

## Preplanned Studies

## Preliminary Study of the Protectiveness of Vaccination Against the COVID-19 in the Outbreak of VOC Omicron BA.2 — Jilin City, Jilin Province, China, March 3–April 12, 2022

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### Summary

#### What is already known about this topic?

An outbreak of coronavirus disease 2019 (COVID-19) of Omicron BA.2 emerged in Jilin City since March 3, 2022, which involved in 27,036 cases by April 12. The vaccination program with inactivated COVID-19 vaccines has been implemented since the beginning of 2021.

#### What is added by this report?

The incidences of moderate, severe, and critical cases in the whole population of the group of 0+1 dose were 1.82-, 9.49-, and 3.85-fold higher than those in the group of 2 doses, and 5.03-, 44.47-, and ∞-fold higher than those received 3 doses vaccination. For the population ≥60 years, the incidences of moderate, severe, and critical cases in the group of 0+1 dose were 29.92, 9.62, and 4.27 per 100,000, showing 4.13-, 43.72-, and 4.85-fold higher than 2 doses, as well as 13.28-, 22.37-, and ∞-fold higher than 3 doses.

#### What are the implications for public health practice?

The incidences of each type of COVID-19 in the population who were fully vaccinated or booster vaccinated in Jilin City were significantly lower than those who were unvaccinated and/or partially vaccinated. Booster vaccination with homologous inactivated vaccines induces stronger protectiveness for COVID-19 caused by variant of concern (VOC) Omicron.

An outbreak of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) Omicron BA.2 strain occurred in Jilin City, Jilin Province, China. By April 12, a total of 27,036 cases had been diagnosed by the reverse transcription-polymerase chain reaction (RT-PCR) as SARS-CoV-2 and reported via the internet-based national direct reporting system for infectious disease. The clinical

severity of those cases was typed according to the Diagnosis and Treatment Protocol for COVID-19 Patient (9th edition) issued by the National Health Commission (NHC) (1). Among them, 13,164 cases were asymptomatic, 13,629 were mild, 196 were moderate, 32 were severe, and 13 were critical. A total of 241 cases were diagnosed as COVID-19, accounting for 0.89% of all COVID-19 cases. There were 2 fatal SARS-CoV-2 positive cases reported who died from other diseases. The SARS-CoV-2 Omicron BA.2 strain shows a great impact on transmission and immunity globally. Numerous studies have revealed that the vaccine effectiveness on COVID-19 transmission of Omicron strains is markedly reduced, regardless of the types of vaccines (2–5). In this report, the vaccine protectiveness on COVID-19 induced pneumonia and more severe clinical types of 241 cases in Jilin City were preliminarily analyzed.

Jilin City is the 2nd largest city in Jilin Province with a registered population of 3,623,713. Among them, 25.6% (915,090) were 60 years and/or older. The COVID-19 vaccination program has been implemented in Jilin City since the beginning of 2021. All people were vaccinated with domestic inactivated vaccines. By March 3, the coverages of COVID-19 full (2 doses) and booster (3 doses) vaccination in the general population were 81.1% (2,937,342) and 32.1% (1,163,069), while those in the population ≥60 years were 79.5% (727,950) and 29.8% (272,943), respectively. In addition, there were 68,347 people who received 1 dose vaccine but had not finished the full vaccination by March 3.

The general population, the population ≥60 years, and <60 years in Jilin City was divided into 3 groups, unvaccinated plus received 1 dose (0+1 dose), full vaccination (2 doses), and booster vaccination (3 doses). More COVID-19 cases distributed in the group of 0+1 dose (n=121) than that of 2 doses (n=90) and 3 doses (n=30). Among them, 2 moderate cases and 1 severe case received only 1 dose of the vaccine. The distribution of the clinical severity in the different

groups of ages and vaccinations was summarized in Table 1. In general population, higher ratios of severe (21.5%) and critical (7.4%) cases were in the group of 0+1 dose, whilst lower ratios were in the groups of 2 doses (5.6% of severe and 4.4% of critical) and 3 doses (3.3% of severe and 0% of critical). Among those 241 cases, 127 cases were at ages of  $\geq 60$  years and 117 were  $< 60$  years. Markedly more numbers and higher ratios of critical cases were in the group of  $\geq 60$  years. Only 1 case  $< 60$  years displayed a critical phenotype and did not receive vaccination. There were no critical cases in the group of  $< 60$  years who received 2 doses of vaccination, and no severe or critical cases who received 3 doses.

The incidences (1/100,000) of COVID-19 in different vaccination groups were further calculated. For the general population in Jilin City, the incidences of moderate, severe, and critical cases in the group of 0+1 dose were 12.53, 4.08, and 1.31 per 100,000, respectively, which were 1.82-, 9.49-, and 3.85-fold higher than those in the group of 2 doses, and 5.03- and 44.47-fold higher than the moderate and severe cases that received 3 doses of vaccination (Figure 1A). For the population  $\geq 60$  years, the incidences of moderate, severe, and critical cases in the group of 0+1 dose were 29.92, 9.62, and 4.27 per 100,000, respectively, which were remarkably higher than that of the general population. The incidences of moderate, severe, and critical cases in the group of 0+1 dose were 4.13-, 43.72-, and 4.85-fold higher than those in the group of 2 doses, 13.28- and 22.37-fold higher than moderate and severe ones in the group of 3 doses, respectively (Figure 1B). Contrarily, the incidence of COVID-19 in the population  $< 60$  years of 0+1 dose group was lower, showing 9.82-, 1.60, and 0.20 per 100,000 in moderate, severe, and critical phenotypes, respectively. There were no critical cases in the group of 2 doses and no severe and critical cases in that of 3 doses. The incidences of moderate and severe disease of 0+1 group were 3.70- and 4.85-fold higher than that of patients receiving 2 doses, while the incidence of moderate cases was 3.81-fold higher than that receiving 3 doses (Figure 1C). The incidence of each type of

COVID-19 in the population who were fully vaccinated or booster vaccinated in Jilin City is significantly lower than those who were unvaccinated and/or partially vaccinated. Booster vaccination induces stronger protectiveness for COVID-19 both in the population  $\geq 60$  years and  $< 60$  years.

## DISCUSSION

As a variant of concern (VOC), SARS-CoV-2 Omicron BA.2 strain attracted great attention worldwide since it emerged in South Africa at the end of 2021, due to numerous amino acid substitutions in the region of the viral spike protein (6–7). Great impact on immunity, particularly on vaccine effectiveness in disease transmission, has been already addressed, regardless of the types of available COVID-19 vaccines (8–11). In line with another study (8), the preliminary data in the Omicron BA.2 strain-associated outbreak in Jilin City here have again verified the protectiveness of vaccination with inactivated vaccine against COVID-19, especially the severe and critical phenotypes. Such protectiveness is notable in the population  $\geq 60$  years.

Booster vaccination of COVID-19 vaccine has been implemented since the emergence of VOC Delta in the middle of 2021 and remarkably accelerated since the emergence of VOC Omicron globally. Heterologous vaccination of different types of vaccine has shown the advantage in the titers of serum neutralizing antibody and in the vaccine effectiveness against disease transmission and symptomatic disease in the real world. However, homologous vaccination has also revealed reliable vaccine effectiveness against COVID-19 (5,12–13). Similar to many areas in China, the inactivated vaccines manufactured by domestic pharmaceutical companies, mainly Sinovac and Sinopharm COVID-19 vaccine (Vero cell) inactivated, were predominantly used in Jilin City. It needs to be emphasized that all booster vaccinations in Jilin City were homologous vaccination with inactivated vaccine. The data in this report reveals the special significance in China and other countries with predominant usage of inactivated vaccine, that booster vaccination with

TABLE 1. The distribution of clinical severity phenotypes in different vaccination groups.

Age (years)	0+1 dose			2 doses			3 doses			Total (n)
	Moderate	Severe	Critical	Moderate	Severe	Critical	Moderate	Severe	Critical	
$\geq 60$	56 (68.3%)	18 (22.0%)	8 (9.8%)	33 (86.8%)	1 (2.6%)	4 (10.5%)	6 (85.7%)	1 (14.3%)	0 (0%)	127
$< 60$	30 (76.9%)	8 (20.5%)	1 (2.6%)	48 (92.3%)	4 (7.6%)	0 (0%)	23 (100%)	0 (0%)	0 (0%)	114
Total	86 (71.7%)	26 (21.5%)	9 (7.4%)	81 (90.0%)	5 (5.6%)	4 (4.4%)	29 (96.7%)	1 (3.3%)	0 (0%)	241

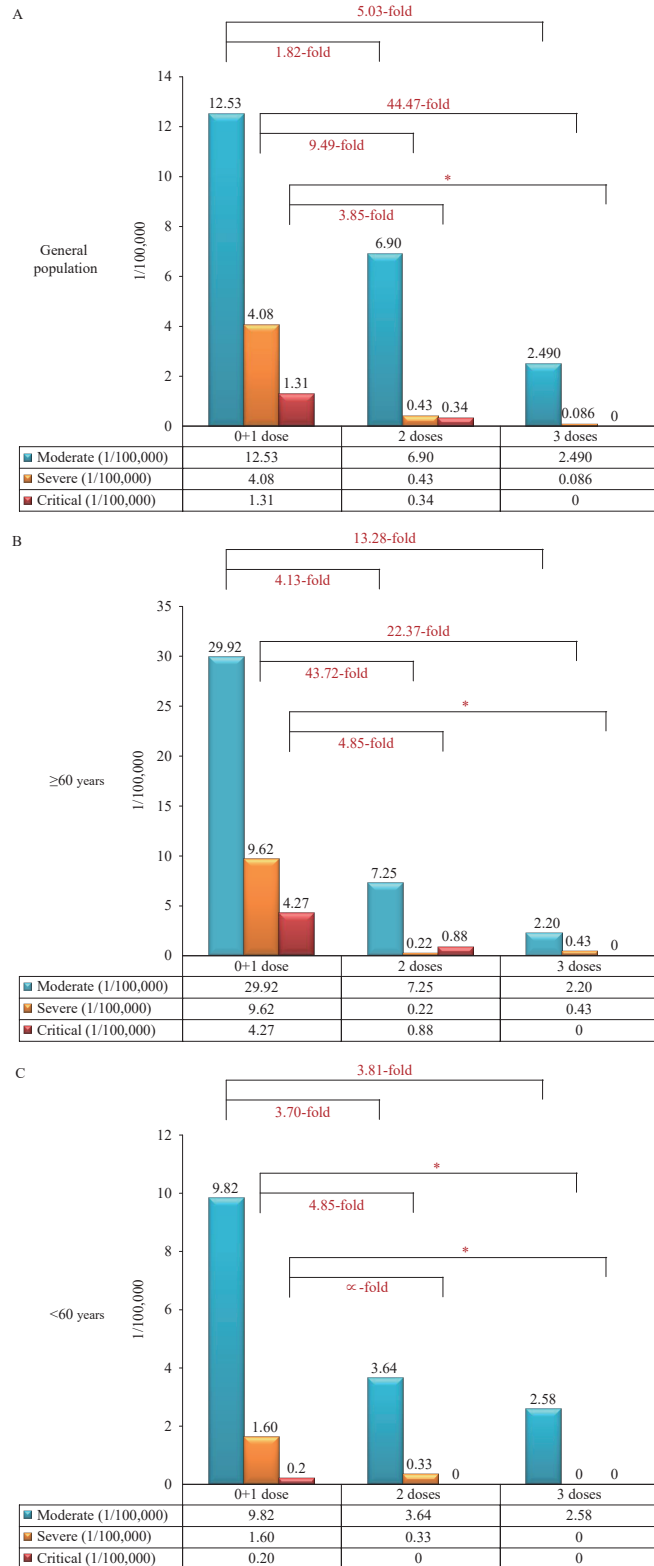


FIGURE 1. The incidences of COVID-19 in the groups of unvaccinated and partially vaccinated (0+1 dose), fully vaccinated (2 doses), and booster vaccinated (3 doses). (A) In the whole population; (B) the population ≥60 years; (C) the population <60 years.

Note: the X-fold changes in the incidence between groups are indicated.

Abbreviation: COVID-19=coronavirus disease 2019.

\* Uncalculatable as there are no cases in the group to be compared.

homologous inactivated vaccine can produce reliable protectiveness to COVID-19 caused by VOC Omicron.

Although the exact effectiveness of inactivated COVID-19 vaccines against transmission, asymptomatic, and mild COVID-19 of VOC Omicron BA.2 in Jilin City is still unexplored, preliminary protective data to COVID-19 here is strong enough to indicate the public significance of the strategy of full and booster vaccination, particularly for the elderly population who has markedly higher risk of having critical and fatal outcomes. Variation of SARS-CoV-2 seems to be inevitable and the impact of newly emerged variants on transmission, immunity, and severity is also unpredictable. Booster vaccination, either homologous or heterologous, probably repeatedly, may be one of the limited specific interventions for relief of the impact of COVID-19 in the future.

This study was subject to some limitations. The preliminary real-world analysis here was a straightforward comparison of incidences of the 3 outcomes of COVID-19 during the outbreak in Jilin City from March 3 to April 12 by vaccination status. The analyses did not control for potential confounding variables, such as the presence of comorbidities and the time since vaccination, although the stratification by age group did provide some ability to control for subject age. Moreover, different antiviral medications, e.g., anti-serum from convalescent patients, antiviral monoclonal antibody, and the antiviral Paxlovid, were applied in clinical settings, which might affect the final outcomes. Further collection and analysis of the relevant data potentially affecting the vaccine effectiveness of those patients are deserved.

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## REFERENCES

1. National Health Commission of the People's Republic of China. The diagnosis and treatment protocol for COVID-19 patient (the 9th Edition, in Chinese). 2022. <http://www.nhc.gov.cn/zyygj/s7653p/202203/b74ade1ba4494583805a3d2e40093d88/files/ef09aa4070244620b010951b088b8a27.pdf>. (In Chinese). [2022-4-17].
2. Altarawneh HN, Chemaitelly H, Hasan MR, Ayoub HH, Qassim S, AlMukdad S, et al. Protection against the omicron variant from previous SARS-CoV-2 infection. *N Engl J Med* 2022;386(13):1288 – 90. <http://dx.doi.org/10.1056/NEJMc2200133>.
3. Suryawanshi RK, Chen IP, Ma TC, Syed AM, Brazer N, Saldhi P, et al. Limited cross-variant immunity after infection with the SARS-CoV-2 omicron variant without vaccination. *medRxiv* 2022. <http://dx.doi.org/10.1101/2022.01.13.22269243>.
4. Smith DJ, Hakim AJ, Leung GM, Xu WB, Schluter WW, Novak RT, et al. COVID-19 mortality and vaccine coverage - Hong Kong special administrative region, China, January 6, 2022-March 21, 2022. *MMWR Morb Mortal Wkly Rep* 2022;71(15):545 – 8. <http://dx.doi.org/10.15585/mmwr.mm7115e1>.
5. Magen O, Waxman JG, Makov-Assif M, Vered R, Dicker D, Hernán MA, et al. Fourth dose of BNT162b2 mRNA COVID-19 vaccine in a nationwide setting. *N Engl J Med* 2022. <http://dx.doi.org/10.1056/NEJMoa2201688>.
6. European Centre for Disease Prevention and Control. SARS-CoV-2 variants of concern as of 7 April 2022. <https://www.ecdc.europa.eu/en/COVID-19/variants-concern>. [2022-4-17].
7. Kawaoka Y, Uraki R, Kiso M, Iida S, Imai M, Takashita E, et al. Characterization and antiviral susceptibility of SARS-CoV-2 Omicron/BA.2. *Res Sq* 2022. <http://dx.doi.org/10.21203/rs.3.rs-1375091/v1>.
8. Plumb ID, Feldstein LR, Barkley E, Posner AB, Bregman HS, Hagen MB, et al. Effectiveness of COVID-19 mRNA vaccination in preventing COVID-19-associated hospitalization among adults with previous SARS-CoV-2 Infection - United States, June 2021-February 2022. *MMWR Morb Mortal Wkly Rep* 2022;71(15):549 – 55. <http://dx.doi.org/10.15585/mmwr.mm7115e2>.
9. Temsah MH, Aljamaan F, Alenezi S, Alhasan K, Alrabiaah A, Assiri R, et al. SARS-CoV-2 omicron variant: exploring healthcare workers' awareness and perception of vaccine effectiveness: a national survey during the first week of WHO variant alert. *Front Public Health* 2022;10:878159. <http://dx.doi.org/10.3389/fpubh.2022.878159>.
10. Lusvarghi S, Pollett SD, Neerukonda SN, Wang W, Wang R, Vassell R, et al. SARS-CoV-2 BA variant is neutralized by vaccine booster-elicited serum, but evades most convalescent serum and therapeutic antibodies. *Sci Transl Med* 2022:eabn8543. <http://dx.doi.org/10.1126/scitranslmed.abn8543>.
11. Rajpal VR, Sharma S, Kumar A, Chand S, Joshi L, Chandra A, et al. 'Is Omicron mild'? Testing this narrative with the mutational landscape of its three lineages and response to existing vaccines and therapeutic antibodies. *J Med Virol* 2022. <http://dx.doi.org/10.1002/jmv.27749>.
12. Natarajan K, Prasad N, Dascomb K, Irving SA, Yang DH, Gaglani M, et al. Effectiveness of homologous and heterologous COVID-19 booster doses following 1 Ad.26.COV2.S (Janssen [Johnson & Johnson]) vaccine dose against COVID-19-associated emergency department and urgent care encounters and hospitalizations among adults - VISION network, 10 States, December 2021-March 2022. *MMWR Morb Mortal Wkly Rep* 2022;71(13):495-502. <http://dx.doi.org/10.15585/mmwr.mm7113e2>.
13. Glatman-Freedman A, Bromberg M, Hershkovitz Y, Sefty H, Kaufman Z, Dichtiar R, et al. Effectiveness of BNT162b2 vaccine booster against SARS-CoV-2 infection and breakthrough complications, israel. *Emerg Infect Dis* 2022;28(5):948 – 56. <http://dx.doi.org/10.3201/eid2805.220141>.