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REVISED Lessons from RespiCompass: Coordinating scenario modelling for respiratory diseases in the EU/EEA

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Abstract

In 2024, the European Centre for Disease Prevention and Control (ECDC) launched RespiCompass, a scenario modelling hub for infectious respiratory diseases. The hub uses an ensemble approach, whereby projections from models developed by separate groups are combined to obtain medium- to long-term scenario-based projections. RespiCompass provides outputs designed to help public health experts and authorities assess respiratory virus risks and evaluate the potential impact of interventions, including vaccination. In building RespiCompass, ECDC has convened modelling teams, disease experts, and policymakers to work together in identifying policy-relevant questions, designing scenario rounds, and interpreting multi-model outputs. Drawing on lessons from other modelling hubs, the first project round of RespiCompass delivered results from six influenza and seven COVID-19 models, navigating the complex challenges of its first year. This article describes how RespiCompass was organised, which challenges arose, how they were addressed, and which operational, technical and collaborative lessons may transfer to similar initiatives.

Keywords

scenario modelling, ensemble modelling, modelling hub, respiratory diseases, preparedness, public health interventions

Open Peer Review

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Any reports and responses or comments on the article can be found at the end of the article.

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REVISED **Amendments from Version 1**

Version 2 responds to the comments of two peer reviewers. We clarified the scope of the article: it documents how the first round of RespiCompass was organised, which challenges arose, how they were addressed and which lessons may transfer to similar initiatives. It does not evaluate the policy impact of the hub. A new Methods section describes the four sources from which the lessons were drawn, and these sources are stated throughout, including in a new column of Table 2. We also added a section on the limitations of this account. This version discusses more carefully the benefits and limits of multi-model approaches, how the ensemble was built, how sources of uncertainty were represented in Round 1 (new Table 3), and the challenges of interpreting results across countries. We added concrete examples throughout. A new Figure 2 shows the timeline of Round 1, and Figure 1 was redrawn to be more readable. We thank the two peer reviewers for their careful and constructive reports.

Any further responses from the reviewers can be found at the end of the article

Introduction

Public health experts and decision-makers face situations where evidence from experimental studies is limited, like following the introduction of new health technologies or at the emergence of a novel disease. In these circumstances, the potential impact and cost-effectiveness of different policy options can be highly uncertain. Mathematical modelling provides a structured way to synthesise diverse data sources and explicitly account for uncertainty, enabling the assessment of public health and health economic impacts by simulating hypothetical situations that would be impractical or unethical to study empirically.[8] For example, modelling has been used to assess the cost-effectiveness of human papillomavirus (HPV)[9] and malaria[10] vaccination, to evaluate control strategies for foot-and-mouth disease outbreaks in livestock,[11] and to guide mitigation decisions during the COVID-19 pandemic.[12–16]

In some situations, collaborative modelling using ensemble approaches offers important advantages over individual models. By combining projections from multiple independently developed models, ensembles provide a more comprehensive representation of uncertainty, capturing variability in assumptions, structure, and parameterisation across contributing models. Their added value is therefore greatest under high structural uncertainty, when several model formulations are plausible.[17] In infectious disease forecasting, this approach was first operationalised in the U.S. FluSight challenge, which produced weekly consensus forecasts for influenza-like illness (ILI) by combining outputs from different models.[18,19] Ensemble modelling has since been applied to forecast COVID-19 case and death trends,[20,21] and to assess the impact of vaccination strategies for diseases such as COVID-19, malaria, and rotavirus.[22–24] Ensemble approaches support more informed and resilient public health decisions by presenting a range of plausible outcomes and reducing reliance on any single set of assumptions. In forecasting, ensembles have consistently been among the most accurate and reliable approaches, often outperforming every contributing model.[18–21]

Scenario modelling hubs have become established platforms for coordinating ensemble modelling efforts in infectious disease medium and long-term projections and policy planning.[25] Definition Box 1 explains how scenario modelling differs from forecasting. In the United States, the COVID-19 (from 2020), Flu (2022), and RSV (2023) Scenario Modelling Hubs have brought together multiple modelling teams to generate ensemble-based scenario projections for medium- to long-term planning and policy evaluations.[26–28] Their projections have supported planning, for example on relaxing non-pharmaceutical interventions as vaccination progressed,[41] the Delta variant resurgence[42] and paediatric COVID-19 vaccination,[22] and their use by public health agencies has been documented.[40] Similarly, the European COVID-19 Scenario Hub (2022–2023) provided insights on vaccination strategies[16] and the projected burden of new SARS-CoV-2 variants.[29–31]

Scenario modelling hubs also have limitations. Additional coordination and analytical layers can reduce flexibility to timely respond to changes in disease dynamics or public health needs. In the US COVID-19 hub, scenarios remained close to reality for 22 weeks on average before new virus variants invalidated key assumptions.[38] Models that share assumptions and data are not entirely independent, so agreement and variation between models needs careful interpretation.[1] Hubs spanning several countries face further constraints: common scenario definitions must fit heterogeneous epidemiological contexts, vaccination programmes and surveillance systems. Hubs also depend on sustained effort from organisers and contributing teams, often without dedicated funding. Finally, a common risk to all scenario modelling approaches is that scenario projections are easily misread as forecasts, and model outputs can convey more certainty than the evidence supports.[2]

In April 2024, ECDC launched RespiCompass—a new scenario modelling hub for respiratory diseases in the EU/EEA. The first scenario round (Round 1), published in November 2024,[7,32] focused on the impact of influenza and COVID-19 vaccination. This paper documents our experience of the first RespiCompass cycle. We describe how the project was organised, from the definition of project goals and scenario design to the recruitment of modelling teams, stakeholder engagement, analysis and communication of results. For each stage, we report the challenges encountered, how they were addressed, and which lessons may transfer to other collaborative modelling initiatives.[32] We conclude with the limitations of this account, a summary of insights and an outlook on future directions.

Definition Box 1. Scenario modelling versus forecast modelling.

Forecast modelling aims to predict the future trajectory of epidemiological indicators, such as weekly COVID-19 hospitalisations. Like weather forecasts, these models provide near-term projections based on recent data. For diseases with short serial intervals like COVID-19 and influenza, reliable forecasts typically extend only a few weeks into the future.[21] These models rely heavily on timely surveillance data to project short-term outcomes. Launched in 2023, ECDC's RespiCast hub leverages an ensemble approach to deliver short-term forecasts of respiratory virus indicators for the EU/EEA.[33]

Scenario modelling in contrast, is not designed to predict the most probable future. Instead, it explores multiple "what-if" scenarios, often referred to as counterfactuals.[8] Scenarios may explore future as well as past time windows. This approach helps assess the potential impact of interventions (e.g., through modelling vaccination strategies) and supports preparedness for emerging threats (e.g., through modelling future pandemic scenarios). Scenario modelling can also explore how different policies or external conditions might have altered disease dynamics. Estimates from model-based counterfactual comparisons are conditional on assumptions (e.g., vaccination coverage, timing of vaccination campaigns relative to transmission peaks) and are therefore likely to differ from estimates derived from observational studies of, for example, vaccine programme impact.[3] Scenario models often require mechanistic representations of disease transmission, and they can be used even when surveillance data are limited. Launched in 2024, ECDC's RespiCompass hub leverages an ensemble approach to deliver scenario projections for respiratory virus burden in the EU/EEA.[34]

Methods

This paper provides a description of the design and implementation of a scenario modelling hub for respiratory diseases in Europe. We structured the paper to address the main components of the project and their execution and include lessons learned that we believe could be helpful to other modellers intending to launch similar platforms. We do not assess here whether the results affected policy decisions, which would require a dedicated evaluation. The scenario projections themselves, including model-based estimates of hospitalisations averted by vaccination under the scenario assumptions, are presented on the RespiCompass website[7] and in an ECDC report.[32]

The lessons in this paper draw on four sources. First, the experience of the ECDC coordinating team and the contracting consortium (Table 1), documented in concept notes, meeting notes, email exchanges and in the scenario documentation.[47] Second, feedback from modelling experts in three technical meetings and further bilateral meetings between June and August 2024. Third, structured interviews with the two contributing modelling teams outside the contracted consortium, held in March 2025. Fourth, a survey conducted among members of the European Respiratory Viruses Network (ERVI-Net)[1] on decision-support needs and communication preferences, answered by 19 of 30 network representatives in May 2024, and subsequent discussions at the ERVI-Net meeting in October 2024. Table 2 links each lesson to its main source.

Results and discussion

RespiCompass vision and governance

RespiCompass builds on the experience of the European COVID-19 Scenario Hub, which was created to foster international modelling collaborations during the acute phase of the COVID-19 pandemic.[34] With the end of the COVID-19 public health emergency, ECDC expanded the hub's scope beyond COVID-19 to create RespiCompass. The founding vision of RespiCompass is:

RespiCompass aims to become a leading resource for evidence-based decision-making in public health preparedness and response to respiratory infectious diseases. RespiCompass aspires to empower policymakers, healthcare professionals, and other stakeholders with robust scenario-based modelling insights to inform strategic planning and resource

[1]The European Respiratory Viruses Network (ERVI-Net) is a network of public health experts and epidemiologists representing EU/EEA Member States and accession countries. It is hosted and coordinated by the European Centre for Disease Prevention and Control (ECDC), with the purpose of coordinating surveillance, prevention, and control of infectious respiratory diseases across Europe.

Table 1. RespiCompass actors and their roles.

Function/Actor	ECDC	National experts & networks	Contributing modelling teams	Contractor
Defining priorities & objectives	Defines project scope and objectives in alignment with ECDC strategy, incorporating input from national experts.	Provide national perspectives on priorities and practical considerations.	Engage in discussions on modelling scope and may propose scenarios.	Contributes to scope definition, Assesses technical feasibility and advises on implementation.
Facilitation & coordination	Connects experts, aligns efforts (e.g., modelling and ECDC literature reviews).	Engage in discussions, provide feedback, and insights into national contexts.	Contributes to modelling discussions and provides feedback on technical feasibility.	Organises scenario launch, supports modeller meetings, develops digital infrastructure.
Knowledge & network building	Integrates expertise across modelling, epidemiology, virology, vaccines, and behavioural science.	Act as the link between national needs and ECDC priorities, foster connections with national modellers.	Participate in project meetings, share insights on technical approaches.	Engages in discussions with ECDC to refine implementation.
Infrastructure & technical implementation	Defines platform requirements, ensures usability and adaptability.	Provide feedback on interpretability and usability for public health agencies and stakeholders, may share relevant data.	Develop models and submit modelling results, provide feedback on user experience and functionality for modelling contributions.	Develops models and submits modelling results, develops and maintains websites, scripts for data reporting, and visualisation tools.

allocation. By fostering collaboration across European and global modelling communities, the hub aims to bridge the gap between advanced modelling expertise and practical public health needs.

RespiCompass brings together a network of contributors (Table 1). It is coordinated by ECDC and draws on internal and external expertise in modelling, epidemiology, virology, immunisation, and preparedness. In its first year, RespiCompass engaged with ERVI-Net,[35] which helped shape the initial scenario round and provided feedback through a survey on decision-making support needs and communication preferences. For the 2025/26 round, RespiCompass engaged the EU/EEA National Immunisation Technical Advisory Groups (NITAG) Collaboration[36] from the first project phase, to better align scenario design with national decision-making priorities. ECDC outsources technical support for the project to a contractor (EU-SMIND, a modelling consortium) which also contributes through submission of modelling results.

RespiCompass benefits from collaboration with the US COVID-19, Flu, and RSV Scenario Modelling Hubs.[26–28] Since 2020, these hubs have collectively conducted around 30 scenario rounds, providing evidence on the value of collaborative modelling and providing a wealth of best practices.[17,22,25,37–42] RespiCompass and the US hubs share methodologies, including ensemble approaches, and they rely on shared infrastructure such as the hubverse[43] for validation, visualisation, and submission management. Collaboration between European and US teams has been mutually beneficial; some US teams contributed directly to ECDC collaborative modelling initiatives, while European teams participated in US hub activities, fostering a global exchange of knowledge and tools.

Project cycle overview

RespiCompass follows an annual project cycle designed to deliver relevant and actionable insights and to ensure project improvement. The process begins with consultations with disease and public health experts to define policy-relevant questions and prioritise scenario options. Scenarios are then designed and shared with participating modelling teams, who —applying a common set of shared assumptions—independently develop their models and submit results following a standard submission format. After analysis and interpretation, findings are disseminated through different channels. In the 2024 project cycle, results were shared through a website[7] and stakeholder presentations, followed by a technical

Table 2. Summary of challenges and lessons learned during RespiCompass design phase and first round, with the main source of each lesson.

Challenge	Key lessons learned/Solutions identified	Main source
Scenario definition	Engage stakeholders early to ensure relevance and feasibility	ERVI-Net
	Use mock/pilot runs to test assumptions and scenario clarity	Meetings with modellers
	Establish structured feedback loops to refine definitions iteratively	Meetings with modellers, ERVI-Net
Recruitment and engagement of participants	Hold regular touchpoints and thematic discussions to maintain engagement	Meetings with modellers, modeller interviews
	Provide logistical and technical support (e.g., compute resources, documentation, timely announcements, funding initiatives)	Meetings with modellers, modeller interviews
	Recognise contributions through authorship and community-building activities	Meetings with modellers, modeller interviews
Timelines and capacity constraints	Align submission deadlines with academic calendars and provide adequate lead time	Meetings with modellers, modeller interviews
	Streamline internal coordination to anticipate delays and bottlenecks	ECDC coordinating team
Model synthesis and insight generation	Introduce peer review of model submissions to enhance rigour	ECDC coordinating team
	Compare ensemble approaches systematically to inform method choice	ECDC coordinating team
	Interpret discrepancies between models as learning opportunities	Meetings with modellers
Communication and dissemination	Adopt multi-channel strategies: webinars and web-based for fast updates, reports for detailed summaries, publications for more focussed insights and modeller engagement	ERVI-Net
	Clarify distinction between forecasting (RespiCast) and scenario modelling (RespiCompass) in all communications	ECDC coordinating team, ERVI-Net
Stakeholder trust and uptake	Transparently present both ensemble and individual model results to highlight uncertainty	ECDC coordinating team
	Frame results within real-world decision-making constraints to enhance usability	ERVI-Net

ERVI-Net: European Respiratory Viruses Network.

report.[32] Each cycle concludes with an evaluation phase to identify areas for improvement. An illustration of the inputs, processes, and outputs for the 2024 project round is provided in Figure 1.

Defining a scenario round

The structured design of infectious disease modelling scenarios has seen important advances in recent years.[8] Defining such scenarios is an inherently iterative process that requires ongoing refinement to balance feasibility constraints, available data, and stakeholder priorities. In the 2024 RespiCompass scenario round, which modelled disease dynamics from 5 August 2024 to 1 June 2025, two scenario axes specified parameters for vaccine uptake and for biological factors, respectively (Figure 1). Values for vaccine coverage scenarios were based on historical coverage data and expert opinion on plausible yearly variation. For COVID-19 the biological axis was used to assess the potential impact of varying levels of waning immunity, whereas for influenza this axis was designed to assess the impact of seasonal variation in viral transmission intensity.

Alongside the definition of scenarios, common outputs across models need to be agreed to allow joint interpretation and communication of results. Moreover, the chosen model output is then used by modelling teams for fitting and evaluation of their models against historical data. Data on COVID-19 hospitalisations over time were available for 28 of the

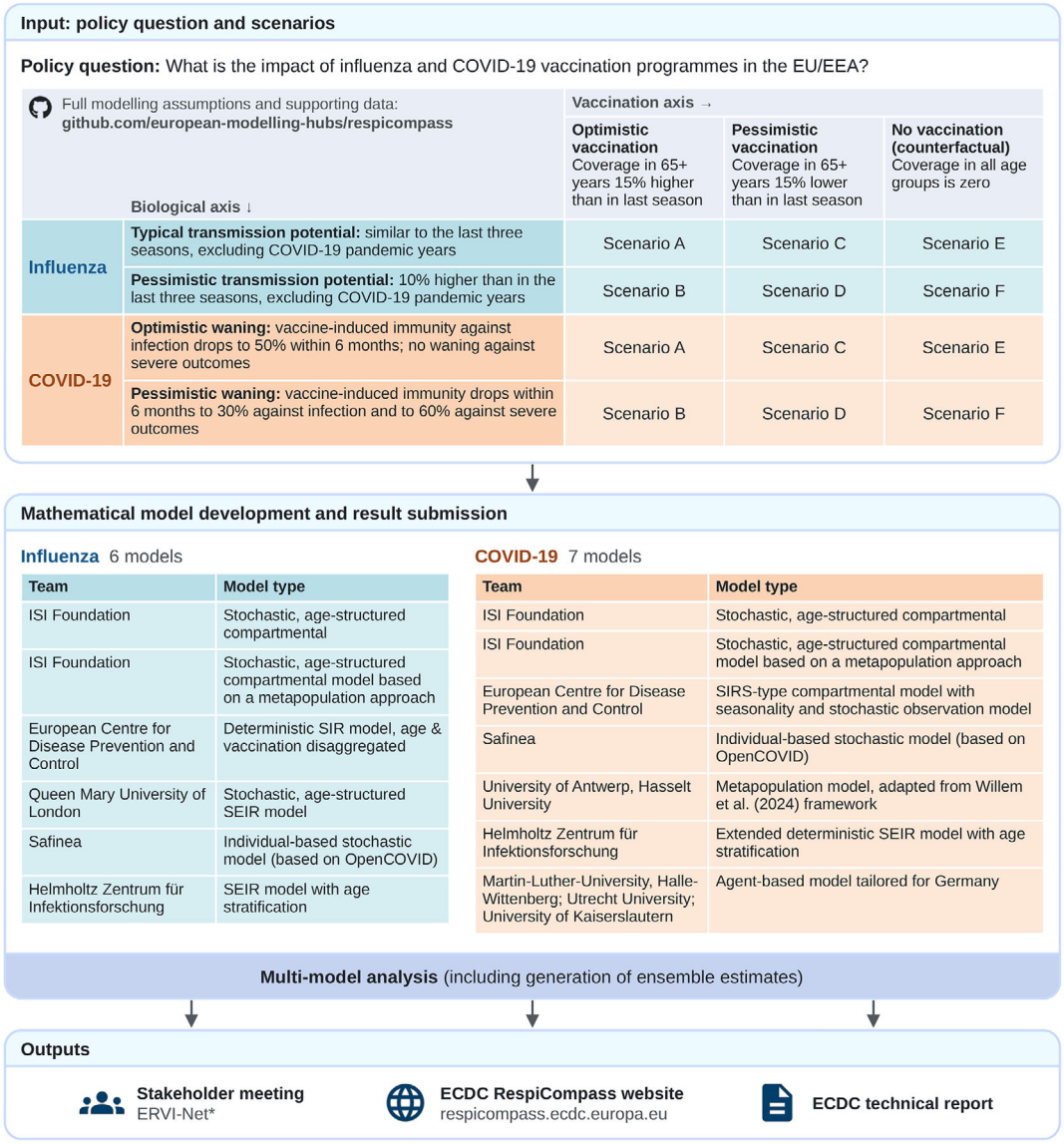


Figure 1. Overview of inputs, processes, and outputs for the 2024 RespiCompass project round. The process begins with the policy question, which informs the scenario definitions (illustrated here by the scenario table for influenza and COVID-19) and underlying assumptions. Based on these inputs, modelling teams (listed with their model types) develop their models and generate projections. Results are then analysed, compared, and interpreted. The findings from this analysis inform the final outputs and recommendations. *European Respiratory Virus Network.

30 EU/EEA countries, but coverage for influenza hospitalisations was limited.[7] We therefore used ILI+ as the influenza target: ILI consultation rates multiplied by influenza test positivity (i.e. the proportion of laboratory samples from ILI consultations positive to influenza virus). This target was available for 26 of the 30 EU/EEA countries. Subsequent discussions with subject experts highlighted that while linked to influenza circulation, ILI+ was less relevant for policy than hospitalisations. Therefore, at the time of reporting results we transformed modelled outputs into averted influenza hospitalisations. For this we used modelled ILI+ cases by vaccination status, converted these for each scenario into hospitalised cases by assuming a hospitalisation risk and a reduced risk for vaccinated cases, and finally computed relative reductions in hospitalisations between each scenario and its no-vaccination counterfactual, whereby the hospitalisation risk per ILI+ case cancels out.[32] Early testing of scenarios revealed additional challenges, including implausible projections under certain epidemiological assumptions. For influenza, the biological axis first contrasted a season with 10% lower transmission potential against a season with 10% higher than usual transmission potential. Under

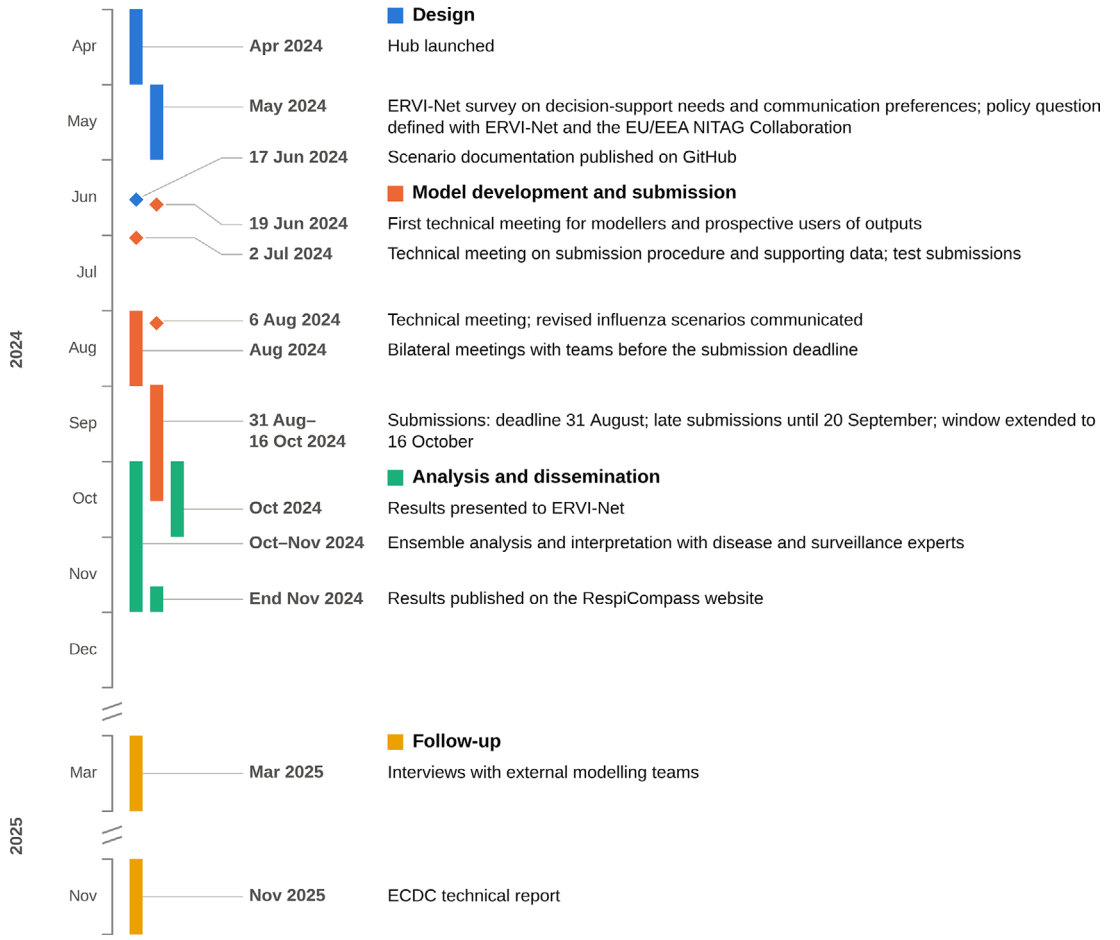


Figure 2. Timeline of RespiCompass Round 1 (2024/25). The timeline shows the steps of RespiCompass Round 1, from the hub launch to the ECDC technical report, in four phases. Scenario design took about two and a half months, model development and submission about four months, and analysis and dissemination about two months. Diamonds mark events with an exact date; bars mark periods and events dated to the month. The time axis is broken between December 2024 and March 2025 and between March and November 2025.

the lower-transmission assumption, seasons without influenza circulation became common in the simulations, an implausible outcome. We redefined the axis as a typical season and a season with 10% higher transmission potential, both relative to the average of the 2017/18, 2018/19 and 2023/24 seasons, and communicated the change at the technical meeting on 6 August 2024 (Figure 2). These experiences highlighted the value of mock-model runs before launching a scenario round to identify potential issues and allow adaptive adjustments. Future work should help define which type of model model is appropriate and evaluate costs versus benefits of mock-modelling efforts.

Precise definitions, scenario documentation, and cross-team communication were essential to avoid misunderstandings of scenario instructions. For example, the meaning of "waning immunity" in COVID-19 models required clarification—did it refer to vaccine-induced immunity, natural immunity, or both? Similar ambiguities arose when vaccine effectiveness (VE) was given without explicitly stating the control group against which effectiveness is measured (i.e. absolute vs relative VE), or for the implementation of influenza transmission potential, which required careful discussion to specify which biological factors were included or excluded. Early modeller feedback thus helped uncover which assumptions were left implicit by our guidance. These experiences highlight the need for effective communication channels among modellers, disease and surveillance experts, data specialists, and public health decision-makers for successful scenario modelling exercises. Embedding structured preliminary testing of scenario definitions, learning from previous scenario rounds, targeted stakeholder reviews, and time for iterative refinements into future cycles will strengthen RespiCompass and improve scenario design.

In a multi-model hub like RespiCompass, model diversity creates both value and complexity. Different models bring varying assumptions, data needs, and levels of flexibility, making it difficult to anticipate in advance which scenario elements will be problematic for whom. What is trivial for one model may be infeasible or unclear for another. For example, the scenarios defined vaccine effectiveness relative to people not vaccinated in the current season, not relative to immunologically naive people. Models that track vaccination and infection history as explicit compartments could apply these values directly. Models with a single vaccinated compartment had to translate those effectiveness values. Similarly, metapopulation models covered multiple countries often at little cost, whereas an individual-based model tailored to one country's population could not as readily be transferred to other countries. This reinforces the importance of early engagement and continuous dialogue to clarify definitions, surface technical barriers, and align expectations. A key lesson from 2024 is that structured mechanisms for model-sharing and discussion, targeted support, and collaborative validation processes are essential to ensure consistency, comparability, and usefulness of outputs.

Modeller recruitment and engagement

To ensure model outputs from several distinct models, ECDC contributed results from two models developed in-house and contracted a modelling consortium which contributed results from four models. Other teams contributed a further seven models to the project. In total, outputs from six influenza and seven COVID-19 models were submitted (Figure 1). Model types were varied and included deterministic age-structured compartmental models, stochastic compartmental models calibrated by approximate Bayesian computation or Kalman filtering, metapopulation models with human mobility, and individual-based models.[47] Participation was open to any team that could implement the scenario specification and submission format. We set no further inclusion criteria, and no submission was excluded or withdrawn.

Recruiting modelling teams was challenging as participants not contracted by ECDC were neither directly compensated nor able to tap into competitive grants linked to the project. Interviews with the two teams outside the contracted consortium revealed that their primary motivation for participation was the opportunity to test and showcase their models in a practical, policy-relevant setting, and to compare their approach with those of other international groups. One of these teams was already using their model to submit forecasts to ECDC's forecasting hub (RespiCast),[33] while the other had refined their model since the end of the COVID-19 public health emergency of international concern (PHEIC) and viewed RespiCompass as an opportunity to validate their work. Technical complexities and a submission deadline of 31 August 2024, directly after the summer holiday period, created resource challenges for the teams. We accepted late submissions until 20 September and then extended the submission window again, to 16 October 2024. Contributing teams made substantial efforts to update different model components, including details of the vaccination and related immunity processes, but faced issues due to high computational needs. Despite these hurdles, teams provided positive feedback on the clarity of project goals, the timely availability of scenario documentation, and the active support and communication by ECDC and the EU-SMIND contractor. Regular meetings to clarify processes, assumptions, and timelines added to a positive collaborative experience, as reported by interviewed modelling teams. Participants suggested further improvements including the creation of a dedicated communication channel and topic-specific discussion groups (e.g., on the use and availability of human-to-human contact data for simulating viral transmission). Finally, participating teams emphasised the value of formal recognition through co-authorship in peer-reviewed publications or official ECDC reports, particularly for junior researchers, and they also recommended in-person meetings to strengthen community building and sustained engagement.

Table 3. Dimensions of uncertainty and their representation in RespiCompass Round 1.

Dimension	Examples	Representation in Round 1
Model structure	Model architecture, implementation of disease transmission, progression and immunity dynamics, calibration method.	Through diversity across the six (influenza) or seven (COVID-19) models. Limited by the low number of models for some countries.
Parameters	Ascertainment rates, severity and waning parameters, seasonal forcing, human contacts and mobility.	Through 100 to 300 trajectories in which teams sampled parameter uncertainty. Not for parameters fixed through scenarios (e.g., vaccine effectiveness).
Scenarios	Vaccine coverage, influenza transmission potential, COVID-19 immunity waning.	Explicitly, through the scenario axes.
Surveillance and other data	Missing data, alternative national surveillance data (e.g., wastewater), additional data streams (e.g., human mobility).	Limited as models all used the provided surveillance data. Partly presented through country-specific model calibration.

Beyond the contributing modelling teams, a number of additional groups followed the 2024 cycle more informally. These teams attended the virtual launch and technical meetings and responded to scenario round e-mails, but ultimately did not submit. From our informal interactions, their decision appeared to be driven by limited staff or funding in 2024 and the compressed submission timeline. Even so, they provided useful feedback on the scenario design and data inputs. Several of these groups went on to submit in the ongoing 2025/26 round, in which nine groups that did not submit in Round 1 take part. This points to a wider pool of modelling capacity that could support future iterations of RespiCompass.

Moving forward, we aim to continue strengthening our engagement with external modelling teams as this is crucial for the long-term sustainability of RespiCompass. The motivations and constraints of potential partners differ. For academic groups, continued participation will likely depend on a clear return on investment in the form of publications, funding opportunities, or career advancement. The main constraint on participation of modellers within public health agencies, on the other hand, is often related to competing priorities and limited capacity. Careful planning around these challenges is crucial. To start with, supporting participation will require attention to timelines and resource needs, including providing sufficient lead time for model development and submission, offering access to cluster computing resources to improve processing power, and designing specific funding channels. Organising in-person meetings could further build collaboration and a sense of community among participants. In addition, complementing ECDC reports with contributions to peer-reviewed publications may serve as an added incentive for participation, particularly among academic partners.

Multiple models and multiple modelled locations

A challenge often encountered in modelling studies is that each additional dimension incorporated into an analysis quickly increases complexity. In RespiCompass, we were not only dealing with two diseases and various scenarios for each of them, but also with multiple models covering distinct simulations for a large number of countries. We presented our main results at the EU/EEA level. At the request of experts, we also included country-specific estimates in an annex of the ECDC report, with due acknowledgement that differences in national healthcare systems, surveillance systems and data availability may introduce variability not fully captured by the models.[32] Indeed, surveillance systems differ between countries in case definitions, testing, healthcare-seeking behaviour, hospital admission practices and reporting completeness.[4] Observed indicators therefore relate differently to infection dynamics in each country.[21] To circumvent this, we expressed the main outputs in our results report as relative reductions in hospitalisations against a no-vaccination counterfactual. Constant ascertainment factors and other multiplicative effects cancel out of such relative measures, making them more robust than absolute measures. Nevertheless, we note relative reductions in hospitalisations remain sensitive to factors such as differences in epidemic timing, or the quality of surveillance data.

A core element of the analysis is synthesising results through ensemble methods—an umbrella of methods that combine results from different models into single estimates. Here, methodological decisions can influence both point estimates and uncertainty ranges. Due to tight project timelines, we were unable to systematically compare different ensemble approaches in the 2024 cycle, highlighting a broader gap: the lack of clear, systematically evaluated guidance for ensemble method selection in infectious disease modelling.[44,45] Such guidance would need to account for factors such as the number of contributing models, biases in geographic or temporal coverage, and hierarchical data structures.

For the 2024 round, we adapted the ensemble method used by all three US Scenario Modelling Hubs: an equally weighted linear opinion pool with a trimming step.[26–28,46] In brief, we first computed, for each country and each model, the relative reduction in hospitalisations in each scenario compared with its no-vaccination counterfactual.[32] We then pooled the modelled estimates of this quantity into a single distribution per scenario and country, giving each model equal weight. Model estimates outside the 1.5 interquartile ranges received zero weight, reducing the influence of extreme outputs on central estimates.[32] We fixed the method, including the trimming threshold, before seeing results, so that settings could not be tuned to individual results. A formal comparison of ensemble methods, including leave-one-model-out and trimming on/off analyses, is beyond the scope of this paper and remains future work.

Each team developed its model methodology and implementation independently. Variation in how teams represent contacts, infection and immunity is desired, because it enters the ensemble as a spread of plausible mechanisms. At the same time, modelling hubs create cohesion by design, through shared data and scenario assumptions, and discussions between modellers can make models more alike. Where models become dependent, agreement between them can overstate robustness.[1] Balancing independence and cohesion is an open design question for collaborative modelling hubs.

The ensemble does not capture all uncertainty relevant to scenario projections. Table 3 distinguishes four dimensions of uncertainty, following an established typology,[5] and shows how each was represented in Round 1. Between-model variation mainly reflects differences in model structure, and within-model variation reflects parameter uncertainty and

variability from the fitting process. Scenario uncertainty was explicit but limited to two axes, given the teams' capacity and time constraints. Ensemble intervals are conditional on the scenario assumptions (including fixed parameters) and shared surveillance data.

While ensemble estimates aggregate outputs from multiple models into a single result, individual model outputs provide valuable insights into where different models agree and disagree. Discrepancies between models often reveal critical insights into how assumptions and methods can shape projections and were the basis of productive discussions with modelling teams on how to improve future scenario definitions, modelling approaches, and data needs. Presenting both the ensemble results—regardless of the methodology used—and the individual model outputs (as we did for the 2024 RespiCompass results)[7] allows end-users to better understand the underlying variability, fostering trust when communicating modelling results to stakeholders. We anticipate maintaining a similar approach in future iterations to ensure transparency and enhance stakeholder trust.

Communication strategies

A survey conducted with ERVI-Net revealed a preference for a dedicated RespiCompass website for time-sensitive communications over traditional formats like technical reports. Considering this, we developed a focussed and visually engaging RespiCompass website. However, managing outputs through a web platform poses challenges. Websites imply that information is up to date, yet some results—such as winter 24/25 burden estimates—quickly become obsolete. More enduring outputs, like model-based estimates of COVID-19 hospitalisations averted by vaccination under the scenario assumptions, may be better suited for dissemination through static technical reports or peer-reviewed publications. To address these needs, we use a multi-channel communication strategy, with output formats matched to the intended use and lifespan of results.

A recurring communication challenge has been clarifying the distinction between forecasting (as pursued by ECDC's RespiCast hub)[33] and scenario modelling (as pursued by RespiCompass).[7] Forecasting aims to predict the most likely short-term future based on trends observed in recent data, while scenario modelling explores disease dynamics under hypothetical conditions, typically in the medium- to long-term—essentially running in-silico experiments (i.e. experiments carried out virtually by a computer, server, or cluster) (Definition Box 1). By explicitly reinforcing this distinction in all communications, we aim to help stakeholders appreciate the complementary roles of forecasting and scenario modelling.

Impact assessment

Evidence on how Round 1 outputs influenced decision-making is limited and qualitative. The policy question was defined with ECDC experts working closely with ERVI-Net and the EU/EEA NITAG Collaboration, two key ECDC stakeholder groups, in view of declining COVID-19 vaccine coverage and influenza vaccine coverage below target among older adults.[32] Results were presented in October 2024 to ERVI-Net, whose representatives work in national public health agencies. Stakeholder priorities also shaped the next round, which addresses newborn RSV immunisation while EU/EEA countries decide on and evaluate new programmes.[6] We have not assessed systematically whether RespiCompass outputs changed national vaccination policies or preparedness plans. Such an assessment requires structured follow-up with national public health institutes and immunisation advisory groups, which future cycles should include.

Limitations

The lessons presented in this account draw mainly on the coordinating team's perspective, on modeller views expressed in technical meetings and two interviews with modelling teams, and on stakeholder views from one survey and network discussions. They reflect a single project cycle within the described governance and funding model, and the policy impact of RespiCompass has not been formally evaluated. This should be considered when transferring the presented lessons to other hubs.

Summary and future directions

The first round of RespiCompass showed that a coordinated multi-model scenario round across the EU/EEA can be delivered within one year. Six influenza and seven COVID-19 models contributed, and results were published five months after public scenario documentation (Figure 2). Table 2 summarises the principal challenges encountered during the hub's design phase and first round, together with the lessons drawn from each. A key lesson was the importance of early stakeholder engagement. Involving public health experts and decision-makers in the scenario design phase helped tailor questions to policy priorities, clarify expectations, and enable transparent discussions around data limitations, which in our experience supported trust in the results.

Technical coordination and feedback loops with modelling teams were equally important. Early test runs surfaced feasibility and consistency issues, enabling pre-emptive refinement of scenario definitions and assumptions. These practices mirror successful design choices from previous hubs,[38] which emphasise the value of iterative development. To enhance rigour, the 2025/26 round introduced a model peer review phase, which supports adherence to scenario assumptions and timely model

development and submission. Additionally, methodological strengthening remains a priority. While ensemble methods allow outputs from different models to be synthesised for easier communication of results, in some cases (e.g., when there is large between-model heterogeneity) presenting individual model results may be more appropriate. Improving transparency will require clear guidance on multi-model analysis, likely informed by lessons from meta-analysis, as well as systematic comparisons of ensemble strategies to identify best practices. For groups building similar initiatives, the Round 1 scenario documentation, submission format and validation workflows are openly available for reuse.[47]

Lastly, communication and uptake of project results remain central to their impact. RespiCompass adopted a multi-channel dissemination strategy, including a website for rapid communication of time-sensitive results, technical documentation for model-based estimates of intervention impact, and live briefings with surveillance network to contextualise findings. Looking ahead, RespiCompass can build on these lessons through refined timelines, expanded stakeholder engagement, capacity-building activities, and a dedicated evaluation of its policy impact. With these steps, the hub is well positioned to support timely, transparent, and stakeholder-focused scenario modelling across the EU/EEA.

Software availability
No new software was created for this article.

Ethics and consent
Ethical approval was not required for this work. The stakeholder engagement described (a survey of the European Respiratory Viruses Network (ERVI-Net) and interviews with participating modelling teams) was conducted as part of the operational development and evaluation of a public health project, rather than as research involving human subjects. The network survey was administered through the official EUSurvey tool and opened with a written notice setting out the purpose of the survey, stating that only authorised staff could access any personal information, asking respondents not to enter personal data in free-text fields, and informing them that aggregated results would be presented to the network and/or published. Consent to participate was implied by voluntary completion of the survey following this notice. Interviews with modelling teams were undertaken by contributors in their professional capacity as project collaborators. No personal or identifying data were collected or reported.

Disclaimer
The views expressed in this article are those of the author(s). Publication in Open Research Europe does not imply endorsement of the European Commission.

Data availability
This article is an operational account of the RespiCompass hub and reports no new primary research data of its own; the Round 1 projections and their analysis are reported separately on the RespiCompass website[7] and in an ECDC report.[32] The scenario specifications, submission instructions, and submitted model outputs underlying the first round are available in the RespiCompass GitHub repository[47] (https://github.com/european-modelling-hubs/RespiCompass). The surveillance data underpinning the project are collated through the European Respiratory Virus Surveillance Summary (ERVISS).[48] Only aggregated findings from the network survey are reported. Individual responses are not shared in order to protect respondent confidentiality, consistent with the notice given to respondents (see Ethics and consent).

Acknowledgements
We gratefully acknowledge the input of EU/EEA national public health and laboratory staff (European Respiratory Viruses Network, ERVI-Net)[35] involved in surveillance activities and submission of surveillance data to The European Surveillance System (TESSy)[49] and European Respiratory Virus Surveillance Summary (ERVISS),[48] which forms the basis for this project. We gratefully acknowledge the contributions of the "OptimAgent" and the "QMUL" (Queen Mary University of London) modelling teams for their model development and result submissions for this project.

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Open Peer Review

Current Peer Review Status: ? ✓

Version 1

Reviewer Report 14 September 2026

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✓ **Alvaro Castro Rivadeneira**
University of Massachusetts Amherst, Amherst, MA, USA

This article provides a clear and accessible review of the experience and lessons drawn from RespiCompass, an infectious respiratory disease scenario modeling hub. The authors first provide an overview explaining why collaborative modeling and scenario modeling are used, and follow that with a more detailed account of RespiCompass. The paper outlines the steps involved and the challenges faced at each stage, from seeking collaborators to defining scenarios. The paper ends by reviewing how this process can be improved in the next season.

Overall, this is a good and clear summary that proves useful in documenting the experience of RespiCompass, and whose lessons may be applied more broadly. The authors should be commended for the accessible language in which it is written, and their care in using useful citations to support their claims. Following are a few additional suggestions:

1. The rationale for the letter is clear and is well explained. The manuscript would benefit from additional reasons as to why collaborative modeling and scenario modeling are used. For instance, the authors could highlight that ensembles often produce the most accurate and reliable forecasts (e.g., reference #14 in their paper - Cramer et al., 2022). Additionally, concrete instances where scenario modeling has been useful could be added. Similarly, some criticisms and challenges that these approaches face should be highlighted initially.

2. Relatedly, the article could improve by including some more critical views of scenario modeling hubs. These have many assumptions and constraints that limit their usefulness, and should be explicitly stated. This is especially important when modeling across countries.

3. More concrete examples throughout the paper would be helpful. I would like to see for instance what scenario elements are "trivial for one model [but] may be infeasible or unclear for another." I would like to know a bit more about the range of modeling strategies (it is mentioned that they are often mechanistic, but specific examples could be given). I would have appreciated an example where expert advice affected result interpretation.

4. A timeline of the process for completing a round would provide a good overview, to see how long it took to define the scenario vs. collecting the models and analyzing the results.

5. The biggest improvement I suggest is to show how the experience drawn from RespiCompass could be used by other teams. It seems that there are concrete examples that might benefit others working on similar endeavors. Items as small as a timeline, the size of the team, examples of models that did not work for the scenario modeling hub, or ways that the information was disseminated to public health authorities.

6. Some smaller suggestions:
- The image resolution for Figure 1 is poor. I was reading this as a PDF, and even when zooming on the figure, I couldn't read all the text.
- For the name "hubverse" the V is not capitalized, and the correct citation is given here (should replace reference #37): https://hubverse.io/cite.html

Consortium of Infectious Disease Modeling Hubs, Kerr M, Borchering R, Castro Rivadeneira AJ, Contamin L, Funk S, Hochheiser H, Howerton E, Krystalli A, Shandross L, Reich NG. A software platform for collaborative infectious disease modelling. Nat Health. 2026; Article s44360-026-00145-7. doi: 10.1038/s44360-026-00145-7

- Reference #39 should be updated to:

Shandross L, Howerton E, Contamin L, Hochheiser H, Krystalli A, Consortium of Infectious Disease Modeling Hubs, et al. Multi-model ensembles in infectious disease and public health: Methods, interpretation, and implementation in R. Stat Med. 2026;45(1–2):e70333. doi: 10.1002/sim.70333.

- The internal links in the PDF don't work (e.g., clicking the link for Figure 1 doesn't take you to the figure).

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Is the rationale for the Open Letter provided in sufficient detail? (Please consider whether existing challenges in the field are outlined clearly and whether the purpose of the letter is explained)

Yes

Does the article adequately reference differing views and opinions?

Partly

Are all factual statements correct, and are statements and arguments made adequately supported by citations?

Yes

Is the Open Letter written in accessible language? (Please consider whether all subject-specific terms, concepts and abbreviations are explained)
Yes

Where applicable, are recommendations and next steps explained clearly for others to follow? (Please consider whether others in the research community would be able to implement guidelines or recommendations and/or constructively engage in the debate)
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: I have worked with infectious disease modeling hubs for five years at an academic institution, and have been a contributor to publications on the topic.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 08 September 2026

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Ye Yao
Fudan University, Shanghai, China

This manuscript provides a useful account of the development and early experience of RespiCompass, a collaborative scenario-modelling initiative for respiratory diseases in the EU/EEA. Coordinating multiple modelling groups, countries, data systems, and public health stakeholders is inherently challenging, and the manuscript addresses an important area that is likely to be of interest to groups developing similar modelling infrastructures. I found the practical experience described in the manuscript valuable. However, several aspects of the manuscript would benefit from further clarification, particularly regarding the scope of its conclusions, the evidence supporting the lessons learned, and the interpretation of uncertainty and policy relevance.

1. The overall objective and scope of the manuscript could be more clearly defined.
At several points, the manuscript appears to move between describing how RespiCompass was organised and operated and evaluating how well the initiative performed. These are related but different objectives. If the main purpose is to document the experience of establishing and coordinating RespiCompass, the manuscript would benefit from focusing more explicitly on the operational process, the challenges encountered, how these challenges were addressed, and which lessons may be transferable to other collaborative modelling initiatives. If stronger

conclusions are intended regarding the success, robustness, or policy usefulness of the framework, additional evidence or clearer criteria for these assessments would be helpful. Given the complexity of such a multinational and multi-model initiative, evaluating its performance is itself a substantial task, and some of the current evaluative statements may therefore require more careful qualification.

2. The basis for some of the stated "lessons learned" could be described more explicitly.
Many of the lessons discussed are reasonable and potentially important, but it is not always clear how they were derived from the RespiCompass experience. For example, were these conclusions based primarily on the experience of the coordinating team, feedback from participating modelling groups, discussions with public health stakeholders, formal evaluation activities, or documented changes across modelling rounds? Providing more information on the source of these lessons would help readers distinguish between observations arising directly from the implementation of RespiCompass and broader expert recommendations regarding collaborative modelling.

3. The interpretation of uncertainty in a multi-model framework deserves further discussion.
The use of multiple models is an important strength, but the resulting ensemble should not necessarily be interpreted as capturing the full range of uncertainty relevant to scenario modelling. Participating models may differ in structure and implementation while still sharing common scenario assumptions, epidemiological evidence, calibration targets, or input data. Uncertainty arising from these shared assumptions may therefore remain largely outside the between-model variation represented by the ensemble. It would be useful for the manuscript to distinguish more explicitly between model structural uncertainty, parameter uncertainty, scenario uncertainty, and uncertainty arising from data and surveillance systems, and to clarify which of these dimensions are meaningfully represented in the RespiCompass outputs.

4. Heterogeneity in surveillance and observation processes across countries should receive greater attention.
One of the fundamental challenges of a multinational modelling initiative is that the observed outcomes used for calibration and evaluation may not be directly comparable across countries. Differences in testing, healthcare utilisation, admission practices, reporting systems, sentinel surveillance, and case ascertainment can all influence the relationship between underlying infection dynamics and observed outcomes. This becomes particularly important when discussing heterogeneity in projected disease burden or intervention impact across countries. The manuscript would benefit from a clearer discussion of how differences in surveillance systems were handled and how they affect the interpretation and comparability of country-specific results.

5. The interpretation of intervention scenarios, particularly vaccination scenarios, should remain clearly conditional on the modelling assumptions.
Differences between vaccination scenarios represent model-based counterfactual comparisons under prespecified assumptions regarding vaccine effectiveness, coverage, waning, population immunity, transmission, and other epidemiological processes. These analyses are highly useful for policy exploration, but their interpretation is different from an empirically identified causal effect of vaccination. I suggest ensuring that the language throughout the manuscript consistently reflects this distinction, particularly when quantitative differences between scenarios are discussed.

6. More information on the construction and robustness of the ensemble would strengthen the manuscript.
Because the ensemble is a central component of the collaborative framework, readers would benefit from additional discussion of why the chosen aggregation approach was considered appropriate, how sensitive the ensemble was to the number and composition of contributing models, and how potential dependence among models was considered. Models participating in the same hub may share data sources, assumptions, or modelling structures and therefore cannot necessarily be regarded as independent sources of evidence. Even if a formal methodological comparison of ensemble approaches is beyond the scope of this manuscript, discussing these issues would provide a more balanced interpretation of what the ensemble represents.

7. The claims regarding policy usefulness could be better supported or more carefully framed.
The manuscript repeatedly emphasises the role of RespiCompass in supporting public health decision-making. This is an important goal of the initiative, but it would be useful to provide more concrete examples of how the modelling outputs entered decision-making processes. For example, were specific scenarios requested by decisionmakers, were outputs used to modify vaccination strategies or preparedness plans, or did stakeholder feedback lead to changes in subsequent modelling exercises? If a systematic evaluation of policy impact has not yet been conducted, this limitation could simply be acknowledged and the conclusions framed primarily around the feasibility and experience of establishing the collaborative modelling process.

Overall, I think the manuscript addresses an important and difficult undertaking and has the potential to provide useful guidance for future collaborative modelling initiatives. The main revisions I would encourage are to more clearly align the conclusions with the type of evidence presented, provide greater transparency regarding how the lessons were derived, and more explicitly discuss the limits of multi-model ensembles and cross-country comparisons.

Is the rationale for the Open Letter provided in sufficient detail? (Please consider whether existing challenges in the field are outlined clearly and whether the purpose of the letter is explained)
Partly

Does the article adequately reference differing views and opinions?
Partly

Are all factual statements correct, and are statements and arguments made adequately supported by citations?
Yes

Is the Open Letter written in accessible language? (Please consider whether all subject-specific terms, concepts and abbreviations are explained)
Yes

Where applicable, are recommendations and next steps explained clearly for others to follow? (Please consider whether others in the research community would be able to

implement guidelines or recommendations and/or constructively engage in the debate)
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Public health modelling

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.