

Evaluating the public health impact of dengue vaccination in Indonesia: A dynamic transmission modeling assessment amidst uncertainties in the implementation strategies

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Objectives

- The objectives of this study were:
- To estimate the public health impact of potential dengue vaccination programs targeting children 1 year and older in Indonesia
 - To estimate the vaccination age at which the maximum number of dengue cases are prevented

Methods

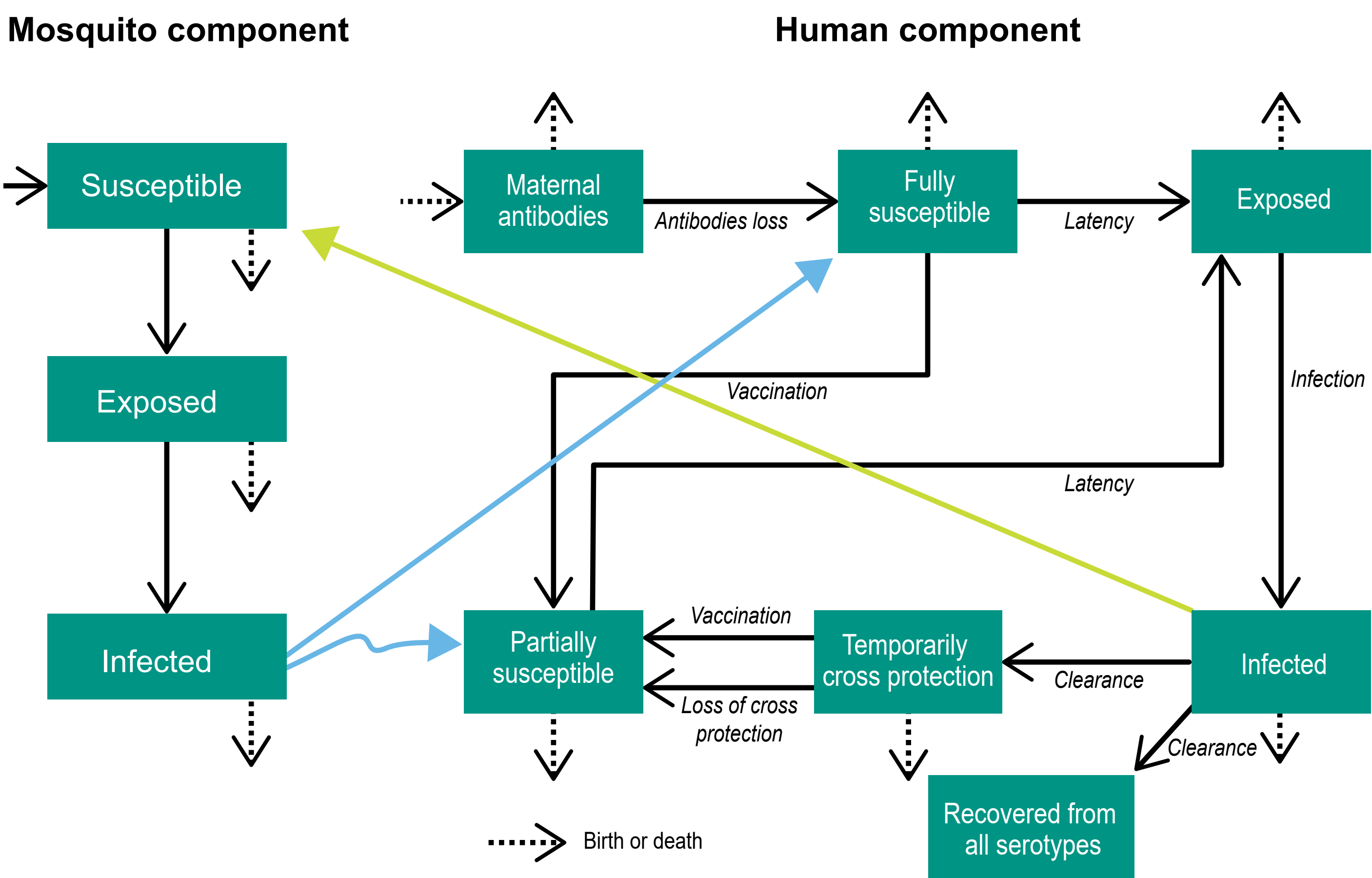
- We developed a comprehensive, deterministic, age-stratified, 4-serotype dynamic transmission model for dengue to evaluate the population-level effectiveness of potential dengue vaccine candidates
- Using the model, which was parameterized and calibrated with country-specific demographic and epidemiological data related to Indonesia,¹⁻⁴ we assessed the number of symptomatic cases, asymptomatic cases, and hospitalizations averted through routine single-dose vaccination of the population over a 10-year time period
- To address vaccine and programmatic uncertainties, a total of 81,648 scenarios were conducted. The scenarios included vaccine efficacy against symptomatic infection (VES) for each serotype, which varied between 50% and 90%; vaccine efficacy against asymptomatic (VEA) infection, which was assumed to be proportional to VES with a proportionality constant varied between 30% and 90%; vaccine coverage rate (VCR), which varied between 30% and 90%; median vaccine duration of protection (VD) (Table 1), which varied between 5 and 10 years; and age at vaccination, which varied between 1 and 18 years

Table 1. Vaccination scenario summary

Vaccine efficacy – symptomatic (VES)				Ratio of asymptomatic to symptomatic vaccine efficacy (VEA/VES) ^a	Vaccine coverage rate (VCR)	Median vaccine duration of protection (VD)
DENV-1	DENV-2	DENV-3	DENV-4			
50%-90%	50%-90%	50%-90%	50%-90%	30%-90%	30%-90%	5-10 years

DENV-i: Dengue virus serotype i; serotypes i=1,...,4

Figure 1. Model flow-diagram



Results

- The model calibration captures well the reported dengue seroprevalence data in Indonesia (Figure 2).
- In the absence of a universal dengue vaccination program, our model estimated a stable annual incidence of 3.5 million symptomatic cases (35 million cumulative cases over 10 years)
- The age at which the maximum number of dengue cases were prevented consistently remained at 2 and 3 years (Figure 3)
- Vaccination scenarios were ranked in ascending order with respect to symptomatic cases averted. Figures 3-5 plots the rank of each scenario versus the fraction of cases averted by each scenario. Scenarios are colored according to their target vaccination age: (dark blue) 1 year, (medium blue) 2-3 years, (green) 4-5 years, (light blue) 6-9 years, (teal) 10-18 years.
- The percentage of symptomatic cases averted by a vaccination scenario was correlated with the target vaccination age (Figure 3).

Figure 2: Model calibration, with corresponding 95% confidence intervals, among children aged 1 to 18 years in Indonesia, 2014¹

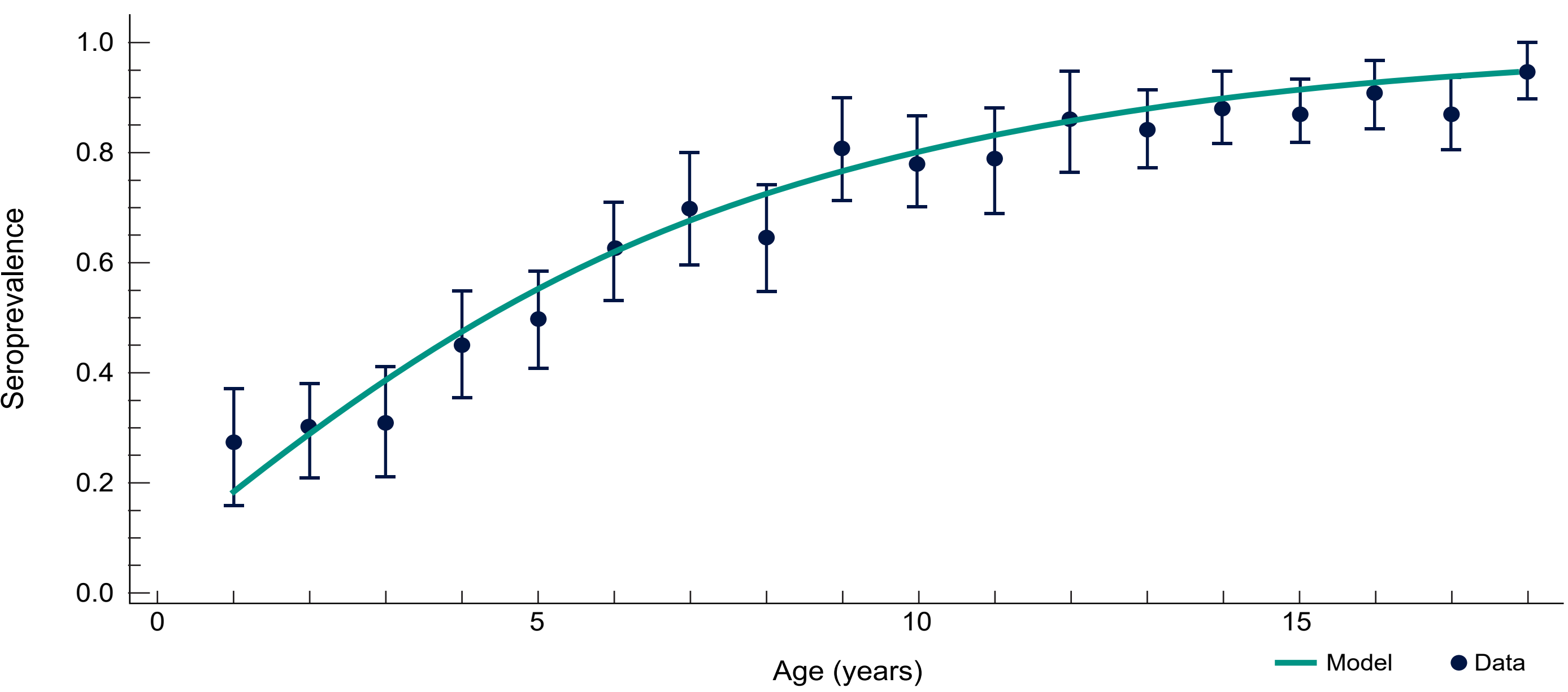
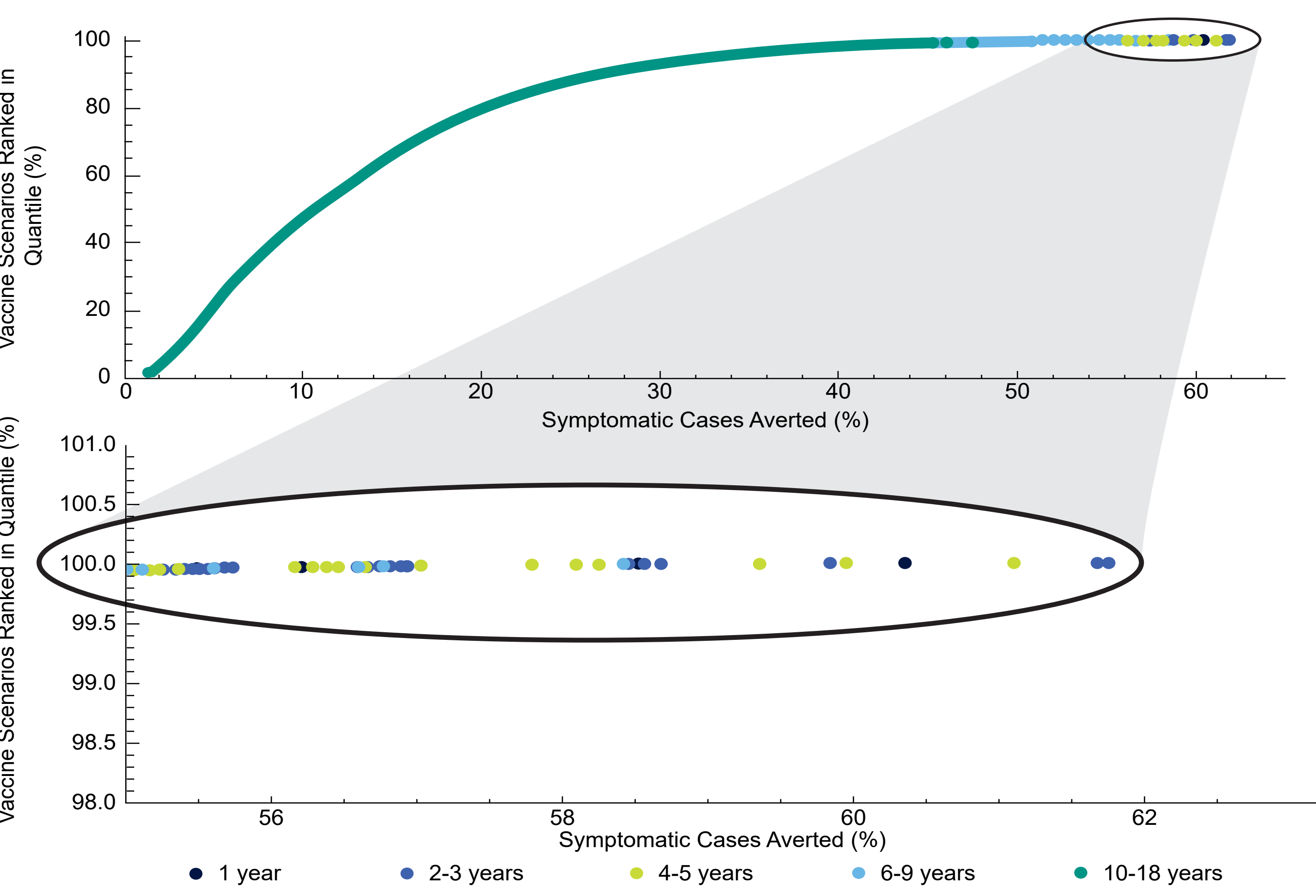


Figure 3. Vaccine scenarios ranked by cumulative symptomatic cases averted



- In the most effective vaccination program scenario, which included VES of 90%, VCR of 90%, VD of 10 years, and the chosen vaccination age at 2 or 3 years, we estimated that 21 million cumulative cases (60%) would be averted over the 10-year period (Figure 4)
- Figure 5 shows the fraction of cases averted relative to cases averted for the scenario with targeted vaccination age 1 year. The bars represent 95% region over all scenarios.
- Among vaccination scenarios that differed only by vaccination target age, vaccination scenarios with target ages of 2 or 3 years averted the greatest number of symptomatic cases.

Figure 4. Cumulative symptomatic cases averted for each targeted age group using the most-effective vaccination strategy over 10 years, showing the greatest number of cases averted

- Holding all other variables constant, the effectiveness of the vaccination program decreased with increasing vaccination age (Figure 4, Figure 5)

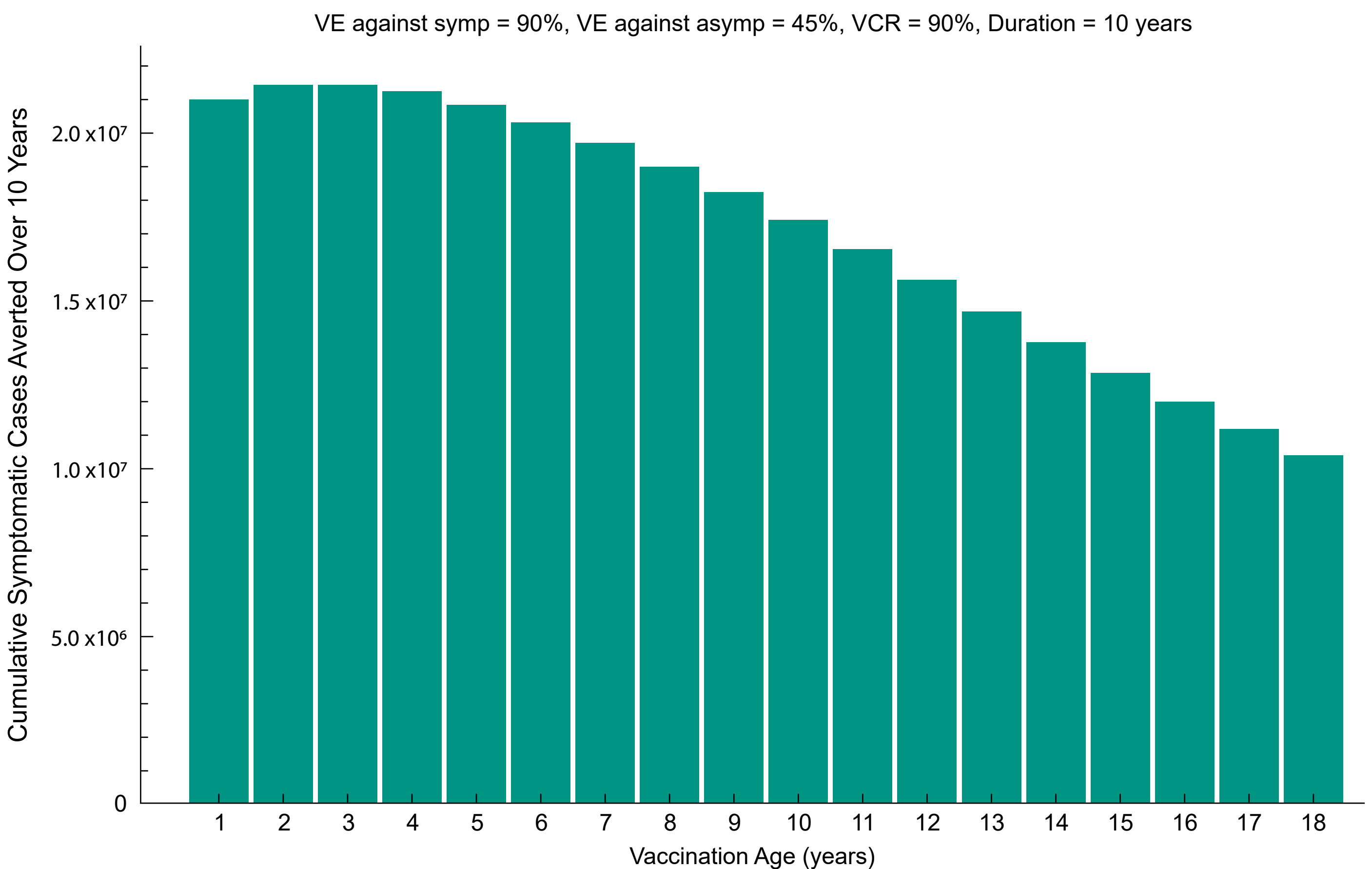
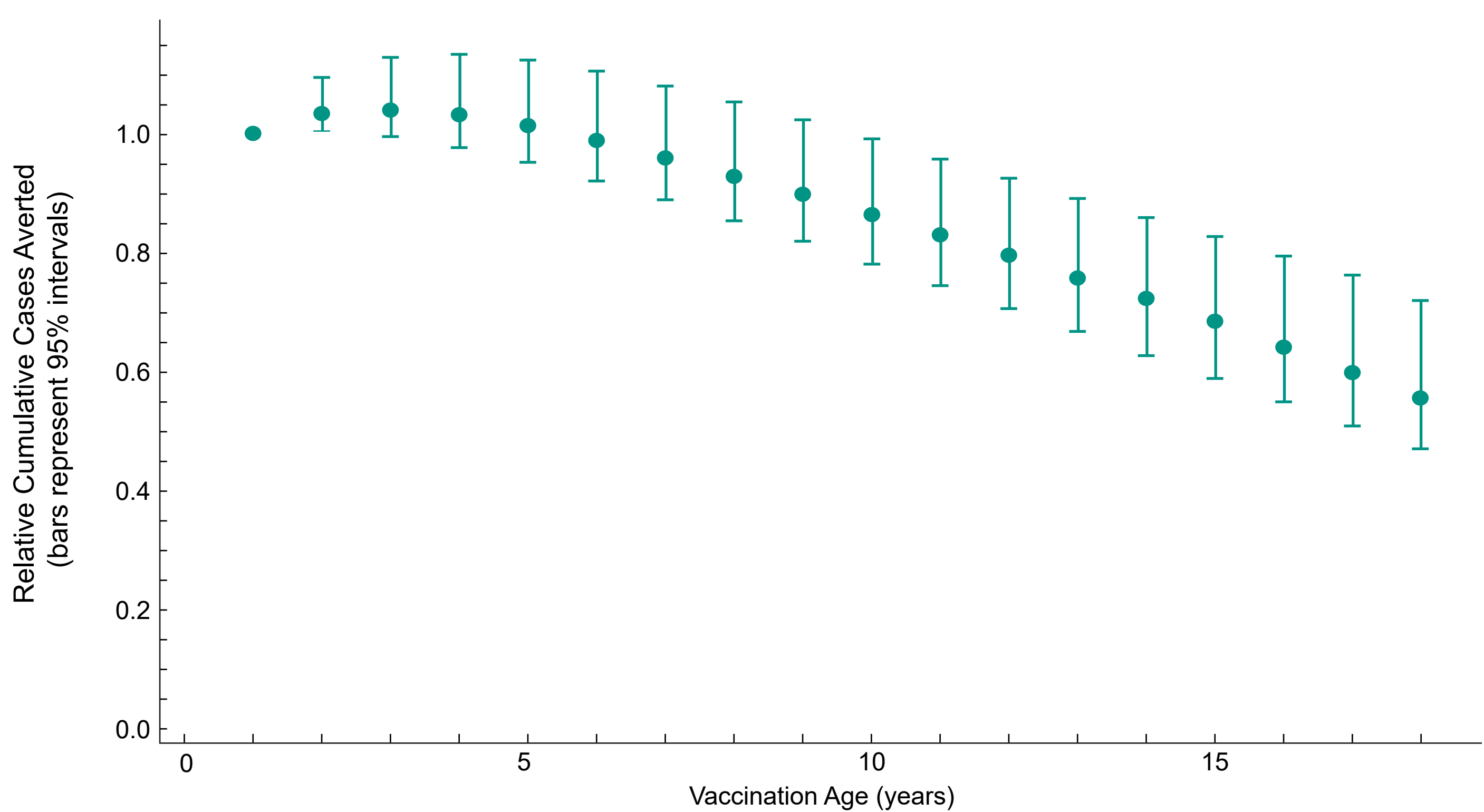


Figure 5. Cumulative cases averted vs vaccination age (VA) relative to cumulative cases averted (95% CI) for vaccination age=1 year over 10 years



Limitations

1. Deterministic and probabilistic sensitivity analyses will be conducted in the future
2. Dengue induced mortality not incorporated

Conclusions

- For a hypothetical dengue vaccine, routine vaccination of children aged 2 or 3 years old in Indonesia would lead to the greatest reduction in the number of symptomatic dengue cases
- The effectiveness of the vaccination program decreased with increasing vaccination age

References

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