

Open-source software for HPV modeling

The development and dissemination of HPVsim

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Background

- Mathematical modeling can help identify combinations of current and future strategies to combat cervical cancer.
- Demand for open-source modeling tools is increasing in response to tighter standards of transparency, complete reproducibility, & accessibility; servicing this need is one of IDM's core goals.
- Starsim, IDM's next generation of open-source models, have seen wide global uptake (Fig 1); models include COVID-19, family planning, HPV, & STIs.

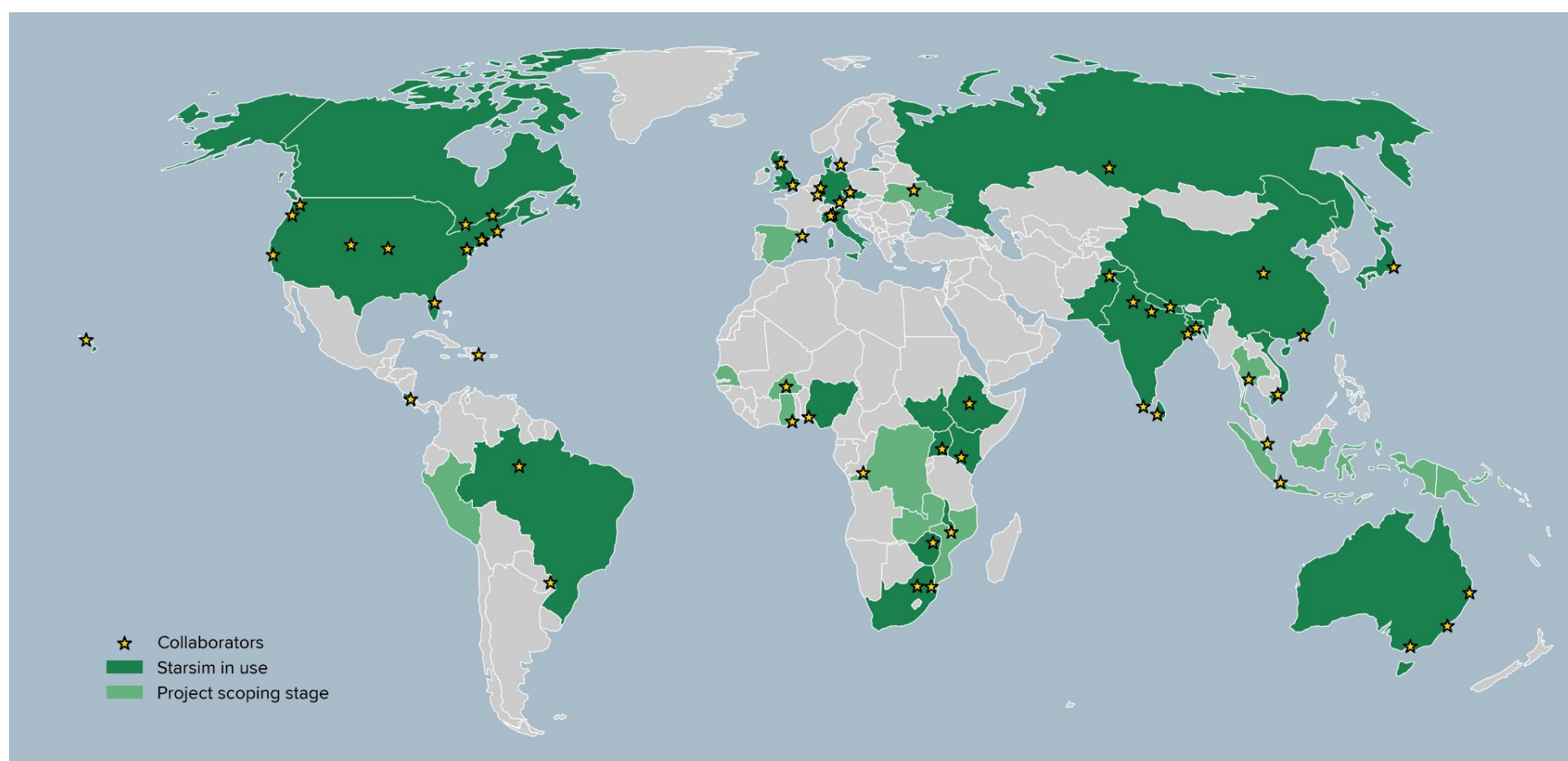


Fig. 1: Global uptake of Starsim models

Aims

- Use the Starsim platform to develop open source software to model HPV
- Run workshops to teach participants to create and analyse their own models.

Methods

- Phases of creating HPVsim:**
 - Stakeholder consultation
 - Modeling architecture
 - Natural history model
 - Model calibration/validation
- Core training workshops:**
 - Makerere University, Kampala, July 2023
 - Strathmore University, Nairobi, July 2023
 - National Disease Modeling Consortium, IIT Bombay, Mumbai, September 2023
 - [Upcoming] African Population Health Research Centre, Nairobi, April 2024

References & contact

- Model: hpvsim.org
- Methods: paper.hpvsim.org
- Contact: info@hpvsim.org

Results - model development

- Expert/stakeholder consultation** revealed the importance of decoupling the **natural history model** from the particular type of screening method or classification system used; therefore, we model a continuous process of disease progression (Fig 2).
- Getting the **modeling architecture** right was essential; the model needed to be able to run in a matter of seconds on PCs in order for it to be useful for widespread adoption in LMIC settings. We achieved significant speed-ups with array-based computation, parallelization, outcome pre-allocation, and a new multi-scale modeling approach; the model runs in <10s.
- Model calibration:** we created models for the 30 most populous countries in Sub-Saharan Africa with customized demographics, sexual networks, and behavioral parameters (Fig 3).

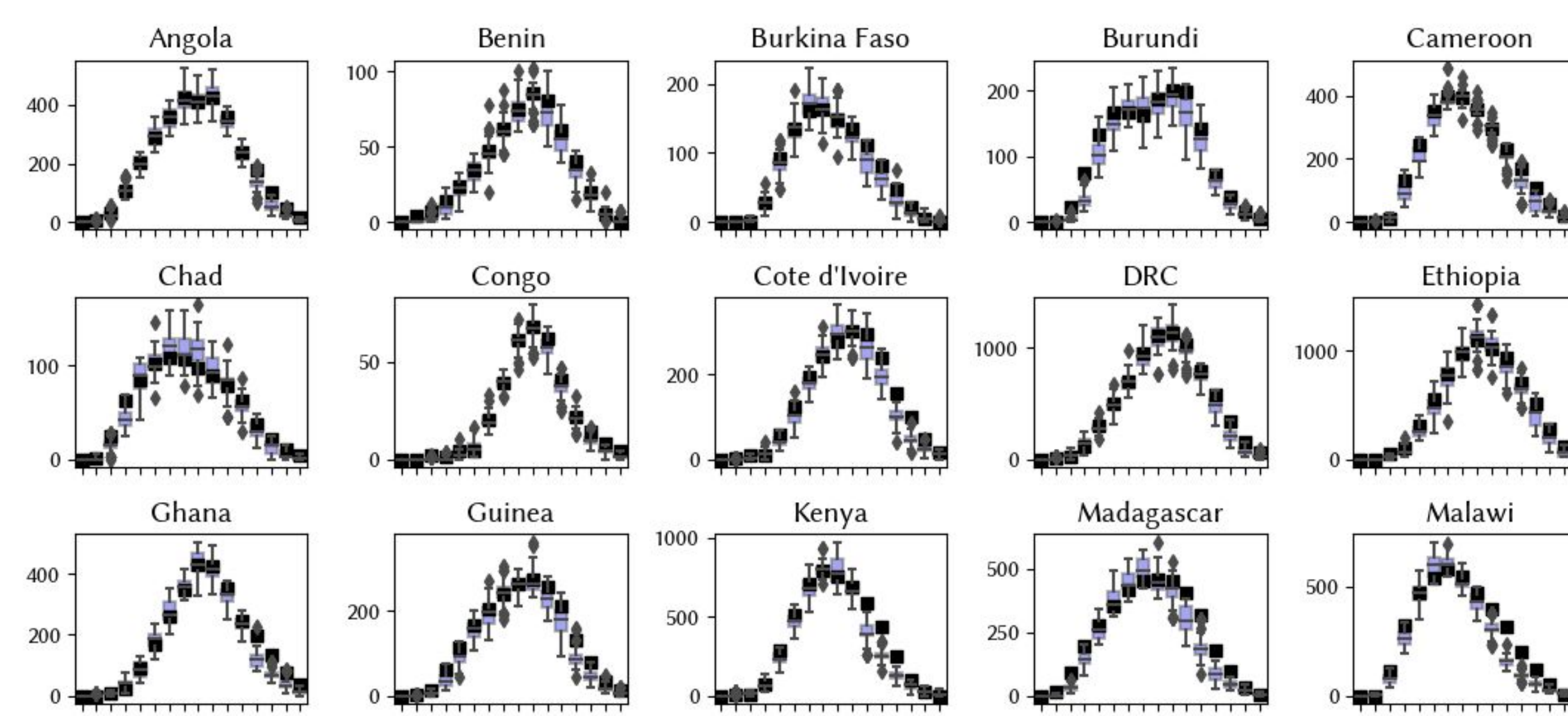


Fig. 3: HPVsim calibration to cervical cancers by age (15/30 countries)

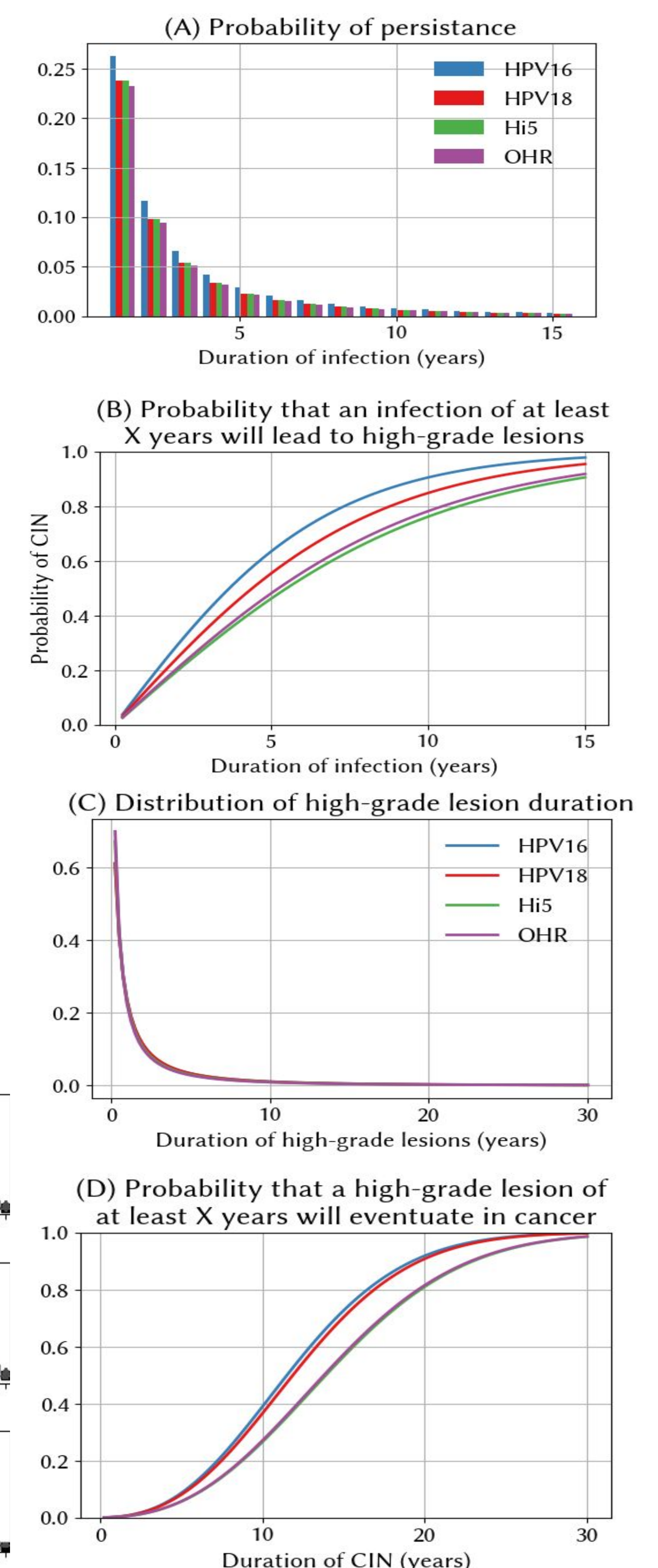


Fig. 2: HPVsim's natural history model

Results - India's model

- India's National Disease Modeling Consortium hosted an HPVsim modeling workshop In September 2023 with the goal of training NDMC members in running analyses.
- The jointly-calibrated national model was fit with local demographic, sexual behavior, and programmatic data
- State-level models are now in the process of being created by the NDMC to model combinations of screening, treatment, and vaccination scale-up.

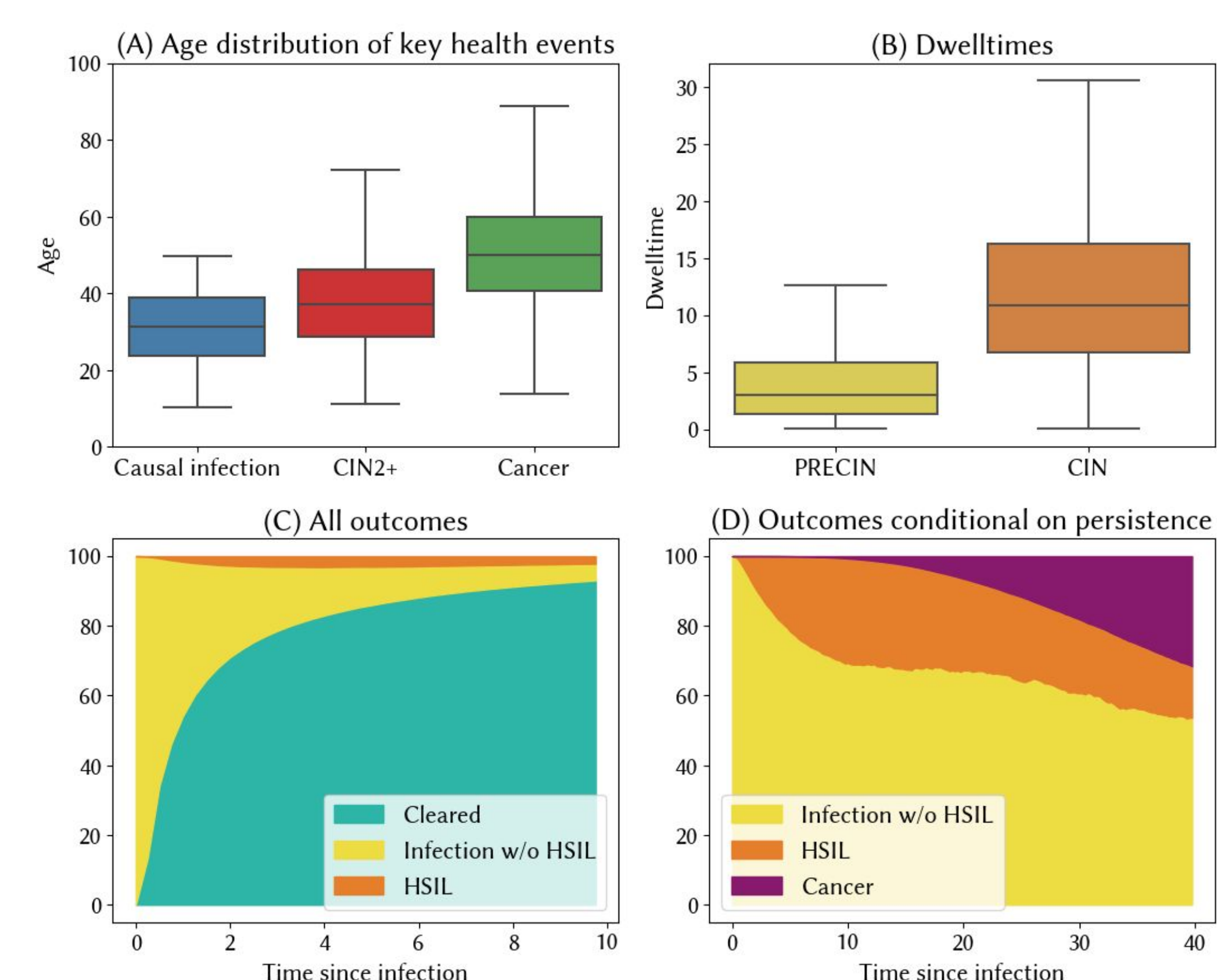


Fig. 4: HPVsim India model: implied outcomes

Summary

We have successfully piloted open-source modeling software for HPV in 3 countries.

Acknowledgments

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