enabling policy makers to make evidence-informed public health decisions. We are proud to read that the excellent scientific quality of RIVM's COVID-19 DAM also compares very favourably internationally. It is rewarding that the AC recognizes the enormous amount of work that was done by RIVM during the COVID-19 pandemic, addressing a wide range of questions and topics, under high pressure, with limited human resources. We agree with the AC and recognise that the time pressure made it necessary to prioritize during the crisis, and the AC found that this was done in a sensible manner. The AC judged RIVM's data access and data flows to be much better as compared to many other countries, irrespective of perceptions within the Netherlands, but also observed that RIVM had to spend a disproportionate amount of time on collecting and linking some types of data because of restrictions in data access and data sharing, and could therefore not obtain access to other types of useful data, such as mobility data based on aggregated mobile telephone data. We appreciate that the AC considers the range of outputs to be impressive, and that RIVM's system to maintain its independent role and position and to prevent undue external influence is robust and has performed well. The AC identified several vulnerabilities in the organisation of infectious disease data analytics and modelling at RIVM that we can and will try to use to further strengthen RIVM's DAM. However, some of these vulnerabilities cannot be addressed by RIVM alone, but require concerted action by other institutions and policy makers in the Netherlands.

We agree with the observation of the AC that there are two paths to assess the quality of data analytics and modelling: one is to inspect the data and code line by line; the other is to develop an alternative model that aims to address the same question, and then compare the results to see to what extent the models agree (what the AC refers to as 'reproducibility' of the models). We used both pathways. To allow for this second path of reproducibility quality assessment by external scientists, RIVM shared data and code rapidly when possible and as rapidly as possible given the circumstances (for example the models for vaccine allocation and impact of vaccination strategies), and RIVM collaborated with research teams that independently developed alternative models that addressed the same questions as RIVM's model (for example, calculation of the time-varying reproduction number Rt, producing short-term projections of COVID-19 ICU admissions and hospitalisations).

These collaborating partners who developed these alternative models were indeed mostly based in other countries. Within the Netherlands, alternative models for COVID-19 ICU admissions and hospitalisations were developed during the pandemic by research teams at TNO and LCPS, which resulted in collaboration with these teams.

Response to strategic recommendations of the audit committee

1. Structurally strengthen the capacity of RIVM's infectious disease DAM teams.
We acknowledge this to be an important priority. A structural increase in capacity will help to address recommendations 2, 4, 5, 6, and 7 by the AC. For the time being we have secured temporary funding from the Ministry of Health, Welfare and Sports (VWS) to expand the teams, and we explore with VWS whether this can become structural funding, see recommendation 8.

To strengthen the surge capacity of the teams, we propose a three-step approach.

The first step is to enlarge the data analytics and modelling capacity at RIVM substantially. This means a structural change towards a larger team of modellers and data scientists, with a software engineer position. To ensure long-term viability, it is essential to have PhD positions and postdoc positions. Of these, we have already opened up vacancies for four PhD positions, one postdoc position, one software engineer, and one data scientist. To attract skilled researchers, RIVM needs to provide a clear and appealing career perspective, and salary levels should be in line with Dutch academic salaries. For some fields of expertise, such as data science, it is difficult to recruit researchers at a salary level below commercial salary scales. Please note that to realise this step we are dependent on funding from our commissioning clients (i.e. VWS), and on changes in the salary system that RIVM has to comply to.

The second step is to enlarge the surge capacity by creating a flexible pool of modellers and data scientists within RIVM, who can be called upon during a crisis. The advantage of such a pool of RIVM employees is that the onboarding time is short. The willingness and ability of skilled employees to cope with immense pressure in a crisis situation is difficult to predict; therefore, it is important to screen for skills as well as competencies, and to arrange support for the employees in this pool.

The third step is to enlarge the surge capacity by creating an external pool of skilled modellers and data scientists in the Netherlands, who are willing to work with or within RIVM during a crisis situation. To create such a pool, we need to explain what we have learned during the crisis (see recommendation 2). We need to explain the role of RIVM and its legal context, how evidence-informed policy advice for infection control as defined by the legal obligations and core tasks of RIVM works, and how work in such a government agency differs from the work in academic centres (see recommendation 5). Furthermore, we need to explain the implications of the Open Government Act, and how this differs from Open Science and the generic requirements of traceability and reproducibility of results (see recommendation 6). We will reach out to external experts and will convey a first meeting this calendar year to explore this idea, and we are already exploring possible ways to obtain funding for this third step with VWS.

2. Prioritise training of new infectious disease DAM experts in the Netherlands and attract more Masters and PhD students to RIVM.

Passing on the accumulated expertise among top scientists to new generations is a priority for pandemic preparedness, and we are already acting on this recommendation.

As of May 2023, we have enrolled two Masters students, one PhD student, one PhD student on secondment, and one junior researcher has committed to doing a PhD on the job. We are currently recruiting four other PhD positions.

We are preparing a short course on infectious disease data analytics and modelling for the newly recruited researchers, as part of our onboarding process, where we address issues learned during the pandemic. We aim to include the experience and lessons learned from international colleagues as well. We expect to have this up and running by the end of 2023. In addition, we plan to offer this training to interested academics in different fields, see recommendation 5.

3. Structurally improve the access to all data streams that are relevant for DAM at RIVM.

We very much agree with this recommendation. Improving access to data streams and their intrinsic quality is very much needed and would also enable using human resources for other much needed activities during a crisis.

Our priority is to secure sustainable funding for data streams essential to infectious disease control (see recommendation 8), such as contact patterns. We have expertise in collecting and analysing these data, but this is based on 20 years of short-term funded projects. More structural, long-term funding would ensure that this expertise in data analysis and data collection can be better sustained and further improved. Strict privacy regulations and interpretation thereof by the authorities in the Netherlands prohibit RIVM from accessing certain data streams, such as aggregated mobile telephone data to measure mobility, and we plan on securing access to information on mobility in the near future. We are working on a proposal for infectious disease surveillance, to obtain an overview of which data streams were missing, which data streams were of lower quality, and which data was fragmented. We will explore how to ascertain sustainable funding for better access to these essential data streams with VWS, including data on contact patterns, and also how to ensure mobility data streams can be monitored for infectious diseases, given the current interpretation of GDPR in the Netherlands.

Various other data streams are fragmented or of lower quality than needed, or are non-existent. This requires a collective effort. Together with Statistics Netherlands (CBS), the Regional Health Services and its umbrella organisation GGD-GHOR, and with VWS, we are exploring how this can be structurally improved. This already has the attention of VWS, and is one of the overarching lessons learned from the pandemic as also recognised in other evaluations. This may involve the introduction of new legislative rules and regulations and the development of new specific registries that RIVM will depend upon to address recommendation 3 as adequate as possible.

4. Improve the transparency of and communication about RIVM’s infectious disease DAM work.

We agree with the AC that the interaction between science and policy requires intensive dialogue during a crisis that warrants more than the exchange of reports and paperwork. Given the time pressure during the pandemic, we had to prioritize. In the aftermath of the crisis we will make it a priority to further communicate how scientific advice interacts with policy decisions in the Dutch governmental and RIVM contexts, and to better communicate the existing checks and balances that safeguard the scientific quality of the advice.

Besides the material that can be found on https://www.rivm.nl/en/coronavirus-covid-19/modelling/scientific-models, several activities have been planned that will further improve the transparency. These activities are detailed below.

For infectious disease data analytics and modelling, a first activity is to better explain what we do. The stakeholder analysis demonstrates that some stakeholders perceived that RIVM did not address certain topics (such as modelling the effectiveness of measures in schools, the effects of changes to the testing policy, and the use of the COVID certificate), even though we actually successfully delivered advice on these topics. Also, some stakeholders perceived that RIVM did not provide explanations of our modelling methods beyond the information that was presented to the House of Representatives, even though we actually made methodological explanations publicly available on our website, in preprints, and in publications. Together with RIVM's communication unit we are exploring how to communicate this better, and to explore more precisely what parties believe that is still missing. As a part of this, we plan to communicate our ongoing work using dedicated webpages that are kept up-to-date and are easily findable. We will continue to communicate our most recent work by publishing manuscripts on preprint servers, and we will continue to communicate our finished work by submitting manuscripts to international peer-reviewed journals.

A second activity is to further improve the explanation of the internal checks and balances we conduct, and how the quality assurance system works. We have formalized the quality assurance system and made it operational in the Modelling of Infectious Diseases department (EPI-MOD) within the Centre for Infectious Disease Control (CIb). We are now disseminating this to other units within the CIb. Together with RIVM's communication unit we are exploring which communication tools are most suitable to make known the existence and content of the webpages detailing our ongoing work.

A third activity is to better explain the role of RIVM in providing evidence-informed advice in infectious disease management and control. As part of this activity, we will include in our presentations and courses in the Netherlands, whenever relevant, a slide explaining how infectious disease control is organized in the Netherlands, and the division of tasks and roles between institutions. The role of the RIVM will be relevant information for the memorandum of understanding that will underly the collaborative networks (see recommendation 5).

A fourth activity is to explain to other researchers and the general public how the Open Government Act (WOO) and GDPR together put strict demands on how code and data should be reported, which indeed sometimes interferes with the goal of open science. This is specific to those Dutch governmental agencies that collect raw data and analyse it at the required high resolution in order to provide government advice. RIVM is developing guidelines for writing code in such a way that makes it easier to publish code and data within the legal framework of the Open Government Act and the GDPR. To guarantee that research is reproducible and that code and data are useable, we aim to provide code with synthetic data for publication.

A fifth activity is to communicate the various collaborative research projects in which our data analytics and modelling work is embedded. Most of the collaborations are international. As of January 1st 2023 we are now also part of the European Union-funded research project ESCAPE (https://www.escapepandemics.com/),in which the international collaboration between university-based research teams, research institutes, and public health institutes is essential. A substantial proportion of this project is devoted

to communication. Furthermore, we participate in networks such as the 'nowcasting hub' and 'scenario-modelling hub'. We will intensify our communication that such collaborations are essential for assessing the quality of data analytics and modelling, as they provide the opportunity to compare the results of alternative, independently developed models that address the same question. We will use our experience in international collaborations to set up collaborative structures on a national level as well (see recommendation 5), which (depending on funding) will facilitate academic teams in the Netherlands to develop independent models against which RIVM models can be compared.

Transparency and communication of scientific research for policy making require continuous effort. To free up capacity, it is essential that capacity issues are solved which will speed up publication time and allow other questions from stakeholders to be addressed (depending on available capacity and funding, as well as planning)

We appreciate that the AC mentioned the personal threats to researchers appearing in media to communicate results and advice. This is something beyond RIVM's capacity to solve. It is important to tackle this together with the help of the broad research community and the government, and that all stakeholders clearly state that there is no tolerance for such behaviour.

5. Establish a national network of collaborating institutions based on pre-existing memorandums of understanding, within which data and models can be shared more easily.

Besides our extensive international collaborations, we are currently exploring how to set up a national-level collaboration. We have learned that it is essential to be very clear about the different roles and responsibilities of the different partners in such a collaboration (see recommendation 4). We will create memorandums of understanding, acknowledging the different roles, different responsibilities and different tasks of the partners in a collaborative network. Memorandums of understanding will also specify how data and models can be shared most easily. If possible, we are considering making this an active network, such that different partners get to know one another, which facilitates collaboration during a crisis. This national network should be compatible with the existing international networks, in order to ensure a seamless fit in collaboration during a crisis. This will be accomplished through internships, secondments, and/or a course programme aimed at researchers who work in a different field and are interested in infectious diseases, and at junior researchers who choose to focus on infectious diseases.

We are currently exploring with VWS to obtain the required sustainable funding to set up a collaborative network of institutions in the Netherlands. We are currently exploring with the Dutch funding agency for medical research (ZonMw) how to achieve synergy between their research funding programmes and RIVM's responsibilities and tasks.

6. Strengthen the endeavour to incorporate behavioural data and the wider impact of pandemics into the DAM work.

There are several recently started activities that strengthen the incorporation of more behavioural data into infectious disease data analytics and modelling work.

The ongoing efforts and achievements in integration of behavioural sciences with infectious disease modelling at RIVM may be illustrated by looking at the work on the mpox outbreak in the Netherlands. Infectious disease modellers are co-authors on a

paper led by behavioural scientists, and behavioural scientists are co-authors on a paper led by modellers (available as preprints on medRxiv: https://www.medrxiv.org/content/10.1101/2023.01.31.23285294v2; https://www.medrxiv.org/content/10.1101/2023.02.28.23286578v2).
We believe that RIVM EPI-MOD unit is well-equipped to further the integration of behavioural data into infectious disease modelling. We distinguish here between two categories of behavioural data: actual behaviour, and intended behaviour. Actual behaviour includes, for example, data on vaccination coverage (do people get vaccinated or not?), data on social contacts at risk of transmitting infections (do people have such contacts or not?), data on mobility and time use (what proportion of time is spent in which setting, and how far do people travel to these settings?). Intended behaviour includes, for example, data on whether people indicate that they are willing to be vaccinated, whether they indicate that they will follow governmental measures, and data that informs us regarding the intentions and drivers of future behaviour.

With respect to actual behaviour, the EPI-MOD department has substantial experience in measuring and analysing actual self-reported behaviour with respect to contact patterns (POLYMOD project in 2007, PIENTER3 in 2017, the COMIX study in 2020-22, The SCONE study in 2020-2021, the PICO studies in 2020-22 [https://www.rivm.nl/en/pienter-corona-study/results, see the self-evaluation report]). In these projects we asked participants about their actual contact behaviour, but also about their vaccination status, their compliance with the advice to maintain social distancing, and whether they wear a facemask. We have considerable experience in including this actual behaviour in infectious disease models. We are working to gain access to data on actual mobility behaviour (see data access, point 3). Having access would allow us to include more data on actual behaviour into infectious disease models.

With respect to intended behaviour, the EPI-MOD department has experience in setting up and conducting Discrete Choice Experiments (DCE, https://pubmed.ncbi.nlm.nih.gov/32487041/), and in including risk perception and behaviour in the MORPHINE project (2015-2019), funded through the Strategic Programme RIVM (SPR). We have now obtained funding for the new SPR project "BEHAVING" which aims to include behavioural data in transmission models, with a specific focus on COVID-19 and STDs (with two PhD positions, with a supervision team consisting of epidemiologists, modellers and behavioural scientists, including Prof. Marijn de Bruin who heads the Behavioural Unit of RIVM). The project starts in 2023 and will run for four years until 2027.

7. Strengthen internal collaboration between RIVM offices or departments involved in DAM work.

We are taking concrete steps to further strengthen and maintain internal collaboration within RIVM. RIVM has recruited a model coordinator, within the department SIM (which offers consultancy services in the fields of statistics, informatics and modelling), to coordinate between the various modelling groups that work on a variety of topics using a broad range of methods within the institute, and to strengthen the implementation of various models. The function of coordinator was vacant during the audit period. As of May 1st 2023 the new coordinator has taken up the task of coordinating modelling work being done and to strengthen collaboration between the RIVM departments involved in modelling. The function focusses more on the modelling part rather than the part of data analytics and data handling within the DAM work.

RIVM is conducting "reprohacks" (Reproducibility hackathons) where researchers try to reproduce the research output, such as figures, tables and data, from a specific article, using the code and data that were published with this article. Specifically, in one of the reprohacks researchers reproduced the work on the age-specific contact patterns that were collected during the COVID-19 pandemic in the CoMix project and the SCONE projects, based on the publicly available information in preprints and from the code and data in the publicly accessible repositories GitHub and Zenodo. Such reprohacks strengthen collaboration as they benefit both the participating researchers and the authors of the articles; participants learn new skills that they may apply in their own research, while authors get feedback on the reproducibility of their work, which will be used to further improve the reproducibility of their research.

We are also working on further strengthening internal collaboration within RIVM's Centre for Infectious Disease Control. Here, collaboration on both the modelling and the data analytics are fostered by formalization and operationalization of a shared quality assurance system at the Centre for Infectious Disease Control. Documenting and publishing activities, and sharing a common system of good practice, will benefit collaboration. The Centre for Infectious Disease Control is writing position papers, specifying which tasks are covered by specific groups, and which tasks require collaboration between groups. As a concrete example, collaboration between EPI-MOD and Z&O-NRS has started calculating the time-varying reproduction numbers Rt (a typical task for EPI-MOD) from sewage water surveillance (a typical task for Z&O-NRS), which will result in a manuscript for submission to a peer-reviewed journal.

8. Ensure sustainable funding for RIVM's infectious disease DAM work and for collaborative research to improve future pandemic preparedness.

We agree that funding should be adequate and sustainable for the tasks of RIVM's infectious disease data analytics and modelling, and that funding has to be sustainable for collaborative research to further improve future pandemic preparedness. We emphasize that sustainable funding should cover both personnel and data access, to ensure that we can maintain and foster expertise, and that available data is up-to-date. We are exploring with VWS possible ways to secure sustainable funding for RIVM's work, and to secure sustainable funding for collaborative work. The latter would make it possible to set up collaborative networks (see recommendation 5).