WHO guidance on using mathematical modelling for immunization decision-making

NISH Webinar 19: Preparing for New TB Vaccine Introduction in Africa

15 July 2026

So Yoon Sim

WHO Department of Immunization, Vaccines, and Biologicals

Agenda

- **Introduction** to WHO guidance rationale & process
- **Deep-dive** on Guidance for using modelling for immunization decision-making
- **Questions & Answers**

Introduction: WHO guidance rationale & process

Mathematical modelling of infectious diseases

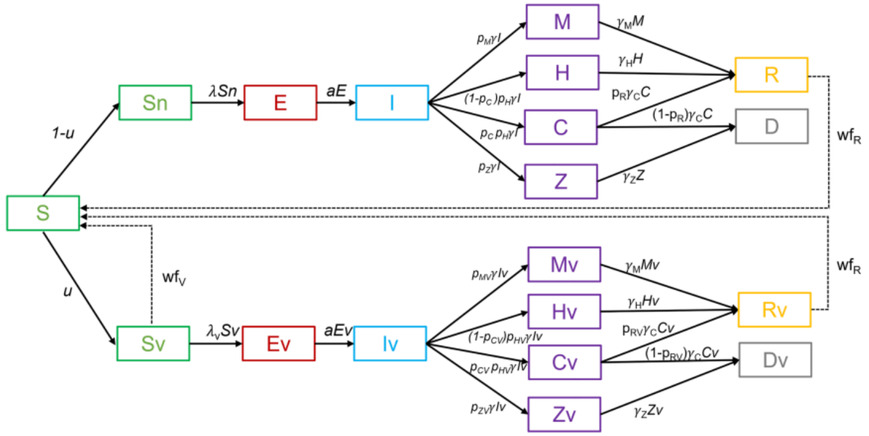
Mathematical models are **tools that simplify real world systems**

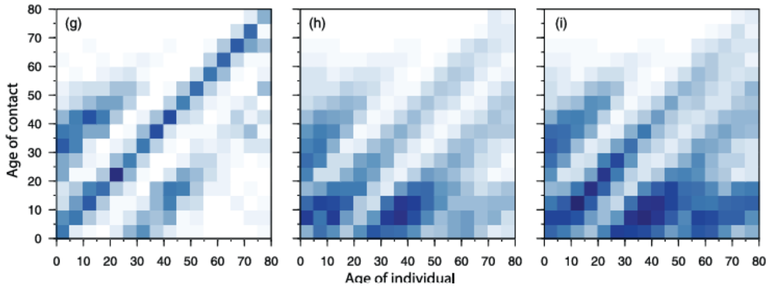
.. A “model” is a set of equations translated into computer codes, using software programs

.. Models can synthesize available evidence and information

.. Models can simulate how diseases spread

.. Models can estimate the impact of interventions such as vaccination programs





Modelling in Immunization Decision-Making: A Disconnect

Global level (SAGE)

- Modelling embedded in EtD
- Established protocols
- Strong modelling access

Different contexts, resources and approaches

Country level

- Use is variable and ad hoc
- Limited guidance
- Limited capacity & time

WHO guidance needed to bridge this gap?

From Modelling Outputs to Policy Decisions

MODELLING

- Estimate long-term population impact
- Compare immunization strategies
- Explore uncertainty & scenarios
- Inform cost-effectiveness

NEED

- Judge relevance to local context
- Understand assumptions & limits
- Assess uncertainty & credibility
- Use modelling alongside other evidence

WHO guidance = tools, questions, and processes to do this systematically

WHO guidance development (2023-25)

2023, 98, 127–144 No 13

World Health Organization
Organisation mondiale de la Santé

Weekly epidemiological record
Relevé épidémiologique hebdomadaire

31 MARCH 2023, 97th YEAR / 31 MARS 2023, 97e ANNÉE
No 13, 2023, 98, 127–144
http://www.who.int/wer

Contents

Sommaire

Meeting of the Immunization and Vaccine-related Implementation Research Advisory Committee (IVIR-AC), February 2023

The IVIR-AC recommendations are based on technical discussions during a virtual meeting of the IVIR-AC, held 13–16 February 2023.[1] Eight groups sought technical feedback from IVIR-AC on topics that included COVID-19 vaccine impact modelling to inform vaccine prioritization and strategy, optimization of maternal and neonatal tetanus elimination (MNTE) assessments in conflict-prone areas, and vaccine value assessments[2] to capture vaccine impact on antimicrobial resistance (AMR) and antibiotic use.

The IVIR-AC secretariat began the meeting by sharing the results of a review of declarations of interests from all meeting contributors by an internal WHO panel. Contributing IVIR-AC members included: Rakesh Aggarwal, Habib Hasan Farooqui, Alexandra Hogan, Stefan Flasche, Sun-young Kim, Julie Leask, Paula M. Luz, Dafrossa C. Lyimo, William Moss, Walter Orenstein, Virginia Pitzer, Sheetal Silal, Xuan-yi Wang, Joseph Wu. The IVIR-AC members have not received funding specifically for this meeting. IVIR-AC recommendations were made through consensus of IVIR-AC members, following discussions in open and closed sessions of the drafts that were prepared by designated IVIR-AC member focal points.

[1] Meeting of the Advisory Committee on Immunization and Vaccines-related Implementation Research (IVIR-AC). Geneva: World Health Organization, 2023 (https://terrance.who.int/mediacentre/data/sage/IVIR-AC_Pink%20Book%20Feb2023.pdf, accessed February 2023).

[2] Full value of vaccine assessments (FVVA). Geneva: World Health Organization, 2022 (https://www.who.int/teams/immunization-vaccines-and-biologicals/product-and-delivery-research/full-vaccine-value-assessments, accessed February 2023).

Réunion du Comité consultatif sur la vaccination et la recherche sur la mise en œuvre des vaccins (IVIR-AC), février 2023

Les recommandations de l'IVIR-AC présentées ici sont basées sur les discussions techniques qui ont eu lieu lors d'une réunion virtuelle du Comité qui s'est tenue du 13 au 16 février 2023.[1] Huit groupes ont sollicité des commentaires techniques de l'IVIR-AC sur des sujets tels que la modélisation de l'impact des vaccins contre la COVID-19 pour déterminer les priorités et la stratégie vaccinales, l'optimisation de l'évaluation de l'élimination du tétanos maternel et néonatal (TMN) dans les zones sujettes aux conflits et l'évaluation de la valeur des vaccins[2] pour déterminer leur impact sur la résistance aux antimicrobiens (RAM) et l'usage des antibiotiques.

Le secrétariat de l'IVIR-AC a commencé la réunion en présentant les résultats d'un examen des déclarations d'intérêts de tous les participants à la réunion par un groupe interne de l'OMS. Les membres contributeurs de l'IVIR-AC étaient les suivants: Rakesh Aggarwal, Habib Hasan Farooqui, Alexandra Hogan, Stefan Flasche, Sun-young Kim, Julie Leask, Paula M. Luz, Dafrossa C. Lyimo, William Moss, Walter Orenstein, Virginia Pitzer, Sheetal Silal, Xuan-yi Wang, Joseph Wu. Aucun n'a reçu de financement spécifique pour cette réunion. Les recommandations de l'IVIR-AC ont été formulées par consensus des membres à la suite de discussions en sessions ouvertes et fermées sur les projets de recommandations préparés par des membres référents désignés.

[1] Meeting of the Advisory Committee on Immunization and Vaccines-related Implementation Research (IVIR-AC). Genève, Organisation mondiale de la Santé, 2023 (https://terrance.who.int/mediacentre/data/sage/IVIR-AC_Pink%20Book%20Feb2023.pdf, consulté en février 2023).

[2] Full value of vaccine assessments (FVVA). Genève, Organisation mondiale de la Santé, 2022 (https://www.who.int/teams/immunization-vaccines-and-biologicals/product-and-delivery-research/full-vaccine-value-assessments, consulté en février 2023).

127

An initiative led by WHO, informed by advice from the WHO Immunization and Vaccine-related Implementation Research Advisory Committee (IVIR-AC) advised on Guidance for using modelling for immunization decision-making

- Target group: stakeholders involved in immunization decisionmaking (NITAGs, EPI managers, immunization technical working groups, RITAGs, and technical partners)
  - Interpret modelling assumptions and uncertainty
  - Assess relevance and credibility of results
  - Apply modelling within Evidence-to-Decision processes
- Helpful advice on how to position modelling as input among other sources of evidence

Meeting of the Immunization and Vaccine-related Implementation Research Advisory Committee (IVIR-AC), February 2023

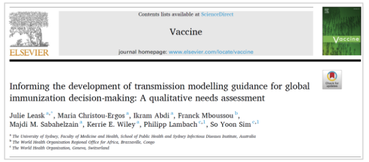
WHO guidance development: three-stage approach

Decision maker needs assessment informed content and format of the guidance

WHO Guidance for Using Modelling for Immunization Decision-Making

Training and ongoing support through existing mechanisms for NITAGs and national decision makers

What decision-makers need from modelling guidance


Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

Informing the development of transmission modelling guidance for global immunization decision-making: A qualitative needs assessment

Julie Leask[1,*], Maria Christou-Ergos[2], Ikram Abdi[2], Franck Mboussou[3], Majdi M. Sabahelzain[4], Kerrie E. Wiley[1], Philipp Lambach[2,5], So Yoon Sim[2,5]

[1] The University of Sydney, Faculty of Medicine and Health, School of Public Health and Sydney Infectious Diseases Institute, Australia
[2] The World Health Organization Regional Office for Africa, Brazzaville, Congo
[3] The World Health Organization, Geneva, Switzerland

Leask et al., 2025, *Vaccine*

Qualitative needs assessment study across six WHO regions

Varied use
Use differs across countries, income groups, and decision-makers

Local context
Resources, capacity, data, and local priorities shape use

Study objectives

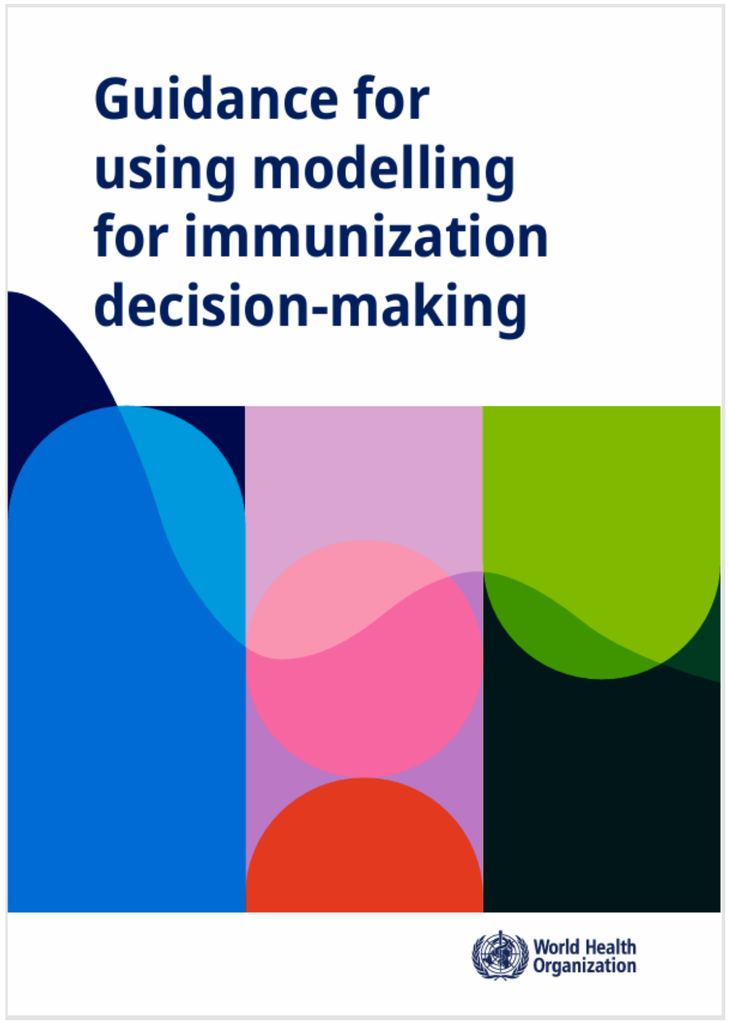
1. Understand how modelling is currently used
2. Identify end-user needs and challenges
3. Define the most useful guidance formats

Translation capacity
Users need support with assessing, validating, and communicating modelling results

Co-creation
Trust-based relationships and routine engagement between modellers and decision-makers are critical

Preferred format
Guidance document accompanied by interactive training and community of practice

WHO guidance publication

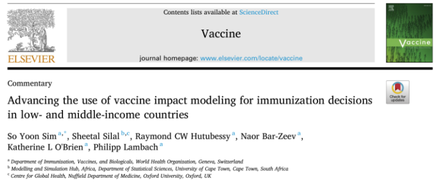


Objective
Help decision makers to interpret, use, and apply modelling to support evidence-informed decision-making

Target audience
- ✓ NITAG and RITAG members, including secretariats
- ✓ EPI managers
- ✓ Technical working groups and partners

Link
https://iris.who.int/handle/10665/385083.
License: CC BY-NC-SA 3.0 IGO

QR Code to the guidance document

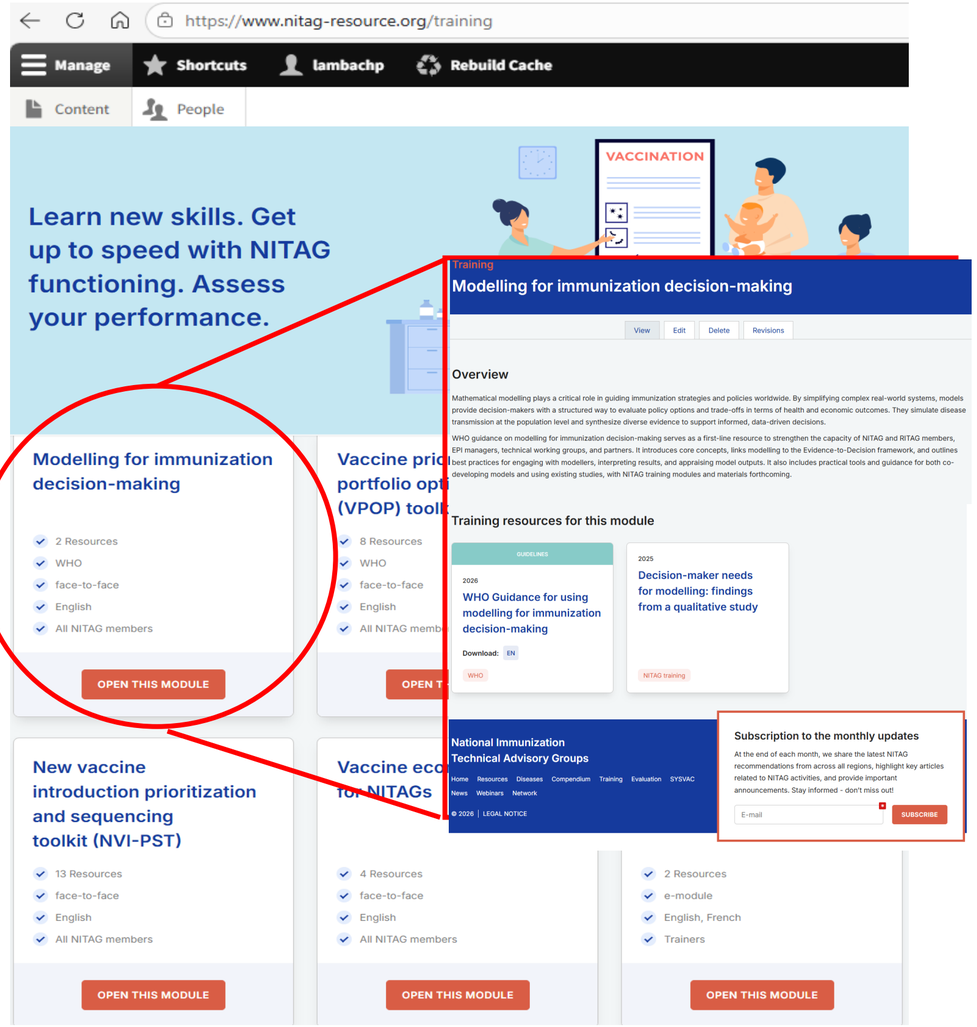

Contents lists available at ScienceDirect
Vaccine
journal homepage: www.elsevier.com/locate/vaccine
Commentary
Advancing the use of vaccine impact modeling for immunization decisions in low- and middle-income countries
So Yoon Sim, Sheetal Silal, Raymond CW Hutubessy, Naor Bar-Zeev, Katherine L O'Brien, Philipp Lambach

Sim et al., 2026, *Vaccine*

Commentary with context and rationale for the guidance

Next steps

Planned activities for 2026-28



NITAG technical capacity strengthening through online course, training, and ongoing support

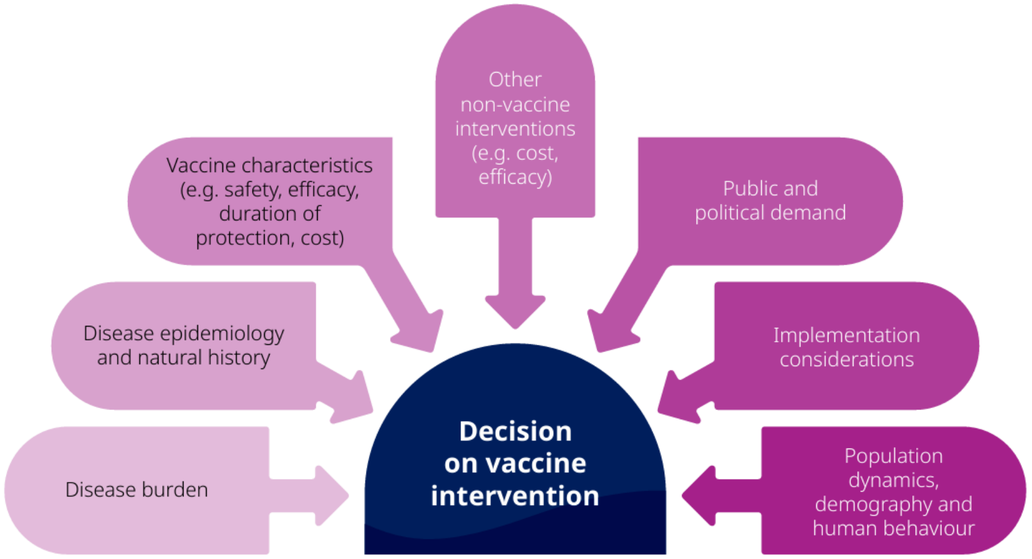
Training modules tailored to pressing policy questions faced by NITAGs and country decision makers

Community of practice for knowledge sharing, peer-to-peer learning, and collaboration

Partnership with local institutions across six WHO regions

Guidance for using modelling for immunization decision-making

How to determine whether modelling could provide useful information for your decisions

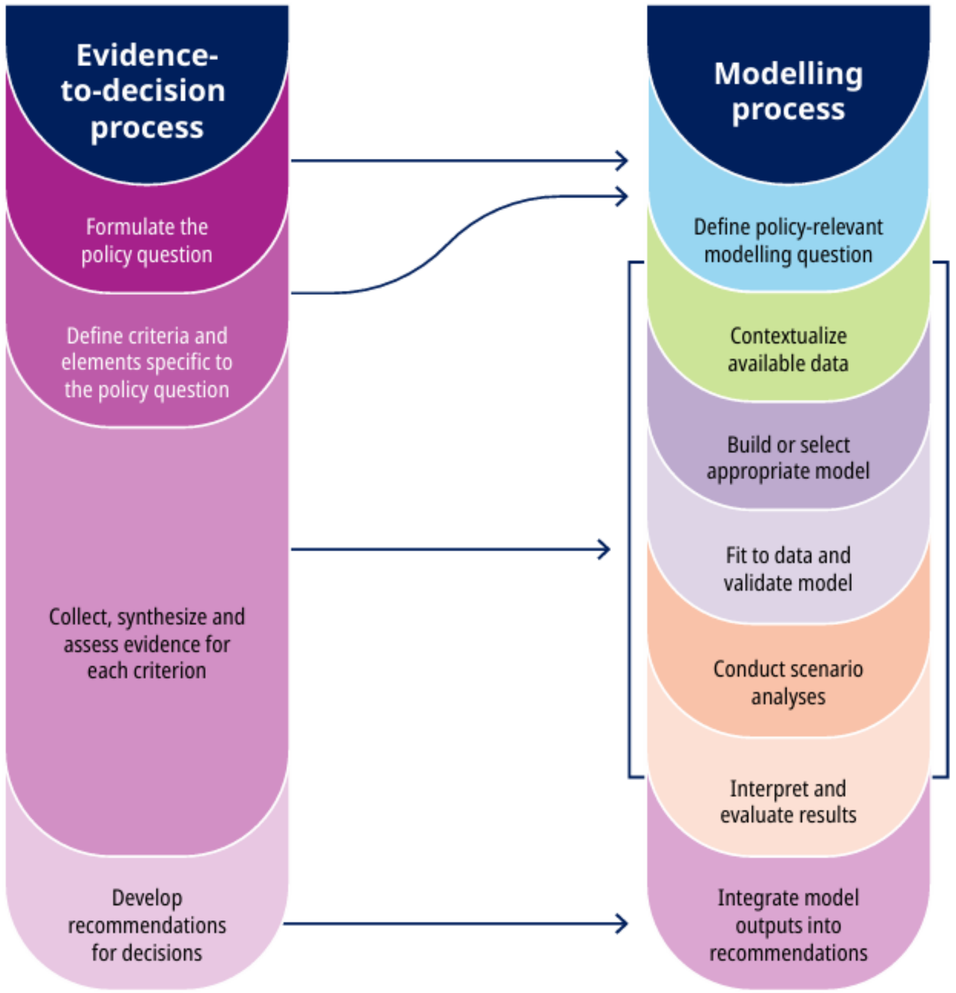


Modelling is one of many sources of information and may not always be necessary or appropriate

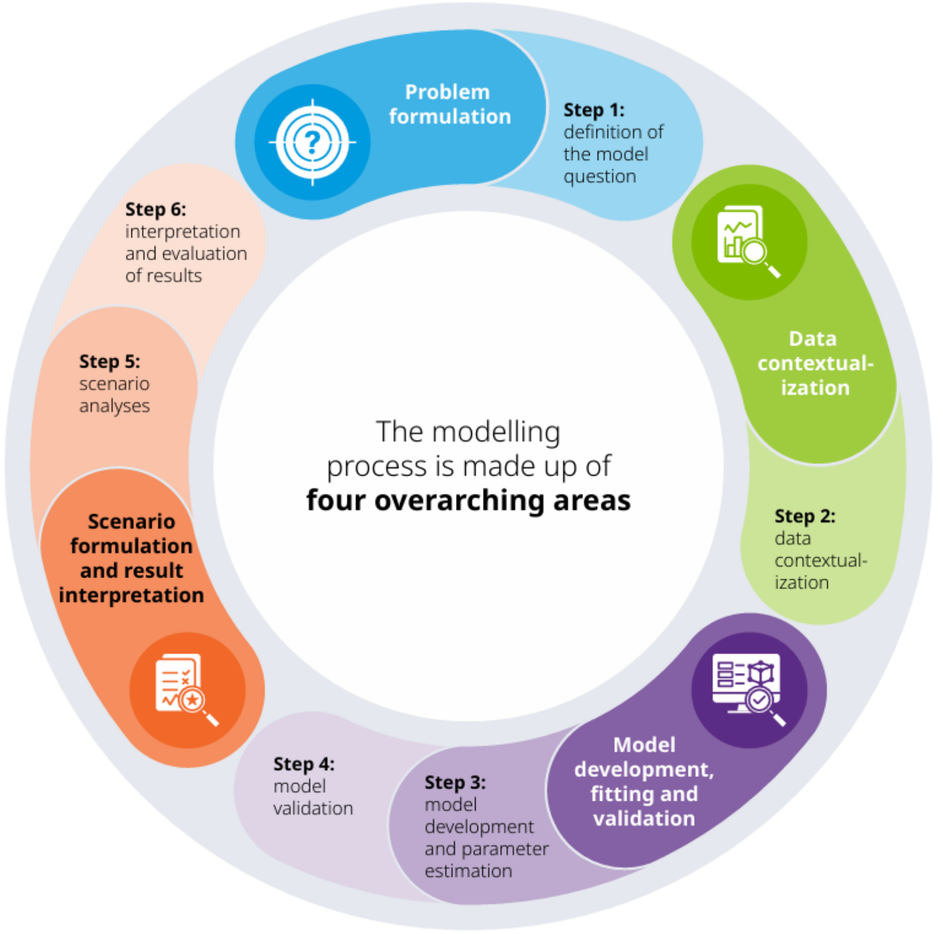
Modelling is particularly useful when:

- Overall population impact is not captured in available studies
- Impact can be expected only several decades in the future
- There is uncertainty about virus evolution or vaccine characteristics
- There is a need to explore multiple hypothetical scenarios about vaccination strategies
- There is a need to compare scenarios with counterfactuals that cannot be evaluated in the real-world settings
- Incomplete and insufficient surveillance data

How to put modelling in the evidence-to-decision process

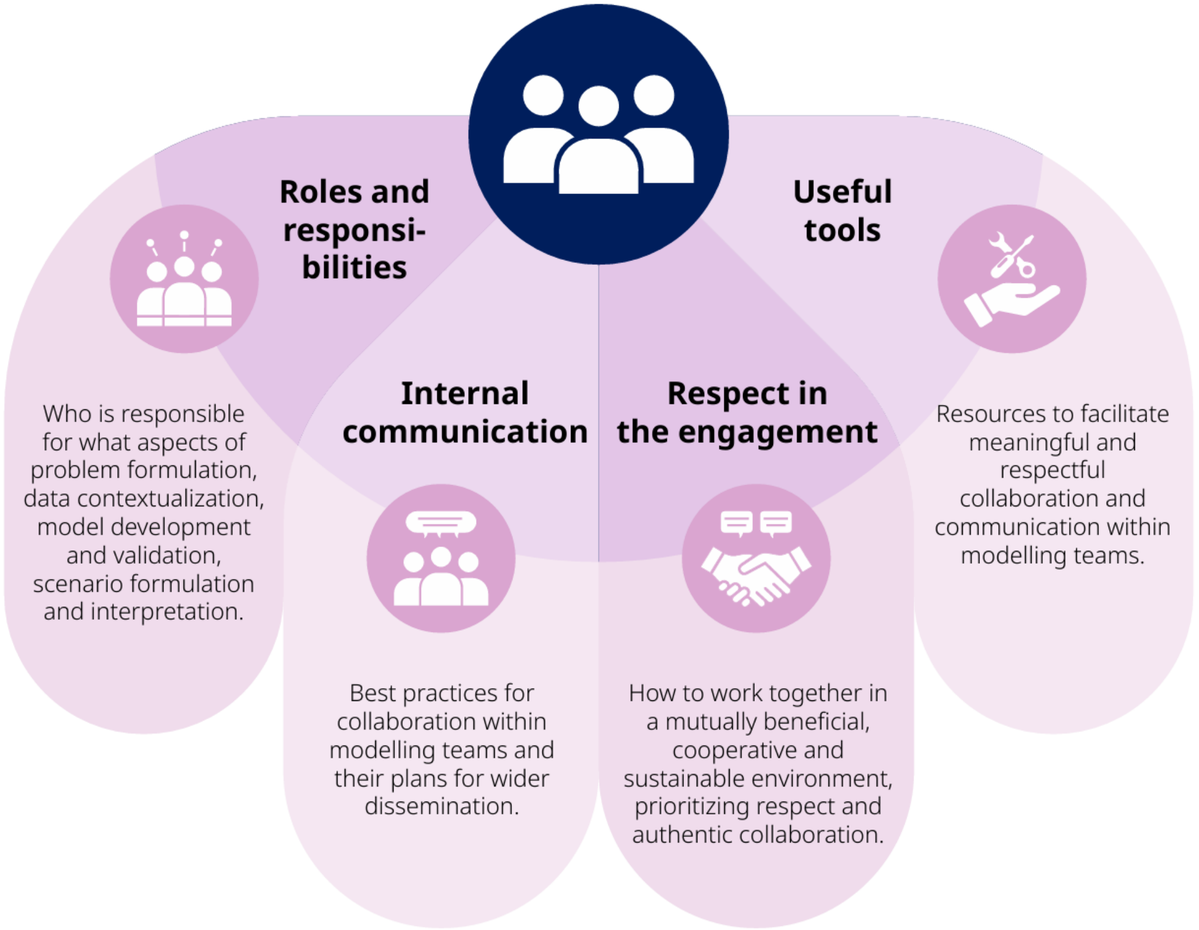


How to participate in the modelling process



Problem formulation	Advise on priorities for research and modelling
	Define decision problems
	Translate policy question into quantifiable modelling questions
	Advise on feasibility assessment
	Synthesize knowledge on disease and vaccine/clinical trials
Data contextualization	Conduct an extensive literature review to understand the broader views of similar questions and existing modelling work on the topic in various settings
	Review model structures, assumptions and parameters
	Review roles and dose regimens of vaccines in the model
	Review assumptions about the disease and transmission
	Assess feasibility of vaccine implementation
Model development, fitting and validation	Make sure data are parameterized correctly for the model
	Help identify the sources of data for modelling
	Review data inputs and data for model validation
	Review or provide data related to vaccine characteristics and efficacy
	Review or provide data related to disease characteristics
Scenario formulation and result interpretation	Perform scenario analyses and sensitivity analyses
	Review scenario formulation and interpretation
	Assemble model results
	Provide feedback on the practical points regarding the model scenarios
	Review vaccine scenario construction and interpretation

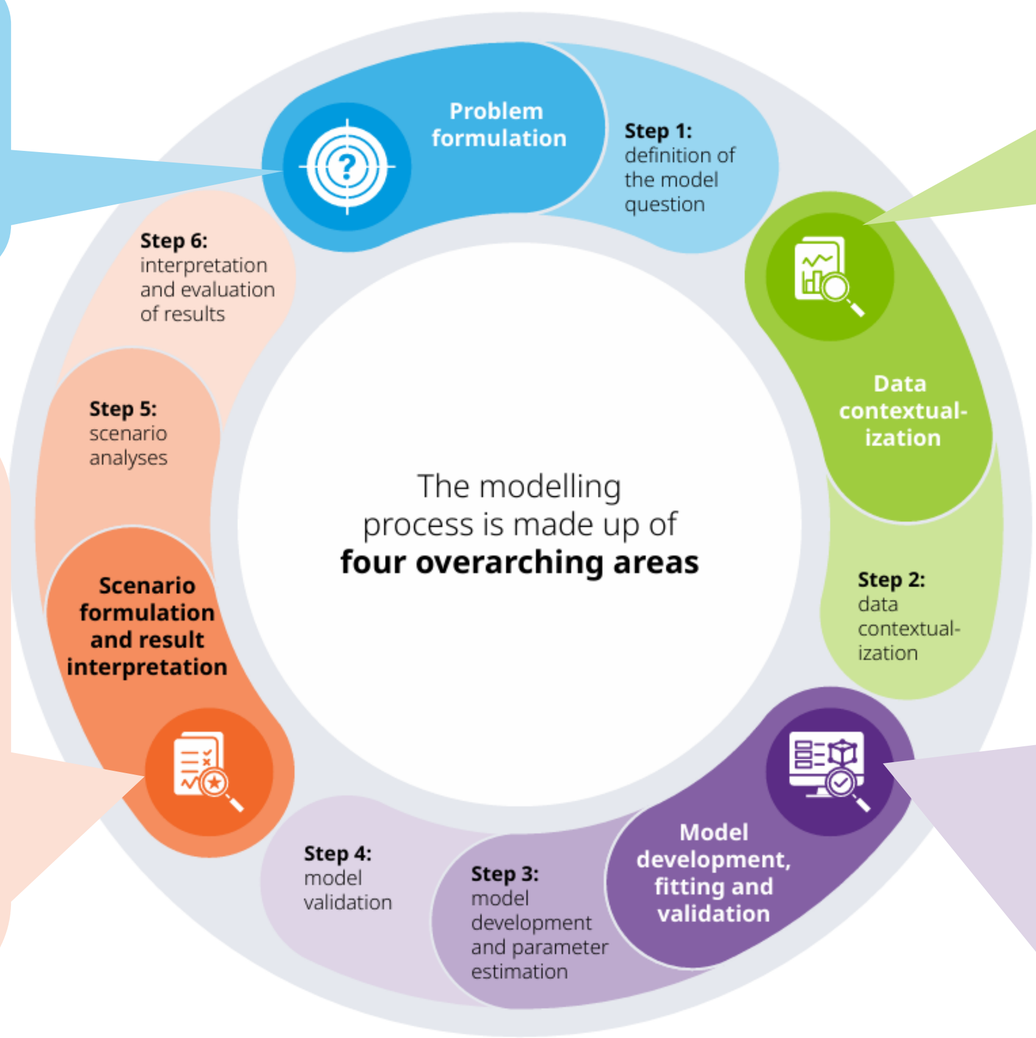
How to collaborate effectively with modelers



How to appraise and evaluate modelling results

Problem formulation questions
- ❑ What is the decision or policy question of interest? Can it be addressed through modelling?
- ❑ What modelling question does the study try to address? Does it match the policy question?

Data contextualization questions
- ❑ What data were used? Are they representative of the population of interest?
- ❑ Where did the data come from?
- ❑ How were data gaps addressed?
- ❑ Was a quality assessment conducted?



Scenario formulation and result interpretation questions
- ❑ What can be learned about the policy question from interpreting modelled outcomes and scenarios?
- ❑ What are the most important model findings? How might they provide insights for the decision?
- ❑ For what period of time were impacts measured?
- ❑ What assumptions were tested across a range of scenarios?
- ❑ Is the full range of uncertainty around key parameters explored sufficiently?
- ❑ Do key model results change qualitatively within the observed range of uncertainty of key parameters?

Model development, fitting and validation questions
- ❑ What type of model will be most appropriate to answer the policy question of interest?
- ❑ How will the model be assessed to determine whether it fits to the data and whether it makes epidemiological sense?
- ❑ What outcome measure should the model estimate to best answer the policy question of interest?
- ❑ What model structure will best capture the main sources of uncertainty?
- ❑ How will the model incorporate key mechanisms of disease epidemiology, dynamics and progression, transmission patterns, population behaviour, immunity and vaccine introduction?
- ❑ How will model assumptions be made to align with available data and evidence? On what basis will these assumptions be made? How realistic will they be?
- ❑ How will these key assumptions and mechanisms in model structure impact model results?
- ❑ How will the number of vaccine doses received (dose dependencies) be tracked in the model structure?

Putting guidance into practice: NITAG recommendations for HPV vaccination

In summary: How can NITAG use modelling for HPV vaccination recommendations?

Example *policy* question
"Should the country vaccinate against HPV, and how is it best implemented?"

Example *modelling* question
"What will be the health and economic impact of implementing an immunization programme for one dose versus two doses for girls and/or boys in specific age groups in the country?"

Review available local data, identify gaps, and assess data quality

- Cervical cancer burden and reporting system
- HPV vaccine effectiveness (1 dose vs. 2 doses)
- Immunization program and disease treatment costs, etc.

Build a model OR use existing modelling results

- Model structure or specification for HPV transmission in the country
- Impact of assumptions on modelling results and uncertainty
- Comparison between modeling results with real-world data or expected patterns

Formulate scenarios and interpret results

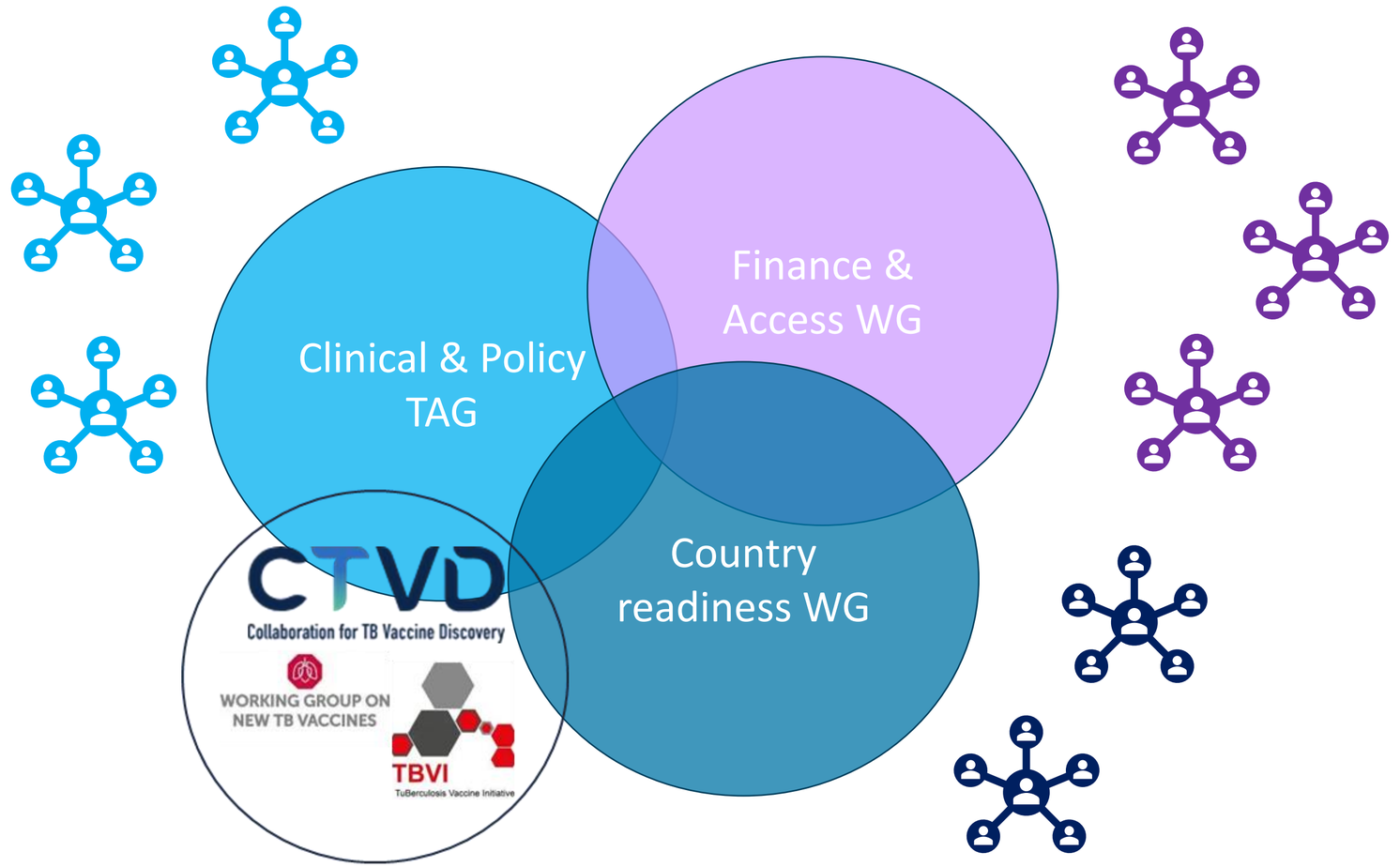
- Scenarios (e.g. different schedule, coverage rates, age range, girls and boys)
- Relevance of modelling results to the policy question and local context
- Critical questions to engage with modelling results

Integrate modelling results into recommendations

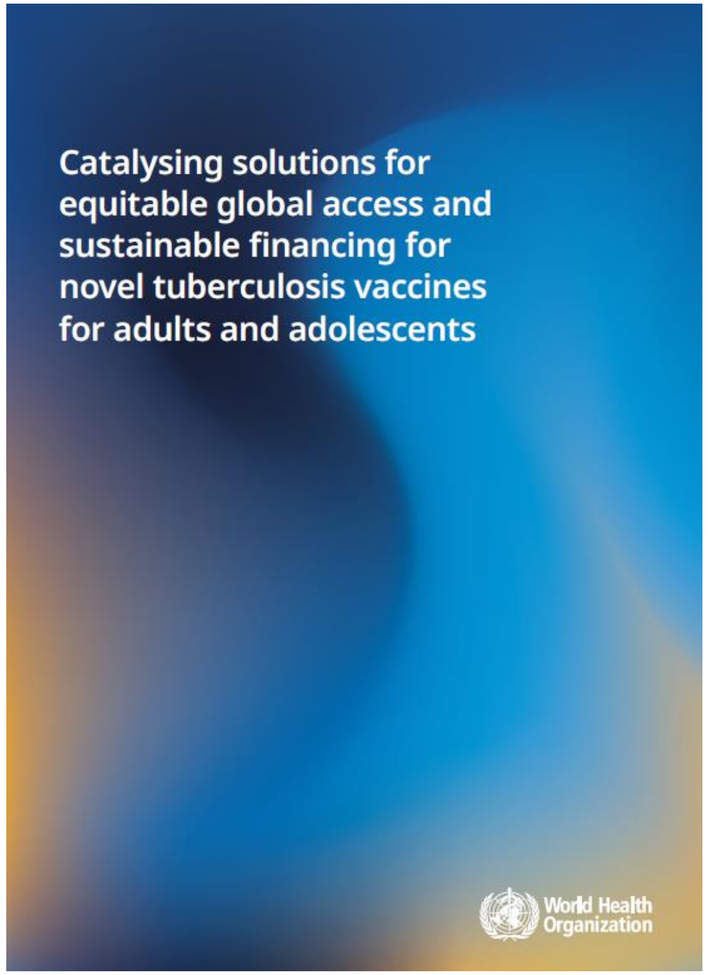
Evaluate the modelling and translation process

Preparing for TB vaccine introduction in Africa

WHO TB Vaccine Accelerator: Three WGs are integrated with each other, and work with other partners and networks



Finance & Access Working Group
Taskforce 2 on early global economic evidence generation



SOLUTION 1
Global catalytic instrument(s) that assure(s) funded demand from countries and donors to incentivize manufacturers to expand capacity and negotiate more affordable price(s).

SOLUTION 2
Systematic and early generation of country-led evidence packages including demand forecasts, cost-effectiveness analyses and budget impact studies that enable governments to make timely and informed decisions.

SOLUTION 3
Clarity on available domestic financing commitments and external support, supported by scenario modelling[1], that can help identify gaps and mobilize resources.

SOLUTION 4
Coordination platform for supply and demand stakeholders to align, supported by shared roadmaps and regular dialogue that can help synchronize timelines between manufacturing, financing and country access.

SOLUTION 5
Sharing of key information that is important for equitable access and is not commercially sensitive, to support country planning and trust building through market transparency.

SOLUTION 6
Advocacy for licensing and technology transfer to at least one manufacturer in each high-burden region that can help strengthen supply security, regional ownership and vaccine acceptance.

https://www.who.int/publications/i/item/9789240116900

Taskforce 2 scope focuses on economic evidence to accelerate access and financing decisions and early signals

Interventions: **Novel TB Vaccines for adults and adolescents**

Value chain: **Economic evidence related to finance and access to products**

Models and estimates: **Global cost-effectiveness analyses based mathematical modelling, budget impact estimates, cost of production estimates** that enable countries and donors to prioritize TB vaccine demand and financing; epi data& other need to generate these estimates

Uncertainties: In the absence of complete data, **scenario planning** through modelling can guide early strategies

Timing and early nature of the work: Comprehensive evidence at this stage will also support **risk assessments for demand and financing**, **and pricing assumptions**, ensuring public health needs translate into funded demand.

National decision-making and budget allocation processes will occur at a later stage, with final trial data and product licensure. The work today supports early signals needed on access and financing.

Slide from the previous NISH webinar: How to put modelling in the evidence-to-decision process

Incorporating modelling in GRADE EtR

GRADE

EtR Domain	Modelling Contribution	NITAG Decision-Making Support
Problem Priority	Integrates notification data to project future TB trajectories if no new action is taken.	Establishes the urgency and scale of the national need.
Benefits & Harms	Translates trial efficacy into Population Impact (cases and deaths averted).	Defines the Public Health Value and strength of recommendation.
Values & Preferences	Simulates the reduction in catastrophic costs for households due to prevented TB cases.	Ensures the vaccine aligns with community economic priorities.
Resource Requirements	Simulates HR, cold-chain capacity, and dose volumes for various rollout scales.	Informs National Operational Planning and logistical roadmaps.
Cost-effectiveness	Calculates the ICER (cost per DALY averted) and predicts long-term healthcare savings.	Determines Value for Money to secure Treasury and political buy-in.
Equity	Disaggregates impact by age, HIV status, or region to see if the vaccine closes health gaps.	Guides Sub-population Targeting for high-burden geographies.
Acceptability	Models "What-If" scenarios for vaccine hesitancy and provider-side "fatigue".	Shapes Communication Strategies and social mobilization efforts.
Feasibility	Tests different delivery platforms (e.g., school-based vs. clinic) to find bottlenecks.	Selects the Optimal Delivery Channel for the local context.

Source: Dr waasila Jassat. NAGI TB Vaccine Working Group Chair. NISH WHO Webinar: Mathematical Modelling for New TB Vaccine Decision-Making in Africa

Conclusion

- Mathematical models can simulate how diseases spread and estimate the impact of interventions such as vaccination programs.
- Modelling is one of many sources of information and may not always be necessary or appropriate.
- There is no single, “correct” model for all types of policy question, and the appropriateness of a model could be determined primarily based on the question.
- And therefore it is important to ask critical questions that make assumptions, uncertainty and relevance of modelling results explicit.
- Co-creation between local decision makers and local modellers, based on local data, is key to contextually relevant modelling results.
- Key tools from WHO guidance could be applied to TB vaccine introduction in Africa.

QR Code to the guidance document

Thank you

For further questions, please reach out to sims@who.int