



Editorial

Herd immunity and vaccination of children for COVID-19



Recognized individual risk factors for a more severe clinical outcome of COVID-19 are age above 65 years and underlying comorbidities, such as obesity, chronic obstructive lung disease, and diabetes (Velavan and Meyer, 2020a; Velavan and Meyer, 2020b). While the frequency of severe cases and mortality among children are reported to be extremely low when compared with adults (Dong et al., 2020), transmission from children could be a significant contributor to the spread of SARS-CoV-2, as with other respiratory viruses. However, the relative importance of children in SARS-CoV-2 transmission is still unclear, in particular, whether asymptomatic children, those with low viral loads, and perhaps with prolonged viral shedding, play a significant role. Few studies describe children as index cases in familial clusters (Zhang et al., 2020; Zhen-Dong et al., 2020), and clearly, children more often have asymptomatic infections when compared with adults (Dong et al., 2020; Zhen-Dong et al., 2020; Bi et al., 2020). It is of urgent importance in modeling the pandemic to undertake careful surveillance, including asymptomatic children and rates of infection based on serology, to better characterize infection in children and their role in transmission networks.

Even if different control measures slow down, eventually stopping the local spread of COVID-19 disease, the successful suppression of this disease still leaves the population at risk of a resurgence due to insufficient acquisition of immunity. If herd immunity can be induced, it would act as a barrier to stop the spread of infection (Gomes et al., 2020). In addition to vaccines, variable susceptibility and exposure largely determine herd immunity. Vaccination of children to induce herd immunity has proven successful in preventing the spread of many infectious diseases, where children have a significant role in transmission. A high level of immunity in one age group, who play a role in transmission, can create herd immunity for others (Kim et al., 2011), and it is evident that immunization of children is more effective than vaccination of elderly people, in certain situations, as demonstrated in immunization against influenza (Kim et al., 2011; Kim, 2014), pneumococcal disease (Pittet and Posfay-Barbe, 2012), rotavirus (Lopman et al., 2012) and many others. It is noteworthy that the relative role of different age groups in transmission must be taken into account – for example, vaccination of adolescents and young adults prevents spread of meningococcal disease, but infants and toddlers must be targeted to induce herd immunity for pneumococcal and Hib disease, and school-age children for influenza transmission. Children may need protection as well,

since some become ill, although never severely. The indirect benefits of COVID-19 vaccination in children may provide or create some protection for older, unvaccinated populations. When children are vaccinated, it will be easier to achieve enough immunity needed for overall protection in a given population.

COVID-19 mortality is strongly age-dependent, and Africa has a comparably younger population than other continents (Mougini et al., 2020). Thus, children might be an important target for interventions aimed at reducing transmission in countries with young populations, especially since access through school immunization may be more straightforward than accessing adults. Although the priority for COVID-19 vaccination would logically be for those at the highest risk of infection, such as healthcare workers, and those at the highest risk of severe disease, such as older adults, vaccination of children may be another critical group for their own protection and to support herd immunity.

A multisystem inflammatory syndrome, similar to Kawasaki disease, has recently been recognized and may be associated with SARS-CoV-2 infection, perhaps as a post-infectious inflammatory syndrome. One-quarter of these cases may develop coronary vascular damage and other cardiac complications. As there is growing evidence of a link between a SARS-CoV-2 infection and this inflammatory syndrome (Verdoni et al., 2020), the condition should be included as a potential adverse event of special interest in vaccine studies. Although it is thought that some of the described cases do not have any evidence of an immune response to SARS-CoV-2, it is still unclear whether the phenomenon could be mediated by immune responses to novel vaccines.

Since children remain relatively unaffected by COVID-19 disease, it is vital to accrue substantial safety data among adults before initiating pediatric studies and to further understand the biology of the Kawasaki syndrome to inform the risk-benefit relationship for vaccination of children. Also, the efficacy trials in adults with disease endpoints would be relevant to confirm that new vaccines do not induce enhanced disease, when vaccinees are exposed to the virus in the community, as has been described in some animal models with previous coronavirus vaccines.

COVID-19 vaccine studies are essential to protect older adults from the disease, but to affect transmission at a large scale and achieve herd immunity, it may be necessary to obtain high population coverage with vaccines, including the pediatric population. COVID-19 vaccine trials in children will allow the development of evidence-based

vaccination policy and, combined with more robust data on the role of children in transmission, could greatly assist decision-making.

Vaccine developers must focus on the investigation of new COVID-19 vaccines among adults as the primary target population; however, we should not ignore children who are an important group in the population who may benefit from direct protection and play a key role in the overall immunity in the population.

Contribution statement

All authors have an academic interest and contributed equally. TPV is a member of the Pan African Network for Rapid Research, Response, and Preparedness for Infectious Diseases Epidemics consortium (PANDORA-ID-NET RIA2016E-1609).

Conflict of interest

The authors TPV and PGK disclose no conflict of interest. AJP is Chair of the UK Dept. of Health and Social Care's (DHSC) Joint Committee on Vaccination & Immunisation (JCVI) and is a member of the WHO's SAGE. AJP is an NIHR Senior Investigator. The views expressed in this article do not necessarily represent the views of DHSC, JCVI, NIHR, or WHO. AJP is the chief investigator on trials of a coronavirus vaccine, Chadox1 nCov19.

Funding source

The authors disclose no funding source.

Ethical approval

Not applicable

Acknowledgments

We acknowledge input on the manuscript from Vasee Moorthy representing The World Health Organization.

References

- Bi Q, Wu Y, Mei S, Ye C, Zou X, Zhang Z, et al. Epidemiology and transmission of COVID-19 in 391 cases and 1286 of their close contacts in Shenzhen, China: a retrospective cohort study. *Lancet Infect Dis* 2020;(April).
- Dong Y, Mo X, Hu Y, Qi X, Jiang F, Jiang Z, et al. Epidemiology of COVID-19 among children in China. *Pediatrics* 2020;145(June (6)).

- Gomes MG, Corder RM, King JG, Langwig KE, Souto-Maior C, Carneiro J, et al. Individual variation in susceptibility or exposure to SARS-CoV-2 lowers the herd immunity threshold. *medRxiv* 2020;2020(January).
- Kim TH. Seasonal influenza and vaccine herd effect. *Clin Exp Vaccine Res* 2014;3 (July (2)):128–32.
- Kim TH, Johnstone J, Loeb M. Vaccine herd effect. *Scand J Infect Dis* 2011;43 (September (9)):683–9.
- Lopman BA, Payne DC, Tate JE, Patel MM, Cortese MM, Parashar UD. Post-licensure experience with rotavirus vaccination in high and middle income countries; 2006 to 2011. *Curr Opin Virol* 2012;2(August (4)):434–42.
- Mougeni F, Mangaboula A, Lell B. The potential effect of the African population age structure on COVID-19 mortality. *medRxiv* 2020;2020(January).
- Pittet LF, Posfay-Barbe KM. Pneumococcal vaccines for children: a global public health priority. *Clin Microbiol Infect* 2012;18 Suppl 5(October):25–36.
- Velavan TP, Meyer CG. The COVID-19 epidemic. *Trop Med Int Health* 2020a;25 (March (3)):278–80.
- Velavan TP, Meyer CG. Mild versus severe COVID-19: laboratory markers. *Int J Infect Dis* 2020b;95(April):304–7.
- Verdoni L, Mazza A, Gervasoni A, Martelli L, Ruggeri M, Ciuffreda M, et al. An outbreak of severe Kawasaki-like disease at the Italian epicentre of the SARS-CoV-2 epidemic: an observational cohort study. *Lancet* 2020;(May).
- Zhang Y, Su X, Chen W, Fei CN, Guo LR, Wu XL, et al. [Epidemiological investigation on a cluster epidemic of COVID-19 in a collective workplace in Tianjin]. *Zhonghua Liu Xing Bing Xue Za Zhi* 2020;41(March (5)):649–53.
- Zhen-Dong Y, Gao-Jun Z, Run-Ming J, Zhi-Sheng L, Zong-Qi D, Xiong X, et al. Clinical and transmission dynamics characteristics of 406 children with coronavirus disease 2019 in China: a review. *J Infect* 2020;(April).

Thirumalaisamy P. Velavan^{a,b,c,*}

^a*Institute of Tropical Medicine, Universitätsklinikum Tübingen, Germany*

^b*Vietnamese-German Center for Medical Research, Hanoi, Viet Nam*

^c*Faculty of Medicine, Duy Tan University, Da Nang, Viet Nam*

Andrew J. Pollard
Oxford Vaccine Group, Department of Paediatrics, University of Oxford, NIHR Oxford Biomedical Research Centre, Oxford, UK

Peter G. Kremsner^{a,b}
^a*Institute of Tropical Medicine, Universitätsklinikum Tübingen, Germany*

^b*Centre de Recherches Medicales de Lambarene, Gabon*

* Corresponding author at: Institute of Tropical Medicine, University of Tübingen, Wilhelmstrasse 27, 72074 Tübingen, Germany.
E-mail address: velavan@medizin.uni-tuebingen.de (T. Velavan).

Received 15 June 2020