FOURTEENTH INTERNATIONAL

ROTAVIRUS SYMPOSIUM

MARCH 14–16 **2023** BALI INDONESIA

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Impact of Rotavirus Vaccination in 112 Countries: 2006-34

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EMORY UNIVERSITY

Estimating Vaccine Impact for Vaccine Policy

Gavi The Vaccine Alliance

BILL & MELINDA GATES foundation

VACCINE IMPACT MODELLING CONSORTIUM

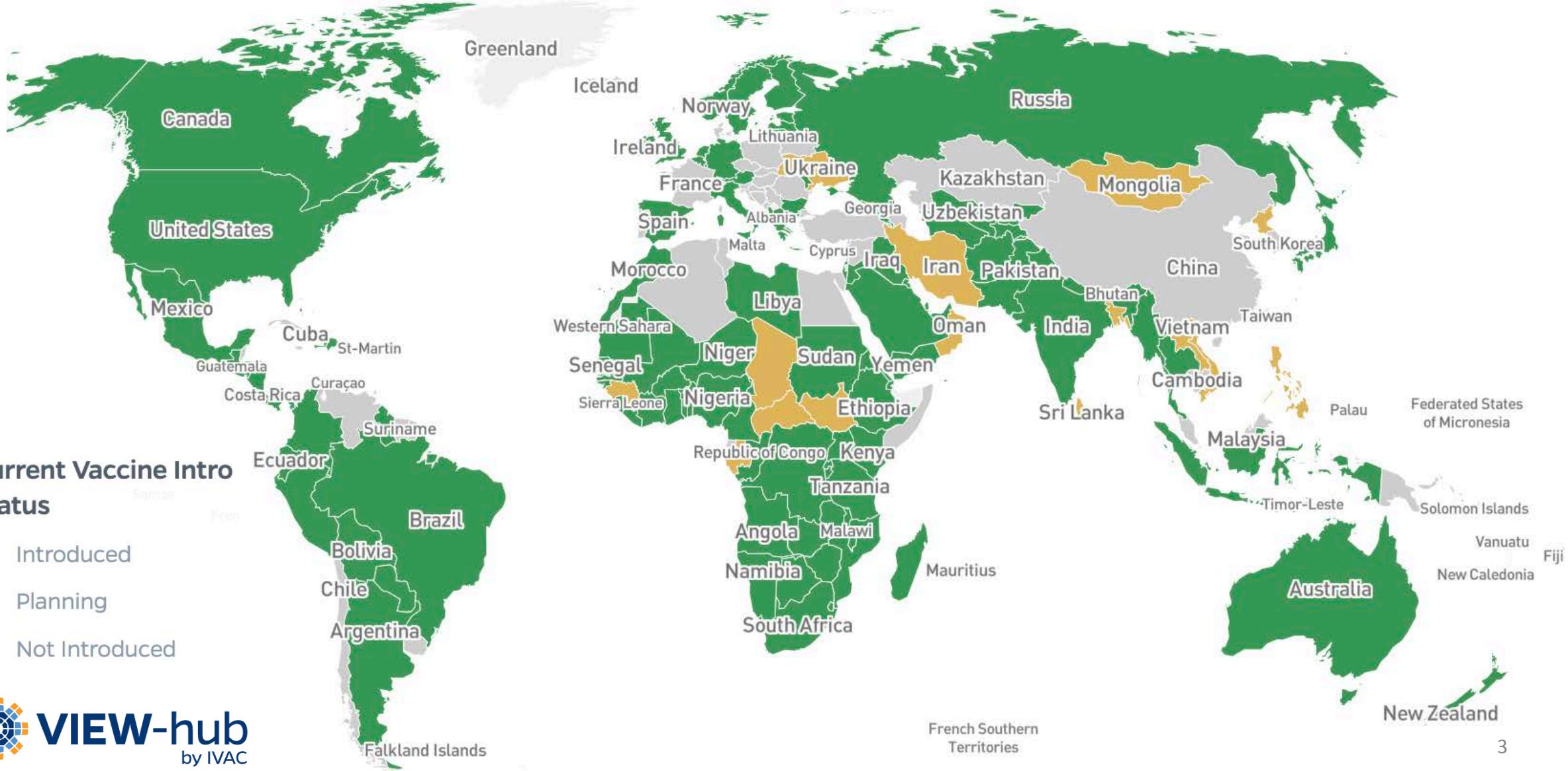
Will **prevent**

97 million deaths

from 2000-2030

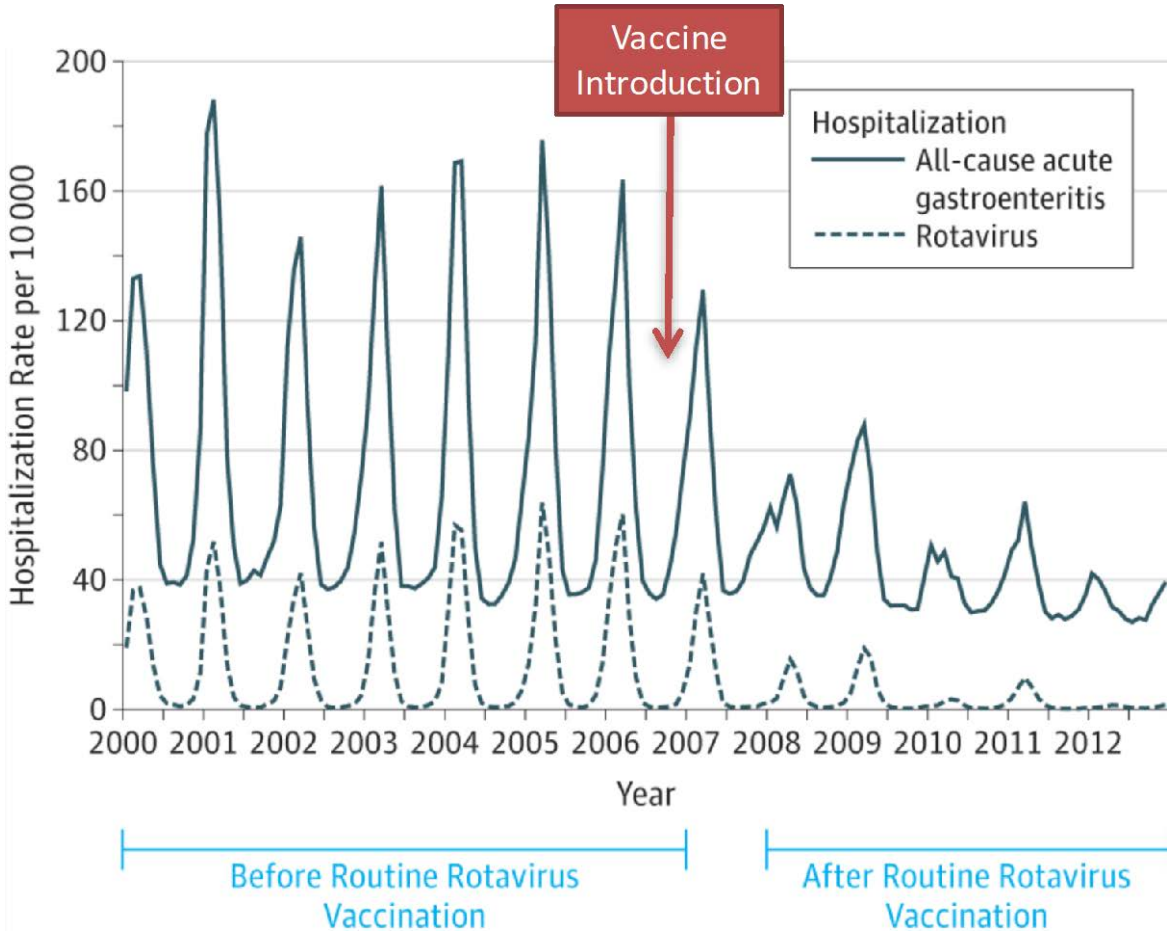
Toor et al, eLife, 2021

Rotavirus Vaccines Introduced in Over 100 Countries



VIEW-hub by IVAC

Overall Effect of Rotavirus Vaccine in the US



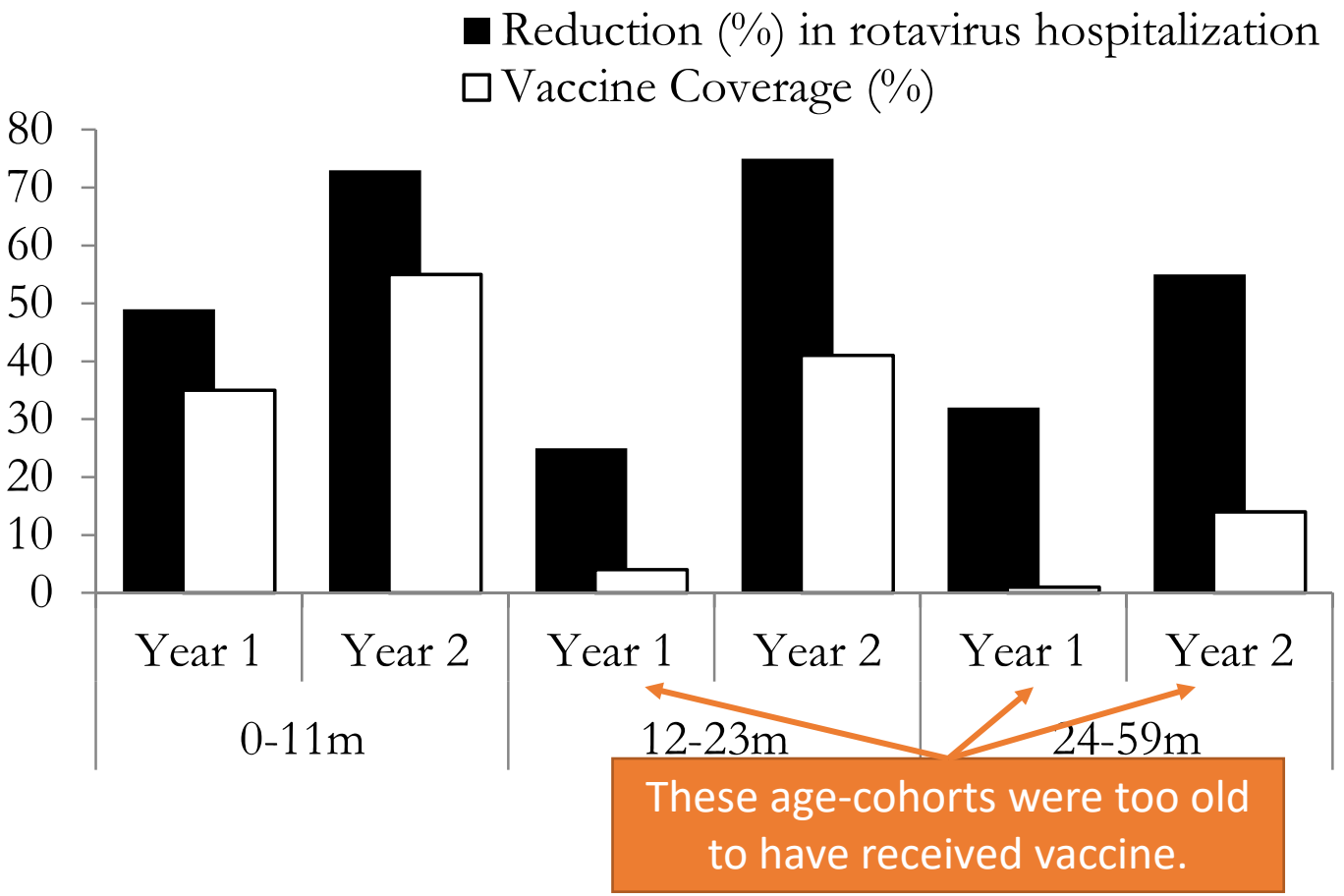
Gastanaduy, Curns, Parashar, Lopman. *JAMA 2013*

Leshem, Tate Steiner, Curns, Lopman, Parashar. *JAMA 2015*

Rotavirus Vaccines are Less Efficacious in LMICS (Direct effect)

Burnett et al*, Lancet GH 2020*

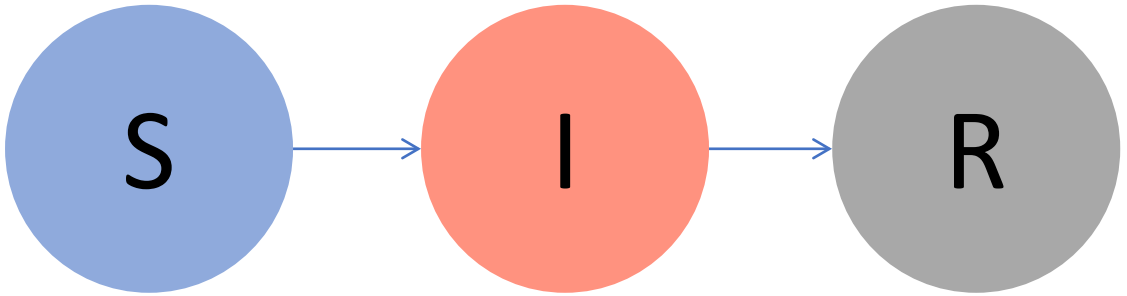
Rotavirus Vaccine in Moldova: 2009 to 2014 (Indirect Effect)



Gheorgita, CID 2016

Mathematical Modeling of Infectious Diseases

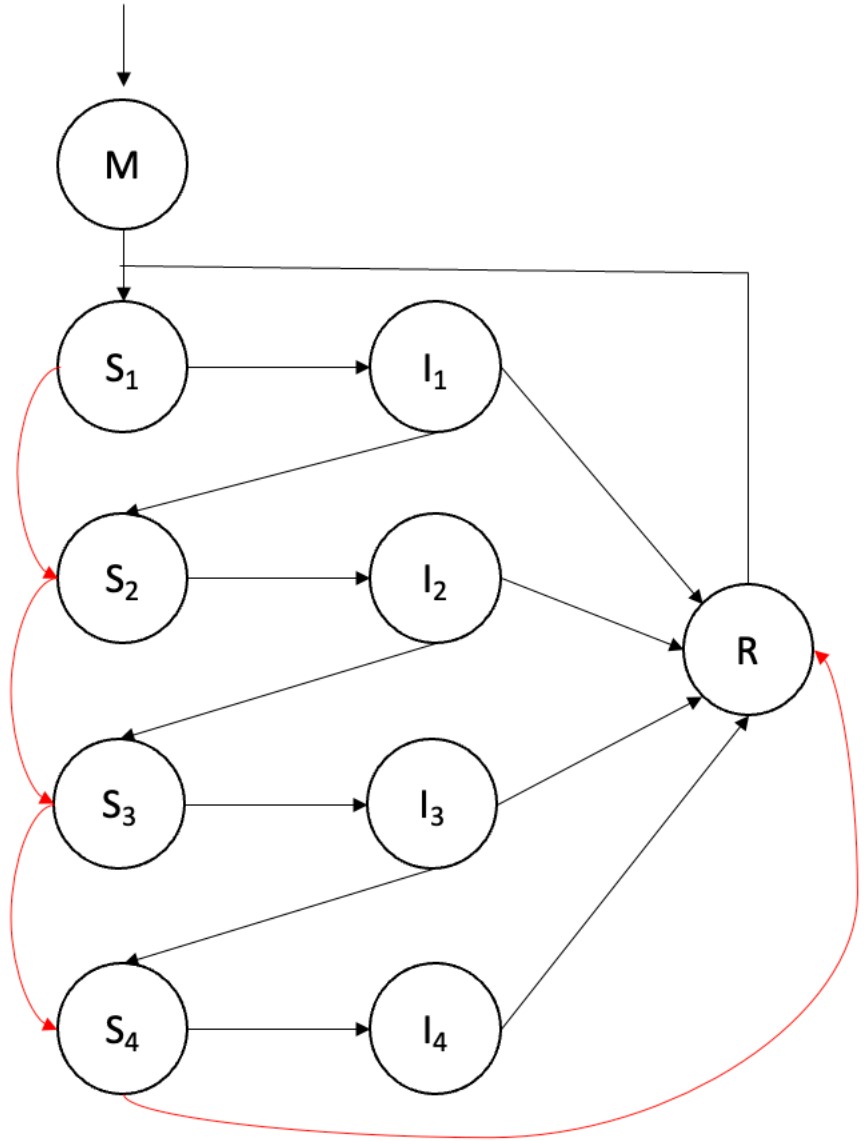
- A framework to integrate mechanistic knowledge
- Captures feedbacks and interdependencies
- Quantifies the direct and indirect effects
- Allow us to ask ‘what if’ questions



Our Rotavirus Model

Key Features:

- Location-specific:
  - Demography
  - Epidemiology
- Incremental gains in immunity with each infection
- Vaccination:
  - Two-doses
  - Confers similar immunity as a natural infection



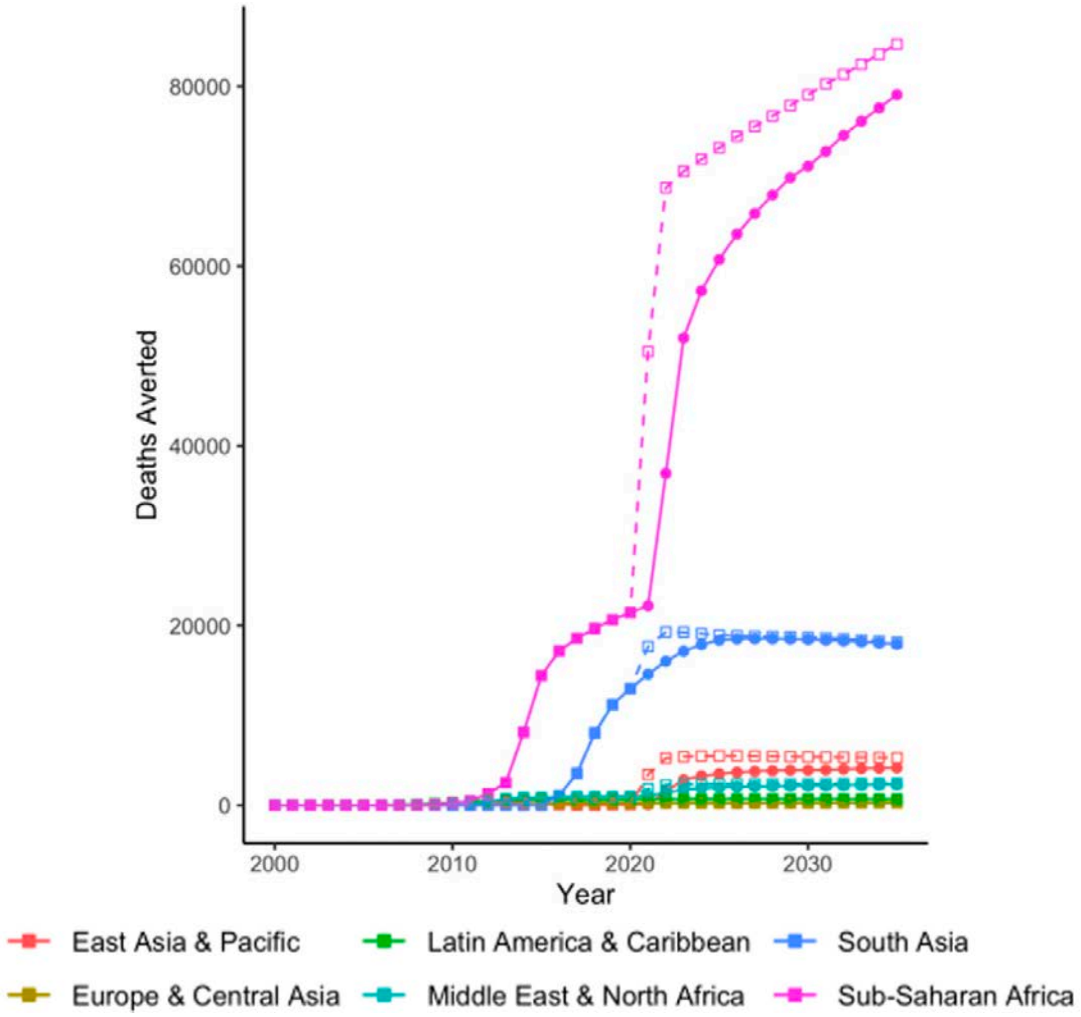
Estimating Rotavirus Impact: Study Design

- *Setting:* 112 Countries, 1980-2100

- *Vaccination:* Two-Dose Vaccine @ 2 + 4 months
  - Rotarix is the commonly used vaccine in low- and middle-income countries

- *Scenarios*: Developed by Gavi
  1. “Default”
  2. “Best Case”

Regional Vaccine Impact



Solid: Default, Dashed: Best

Regions with Large Number of Deaths Averted (1000s) [95% UI]:

1. Sub-Saharan Africa: 77 [72-85]
2. South Asia: 18 [16-21]

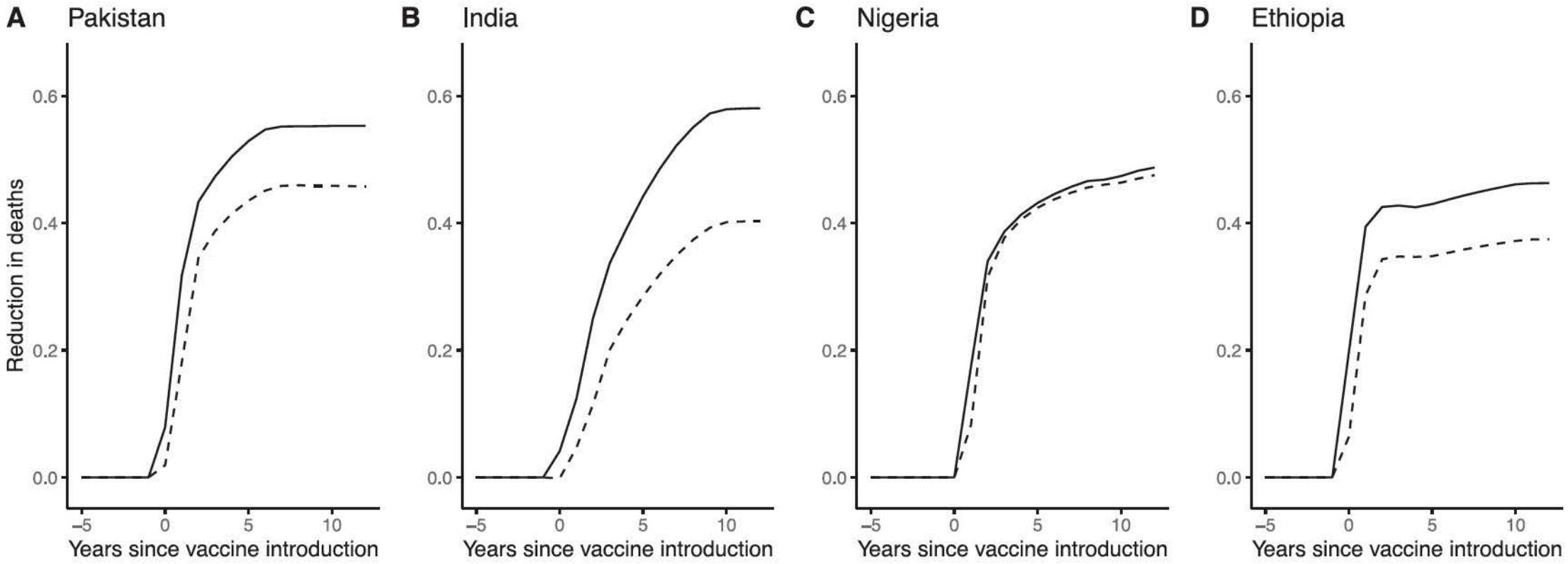
Region	Percent Reduction in Deaths by 2034 (%) [95% UI]
South Asia	57 [50-65]
Latin America & Caribbean	54 [49-59]
Europe & Central Asia	50 [46-56]
Middle East & North Africa	49 [47-48]
Sub-Saharan Africa	48 [45-53]
East Asia & Pacific	45 [39-50]

Comparison of Direct vs. Indirect Effects in Pakistan, India, Nigeria, and Ethiopia

%DE: 82%

Solid: Overall Effect, Dashed: Direct Effect

Comparison of Direct vs. Indirect Effects in Pakistan, India, Nigeria, and Ethiopia



%DE: 82%

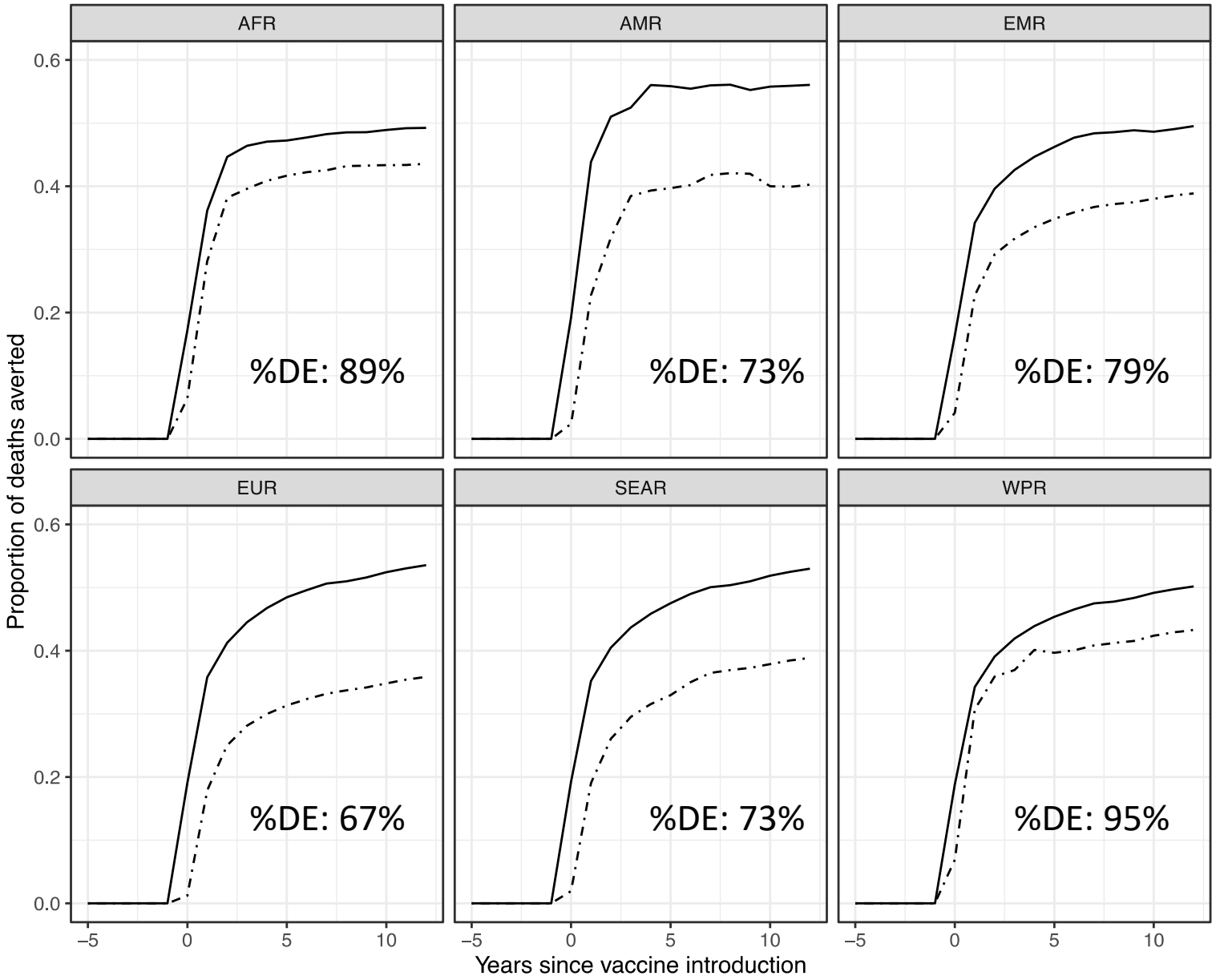
%DE: 69%

%DE: 97%

%DE: 81%

Solid: Overall Effect, Dashed: Direct Effect

Direct & Indirect Effects Globally



Solid: Overall Effect, Dashed: Direct Effect

What drives the size of indirect protection in our model?

Potential Drivers

1. Birth Rate
2. Under-5 Mortality
3. Vaccine Coverage

All may reduce the size of susceptible population

Analysis

- Linear regression of indirect effect size against potential drivers

Drivers of Size of Indirect Effects

- Indirect effects…

1. ***Birth Rate***
   Decrease by 0.66% (95% UI: 0.48%-0.84%)
   for an increase of one birth per 1000 people

1. ***Under-5 Mortality***
   Increase by 0.07% (95% UI: 0.02%-0.12%)
   for an increase of one under-5 death per 1000 births

3. ***Vaccine Coverage*:**
   Increase by 0.12% (95% UI: 0.05%-0.19%)
   for an increase in vaccine coverage of 1%

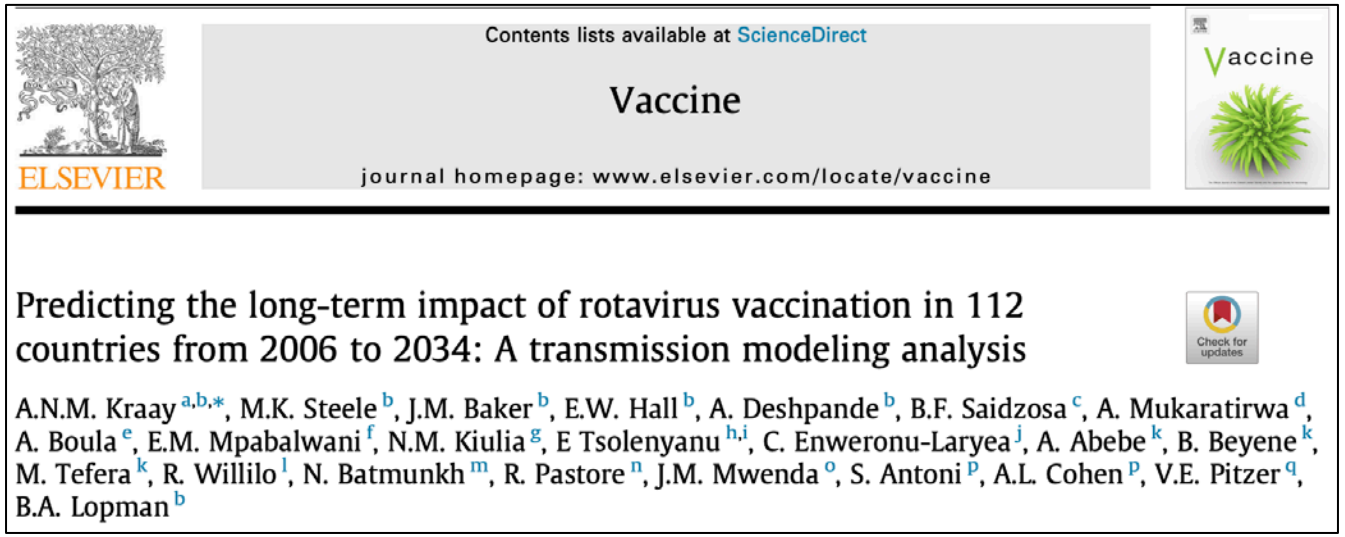
Summary

- Dynamic mathematical modeling can predict the full range of vaccine impact
  - Complexity of direct & indirect effects
  - Variation by region

- 102,000 under-5 deaths averted yearly by 2034 across all 112 countries (49% reduction)
  - 77,000 deaths averted yearly in Sub-Saharan Africa (48% reduction)
  - 18,000 deaths averted yearly in South Asia (57% reduction)

- Higher indirect effects are associated with lowering susceptibility. As vaccine coverage increases, we will observe a larger indirect effect (herd immunity).

Published Studies



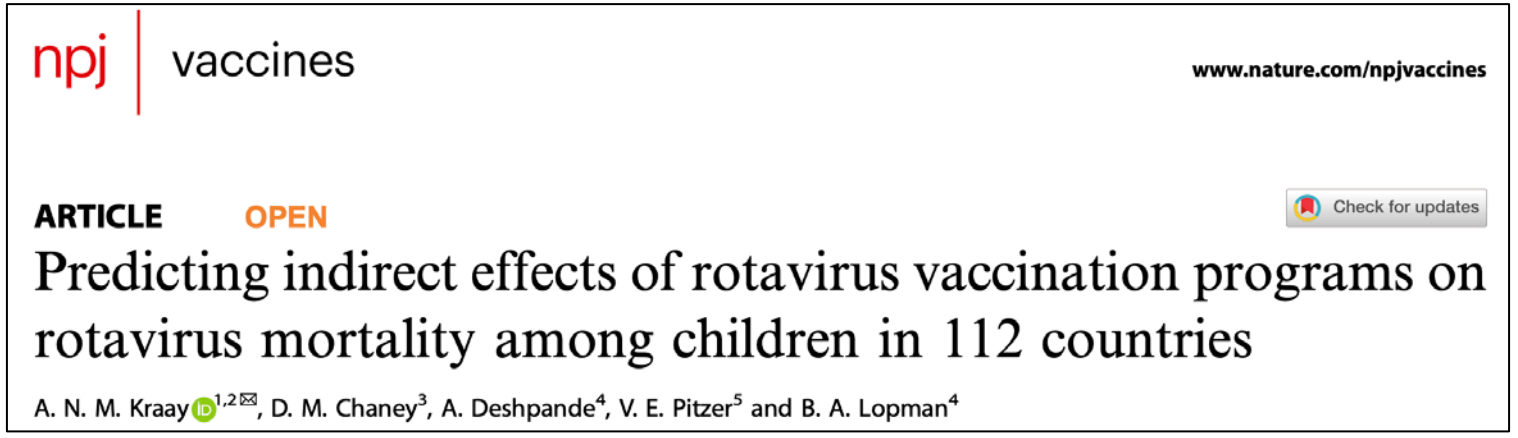
Contents lists available at ScienceDirect

Vaccine

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

Predicting the long-term impact of rotavirus vaccination in 112 countries from 2006 to 2034: A transmission modeling analysis

A.N.M. Kraay [a,b,*], M.K. Steele [b], J.M. Baker [b], E.W. Hall [b], A. Deshpande [b], B.F. Saidzosa [c], A. Mukaratirwa [d], A. Boula [e], E.M. Mpabalwani [f], N.M. Kiulia [g], E Tsolenyanu [h,i], C. Enweronu-Laryea [j], A. Abebe [k], B. Beyene [k], M. Tefera [k], R. Willilo [l], N. Batmunkh [m], R. Pastore [n], J.M. Mwenda [o], S. Antoni [p], A.L. Cohen [p], V.E. Pitzer [q], B.A. Lopman [b]



npj | vaccines

www.nature.com/npjvaccines

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Predicting indirect effects of rotavirus vaccination programs on rotavirus mortality among children in 112 countries

A. N. M. Kraay [1,2✉], D. M. Chaney[3], A. Deshpande[4], V. E. Pitzer[5] and B. A. Lopman[4]

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- A. Abebe
- B. Beyene
- R. Wililo
- N. Batmunkh
- R. Pastore
- J.M. Mwenda
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- A.L. Cohen
- V.E. Pitzer

VACCINE IMPACT MODELLING CONSORTIUM

Impact of Rotavirus Vaccination in 112 Countries: 2006-34

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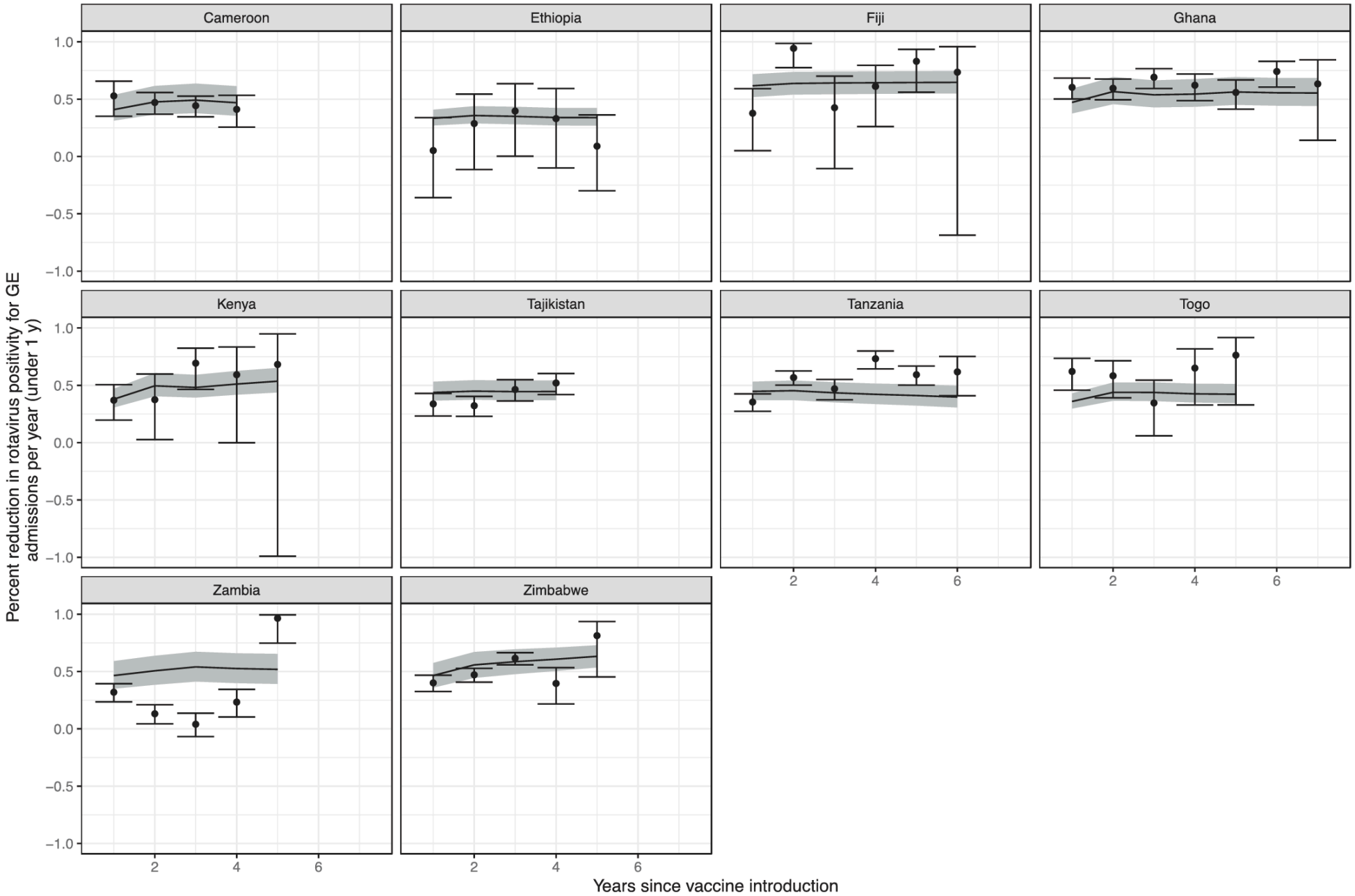
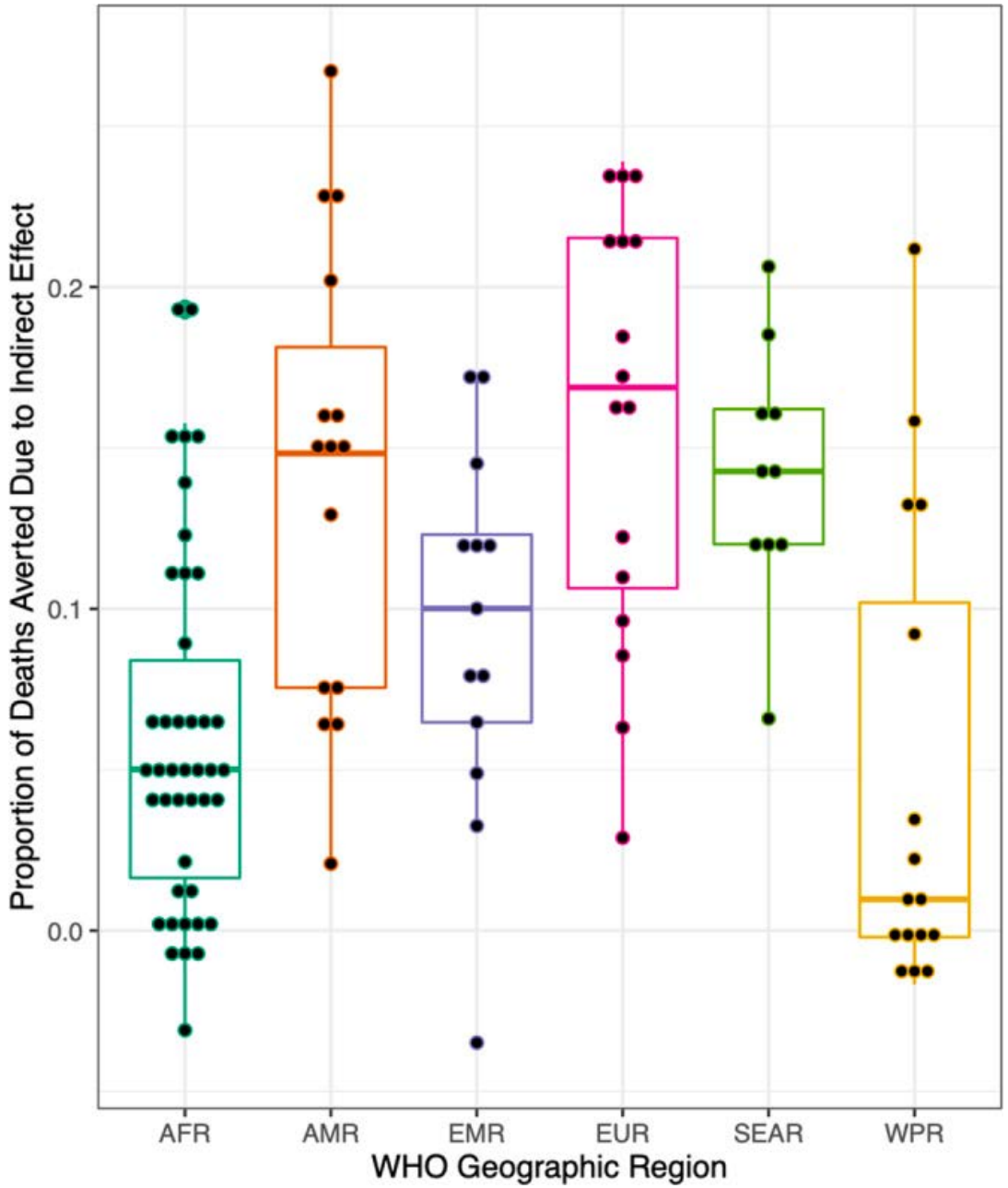
Appendix


Cameroon
Ethiopia
Fiji
Ghana
Kenya
Tajikistan
Tanzania
Togo
Zambia
Zimbabwe
Percent reduction in rotavirus positivity for GE admissions per year (under 1 y)
Years since vaccine introduction
1.0
0.5
0.0
−0.5
−1.0
2
4
6


Proportion of Deaths Averted Due to Indirect Effect
0.2
0.1
0.0
AFR
AMR
EMR
EUR
SEAR
WPR
WHO Geographic Region