

Background

- As the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic progressed, a substantial fraction of HK population was infected during January 2022-February 2023 by Omicron variant.
- The subsequent evolution of population immunity that reflects the additional protection of vaccination and infections is rarely explored.

Objectives

- To quantify dynamics of effective population-level immunity against SARS-CoV-2 infection in HK.

Methods

- We developed a deterministic age-structured COVID-19 transmission model [1] with vaccination status and Bayesian inference framework to analyse epidemiological surveillance data from HK including age-specific reported cases, vaccinations, waning pattern of both natural infection- and vaccination-induced immunity.
- We fitted the transmission model to daily reported cases for children, adults and the elderly.
- The transmission rate was estimated based on a random walk model and estimated cases follow a negative binomial process to account for reporting error.
- We estimated age-specific effective protection against SARS-CoV-2 infection and reporting rate over time.

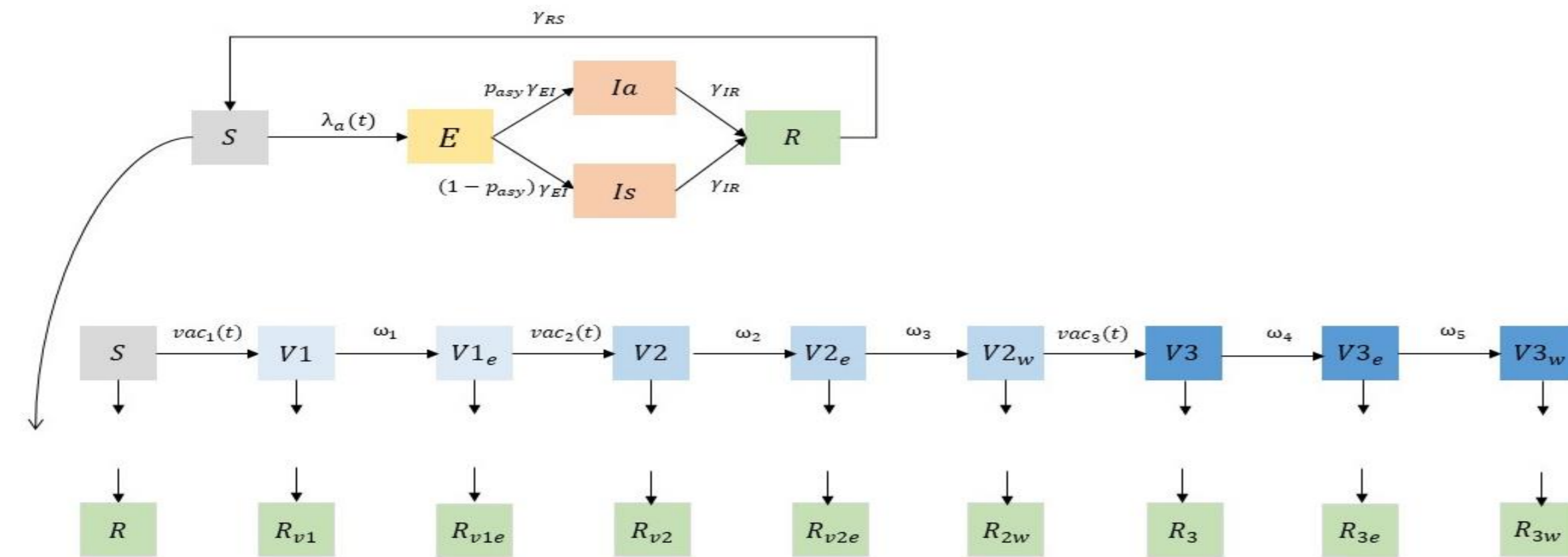


Figure1. Model compartments were expanded to account for 8 vaccination strata, corresponding to first dose, first dose effective, second dose, second dose effective, second dose waning, booster dose, booster dose effective and booster dose waning.

Results

- Between 1 January 2022 to 31 May 2022, 52% (95 credible interval (CI): 25-78%) of the HK population were estimated to have been infected by SARS-CoV-2. Of those, adults aged 18-64 had the highest attack rate (57%, 95% CI: 28-86%) (Figure 2).
- At the end of February 2022, there were around 18,000, 140,000 and 60,000 infections at the peak for 3 age groups, respectively.

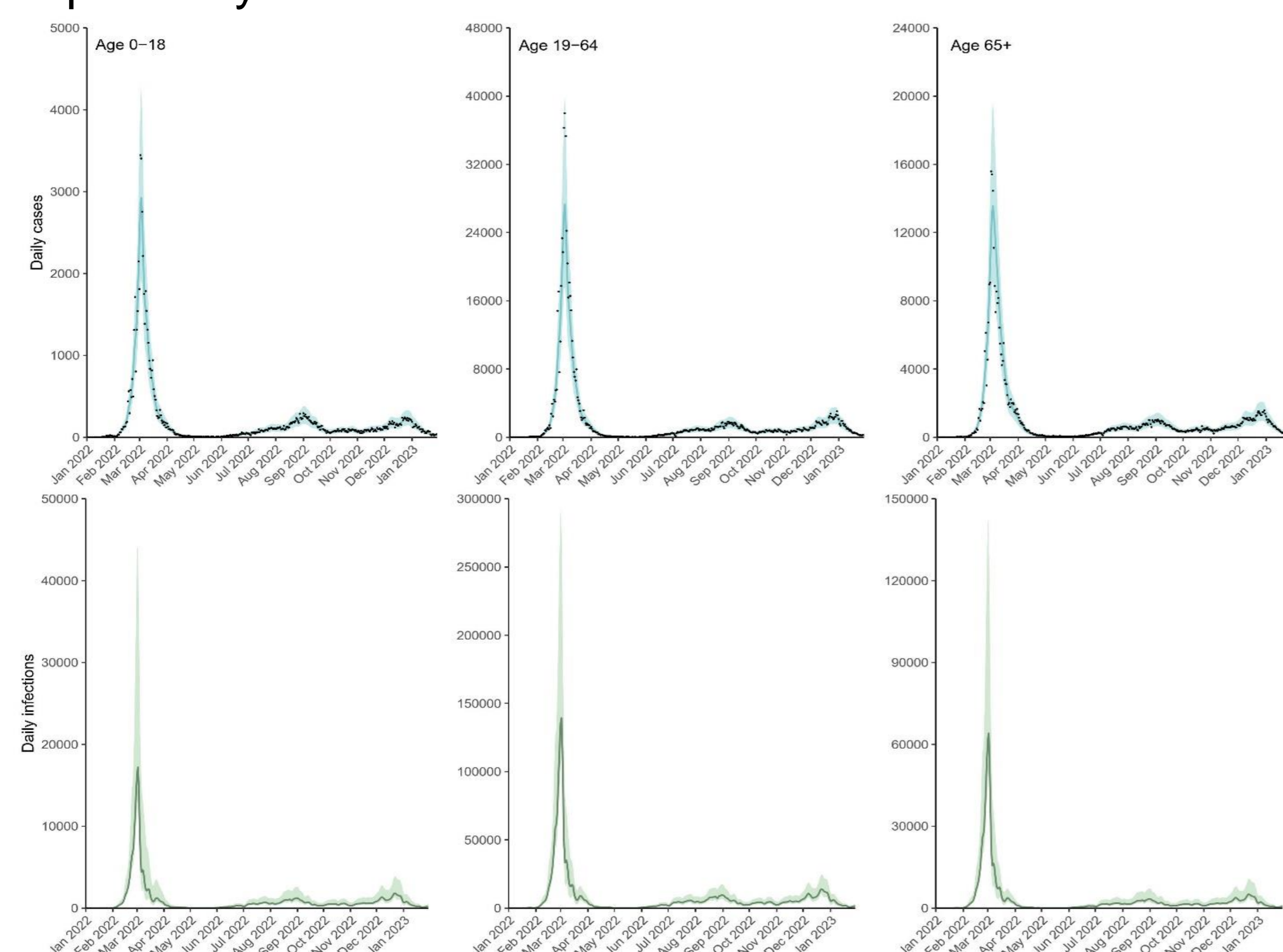


Figure2. Model fitting and estimated daily number of infections for 3 age groups. Black dots represent the observed cases, blue lines represent median estimated cases and shaded areas are 95% CIs.

- Effective protection against SARS-CoV-2 infection that accounted vaccine effective and waning effects of protection increased significantly from 8% to 30% (95% CI: 24-57%) and 10% to 55% (95% CI: 40-80%) for children and adults, respectively. At the end of January 2023, over 60% (median) of the adults gained effective immunity against SARS-CoV-2 infection while only 45% of children had immunity against infection (Figure 3).

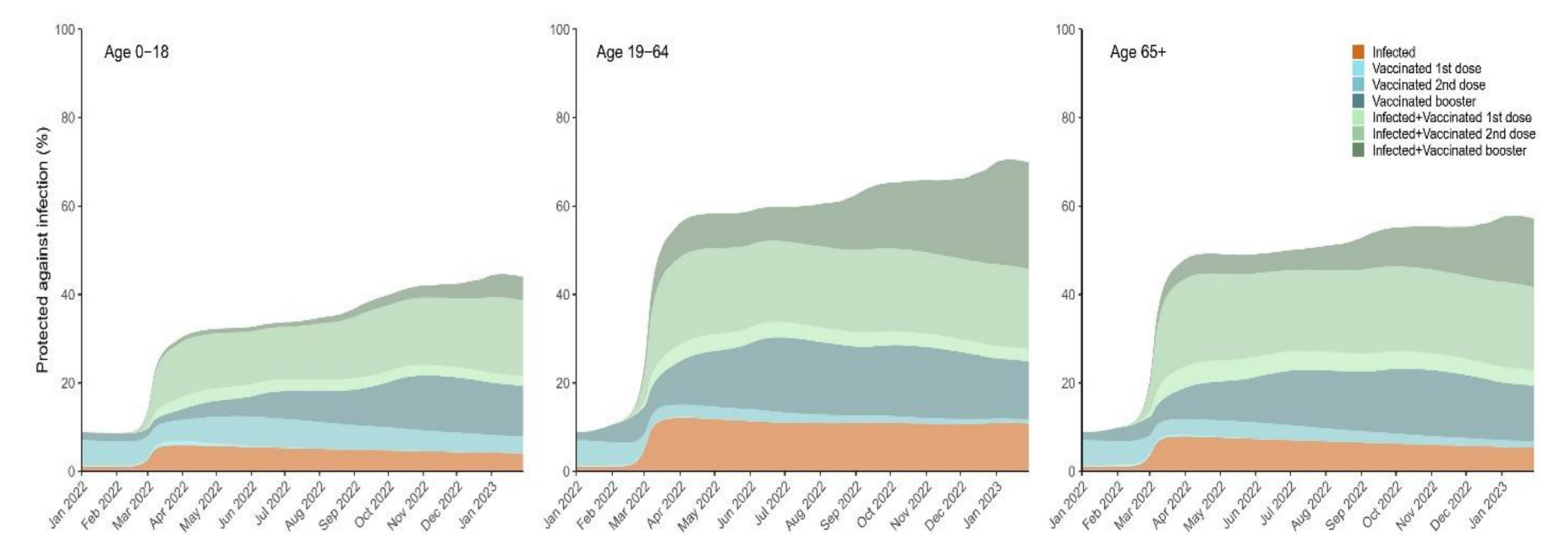


Figure3. Estimated effective protection (median estimates) against SARS-CoV-2 infection by infection, vaccination status and age groups.

- The reporting rate was assumed constant for symptomatic infections and time-varying for asymptomatic infections. We estimated that symptomatic reporting rate for the elderly was the highest among all age groups 56.7% (95% CI: 26.9%, 64.4%).
- Asymptomatic reporting rate increased rapidly after the deployment of mass testing with RAT at the end of January, 2022 and declined gradually, maintaining similar levels thereafter.

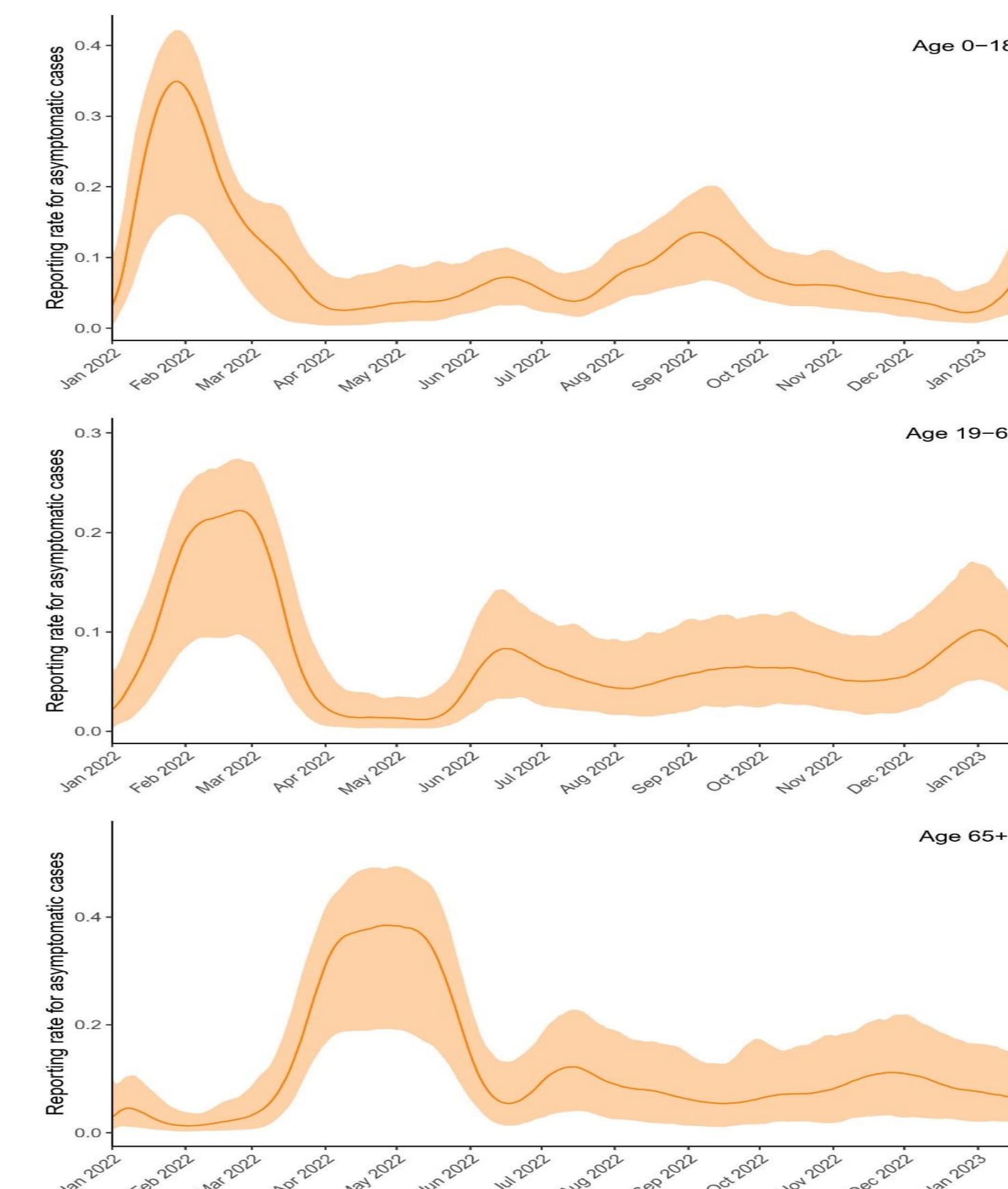


Figure3. Estimated time-varying reporting rates for asymptomatic cases for 3 age groups. Solid lines are median estimates whereas shaded areas represent 95% CIs.

Conclusion

- Effective protection against SARS-CoV-2 infection increased substantially during the fifth wave, resulting in a large proportion of the HK population with hybrid immunity.
- There were a large proportion of children still susceptible to SARS-CoV-2 Omicron infection.
- Future analyses may focus on incorporating two co-circulating Omicron subvariants for more specific immunity patterns.

References

[1] Perez-Guzman PN, Knock E, Imai N, et al. Epidemiological drivers of transmissibility and severity of SARS-CoV-2 in England [published correction appears in Nat Commun. 2023 Dec 7;14(1):8099]. *Nat Commun.* 2023;14(1):4279. Published 2023 Jul 17. doi:10.1038/s41467-023-39661-5