these methods; cell culture or other viability tests are needed when investigating outbreaks.

In conclusion, community-acquired pneumonia is not only caused by *Chlamydia pneumoniae*, a known respiratory chlamydial pathogen in humans, but also by zoonotic infections due to *C psittaci*, avian and mammalian strains of *C abortus, C caviae*, and *Chlamydia pecorum*, another ruminant chlamydial species.[10]

I declare no competing interests.

Nicole Borel
nicole.borel@uzh.ch

National and international Reference Laboratory for Ovine Chlamydiosis, Institute of Veterinary Pathology, University of Zurich, CH-8057 Zurich, Switzerland

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COVID-19 immunisation strategies for adolescents


Getty Images/Jordi Salas

Published **Online** September 24, 2024 https://doi.org/10.1016/S1473-3099(24)00563-2

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With ongoing genetic and antigenic evolution of the SARS-CoV-2 spike protein, the primary circulating variants are currently the omicron subvariants JN.1, KP.3, and LB.1.1.[1] The effect of COVID-19 on adolescents has become increasingly evident as the pandemic progressed. Although early data indicated that clinical symptoms in adolescents were relatively mild, the spread of omicron and delta variants has led to a significant increase in adolescent hospitalisation rates.[2] Due to prioritising adults with underling conditions and the elderly as the primary target groups for COVID-19 vaccination, research on vaccination strategies for adolescents has lagged behind that for adults, also resulting in a lower vaccination rate among adolescents than adults.[3] Given that most adolescents are students engaging in dense social activities, frequent social interactions, and having potentially insufficient awareness of personal protective measures, they might contribute to the rapid transmission of the virus within a population. Therefore, investigating the safety and immunogenicity of the omicron variant vaccine in adolescents is crucial to formulate the public health strategies.

In *The Lancet Infectious Diseases*, Amparo L Figueroa and colleagues[4] reported on the safety and immunogenicity of a single-dose bivalent COVID-19 vaccine mRNA-1273.222 (Wuhan-Hu-1 [ancestral strain D614G] and omicron subvariants BA.4 and BA.5) in adolescents aged 12–17 years in an open-label, single-arm trial (part 3 of TeenCOVE; NCT04649151). In this trial, vaccine-naive adolescents who were SARS-CoV-2 positive received at least one dose of mRNA-1273.222 (50 µg) compared with SARS-CoV-2-negative young adults (aged 18–25 years) who received two doses of monovalent ancestral stain vaccine mRNA-1273 (100 µg) in the COVE trial (NCT04470427).[5] The safety analysis included 379 adolescents, revealing that the most solicited adverse events were grade 1 or 2, with no new safety concerns identified. The immunogenicity data were collected from 245 participants in this study. A single-dose of mRNA-1273.222 induced superior neutralising antibody (nAb) responses against BA.4 and BA.5 (geometric mean ratio [GMR] 95% CI lower bound >1; GMR 48·95 [95% CI 44·21–54·21]) and non-inferior nAb responses against ancestral SARS-CoV-2 (GMR 95% CI lower bound >0·667; GMR 4·25 [95% CI 3·69–4·88]) in SARS-CoV-2-positive adolescents, compared with the mRNA-1273 primary series in young adults. Although the antigen content of the mRNA-1273.222 vaccine was halved, it could induce similar nAb responses against the ancestral strain as mRNA-1273, partly due to the previous SARS-CoV-2 infection history among participants. Additionally, mRNA-1273.222 induced robust antibody titres

(geometric mean concentration [GMC]: 2771·0 [95% CI 2500·8–3070·3]) against the BA.4 and BA.5 variant. In summary, this omicron-containing mRNA-1273.222 vaccine showed favourable safety and immunogenicity in the adolescents.

Besides part 3 of the trial, in the TeenCOVE trial, researchers previously reported the safety, reactogenicity, and immunogenicity of mRNA-1273 (100 µg) as a two-dose primary series (parts 1A and 1B) and mRNA-1273 (50 µg) as a booster dose (part 1C) in healthy adolescents aged 12–17 years,[6,7] and part 2 of the trial was an open-label study that assessed the mRNA-1273 (50 µg) two-dose primary series in healthy adolescents. Combined with part 3 of the trial, the TeenCove trial studied the safety and immunogenicity of both monovalent ancestral strain and omicron-containing bivalent vaccines in adolescents. With more clinical trial results on COVID-19 vaccines for adolescents become available, they will help refine immunisation strategies for adolescents, potentially reducing vaccine hesitancy and improving vaccination rates among this group.

As the COVID-19 pandemic enters a new phase, vaccine antigen components and immunisation strategies are continually updated. Starting in May, 2023, WHO recommended the use of monovalent circulating variant vaccines to avoid the potential reduction in immune response to the circulating variants due to repeated exposure to the original strain and to mitigate the effect of lower target antigen concentration in bivalent vaccines.[8] However, clinical trials of monovalent omicron-variant vaccines in adolescents are still scarce. Whether the monovalent omicron variant vaccine is more immunogenic than the bivalent vaccine in adolescents will require additional data from relevant clinical trials. Compared with adults, clinical trials of COVID-19 vaccines in adolescents are delayed, particularly with updates involving omicron variants, delaying the implementation of new immunisation strategies for COVID-19 vaccines in adolescents. The rapid mutation cycle of SARS-CoV-2 and the complex epidemiological landscape make adolescent vaccination strategies outdated quickly. Although hospitalisation and mortality rates among adolescents are low,[9] the effect on academic performance, school management, and the increased risk of transmission to other groups exacerbate the societal burden.

Overall, effective implementation of immunisation strategies for adolescents is a crucial component in the prevention of COVID-19. It is time to accelerate the studies on COVID-19 vaccine immunisation strategies in adolescents and children to provide the necessary data for the catch-up of immunisation strategies against COVID-19.

We declare no competing interests.

*Wei-Xiao Wang, *Feng-Cai Zhu*
jszfc@vip.sina.com

National Vaccine Innovation Platform, School of Public Health, Nanjing Medical University, Nanjing, China (W-XW, F-CZ); Jiangsu Provincial Medical Innovation Center, National Health Commission Key Laboratory of Enteric Pathogenic Microbiology, Jiangsu Provincial Center for Disease Control and Prevention, Nanjing 210009, China (F-CZ)

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REVISITing treatment of metallo-β-lactamases

Published **Online** October 7, 2024 https://doi.org/10.1016/S1473-3099(24)00561-9

Metallo-β-lactamase enzymes, named because of the presence of one or two zinc ions at the catalytic site, are responsible for β-lactam antibiotic hydrolysis and are increasing in prevalence worldwide.[1] Despite the increase in antibiotic development over the past decade, a β-lactamase inhibitor that binds to