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Letter to the Editor

Adjusted control rate closely associated with the epidemiologic evolution of the recent COVID-19 wave in Shanghai, with 94.3% of all new cases being asymptomatic on first diagnosis



Abbreviations

ADNC	adjusted daily new cases
TAC	transformed asymptomatic cases
ACR	adjusted control rate

A prospective contact-tracing study¹ previously published in *Journal of Infection* showed that COVID-19 caused by SARS-CoV-2 could be rapidly and efficiently transmitted from asymptomatic cases during the incubation period, demonstrating strong infectivity, and that COVID-19 developed in younger people had fast onset and nonspecific atypical manifestations much milder than in older patients. Close to the end of February, and right before the start of spring in 2022, a wave of COVID-19 emerged and quickly spread in Shanghai, China, with a population of 24.9 million. Based on data from the Shanghai Municipal Health Commission (<https://wsjkw.sh.gov.cn/yqfk2020/>), as of June 20, 2022, a total of 627,116 cases have been infected, including 591,511 (94.3%) asymptomatic carriers and 35,605 (5.7%) symptomatic cases on first diagnosis; 22,515 (3.8%) asymptomatic carriers on first diagnosis transformed to symptomatic cases during the later disease course; SARS-CoV-2 has directly or indirectly caused 588 deaths, with a raw case fatality rate of 0.1% in all positive cases, 1.0% in all symptomatic cases including those transformed from asymptomatic carriers on first diagnosis, and 1.7% in symptomatic cases on first diagnosis. It is deducible that without strict and comprehensive control measures, more cases may have died. The BA.2.2 sub-lineage of the omicron variant of SARS-CoV-2 (B.1.1.529)^{2–5} with an R0 of 9.5 was identified as the culprit for this COVID-19 wave, while worldwide it only comprises a minor proportion of BA.2 (0.3% in the GISAID database); the feature mutations of BA.2.2 was not significantly associated with disease severity.⁶ With the implementation of strict and comprehensive public health measures with unprecedented joint efforts including largescale SARS-CoV-2 RNA and antigen testing for early diagnosis, timely quarantine of infected cases and tracing of close contacts, construction of shelter hospitals of different sizes in different locations, and lockdown of places with severe outbreaks, the situation has currently been well under control. The zero COVID-19 policy is operational in, and rather unique to China, as it is no longer employed in other countries. Dynamic zero COVID-19 community transmission was first achieved on April 29, 2022, and the number of daily new cases has now dropped to only 9, as of June 20, 2022 (Fig. 1). Resumption to normal life and work has been ongoing gradually and orderly.

Looking into the epidemiologic evolution of the omicron wave, several intriguing aspects are noteworthy. The numbers of new

cases by date are distributed in an almost symmetric manner, with the symmetry axis on April 13, 2022 when the number of adjusted daily new cases (ADNC; the number of reported new cases minus the number of transformed asymptomatic cases (TAC), define as symptomatic cases deriving from previously identified asymptomatic cases) peaked at 27,605 (Fig. 1A). From April 7 when the ADNC first surpassed 20,000, there existed a significant number (Fig. 1B) and proportion (Fig. 1C) of TAC, and the number remained at a high level until May 1, 2022, and first dropped to below 50 on May 15, 2022. To control COVID-19, it would be important to early identify and quickly quarantine all newly infected cases, and the cases diagnosed in people not undergoing quarantine may indicate community transmission and pose a great challenge to COVID-19 control. The number of newly identified non-quarantined cases peaked at 1364 on April 2, 2022, 11 days before the peak day of new cases, and was also distributed almost symmetrically (Fig. 1D). The control rate, which is defined as the proportion of new cases identified in quarantined people relative to all new cases, may be closely associated with the evolution of the COVID-19 wave, and the adjusted control rate (ACR) with removal of transformed asymptomatic cases in all new cases may be an even more robust indicator (Fig. 1E). During the initial phase of this wave, the ACR dropped to 40.4% on March 17, 2022, and then quickly returned to 88.9% on March 20, 2022, after which the ACR remained fluctuating until April 3, 2022 with the number of ADNC of 8935. Since April 4, 2022, when the ADNC number (13,350) first surpassed 10,000 (which might be associated with more comprehensive quarantine measures), the ACR increased in an almost linear manner until 100.0% with the first dynamic zero COVID-19 community transmission achieved on April 29, 2022, 16 days after the peak day of new cases (the peak day was 9 days after the start of this period) and 2 days after the first day with the number of ADNC first returning to below 10,000 (Fig. 1F). The period April 4 to 29, 2022 might represent an extremely important and critical period with numerous joint efforts and comprehensive control interventions which efficiently blocked the exacerbation of the wave and brought the situation under control. Between April 30 and June 1, 2022, the ACR remained nearly 100.0% with zero new cases identified in the non-quarantined community through repeated SARS-CoV-2 screening, and the number of ADNC first dropped to below 100 on May 29, 2022, and further decreased to only 10 on June 1, 2022, when people in Shanghai started to resume to normal activities. Between June 2 and 12, 2022, the ACR fluctuated largely (45.5% to 100.0%), and the number of ADNC returned to 36 on June 12, 2022. From June 13 until 20, 2022, the fluctuation degree of the ACR became smaller, with the number of new cases identified in non-quarantined people ranging between 0 and 3. Currently, proof of negative SARS-CoV-2 RNA test within 2 or 3 days is a necessity for using public transport and entering certain public places, and there are many fixed points offering free SARS-CoV-2 RNA tests, the re-

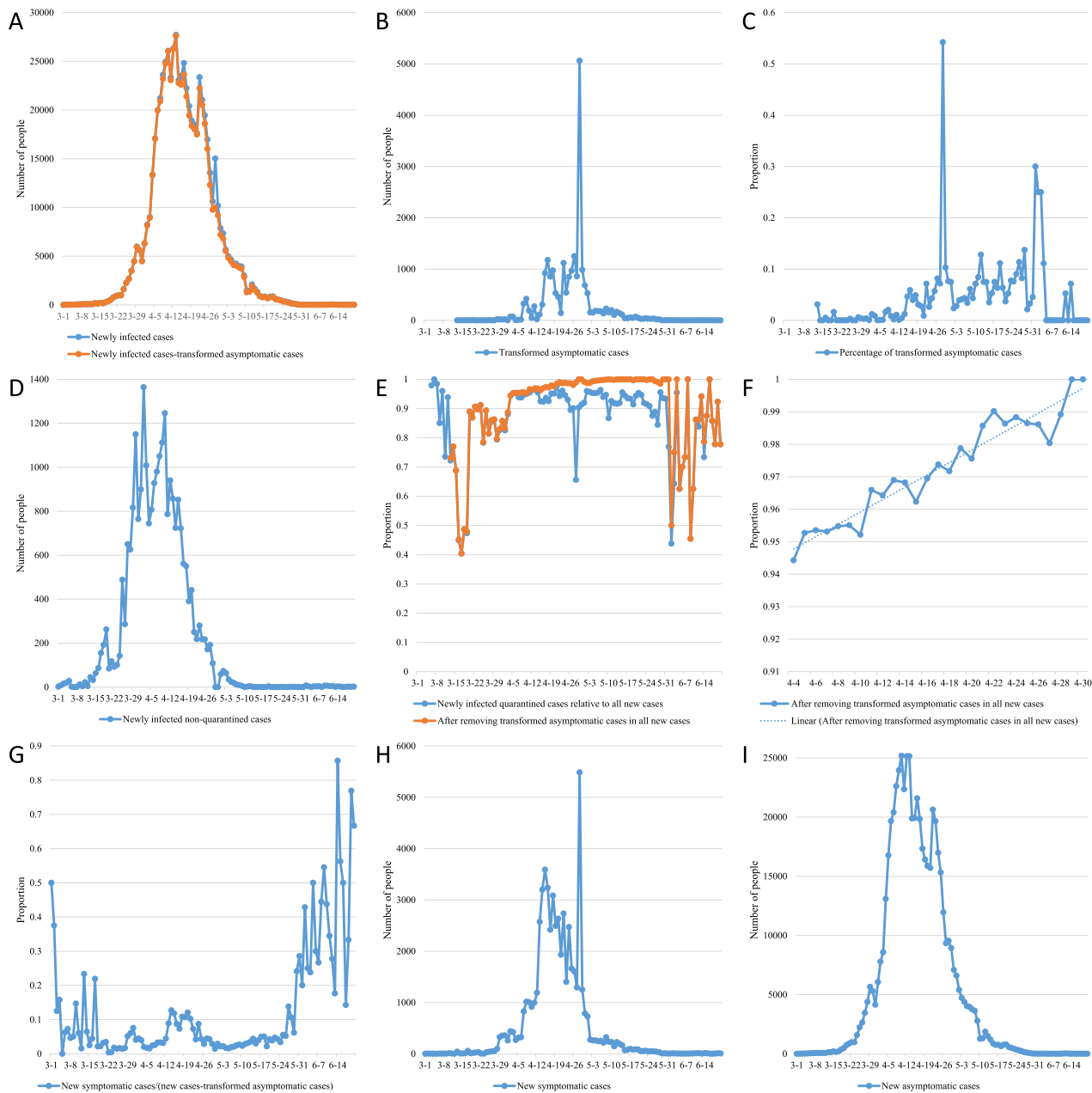


Fig. 1. Epidemiologic dynamics of the recent omicron wave in Shanghai, China, as of June 20, 2022. (A) Numbers of reported raw and adjusted (after removing transformed asymptomatic cases) cases by date; (B) Number of transformed asymptomatic cases by date; (C) Percentage of transformed asymptomatic cases by date; (D) Number of newly infected cases in non-quarantined people by date; (E) Numbers of raw and adjusted (after removing transformed asymptomatic cases) proportions of new cases identified in quarantined people relative to all new cases by date; (F) Adjusted proportion of newly infected quarantined cases by date between April 4 and 30, 2022 with linear regression; (G) Adjusted proportion of new symptomatic cases by date; (H) Number of new symptomatic cases by date; (I) Number of new asymptomatic cases by date.

sults of which could usually be returned on the same day. This ensured active dynamic COVID-19 surveillance with large coverage during people resuming to normal activities. Notably, from time to time positive cases could still be detected in the non-quarantined community, indicating the possibly continuing risk of community transmission. The majority (94.3%) of newly diagnosed cases were asymptomatic, based on thorough, repeated, and combined SARS-CoV-2 RNA and antigen screening. Between April 4 and 26, 2022, when the ADNC number were above 10,000, the adjusted proportion of new symptomatic cases ranged between 1.5% and 12.7% (Fig. 1G). Except the outlier, the number of daily new symptomatic cases peaked at 3590 on April 15, 2022 (Fig. 1H), and the num-

ber of new asymptomatic cases were highest (25,173) on April 10, 2022 (Fig. 1I).

Together, this report on the recent omicron wave in Shanghai with some new concepts like ACR proposed may provide important epidemiologic dynamics data as useful hints and references for COVID-19 prevention, surveillance, and control. The zero COVID-19 policy is operational in, and now unique to China. Still, besides vaccination, timely, powerful, precise, stratified, and dynamic prevention and control measures including the One Health approach are greatly warranted to effectively and efficiently control the COVID-19 pandemic.^{1,7-10}

Author' contributions

Conception or design: Huang L. Acquisition, analysis, or interpretation of data: Huang L. Drafting of the manuscript: Huang L. Critical revision of the manuscript for important intellectual content: Huang L. Statistical analysis: Huang L. Administrative, technical, or material support: Huang L. Huang L has approved the current version of the manuscript for submission and publication.

Declaration of Competing Interest

None exist.

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Data sharing

The data for this study are publicly available in the Shanghai Municipal Health Commission website (<https://wsjkw.sh.gov.cn/yqfk2020/>).

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