Journal of Infection 86 (2023) e123–e125

Contents lists available at ScienceDirect

Journal of Infection

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

Letter to the Editor

The risks of death and hospitalizations associated with SARS-CoV-2 Omicron declined after lifting testing and quarantining measures☆

Dear Editor,

We reported the estimated infection–fatality ratio (IFR) and infection-hospitalization ratio (IHR) after lifting non-pharmaceutical interventions using a mathematical compartment model that accounted for unascertained infections. China lifted the testing and quarantining measures against SARS-CoV-2 Omicron on 7 December 2022. One online survey study conducted on December 27–30, 2022, in Macao, China, reported 70% of the population infection rates.[1] This concurrence of the surge of Omicron infection and the excess winter mortality among old adults has sparked a widespread susception of an increasing medical burden of the disease after the lifting. However, a well-known problem with web surveys is selection bias, which could lead to unreliable survey outcomes.[2] It is unclear which statistical techniques[3] were used to address the problem. Moreover, the authors noted that unascertained infections were difficult to count in the survey.

The risks of death and hospitalization provide an alternative way of converting COVID-19 mortality into an estimate of infections and further into the requirement of hospital resources, and a reverse way to convert the requirement of hospital resources into an estimate of infections and further into COVID-19 mortality, which together comprises a self-checking robust way to qualify for the medical burdens of Omicron variants. Thus, a better understanding of the changes in IFR and IHR after lifting testing measures is needed. We highlighted the difference between IFR—a metric quantifying the likelihood of people dying once infected,[4] and the case-fatality ratio (CFR) with the infections being replaced by the ascertained infections. Because of the great uncertainty surrounding the number of infections after the lifting, estimates of the IFR and IHR that rely on detected cases are likely to be misleading.[5–8]

We developed a stochastic dynamic model of SARS-CoV-2 transmission and a period-based fitting framework to estimate these risks (Supplementary). The model was a population-based age-specific, susceptible-exposed-infectious-ascertained-vaccinated-removed model, which accounted for screening and quarantine measures, primary and booster vaccination, waning immunity, and disease severity (Fig. S1). All compartments and parameters were summarized in Tables S1 and S2. We fitted the model using the data from the Omicron wave in Hong Kong, China, from January 2022 to October 2022. Age-specific and all-age IFR and IHR were then calculated as reported deaths and hospital admissions divided by the estimated total infections including unascertained cases.

To account for time-varying probabilities of being ascertained, we divided the Omicron wave in Hong Kong, China, into seven periods: Weak testing (1 January to 8 February), Weak testing and stringent social distancing measures (8–19 February), Self-testing and slow isolation (20 February to 5 March), Testing and proper isolation (6 March to 31 March), Testing and rapid isolation (1 April to 30 April), Self-testing and lifting testing and quarantine measures (1 May to 30 May) and Post-lifting (June 1–22 October) based on the time-varying testing measures (Table S3). We considered 1 January to 30 May as the period before the lifting and 1 June to 22 October as the period after the lifting.

All-age IFR and IHR before the lifting were estimated to be 0.2748% (95% Confidence intervals 0.2164–0.3614) and 1.5063% (1.1857–1.9805) (Table S5), respectively, which were less than one-third of case-fatality ratio (CFR) and case-hospitalization ratio (CHR) that were calculated based on ascertained cases only (Table S4). All-age IFR and IHR after the lifting further declined, with values of 0.0339% (0.0272–0.0477) and 0.9811% (0.7863–1.3788), less than one-fourth of CFR and CHR in the same period. In line with the reported CFR, we identified a J-shaped pattern of age-specific IFR (Fig. 1). The post-lifting IFR was 0.0005% (0.0004–0.0007) for people aged 3–11, 0.0000% (0.0000–0.0000) for people aged 12–19, monotonically increasing until 0.6367% (0.5103–0.8948) for people aged 80+. Estimated age-specific IHR formed a V-shaped pattern, with the lowest rates found in populations aged approximately 12–19 years and progressively higher rates among younger and older populations. Post-lifting age-specific IHR were 5.3215% (4.2648–7.4788) for people aged 0–3, 0.3175% (0.2545–0.4463) for people aged 12–19%, and 6.7391% (5.4009–9.4712) for people aged 80+, respectively. The prior-lifting IFR and IHR presented the same patterns. The difference between IFR and CFR, and that between IHR and CHR, were more prominent in periods with higher ascertainment probabilities—-when testing and quarantine measures were implemented less widely (Fig. 2). In addition, IFR and IHR were relatively stable across the periods before the lifting, although the testing and quarantine measures varied highly across these periods. In contrast, CFR and CHR varied highly with the ascertainment probabilities because of the variations in the testing and quarantine measures, with lower values for higher ascertainment probabilities.

Our age-specific and all-age estimation of the IFR and IHR showed that the risk of death and hospitalizations among people infected with Omicron declined after the lifting, with considerably lower values than reported CFR and CHR. Understanding these changes in IFR and IHR has direct implications for quantifying the need for medical resources, especially when great uncertainty surrounds the number of infections after the lifting. Although our

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https://doi.org/10.1016/j.jinf.2023.02.033

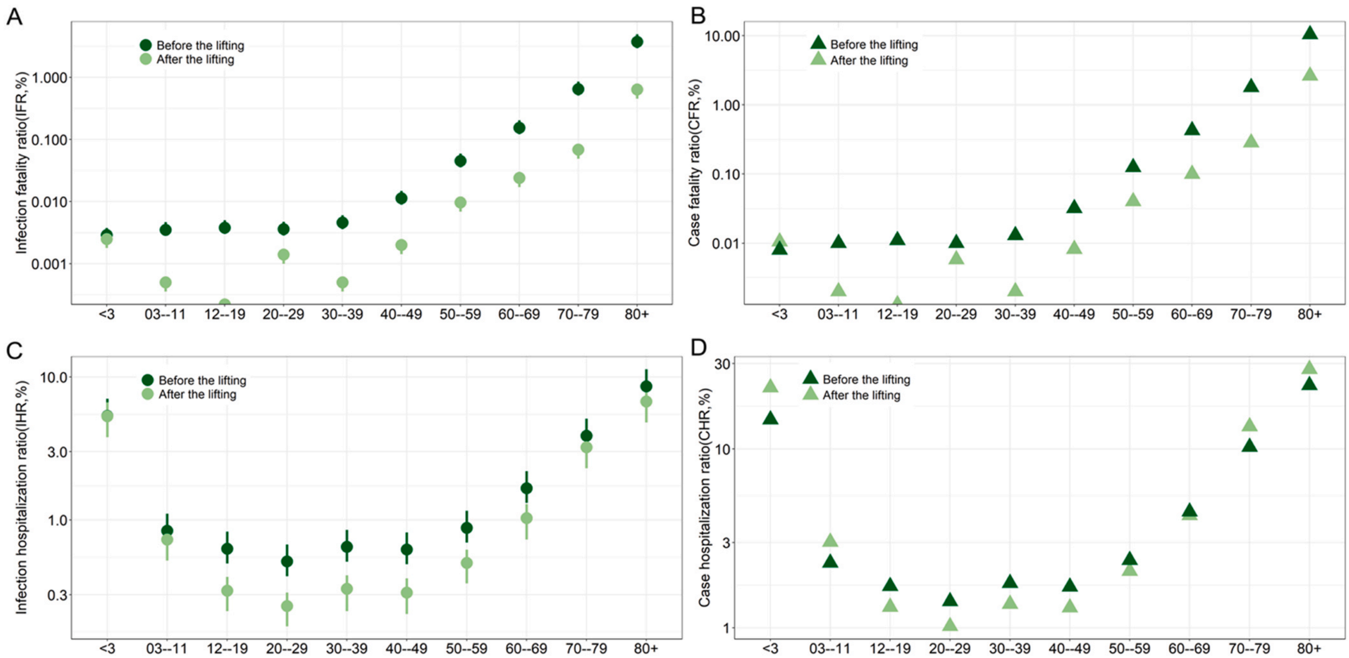

Fig. 1. Age-specific risks of death and hospitalization.

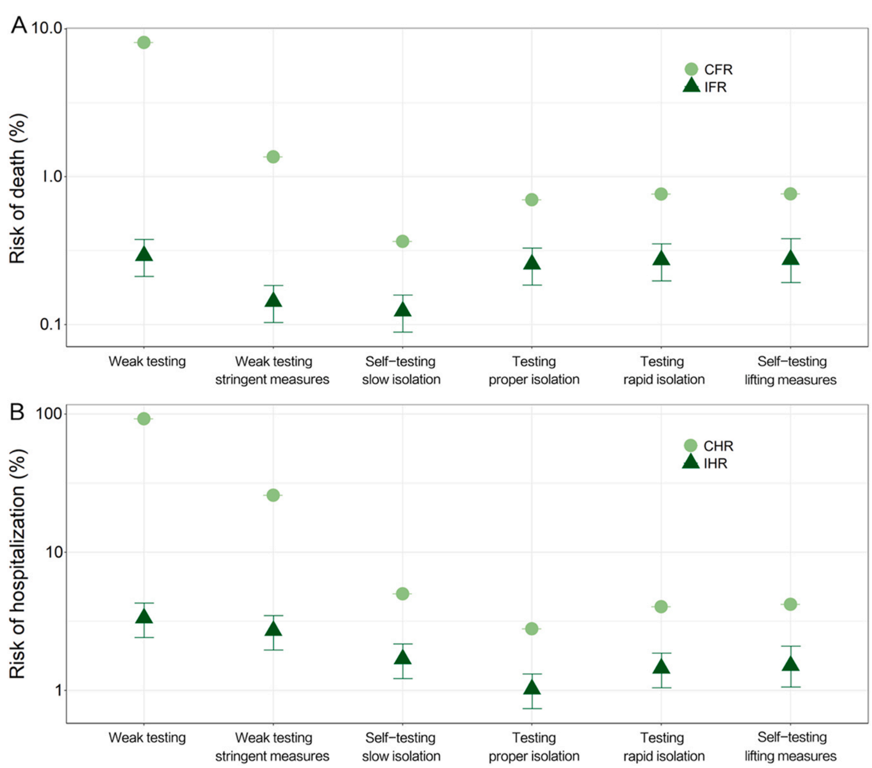

Fig. 2. Comparison of the estimated and reported risks of death and hospitalization across different periods when testing measures vary.

analysis shows relatively stable IFRs and IHRs across different periods, it is key to remark that most Omicron infections recorded in our data occurred in seasons other than winter. We were not able to evaluate the differences in risks across seasons, but our findings present a basis for future comparison. The finding has profound implications for understanding the medical burden of pathology and informing medical resource allocations, which should take into consideration the impact of case ascertaining measures and the limitation in data collection.

Funding

The study was supported by the Chinese Academy of Medical Sciences (CAMS) Innovation Fund for Medical Sciences (2021-I2M-1-

038, 2020-I2M-1-001), the Science Fund for Creative Research Groups of the National Natural Science Foundation of China (82221004) and the Non-profit Centraund for Creative Research Groups of the National Natural Science Foundation of China (82221004). The funders played no direct role in the study.

Ethic approval and consent to participate

Institutional review and informed consent are approved by the Institute of Pathogen Biology, Chinese Academy of Medical Sciences & Peking Union Medical College. All data were collected from publicly available sources. Data were deidentified, and the need for informed consent was waived.

Consent for publication

Not applicable.

CRediT authorship contribution statement

YD and SH contributed equally to this work as co-first authors. JW, WY and LR had access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Concept and design: SH, JW, WY, LR. Acquisition, analysis, or interpretation of data: YD, SH. Drafting of the manuscript: YD, SH. Critical revision of the manuscript for important intellectual content: All authors. Statistical analysis: YD, SH.

Declaration of Competing Interest

We declare no competing interests.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jinf.2023.02.033.

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