Malays J Pathol 2022; 44(2): 177 – 185

SPECIAL ARTICLE

COVID-19 vaccination for children in Malaysia - A position statement by the College of Paediatrics, Academy of Medicine of Malaysia

CHEAH Fook Choe[1]*, THONG Meow Keong[2], ZULKIFLI Ismail[3], ZILFALIL Alwi[4], AMIR HAMZAH Abdul Latiff[5], Patrick CHAN Wai Kiong[6], Erwin KHOO Jiayuan[7], NORAN Naqiah Hairi[8]

[1]Department of Paediatrics, Universiti Kebangsaan Malaysia Medical Centre; [2]Department of Paediatrics, University Malaya Medical Centre; [3]KPJ Healthcare University College; [4]Human Genome Centre, School of Medical Sciences Universiti Sains Malaysia; [5]Allergy and Immunology Centre, Pantai Hospital Kuala Lumpur; [6]Gleneagles Hospital Kuala Lumpur; [7]Department of Paediatrics, Centre for Bioethics and Humanities, International Medical University; [8]Department of Social & Preventive Medicine, Faculty of Medicine, Universiti Malaya

Professor Dr Cheah Fook Choe is the Chairperson of the Position Statement Writing Group, and the vice-President, College of Paediatrics, Academy of Medicine of Malaysia. Professor Dr Thong Meow Keong is the President, College of Paediatrics, Academy of Medicine of Malaysia.

Abstract

The availability of COVID-19 vaccines and mass vaccination programmes in adults have significantly reduced the case attack rates and disease burden. COVID-19 vaccination successfully decreases the population at risk of infection, allowing for the safer re-opening of economies and reducing the pandemic's crippling impact on healthcare systems. However, the rapidly mutating severe acute respiratory syndrome-coronavirus-2 poses challenges in diminishing vaccine-induced immunity and vaccinating a significant proportion of adults to achieve herd immunity. These challenges necessitated adolescent vaccination. With the recent emergence of the highly transmissible Omicron variant and the increasing COVID-19 hospitalisation rates of children below 12 years old, many countries opted to also vaccinate younger children. Phase II/III clinical trials and real-world experience demonstrate that COVID-19 vaccinations are effective and safe for younger children and adolescents. Before Malaysia introduced its national COVID-19 vaccination programme for children 5-11 years old (which ran between March and June 2022), an expert advisory statement was issued by the College of Paediatrics, Academy of Medicine of Malaysia, to highlight the benefits and importance of vaccinating children. The advisory statement included clarifications about vaccine-related side effects such as post-vaccination myocarditis and allergic reactions to encourage informed decision making by healthcare providers and parents. This paper, which was prepared based on the critical appraisal of the current evidence, evaluation of the international experiences and the positive impact of COVID-19 vaccination in children, collectively sums up the rationale to support and ensure the success of the nationwide vaccination programme for children. Hence, the College recommends COVID-19 vaccination for children in Malaysia.

Keywords: SARS-CoV-2, MIS-C, myocarditis, anaphylaxis, mRNA vaccine, COVID-19, vaccination

INTRODUCTION

The College of Paediatrics, Academy of Medicine of Malaysia, with the collaborative efforts of various experts from the different paediatric sub-specialities and public health, developed this position statement based on available evidence supporting the move towards vaccinating children against coronavirus disease 2019 (COVID-19). Although the disease may appear generally mild in children, the consequences of infection in unvaccinated children may be serious, debilitating and include various ill-defined long-term complications.

**Address for correspondence*: Professor Dr Cheah Fook Choe, Department of Paediatrics, Universiti Kebangsaan Malaysia Medical Centre. Tel: +60-3-91455391 Fax: Nil E-mail: *cheahfc@ppukm.ukm.edu.my*

These are largely avoidable with vaccination and advantageous against the lesser risk of recognised side effects inherent with vaccines. These recommendations are developed from reviews of current published literature, expert opinions and clinical observations that incorporate the local socio-cultural context.

The shifting trend of COVID-19 infections in children

The successful rollout of mass vaccination in Malaysia among adults and adolescents 12-17 years saw a marked reduction in severe COVID-19 cases and hospitalisation, alleviating the strained medical services in the country. Although younger children were relatively spared during the initial phases of the pandemic, the emergence of the severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) Delta and the current Omicron variants have rapidly increased the infection rates in unvaccinated children. Many of these children are developing severe disease requiring hospitalisation.[1-3]

The Omicron variant is highly transmissible, raising significant concerns about a new wave of SARS-CoV-2 infections globally. In some countries, COVID-19 cases double every 1.5-3 days,[4] with reports showing a surge of COVID-19 infections, particularly among children.[5-7] It has been observed that children infected with the Omicron variant have a 20% greater hospitalisation risk than the Delta variant.[5] In contrast to the lower numbers of adult hospitalisations, paediatric admissions in the United States of America (USA) during the final week of December 2021 increased by 48%. Children infected by the Omicron variant generally present with body aches and tiredness,[8] or symptoms mimicking a cold or flu lasting for three days.[9] This is unlike the more defined presenting symptoms with the earlier variants, i.e. fever, cough, gastrointestinal symptoms (diarrhoea, nausea/vomiting) or loss of smell or taste.[9-11] Although the Omicron variant has a lower risk of hospitalisation among adults,[12] the clinical severity and disease spectrum of this variant in children is still ill-defined at this stage, i.e. if the extent of organ involvement and complications are milder or more severe than the earlier variants such as Delta.[13]

The experience with the Delta variant affecting children who later developed the multisystem-inflammatory syndrome in children (MIS-C) highlights a pressing situation as it could potentially cause a significant impact in tandem with the rising Omicron infections. Paediatric intensive care unit (PICU) admissions with the Delta variant increased by 11-fold, with a high proportion of cases manifesting cardiac involvement.[14] The long-term effects of MIS-C in this cohort of children are still unknown even though most had recovered with treatment.[14,15] Furthermore, the COVID-19-related mortality among children in Malaysia increased. In 2020, there were six deaths involving children (0-17 years old), but from July to December 2021, the number surged more than 15-fold to 105 deaths.[16]

Some risk factors may be associated with more severe disease, such as obesity, chronic neurological conditions or chronic lung disease other than asthma, and pre-existing cardiac conditions.[17,18] Even without clearly identified risk factors or comorbidities, an unvaccinated child is still at risk of COVID-19 and could potentially develop complications and succumb.

Emerging reports indicate that paediatric hospitalisations involve predominantly unvaccinated or under-vaccinated children (having received only one dose),[5,13] or those living in households with unvaccinated adults.[7] With universal vaccination coverage almost achieved among the adult and adolescent populations, younger children will become more 'exposed' and susceptible to COVID-19 until they receive similar protection.

Implementation of vaccination programmes for children

As of November 2021, more than 100 countries have planned to expand COVID-19 vaccinations to children, starting with adolescents 12–17 years old.[19] Since then, many countries in the Asia-Pacific region have started mass vaccination for adolescents, including Malaysia. Countries like Singapore, Japan and Australia have commenced or are preparing to vaccinate younger children (5-11-years).[20] The national COVID-19 immunisation for 5-11-year-olds started on the 7th of March 2022 and continued until June 2022. Though the Sarawak State government had reported plans to vaccinate younger children from 3 years old like in Bahrain and China, this has not been rolled out yet. Cuba reportedly will vaccinate children aged 2 years and above.[19] The USA recently started vaccinating children from 6 months old to 5 years old.[20]

The age eligibility for vaccination, dosing-booster schedules and type of vaccines used, vary between countries. Nevertheless, immunised protection derived from a country's chosen national schedule is better than no vaccination. Vaccination reduces the number of infections and diminishes the disease burden from severe illness and complications. This is reflected by the declining number of COVID-19 cases, hospitalisations and deaths among the vaccinated adult population. In the USA, the vaccination of more than 700,000 children showed a significant reduction in positive cases.[2] In Malaysia, the emergence of the Delta variant resulted in a surge of COVID-19 infections among Malaysian children, with more than 300,000 cases by the end of August 2021, i.e. 25-fold greater than the whole of 2020.[22] However, with the implementation of the adolescent vaccination programme, the case numbers involving 12-17-year-olds reduced markedly, whilst the numbers among children below 12 years old remained high.[16]

Despite the positive impact of vaccination, its uptake was curtailed by concerns about the reported post-mRNA vaccination myocarditis in adolescents. In a reactive response, some countries, such as Hong Kong, resorted to a single dose rather than a two-dose vaccine schedule as a higher incidence rate of post-vaccination acute myocarditis/pericarditis was observed among the adolescent age group, especially after the second dose. However, these cases were mild, requiring only conservative management.[23,24] Studies are needed to determine if the omission of the second dose results in a significant reduction in post-vaccination myocarditis without compromising the level of protection against COVID-19.

Besides Hong Kong, a single dose regime was also initially offered to children aged 12-15 years old in the United Kingdom. However, the recommendation has been updated to a two-dose schedule as more evidence has emerged to indicate (a) the less than substantial risk of myocarditis compared to that arising from infection and (b) the increased efficacy required to overcome the Omicron variant.[25,26]

The importance of vaccinating children: Impact beyond physical health

Vaccinating children against COVID-19 has direct and indirect benefits. In protecting against SARS-CoV-2 infection and COVID-19-related complications such as the risk of severe disease, MIS-C and long COVID-19, vaccines will indirectly reduce the overall disease burden of hospitalisation, intensive care use, and mortality.

COVID-19 has also negatively impacted children's intellectual and emotional development and mental health.[27] The implementation of multiple lockdowns during this pandemic has resulted in increased cases of anxiety, depression, irritability and inattention.[28,29] The negative impact on emotional health also affects their overall physical well-being. In the USA alone, the childhood obesity rate among 2-19-year-olds experienced a 2-fold increase in the reported body mass index every month during this pandemic.[30] The rise in the obesity rate was linked to school closures, increased stress and less opportunity for physical activity.

The benefits of the vaccination of children include more freedom from movement restrictions and allowing children to return to a safer school environment. At the same time, it may reduce community transmission and the threat of intermittent school closures. It is recognised that children of all ages, when infected, may spread the virus to others.[31-33] Thus, vaccination decreasing COVID-19 transmission within this age group will mitigate in-school transmissions and reduce transmission to adults. Parents would also be more reassured in sending their vaccinated children to school, especially if other children are vaccinated. Indirectly, these measures will benefit the economy as the work productivity of parents, and other family members will not be disrupted due to being quarantined or needing to take care of a child testing positive for COVID-19.[34]

Vaccination not only reduces the risk of infection and disease severity but also the magnitude of the viral load in breakthrough infections. It has been shown that breakthrough infections in fully vaccinated individuals have up to a 40% lower viral load and faster viral clearance than unvaccinated individuals.[35,36] This lowers the risk of transmission and the potential for developing new viral mutations.

Although vaccination is protective, preventive measures such as physical distancing, hand hygiene and masking up in confined spaces should continue as public health mitigation and containment efforts.

Vaccines for children

The SARS-CoV-2 virus is still evolving[37], highlighting the importance of ensuring that the population across the age groups, including children, are protected with vaccination.

Emerging evidence continues to reveal the efficacy and safety of vaccinating children.[20]

In the context of efficacy and safety data, vaccine selection should be based on published studies from sufficiently powered clinical trials of at least Phase II. Local health and regulatory agencies empowered to approve vaccines base their decision-making process on currently available evidence. Vaccine approvals may be revised as new data on the types of vaccine, age eligibility, the number of doses, and the need for boosters emerge. Some examples of COVID-19 vaccines available are listed in Table 1. At the time of this publication, the vaccines currently approved in Malaysia for children are the Pfizer-BioNTech mRNA, and the Sinovac inactivated virus vaccines.

mRNA vaccine – The Pfizer-BioNTech vaccine schedule consists of two 10 μg doses (in contrast to a 30 μg dose for ages 12 years and above) administered 21 days apart. The Phase I dose-identification study for this vaccine indicated that the immune response from the 20 μg dose and 10 μg dose was not significantly different. Hence, the lower dose was chosen for use in children 5-11 years old.[42]

Contrary to many public misconceptions, the mRNA vaccine is not a DNA vaccine. mRNA vaccines are developed using the nucleoside-modified messenger RNA platform containing the SARS-CoV-2 spike protein genetic code. They are formulated in lipid nanoparticles that act as its vehicle. The concept of the mRNA vaccine is to use the viral genetic code to train the human immune system to specifically target the spike protein on the surface of the SARS-CoV-2 virus.

Once the code is presented to the dendritic cells, it is absorbed and translated intracellularly within the cytoplasm (not the nucleus) to express the targeted spike protein. This triggers the production of immune cells and antibodies. The mRNA degrades and is cleared from the body within a few days.[43] Hence, there is no plausibility of genetic modification of the host caused by utilising an mRNA vaccine.

A drawback to vaccination is that the host immunity against the virus wanes with viral mutations that change the configuration of the targeted spike proteins. The Pfizer-BioNTech vaccine has shown a reduced efficacy against infections with the Omicron variant in individuals who have had two doses, suggesting that booster doses may be required.[44]

Concerns and cautionary advice in vaccinating children

Post-mRNA vaccination myocarditis

Reports of a possible association between

Table 1: The types and examples of COVID-19 vaccines

Vaccine type	Manufactured by	Remarks
mRNA vaccines	• Pfizer-BioNTech • Moderna	• Pfizer-BioNTech and Moderna vaccines have been approved for use for children from 6 months and above with demonstrated efficacy and safety.[20]
Inactivated virus vaccine	• Sinovac	• The vaccine has been tested in children as young as 3 years old in Phase I/II studies, showing non-inferiority compared to vaccinating adults.[38] • More evidence from larger Phase III studies is needed to determine its efficacy in children.
Viral vector vaccines	• AstraZeneca • CanSino Biologics • Johnson & Johnson • Sputnik V/M	• AstraZeneca – Indicated for ages 18 years and above • CanSino Biologics – Trials are ongoing for children 6-17 years old. • Johnson & Johnson – Indicated for ages 18 years and above. • Sputnik V – Indicated for adults; Sputnik M for children 12-17 years old is pending registration.[39]
Protein subunit vaccine	• Novavax	• Granted conditional marketing authorisation by the European Medicines Agency and emergency use by the World Health Organization.[40,41] • Indicated for ages 18 years and above.

COVID-19 vaccination and post-mRNA vaccination myocarditis have triggered concerns among healthcare providers and parents. However, the risk of developing myocarditis from COVID-19 is 16-times higher than with the mRNA vaccine.[45] The reported incidence of vaccine-related myocarditis was low among children 12-17 years, i.e. 4.2 cases per million doses in females and 32.4 cases per million doses in males.[46] Post-vaccination myocarditis appears to primarily affect male adolescents >16 years old, particularly after the second dose. Affected individuals made a quick recovery[26] as this adverse event was generally self-limiting and treated conservatively.[23] The Centers for Disease Control and Prevention (USA) published the safety profile of 8.7 million doses of the Pfizer-BioNTech COVID-19 vaccine given to children 5-11 years old, reporting predominantly local or systemic reactions with only 11 cases of non-fatal myocarditis.[47] Furthermore, the Malaysian vaccine safety study (Case-Based Monitoring of Adverse Events Following COVID-19 vaccination [SAFECOVAC – NMRR-21-822-59745]) involving data from 433,674 hospital admissions from 216 public and private hospitals between February and September 2021 showed that a total of 25 myocarditis events were observed within 21 days of COVID-19 vaccination.[48] Of these, 14 were related to the Pfizer-BioNTech mRNA vaccine, nine to the CoronaVac vaccine and two to the Astra-Zeneca vaccine. In line with global data, the SAFECOVAC findings indicate that post-vaccination myocarditis events are rare and that most cases were mild, self-limiting, and spontaneously resolved. Cumulative observations to date conclude that the myocarditis post-vaccination behaves differently from the typical post-infectious viral myocarditis, the latter being more severe, resulting in higher mortality.

Allergy to vaccines

All vaccines have the potential to cause an allergic reaction. Allergy to the mRNA-based vaccine is a reaction to the polyethylene glycol (PEG), a stabiliser used in nanomedical formulations.[49] The reported cases of severe anaphylactic reactions post-mRNA vaccines are marginally higher than that reported for influenza vaccines (4.7 cases per million doses vs 1.3 cases per million doses).[49]

The mRNA vaccine is contraindicated in individuals with a history of anaphylaxis to PEG-containing substances and unexplained recurrent anaphylaxis to unidentified injectable medications. Alternatives such as inactivated vaccines may be used in such situations. mRNA vaccines can nonetheless be given to children with a previous history of allergies, even those with a history of anaphylaxis to specific unrelated substances. They are categorised as 'high-risk' and should be observed longer in a controlled environment.[50] As such, parents and caregivers are encouraged to disclose the child's complete medical history during the pre-vaccination assessment.

Socio-cultural and religious sensitivities

The mRNA COVID-19 vaccines are not derived from cell cultures and do not include animal products. Hence, the issue of concern with regard to some cultural and religious beliefs is negligible.

Post-vaccination care

Parents of children who will be vaccinated are advised that local and systemic reactions are expected after vaccination. The most frequently reported reactions are pain over the inoculation site, fatigue, headache and fever. The College advises that children receive adequate rest two days before and seven days after receiving mRNA vaccines. Some clinicians even recommend up to two weeks of rest following inoculation. Adequate rest should include avoiding strenuous physical activities, limiting screen time and having sufficient night-time sleep.

Other childhood vaccinations

COVID-19 vaccination should not interfere with the routine scheduled childhood immunisation programme. In the future, children may be given COVID-19 together with other vaccines, such as the influenza vaccine.

Ethical considerations in vaccinating children

The mounting concerns about the indirect effects of the COVID-19 pandemic[34,51] are more significant in children from disadvantaged socio-economic groups as it will potentially widen the health inequity gap.[52]

The College believes the urgency to vaccinate children against COVID-19 is to allow them to resume social interaction with their peers, which is an integral component of normal childhood development. More importantly, it facilitates a "cocoon vaccination" strategy to protect other vulnerable children and individuals in the

community or household who are not eligible for the vaccine.

Even so, when COVID-19 vaccinations are offered to children, parents must receive clear and balanced advice about the risks and benefits. Their decision should be based on understanding and acceptance rather than compulsion as with mandatory vaccination. Mandating vaccination may be misconstrued and potentially result in a backlash that could undermine the vaccine uptake. It might also indirectly threaten the already established childhood national immunisation programme. Appeals to altruism may instead enhance vaccine advocacy to all eligible individuals.[53] Children and adults will equally benefit from one another with increased vaccination uptake in the population. Already, maternal COVID-19 vaccination is shown to confer significant protection to her newborn when infants younger than 6 months are not eligible to be vaccinated.[54]

Regarding child health, the doctor-patient-parent relationship remains a primary focus in ethics. Parental consent and assent from age-appropriate children require balanced information, curated from a culturally sensitive, age-appropriate explanation of the benefits of vaccination, awareness of a child's best interest and assertion against any form of maleficence, allowing an informed shared-decision making. Otherwise, adverse experiences could impact vaccine confidence and jeopardise trust in healthcare professionals.

CONCLUDING REMARKS

The COVID-19 pandemic is still evolving with the emergence of new variants, which further highlights the urgency in maximising the protective benefits of vaccination across different age groups, especially children. The College encourages fostering the triadic doctor-patient-parent relationship toward shared-decision making while also recognising parental autonomy, promoting self-regulation and cultivating the good practice of soliciting assent from minors. The pandemic has already imposed a significant burden on children through physical activity restrictions and school disruptions. During the transition to the endemic phase, the consequence of not vaccinating children creates a vulnerable segment within our population. The unvaccinated are at risk of infection by highly contagious new variants, developing more severe disease and sustaining potential long-term complications such as MIS-C and long COVID-19, the future impact of which is still unknown. In addition, unvaccinated children will be exposed to socio-educational deprivation that may result in the burgeoning of new mental health issues and behavioural and adjustment disorders. The burden of disease transmission from children to adults is another concern, as is the socio-economic impact that a COVID-19 infected child may pose on the parents or guardian. The current available evidence on COVID-19 vaccines indicates that they are efficacious and safe for use in children. Although many countries are transitioning to endemicity, new waves of the pandemic are still a threat with emerging new variants. Reducing the risk of severe disease and limiting the strain to our health system are largely achieved through a high uptake of vaccination across the age groups, including children. Based on the published safety profiles and mounting evidence of the benefits of COVID-19 vaccination, the College unequivocally recommends the vaccination of children, especially the school-going age group of 5 years and above.

Disclaimer: As the COVID-19 pandemic is a dynamic situation and still evolving, the recommendations in this position statement may change or may no longer be applicable when new evidence emerges.

Acknowledgements

This position paper was supported by an

Summary of recommendations

- COVID-19 vaccines are safe and protective for children aged ≥5 years against infection and to prevent severe disease and related complications that may lead to death.
- Local and systemic reactions are to be expected as in any form of vaccination, but in the vast majority, these are not serious side effects.
- Precautionary steps to take post-vaccination include adequate sleep and rest and avoiding strenuous physical activities.
- COVID-19 vaccination is strongly recommended for children ≥5 years old.

unrestricted educational grant from ZP Therapeutics. None of this company staff or employees is represented or contributed in the form of input, ideas, reviews and interpretation of the curated evidence during the preparation of this position paper.
None of the members in the writing group is affiliated with ZP Therapeutics.

Conflict of interest: All authors have no conflicts of interest to declare.

REFERENCES

1. Canadian Paediatric Society. COVID-19 vaccine for children 12 years and older – Position statement. December 18 2021. Available at: https://cps.ca/en/documents/position/covid-19-vaccine-for-children. Accessed January 2022.
2. Centers for Disease Control and Prevention. COVID-19 Tracker. Available at: https://covid.cdc.gov/covid-data-tracker/#vaccinations-cases-trends. Accessed December 2021.
3. Centers for Disease Control and Prevention. Morbidity and Mortality Weekly Report (MMWR) - COVID-19 Graphics. Available at: https://www.cdc.gov/mmwr/mmwr_covid19_graphics.html. Accessed January 2022.
4. Reuters. Omicron cases doubling in 1.5 to 3 days in areas with local spread -WHO. December 18 2021. Available at: https://www.reuters.com/business/healthcare-pharmaceuticals/omicron-cases-doubling-15-3-days-areas-with-local-spread-who-2021-12-18/. Accessed January 2022.
5. The Standard UK. Children may be more at risk from Omicron, experts warn. December 15 2021. Available at: https://www.standard.co.uk/news/uk/children-risk-omicron-covid-variant-south-africa-b972091.html. Accessed December 2021.
6. India Today. Increased severity in kids, more hospitalisations: preliminary report on Omicron from South Africa. December 8 2021. Available at: https://www.indiatoday.in/coronavirus-outbreak/story/is-omicron-making-kids-more-sick-south-africa-report-who-1885301-2021-12-08. Accessed December 2021.
7. CBS News (USA). South Africa investigates "sharp increase" in hospitalised children with COVID. December 3 2021. Available at: https://www.cbsnews.com/news/omicron-variant-children-south-africa/. Accessed December 2021.
8. Lima DGS, Figueiredo TMR, Pereira YTG, *et al.* The effects of the silence on South African children and adolescents against a global alert on the newly identified coronavirus variant: Omicron. *J Pediatr Nurs.* 2021.
9. The Washington Post. Omicron and children: Pediatric hospitals in part of US filling fast. December 24 2021. Available at: https://www.washingtonpost.com/health/2021/12/24/omicron-children-hospitalizations-us/. Accessed December 2021.
10. Teo JT-R, Abidin NH, Cheah F-C. Severe acute respiratory syndrome-coronavirus-2 infection: a review of the clinical-pathological correlations of coronavirus disease-19 in children. *Malays J Pathol* 2020;42(3):349-61.
11. Wang Z, Zhou Q, Wang C, *et al*. Clinical characteristics of children with COVID-19: A rapid review and meta-analysis. *Ann Transl Med.* 2020;8(10):620.
12. Ledford H. How severe are Omicron infections. *Nature* 2021;600(23/30 December):577-8.
13. CNN. New Omicron variant fills up children's hospital. December 29 2021. Available at: https://edition.cnn.com/2021/12/27/health/covid-kids-hospitals/index.html. Accessed December 2021.
14. Davies P, Evans C, Kanthimathinathan HK, *et al.* Intensive care admissions of children with paediatric inflammatory multisystem syndrome temporally associated with SARS-CoV-2 (PIMS-TS) in the UK: A multicentre observational study. *Lancet Child Adolesc Health.* 2020;4(9):669-77.
15. Fabi M, Filice E, Andreozzi L, *et al*. Spectrum of cardiovascular diseases in children during high peak coronavirus disease 2019 period infection in Northern Italy: Is there a link? *J Pediatric Infect Dis Soc.* 2021;10(6):714-21.
16. Ministry of Health, Malaysia. CovidNow. Available at: https://covidnow.moh.gov.my/. Accessed December 30 2021.
17. Drouin O, Hepburn CM, Farrar DS, *et al*. Characteristics of children admitted to hospital with acute SARS-CoV-2 infection in Canada in 2020. *CMAJ.* 2021;193(38):E1483-e1493.
18. Williams N, Radia T, Harman K, Agrawal P, Cook J, Gupta A. COVID-19 severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection in children and adolescents: a systematic review of critically unwell children and the association with underlying comorbidities. *Eur J Pediatr.* 2021;180(3):689-97.
19. Al Jazeera. Infographic: Vaccinating children against COVID. Available at: https://www.aljazeera.com/news/2021/11/24/infographic-which-countries-are-vaccinating-children. Accessed January 2022" https://www.aljazeera.com/news/2021/11/24/infographic-which-countries-are-vaccinating-children. Accessed January 2022.
20. U.S. Food and Drug Administration. Coronavirus (COVID-19) update: FDA authorizes Moderna and Pfizer-BioNTech COVID-19 vaccines for children down to 6 months of age. Available at: https://www.fda.gov/news-events/press-announcements/coronavirus-covid-19-update-fda-authorizes-moderna-and-pfizer-biontech-covid-19-vaccines-children. Accessed July 2022.
21. Reuters. Factbox: Countries vaccinating children against COVID-19. December 2 2021. Available at: https://www.reuters.com/business/healthcare-pharmaceuticals/countries-vaccinating-children-against-covid-19-2021-06-29/. Accessed January 2022.
22. The Straits Times (SG). Surge in number of COVID-19 cases and deaths among children in

Malaysia. September 18 2021. Available at: https://www.straitstimes.com/asia/se-asia/number-of-children-in-malaysia-infected-with-covid-19-surge-deaths-also-mount. Accessed January 2022.
23. Reuters. Hong Kong panel advises single dose of BioNTech COVID shot for teens. September 16 2021. Available at: https://www.reuters.com/business/healthcare-pharmaceuticals/hong-kong-panel-recommends-single-dose-biontechs-covid-19-shot-teenagers-2021-09-16/. Accessed December 2021.
24. Chua GT, Kwan MYW, Chui CSL, *et al*. Epidemiology of acute myocarditis/pericarditis in Hong Kong adolescents following Comirnaty vaccination. *Clin Infect Dis.* 2021: ciab989.
25. BBC News (UK). COVID: Why are 12-15s now being double-jabbed? November 29 2021. Available at: https://www.bbc.com/news/health-57888429. Accessed December 2021.
26. GOV.UK. COVID-19 vaccination: A guide for eligible children and young people aged 12 to 17 (version 3). 24 December 2021. Available at: https://www.gov.uk/government/publications/covid-19-vaccination-resources-for-children-and-young-people/covid-19-vaccination-a-guide-for-eligible-children-and-young-people-aged-12-to-17. Accessed January 2022.
27. Dembiński Ł, Vieira Martins M, Huss G, *et al*. SARS-CoV-2 vaccination in children and adolescents—A Joint Statement of the European Academy of Paediatrics and the European Confederation for Primary Care Paediatricians. *Front Pediatr.* 2021;9(881).
28. Panda PK, Gupta J, Chowdhury SR, *et al*. Psychological and behavioral impact of lockdown and quarantine measures for COVID-19 pandemic on children, adolescents and caregivers: A systematic review and meta-analysis. *J Trop Pediatr.* 2021;67(1).
29. Ma L, Mazidi M, Li K, *et al*. Prevalence of mental health problems among children and adolescents during the COVID-19 pandemic: A systematic review and meta-analysis. *J Affect Disord*. 2021;293:78-89.
30. Lange SJ, Kompaniyets L, Freedman DS, *et al*. Longitudinal trends in body mass index before and during the COVID-19 pandemic among persons aged 2-19 years - United States, 2018-2020. *MMWR Morb Mortal Wkly Rep.* 2021;70(37):1278-83.
31. World Health Organization. Interim statement on COVID-19 vaccination for children and adolescents. 24 November 2021. Available at: https://www.who.int/news/item/24-11-2021-interim-statement-on-covid-19-vaccination-for-children-and-adolescents. Accessed January 2022.
32. Dethioux L, Dauby N, Montesinos I, Rebuffat E, Hainaut M. SARS-CoV-2 seroprevalence in children and their family members, July-October 2020, Brussels. *Eur J Pediatr.* 2021:1-8.
33. Levorson RE, Christian E, Hunter B, *et al*. A cross-sectional investigation of SARS-CoV-2 seroprevalence and associated risk factors in children and adolescents in the United States. *PLoS One.* 2021;16(11):e0259823.
34. Khoo EJ, Lantos JD. Lessons learned from the COVID-19 pandemic. *Acta Paediatr.* 2020;109(7):1323-5.
35. Centres for Disease Control and Prevention. DC COVID-19 study shows mRNA vaccines reduce risk of infection by 91 percent for fully vaccinated people. June 7 2021. Available at: https://www.cdc.gov/media/releases/2021/p0607-mrna-reduce-risks.html. Accessed December 2021.
36. Thompson MG, Burgess JL, Naleway AL, *et al*. Prevention and attenuation of COVID-19 with the BNT162b2 and mRNA-1273 Vaccines. *N Eng J Med.* 2021;385(4):320-9.
37. McLean G, Kamil J, Lee B, *et al.* The impact of evolving SARS-CoV-2 mutations and variants on COVID-19 vaccines. *mBio.* 2022;13(2):e0297921.
38. Han B, Song Y, Li C, *et al*. Safety, tolerability, and immunogenicity of an inactivated SARS-CoV-2 vaccine (CoronaVac) in healthy children and adolescents: A double-blind, randomised, controlled, phase 1/2 clinical trial. *Lancet Infect Dis.* 2021;21(12):1645-53.
39. ANI News (IND). Russia to register Sputnik M COVID-19 vaccine for children aged 12 to 17. November 24 2021. Available at: https://www.aninews.in/news/world/europe/russia-to-register-sputnik-m-covid-19-vaccine-for-children-aged-12-to-17202111242022215/. Accessed January 2022.
40. World Health Organization. WHO lists 9th COVID-19 vaccine for emergency use with aim to increase access to vaccination in lower-income countries. December 17 2021. Available at: https://www.who.int/news/item/17-12-2021-who-lists-9th-covid-19-vaccine-for-emergency-use-with-aim-to-increase-access-to-vaccination-in-lower-income-countries. Accessed January 2022.
41. European Medicines Agency. EMA recommends Nuvaxovid for authorisation in the EU. December 20 2021. Available at: https://www.ema.europa.eu/en/news/ema-recommends-nuvaxovid-authorisation-eu. Accessed January 2022.
42. Creech CB, Anderson E, Berthaud V, *et al.* Evaluation of mRNA-1273 Covid-19 vaccine in children 6 to 11 years of age. *N Eng J Met.* 2022;386:2011-2023.
43. UK Green Book. COVID-19-SARS-CoV-2. Chapter 14a. 2021. Available at: https://www.gov.uk/government/publications/covid-19-the-green-book-chapter-14a. Accessed January 2022.
44. Andrews N, Stowe J, Kirsebom F, *et al*. Effectiveness of COVID-19 vaccines against the Omicron (B.1.1.529) variant of concern. *medRxiv.* 2021:2021.2012.2014.21267615.
45. Boehmer TK, Kompaniyets L, Lavery AM, et al. Association between COVID-19 and myocarditis using hospital-based administrative data - United States, March 2020-January 2021. *MMWR Morb Mortal Wkly Rep.* 2021;70(35):1228-32.
46. Bozkurt B, Kamat I, Hotez PJ. Myocarditis with COVID-19 mRNA vaccines. *Circulation.* 2021;144(6):471-84.
47. Hause AM, Baggs J, Marquez P, *et al.* COVID-19 vaccine safety in children aged 5-11 years - United

States, November 3-December 19, 2021. *MMWR Morb Mortal Wkly Rep.* 2021;70(5152):1755-60.
48. Ministry of Health Malaysia. MoH's commitment to the effectiveness, safety and quality of the COVID-19 vaccination program in Malaysia through surveillance and research. Press release from the Director-General of Health Malaysia. Available at: https://kpkesihatan.com/2022/01/15/mohs-commitment-to-the-effectiveness-safety-and-quality-of-the-covid-19-vaccination-program-in-malaysia-through-surveillance-and-research%EF%BF%BC/. Accessed January 2022.
49. Bigini P, Gobbi M, Bonati M, *et al*. The role and impact of polyethylene glycol on anaphylactic reactions to COVID-19 nano-vaccines. *Nat Nanotechnol.* 2021;16(11):1169-71.
50. Ministry of Health Malaysia. Clinical Guidelines on COVID-19 vaccination in Malaysia. 3rd Edition. Available at: https://covid-19.moh.gov.my/garis-panduan/garis-panduan-kkm/ANNEX_48_CLINICAL_GUIDELINES_FOR_COVID_IN_MALAYSIA_3rd_EDITION_12072021.pdf. Accessed January 2022.
51. UK Royal College of Paediatrics and Child Health. RCPCH statement in response to CMOs advice regarding offering COVID-19 vaccination to all 12-15 years old. September 2021. https://www.rcpch.ac.uk/news-events/news/rcpchstatement-response-cmos-advice-regarding-offering-covid-19-vaccina7onall Accessed January 2022.
52. Khoo EJ. Grasping the reality of health care access for migrants: An initial strategy to end social injustice. *Int J Health Plann.* 2021;36(4):1346-8.
53. Luong KT, Moyer-Gusé E. Can altruistic emotions promote vaccine advocacy? Examining the use of empathy and elevation in vaccine messages. *J Health Commun.* 2021;26(11):753-63.
54. Kugelman N, Nahshon C, Shaked-Mishan P, *et al*. Maternal and neonatal SARS-CoV-2 immunoglobulin G antibody levels at delivery after receipt of the BNT162b2 messenger RNA COVID-19 vaccine during the second trimester of pregnancy. *JAMA Pediatr.* 2021:e215683.