# Assessing the Effectiveness of Test-isolate-quarantine Interventions and Vaccination Programs on Influenza Control in Hong Kong: A Comparative Analysis

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## Background

Contact tracing, isolation, quarantine, symptom monitoring, and vaccination are key interventions for controlling influenza. Vaccination coverage in Hong Kong has been increasing in these years, and starting from 2022/2023, the government expanded the recommended age range for vaccination from under 12 to under 18 years of age.[1] Vaccination is the most important measures to control influenza epidemics, but vaccine effectiveness could be suboptimal due to mismatch of strain.[2]

## Objectives

We aim to assess the impact and effectiveness of implementing different levels of non-pharmaceutical interventions (NPIs) and targeted vaccination programs for different age groups during the influenza season, either separately or in combination.

## Methods

We utilized a stochastic agent-based model, Covasim, to simulate the effectiveness of interventions in influenza transmission. The model was adjusted to align with the specific characteristics of influenza transmission, including the transmission model and disease progression parameters. Covasim generates four distinct contact networks by default: households, schools, workplaces, and community environments (Figure 1). We simulated the Hong Kong influenza transmission over the pandemic H1N1 outbreaks in 2009, and three influenza seasons in 2010-2013 (Table 1). The age structure of the population was built based on data from Hong Kong government. Data of susceptibility, vaccination coverage, and initial immunity level among different age groups are collected and applied in the baseline model. The model has been calibrated with the number of infections, estimated by serology studies by minimizing the mean squared error. After calibration to observed data, we applied the calibrated model to conduct 100 simulation to estimate the impact of five scenarios with different coverage and effectiveness of the targeted vaccination strategy and test-isolate-quarantine strategy.

**Scenarios:**

- S0: Baseline vaccine coverage.
- S1: Vaccine strategy. Allocate vaccine to a) <12, b) <18, c) 65+, d) <18 or 65+, e) all age group, with coverage increasing to 200% of baseline.
- S2: Isolation strategy. Isolation effectiveness for tested positive individuals set at 40% (low) or 80% (high).
- S3: Household contact tracing and quarantine strategy. On top of S2, and quarantine effectiveness for household contacts set at 40% (low) or 80% (high).
- S4: Combinations of S1 and S3.

## Conclusion

Implementing a combination of isolation-quarantine interventions and widespread vaccination can be vital in controlling the spread of the epidemic, especially when vaccine effectiveness is low.

## Acknowledgements

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## Results

In comparison to the baseline, increasing vaccination coverage by 200% (S1) among different age groups leads to a decrease in cumulative infections ranging from 9.7% to 84.6% during vaccine-matched seasons. However, during vaccine-mismatched seasons, the reduction is only between 3.3% and 30.4%. For the implementation of isolation strategy (S2), the reduction in cumulative infections can range from 15.1% to 48.6% when the isolation effectiveness is low. However, when the effectiveness of isolation is at a high level, the reduction can reach 58.8% to 82.5%. Incorporating household contacts tracing and quarantine (S3) on top of S2 further decreases infections. The reduction ranges from 21.7% to 66.6% at low effectiveness of quarantine, and from 78.7% to 92.5% at high effectiveness. When considering scenarios involving both vaccination and the isolation-quarantine strategy (S4), the reduction in infections can increase by 5.6% to 73.2% during vaccine-matched seasons, and even more (7.0% to 90.5%) during vaccine-mismatched seasons, compared to only increasing vaccination coverage.

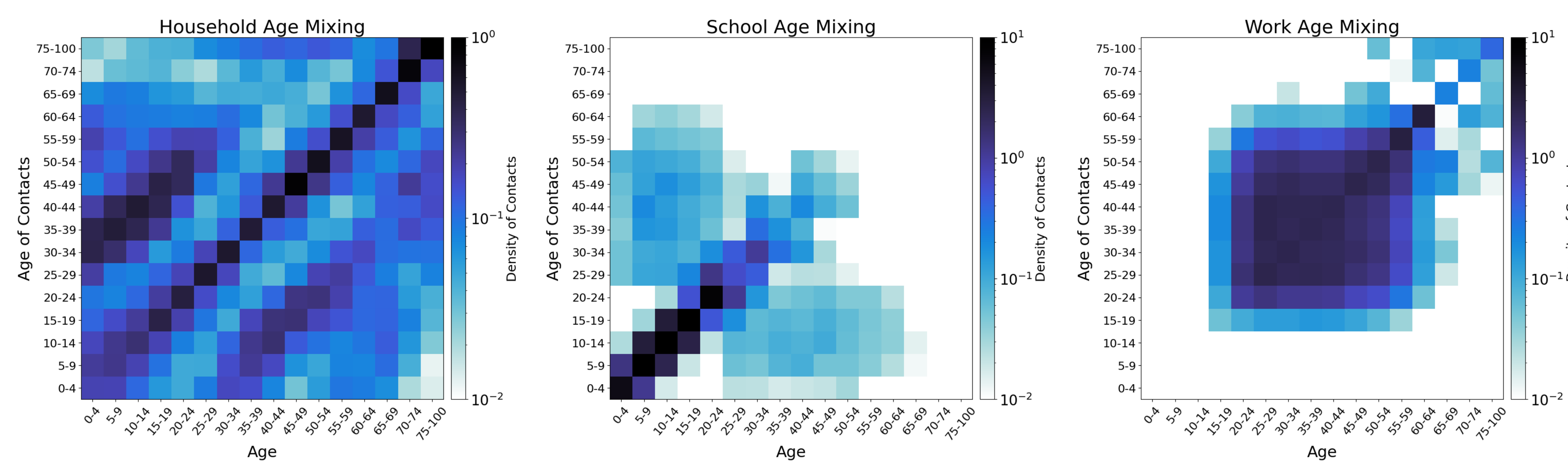


Figure 1. Population networks for households (left), schools (middle), and workplaces (right).

Table 1. Information on the four modeled seasons

| Season | Season1 | Season3 | Season4 | Season6 |
|---|---|---|---|---|
| Start date | 2009/6/8 | 2010/12/4 | 2012/1/4 | 2013/5/31 |
| Cumulative infections | 1376594 | 1130642 | 1974799 | 526863 |
| Attack rate | 0.186 | 0.141 | 0.243 | 0.065 |
| Vaccine matching | Mismatched | Matched | Mismatched | Matched |

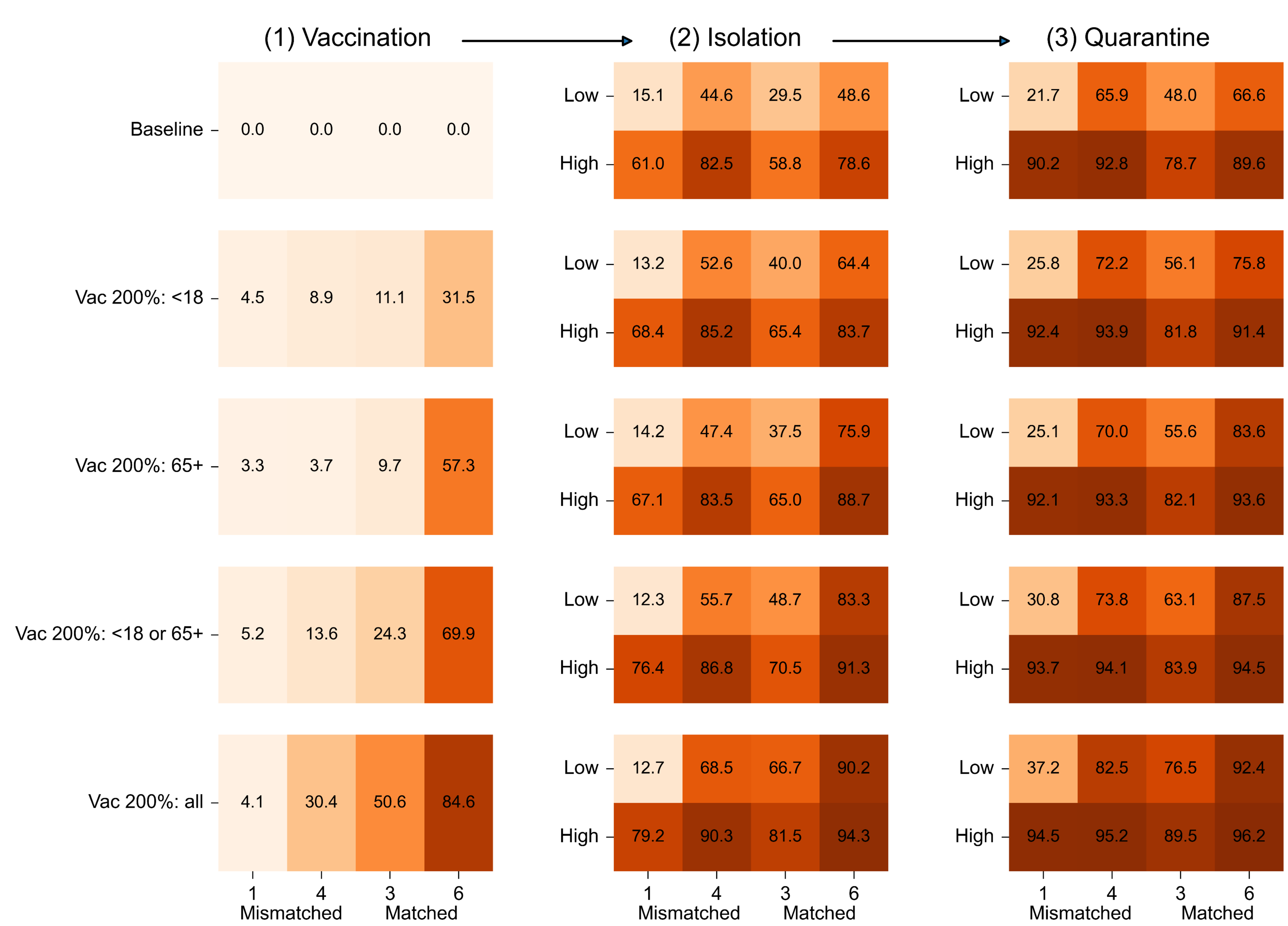


Figure 2. Percentage reduction (median) in the number of cumulative infections attributable to various scenarios.

## References

[1] Cowling BJ, Chan KH, Feng S, et al. The effectiveness of influenza vaccination in preventing hospitalizations in children in Hong Kong, 2009-2013. Vaccine 2014; 32(41): 5278-84.
[2] Peak CM, Childs LM, Grad YH, Buckee CO. Comparing nonpharmaceutical interventions for containing emerging epidemics. Proc Natl Acad Sci U S A 2017; 114(15): 4023-8.