Original research

Child mask mandates for COVID-19: a systematic review

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Abstract

Background Mask mandates for children during the COVID-19 pandemic varied in different locations. A risk-benefit analysis of this intervention has not yet been performed. In this study, we performed a systematic review to assess research on the effectiveness of mask wearing in children.

Methods We performed database searches up to February 2023. The studies were screened by title and abstract, and included studies were further screened as full-text references. A risk-of-bias analysis was performed by two independent reviewers and adjudicated by a third reviewer.

Results We screened 597 studies and included 22 in the final analysis. There were no randomised controlled trials in children assessing the benefits of mask wearing to reduce SARS-CoV-2 infection or transmission. The six observational studies reporting an association between child masking and lower infection rate or antibody seropositivity had critical (n=5) or serious (n=1) risk of bias; all six were potentially confounded by important differences between masked and unmasked groups and two were shown to have non-significant results when reanalysed. Sixteen other observational studies found no association between mask wearing and infection or transmission.

Conclusions Real-world effectiveness of child mask mandates against SARS-CoV-2 transmission or infection has not been demonstrated with high-quality evidence. The current body of scientific data does not support masking children for protection against COVID-19.

Data availability statement

Data are available upon reasonable request. All data relevant to the study are included in the article or uploaded as supplementary information.

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WHAT IS ALREADY KNOWN ON THIS TOPIC

- Child mask mandates have been extensively used as a public health measure during the COVID-19 pandemic.
- Masking recommendations appear to be entirely based on mechanistic and observational data, and a systematic review assessing the evidence has not been performed.

WHAT THIS STUDY ADDS

- In this systematic review, 16 studies found no effect of mask wearing on infection or transmission, while six studies reporting a protective association had critical or serious risk of bias.
- Because benefits of masking for COVID-19 have not been identified, it should be recognised that mask recommendations for children are not supported by scientific evidence.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- COVID-19-related policy recommendations should be informed by high-quality evidence and consider the possibility of harm, especially for children, who are vulnerable and an ethically protected group.
- Healthcare providers and adults working with children should be educated about the absence of high-quality data supporting masking to lower SARS-CoV-2 infection and transmission risks.
- Because absence of harm is not established, recommending child masking does not meet the accepted practice of promulgating only medical interventions where benefits clearly outweigh harms.

Introduction

Mandating masks for children has been one of the most polarising public-health measures implemented during the COVID-19 pandemic. Two Cochrane reviews of randomised controlled trials (RCT) of masking for prevention of upper respiratory infections failed to find a benefit against infection or transmission.[1 2] Most countries have now removed all public mask mandates, while the USA's Centers for Disease Control and Prevention (CDC) and American Academy of Pediatrics continue to recommend masking down to the age of two.[3 4] This recommendation appears to be entirely based on observational data finding associations with lower case rates in masked versus unmasked individuals but does not take into account the potential adverse consequences of masking, especially in young children, including but not limited to impact on speech, language, learning, mental health and physiological factors. Seeing mouth movements and facial gestures accelerate word recognition and speech comprehension,[5–8] the integration of facial information is important for speech perception,[9 10] and recognition of facial expressions is critical for children's abilities to communicate and understand and show emotions.[7 11 12] Mask wearing may also cause breathing difficulties, headaches, dermatitis, general discomfort and pain.[2 13–17]

There is an urgent need to base pandemic-related policy recommendations on robust scientific data that include risk-benefit analyses, preferably with the long-term goals and the beneficiaries of the intervention clearly defined.[18] Ethically, children should be treated as a protected group, where the benefits of any intervention should clearly outweigh harms.

The aim of this systematic review is to evaluate the body of literature on mask wearing in children to assess the existing evidence regarding protection offered by face masks against SARS-CoV-2 infection or transmission.

Methods

We conducted a systematic review to evaluate the evidence for effectiveness of child mask mandates in reducing transmission or disease severity in COVID-19.

References were identified through searches of PubMed, Google Scholar, three major preprint servers (SSRN, MedRxiv and Research Square) and major public health agency publication databases and websites until February 2023 (online supplemental appendix 1). We included primary studies of any design investigating mask effectiveness against COVID-19 (SARS-CoV-2) transmission, infection and disease in individuals <18 years old. Publications of case reports, case series, reviews and comments without new data were excluded, as were studies where age groups were not specified or out of the paediatric range, or when the setting or study objective/design were not applicable. The systematic review was prepared according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The quality risk of bias (ROB) was estimated using the ROB-2 and ROBINS-I tools,[19] a structured approach for assessing the ROB utilising different domains of bias and an overall judgement. All ROB assessments were conducted by two independent reviewers (RD and SNL), and disagreements were resolved by a third reviewer (JS).

Supplemental material

[archdischild-2023-326215supp001.pdf]

Results

Our literature search identified 597 publications that were screened by title and abstract. We then screened 40 full-text references and excluded 18 that did not meet the inclusion criteria (figure 1). Details of the screened publications are presented in table 1. The ROB analysis by the two reviewers resulted in 18 differences in ratings and four differences in overall ROB that needed to be adjudicated.

Figure 1

PRISMA flow diagram. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Table 1

Characteristics of included observational studies

To date, there are no RCTs assessing the effects of masking children in reducing COVID-19 transmission or disease. Among the 22 observational studies identified, the overall ROB was critical in six studies (27.2%), serious in 10 studies (45.5%), moderate in five studies (22.7%) and low in none of the studies (table 2). Of the six studies reporting a significant negative correlation between masking and COVID-19 cases, five had critical and one had serious ROB. Of the 16 studies failing to find a significant correlation, 1 (6.3%) had critical, 10 (62.5%) had serious, 5 (31.3%) had moderate and none had low ROB.

All six studies,[20,21,22,23,24,25] reporting a negative assocation were potentially confounded by crucial differences between masked and unmasked groups, including the number of instructional school days, differences in school size, systematic baseline differences in case rates in all phases of the pandemic, testing policies, contact-tracing policy differences and teacher vaccination rates. These confounders—alone and in combination—resulted in a failure to demonstrate an isolated effect of masks themselves.[20–22]

One study from Boston found that lifting of school mask mandates was associated with increased number of COVID-19 cases,[23] which was questioned upon re-analysis.[26] US studies in North Carolina[24] and Arizona[21] found that mask requirements had negative associations with in-school transmission and COVID-19 outbreaks, respectively. In a 2020 Canadian study published as a preprint, children who did not wear a mask had higher seropositivity than children who wore masks, but the overall seropositivity was low (9/541 or 1.7% in total) and findings were confounded by multiple external factors including social distancing and attendance in schools, social functions and organised sports.

In a Spanish study of almost 600 000 children, the researchers did not find a significant difference in cases between unmasked 5-year-olds and masked 6-year-olds; instead, case rates correlated closely with the age of children,[27] which was also observed in another Spanish study.[28] An observational CDC-funded US study[20] found no significant association between county-wide mask mandates and paediatric case counts on expanded reanalysis.[29] A lack of significant association between masking children and risk of COVID-19 was also reported by the UK Department of Education.[30] In three US studies, there was no correlation between mask mandates and COVID-19 rates,[31] no

significant association between COVID-19 incidence and face mask use,[32] and no risk reduction for COVID-19-related outcomes with student mask mandates.[33] Spanish and Irish studies have independently observed similar primary-school COVID-19 transmission in young children with or without masking, respectively.[28 34] In another CDC study, there was no reduction in COVID-19 incidence in schools requiring student masking compared with those with optional masking.[35] When comparing adjacent school districts with and without mask mandates, multiple studies have reported no difference in transmission.[36–38] A Finnish study compared case rates in children with and without mask mandates in 10–12 year-olds, and the authors found no reduction in COVID-19 case rates when mask recommendations were extended to include 10–12 year olds.[39] Face-mask use among high school athletes was not found to have an impact on transmission.[32]

To explore the effect on disease severity, there was no association between viral load of index cases with confirmed COVID-19 and disease severity among secondary cases.[40] In Sweden, where schools remained open and masks were not required, only 15 of the nearly 2 million children were hospitalised and none died during the spring of 2020; also, the infection rate among teachers was similar to that of other professions.[41] In Finland, where children have not worn masks under the age of 10–12 years, no child died from COVID-19.[42] In Norway, where masks in schools have not been recommended, in-school transmission was <1% among children and< 2% in child-adult contacts during August–November 2020.[43] During a SARS-CoV-2 Delta variant outbreak in a US elementary school in May–June 2021, mask use for staff and students in classrooms did not significantly prevent transmission from symptomatic adults, while very few children went on to infect their family members.[44] In New York City public schools with more than 1600 schools and 1 million enrolled students, the transmission rate (secondary attack rate) during the Delta variant period (October–December 2021) was estimated to be 0.5%.[45]

Table 2

VIEW INLINE VIEW POPUP

Risk-of-bias rating per study.

Discussion

In this systematic review on benefits of child masking against SARS-CoV-2, we identified no RCT on the efficacy for use of face masks and the risk of transmission or disease. Among the 22 identified observational studies of masking for prevention of COVID-19, more than 70% of the studies had a critical or serious overall ROB. None of the observational studies reporting a negative correlation between masking and COVID-19 cases had a level of bias that was less than "serious."

Specifically, of the 6 out of 22 observational studies that reported a significant negative correlation between masking and COVID-19 cases, five had critical and one had serious ROB. Of the 16 out of 22 studies failing to find a significant correlation, only 6.3% had critical ROB, while 62.5% had serious and 31.3% had moderate ROB. Importantly, the largest studies with the lowest ROB did not identify a benefit from masking.[27 28 30] The study (currently in preprint publication) with the most robust internal control showed no benefit from a mask mandate.[38] Observational studies reporting a negative association between masking and COVID-19 rates have failed to demonstrate a benefit when confounding factors have adequately been considered.[20–24] Larger observational studies,[28 31] including a regression-discontinuity analysis[39] and a more robust reanalysis[29] of a prior publication,[20] as well as other observational studies,[27 30 32–38 41–44] failed to find benefit of masking against COVID-19. Observational studies in adults also repeatedly fail to properly adjust for confounding factors to avoid bias.[46–48] Furthermore, the Boston observational study[23] stated they could infer causality between lifting school mask mandates and increases in student and staff cases by using a difference-in-differences technique. However, a subsequent reanalysis called the methodology and results of this study into question and failed to find the same association when expanding the population to include the entire state or using different statistical analysis and also found the initial study's results were likely confounded by differences in prior infection rates.[26]

Observational studies have also failed to find an association between voluntary mask wearing among adults in schools and lower odds of COVID-19 in the school[49] or between mask mandates or mask use and reduced transmission.[50] In addition, a systematic review showed a 10-fold lower secondary attack rate in schools compared with community/household settings.[51]

In adults, there are only a limited number of published RCTs of mask wearing and COVID-19 prevention. DANMASK-19 failed to find a 50% reduction in COVID-19 infections in surgical mask wearers in the community.[52] A cluster RCT in Bangladesh found no effect of community cloth masking on COVID-19 infections, no reduction from surgical masking for anyone under age 50, and only a marginal reduction among >50-year olds and in the context of observer-enforced physical distancing,[53] an association that was found to be insignificant after re-analysis.[54] In a predominantly adult cluster RCT of almost 40, 000 participants from age 10 and up (but not reported by age group and, therefore, not included in our systematic review), there was no difference in COVID-19-like illness or mortality between masked and

unmasked groups.[55] A Cochrane systematic review published in 2020 similarly found use of surgical masks and respirators in adults to have 'little to no effect' on the transmission of respiratory viruses, while side effects included discomfort.[1] In the 2023 updated version that included COVID-19, these conclusions remained unchanged.[2]

Perpetual masking in early childhood is without historical precedent. In children, the harms associated with masking are often challenging to identify, measure and quantify with correlational studies, and many of these outcomes will take years to fully evaluate. An extensive body of research has found harms associated with mask wearing or mask requirements in children.[56] These associated harms include negative impacts on speech, language and learning. Mask wearing causes reduced word identification[57–59] and impedes the ability to teach and evaluate speech.[60] There is a link between observation of the mouth and language processing, and people of all ages continue to focus on the mouth when listening to non-native speech.[61] The sensitive period for language development is through age 4, and development of connected speech is ongoing beyond age 10.[62]

Mask wearing may also impact mental health and social-emotional well-being by limiting the ability to accurately interpret emotions, particularly in younger children.[63–66] There is also evidence that masks hinder social-emotional learning and language/literacy development in young children.[67] Children with special-education needs and autism may be disproportionately impacted by mask requirements as they rely heavily on facial expressions to pick up social cues.[68] Misinterpretation of facial expressions increases anxiety and depression in individuals.[69] School environments with mask mandates were also found to have increased anxiety levels compared to those without mandates.[70] In addition, mask wearing has been associated with physiological harm[2 13 13–17]—many of which are more frequently reported in children than in adults[2 17 71]—which may have multiple negative downstream effects, including reduced time and intensity of exercise, additional sick days, reduced learning capacity, and increased anxiety. Masking has also been found to lead to rapid increase in CO_2 content in inhaled air—higher in children than in adults—and to levels above acceptable safety standards for healthy adult workers, which may rise further with physical exertion.[72–74]

In medicine, new interventions with unknown benefit but known or potential risks cannot be ethically recommended or enforced until absence of harm is demonstrated. Rather, the accepted standard is that an intervention should only be employed after benefit has been demonstrated, ideally through an RCT, together with safety data to ensure that proven benefits outweigh harms. The burden of proof to show that an intervention is both safe and beneficial is the responsibility of the person, institution or body implementing and recommending that intervention.[75]

In this systematic review, we fail to find any evidence of benefit from masking children, to either protect themselves or those around them, from COVID-19. Harms of masking may include affected speech, language and emotional development, and physical discomfort contributing to reduced time and intensity of exercise and learning activities, and the long-term effects are too early to be measured. Adults who work with children should be educated about the lack of clear benefits and the potential harms of masking children, and there is no scientific evidence supporting a recommendation for masking in these professions.

In summary, child mask mandates fail a basic risk-benefit analysis. Recommending child masking to prevent the spread of COVID-19 is unsupported by current scientific data and inconsistent with accepted ethical norms that aim to provide additional protection from harm for vulnerable populations.

Data availability statement

Data are available upon reasonable request. All data relevant to the study are included in the article or uploaded as supplementary information.

Ethics statements

Patient consent for publication

Not applicable.

Ethics approval

Not applicable.

References

1. ↵ Jefferson T, Del Mar CB, Dooley L, *et al*. Physical interventions to interrupt or reduce the spread of respiratory viruses. *Cochrane Database Syst Rev* 2011;**2011**:CD006207. doi:10.1002/14651858.CD006207.pub4 Google Scholar

2. ↵ Jefferson T, Dooley L, Ferroni E, *et al*. Physical interventions to interrupt or reduce the spread of respiratory viruses. *Cochrane Database Syst Rev* 2023;**1**:CD006207. doi:10.1002/14651858.CD006207.pub6 Available: http://doi.wiley.com/10.1002/14651858.CD006207.pub6 Google Scholar

3. ↵ CDC. Use and care of marks. 2022. Available: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/about-face-coverings.html [Accessed 2 Mar 2023]. Google Scholar

4. ↵ American Academy of Pedicatrics. Face masks and other prevention strategies. 2022. Available: https://www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/clinical-guidance/face-masks-and-other-prevention-strategies/ [Accessed 2 Mar 2023]. Google Scholar

5. ↵ Fort M, Kandel S, Chipot J, *et al*. Seeing the initial articulatory gestures of a word triggers lexical access. *Lang Cognitive Proc* 2013;**28**:1207–23. doi:10.1080/01690965.2012.701758 Google Scholar

6. ↵ Benoît C, Mohamadi T, Kandel S. Effects of phonetic context on audio-visual intelligibility of French. *J Speech Lang Hear Res* 1994;**37**:1195–203. doi:10.1044/jshr.3705.1195 PubMed Google Scholar

7. ↵ Pascalis O, Loevenbruck H, Quinn PC, *et al*. On the links among face processing, language processing, and narrowing during development. *Child Dev Perspect* 2014;**8**:65–70. doi:10.1111/cdep.12064 Google Scholar

8. ↵ Charney SA, Camarata SM, Chern A. Potential impact of the COVID-19 pandemic on communication and language skills in children. *Otolaryngol Head Neck Surg* 2021;**165**:1–2. doi:10.1177/0194599820978247 Google Scholar

9. ↵ Mosca R, Kritzinger A, van der Linde J. Language and communication development in preschool children with visual impairment: a systematic review. *S Afr J Commun Disord* 2015;**62**:e1–10. doi:10.4102/sajcd.v62i1.119 Google Scholar

10. ↵ Worster E, Pimperton H, Ralph-Lewis A, *et al*. Eye movements during visual speech perception in deaf and hearing children: gaze during lipreading in deaf and hearing children. *Lang Learn* 2018;**68**:159–79. doi:10.1111/lang.12264 Google Scholar

11. ↵ Vaillant-Molina M, Bahrick LE, Flom R. Young infants match facial and vocal emotional expressions of other infants. *Infancy* 2013;**18**.(Suppl 1) doi:10.1111/infa.12017 Google Scholar

12. ↵ Quinn PC, Anzures G, Izard CE, *et al*. Looking across domains to understand infant representation of emotion. *Emot Rev* 2011;**3**:197–206. doi:10.1177/1754073910387941 Google Scholar

13. ↵ Bakhit M, Krzyzaniak N, Scott AM, *et al*. Downsides of face masks and possible mitigation strategies: a systematic review and meta-analysis. *BMJ Open* 2021;**11**:e044364. doi:10.1136/bmjopen-2020-044364 Google Scholar

14. ↵ Rosner E. Adverse effects of prolonged mask use among Healthcare professionals during COVID-19. *J Infect Dis Epidemiol* 2020;**6**. doi:10.23937/2474-3658/1510130 Available: https://clinmedjournals.org/archives_search.php?jid=jide&volume=6&issue=3 Google Scholar

15. ↵ Ong JJY, Bharatendu C, Goh Y, *et al*. Headaches associated with personal protective equipment – A cross-sectional study among frontline healthcare workers during COVID-19. *Headache* 2020;**60**:864–77. doi:10.1111/head.13811 Available: https://headachejournal.onlinelibrary.wiley.com/toc/15264610/60/5 CrossRef PubMed Google Scholar

16. ↵ Lee H. Effects of long-duration wearing of N95 respirator and surgical facemask: a pilot study. *JLPRR* 2014;**1**. doi:10.15406/jlprr.2014.01.00021 Available: http://medcraveonline.com/JLPRR/volume_issues?issueId=157&volumeId=45 Google Scholar

17. ↵ Canini L, Andréoletti L, Ferrari P, *et al*. Surgical mask to prevent influenza transmission in households: a cluster randomized trial. *PLoS One* 2010;**5**:e13998. doi:10.1371/journal.pone.0013998 Google Scholar

18. ↵ Hughes RC, Bhopal SS, Tomlinson M. Making pre-school children wear masks is bad public health. *Public Health Pract (Oxf)* 2021;**2**:100197. doi:10.1016/j.puhip.2021.100197 Google Scholar

19. ↵ Higgins J, Thomas J, Chandler J, *et al*. 2022. *Cochrane Handbook for Systematic Reviews of Interventions version 6.3*. The Cochrane Collaboration, Available: www.training.cochrane.org/handbook Google Scholar

20. ↵ Budzyn SE, Panaggio MJ, Parks SE, *et al*. Pediatric COVID-19 cases in counties with and without school mask requirements - United States, July 1-September 4, 2021. *MMWR Morb Mortal Wkly Rep* 2021;**70**:1377–8. doi:10.15585/mmwr.mm7039e3 CrossRef PubMed Google Scholar

21. ↵ Jehn M, McCullough JM, Dale AP, *et al*. Association between K-12 school mask policies and school-associated COVID-19 outbreaks - Maricopa and Pima counties, Arizona, July-August 2021. *MMWR Morb Mortal Wkly Rep* 2021;**70**:1372–3. doi:10.15585/mmwr.mm7039e1 CrossRef PubMed Google Scholar

22. ↵ Nelson SB, Dugdale CM, Bilinski A, *et al*. Prevalence and risk factors for in-school transmission of SARS-Cov-2 in Massachusetts K-12 public schools, 2020-2021. *Public and Global Health* 2021. doi:10.1101/2021.09.22.21263900 Google Scholar

23. ↵ Cowger TL, Murray EJ, Clarke J, *et al*. Lifting universal masking in schools - COVID-19 incidence among students and staff. *N Engl J Med* 2022;**387**:1935–46. doi:10.1056/NEJMoa2211029 Google Scholar

24. ↵ Boutzoukas AE, Zimmerman KO, Benjamin DK. School safety, masking, and the delta variant. *Pediatrics* 2021;**149**:e2021054396. doi:10.1542/peds.2021-054396 Google Scholar

25. ↵ Manny E, Carroll A, Charlton C, *et al*. Increased mask use and fewer gatherings associated with lower SARS-Cov-2 Seropositivity among young school-age children. *SSRN Electron J* 2020. doi:10.2139/ssrn.3728570 Available: https://www.ssrn.com/abstract=3728570 Google Scholar

26. ↵ Hoeg TB, Chandra A, Duriseti R, *et al*. Mask mandates and COVID-19: A re-analysis of the Boston school mask study. 2023. Available: https://arxiv.org/abs/2307.11974 [Accessed 4 Oct 2023]. Google Scholar

27. ↵ Coma E, Catala M, Méndez-Boo L, *et al*. Unravelling the role of the mandatory use of face covering masks for the control of SARS-Cov-2 in schools: a quasi-experimental study nested in a population-based cohort in Catalonia (Spain). *SSRN Electron J* 2022. doi:10.2139/ssrn.4052659 Available: https://www.ssrn.com/abstract=4046809 Google Scholar

28. ↵ Alonso S, Alvarez-Lacalle E, Català M, *et al*. Age-dependency of the propagation rate of Coronavirus disease 2019 inside school bubble groups in Catalonia, Spain. *Pediatr Infect Dis J* 2021;**40**:955–61. doi:10.1097/INF.0000000000003279 PubMed Google Scholar

29. ↵ Chandra A, Høeg TB. Revisiting pediatric COVID-19 cases in counties with and without school mask requirements—United States, July 1—October 20 2021. *SSRN Electron J*2022. doi:10.2139/ssrn.4118566 Available: https://www.ssrn.com/abstract=4118566 Google Scholar

30. ↵ U.K. Department for Education. [2022]. *Evidence Summary: Coronavirus (COVID-19) and the use of face coverings in education settings*, Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1055639/Evidence_summary_-_face_coverings.pdf [Accessed 28 Mar 2022]. Google Scholar

31. ↵ Oster E, Jack R, Halloran C, *et al*. COVID-19 mitigation practices and COVID-19 rates in schools: report on data from Florida, New York and Massachusetts. *Health Policy* 2021. doi:10.1101/2021.05.19.21257467 Google Scholar

32. ↵ Sasser P, McGuine TA, Haraldsdottir K, *et al*. Reported COVID-19 incidence in Wisconsin high school athletes in fall 2020. *J Athl Train* 2022;**57**:59–64. doi:10.4085/1062-6050-0185.21 Google Scholar

33. ↵ Lessler J, Grabowski MK, Grantz KH, *et al*. Household COVID-19 risk and in-person schooling. *Science* 2021;**372**:1092–7. doi:10.1126/science.abh2939 Abstract/FREE Full Text Google Scholar

34. ↵ White P, Ceannt R, Kennedy E, *et al*. Children are safe in schools: a review of the Irish experience of reopening schools during the COVID-19 pandemic. *Public Health* 2021;**195**:158–60. doi:10.1016/j.puhe.2021.04.001 Google Scholar

35. ↵ Gettings J, Czarnik M, Morris E, *et al*. Mask use and ventilation improvements to reduce COVID-19 incidence in elementary schools. *MMWR Morb Mortal Wkly Rep* 2021;**70**:779–84. doi:10.15585/mmwr.mm7021e1 CrossRef PubMed Google Scholar

36. ↵ Tennessee Department of Health and Census. Davidson and Williamson counties, TN, student and community comparisons. 2021. Available: https://www.tn.gov/content/dam/tn/health/documents/cedep/novel-coronavirus/datasets/Public-Dataset-Daily-County-Cases-5-18-Years.XLSX [Accessed 5 Apr 2022]. Google Scholar

37. ↵ Cabrera L. [2021]. *Data shows school mask policy in Alachua County has no impact on COVID-19 cases*, Available: https://alachuachronicle.com/data-shows-school-mask-policy-in-alachua-county-has-no-impact-on-covid-19-cases/ [Accessed 5 Apr 2022]. Google Scholar

38. ↵ Sood N, Heick S, Stevenson J, *et al*. Association between school mask mandates and SARS-Cov-2 student infections: evidence from a natural experiment of neighboring K-12 districts in North Dakota. *In Review* 2022. doi:10.21203/rs.3.rs-1773983/v1 Google Scholar

39. ↵ Juutinen A, Sarvikivi E, Laukkanen-Nevala P, *et al*. Use of face masks did not impact COVID-19 incidence among 10–12-year-olds in Finland. *Infect Dis (except HIV/AIDS)* 2022. doi:10.1101/2022.04.04.22272833 Google Scholar

40. ↵ Trunfio M, Longo BM, Alladio F, *et al*. 'On the SARS-Cov-2 'Variolation hypothesis': no association between viral load of index cases and COVID-19 severity of secondary cases''. *Front Microbiol* 2021;**12**:646679. doi:10.3389/fmicb.2021.646679 Google Scholar

41. ↵ Ludvigsson JF. Open schools, COVID-19, and child and teacher morbidity in Sweden. *N Engl J Med* 2021;**384**. doi:10.1056/NEJMc2101280 Google Scholar

42. ↵ Suryawijaya Ong D, Hart J, Russell F. COVID-19 and children's surveillance report; 2022, 13. Available: https://www.mcri.edu.au/sites/default/files/media/documents/covid-19_and_childrens_surveillance_report_13_210322-v2.pdf Google Scholar

43. ↵ Brandal LT, Ofitserova TS, Meijerink H, *et al*. Minimal transmission of SARS-Cov-2 from paediatric COVID-19 cases in primary schools, Norway, August to November 2020. *Euro Surveill* 2021;**26**:2002011. doi:10.2807/1560-7917.ES.2020.26.1.2002011 Available: https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2020.26.1.2002011 Google Scholar

44. ↵ Lam-Hine T, McCurdy SA, Santora L, *et al*. Outbreak associated with SARS-Cov-2 B.1.617.2 (Delta) variant in an elementary school - Marin County, California, may-June 2021. *MMWR Morb Mortal Wkly Rep* 2021;**70**:1214–9. doi:10.15585/mmwr.mm7035e2 Google Scholar

45. ↵ Varma JK, Thamkittikasem J, Whittemore K, *et al*. COVID-19 infections among students and staff in New York City public schools. *Pediatrics* 2021;**147**:e2021050605. doi:10.1542/peds.2021-050605 Google Scholar

46. ↵ Ginther DK, Zambrana C. Association of mask mandates and COVID-19 case rates, hospitalizations, and deaths in Kansas. *JAMA Netw Open* 2021;**4**:e2114514. doi:10.1001/jamanetworkopen.2021.14514 Google Scholar

47. ↵ Adjodah D, Dinakar K, Chinazzi M, *et al*. Association between COVID-19 outcomes and mask mandates, adherence, and attitudes. *PLoS One* 2021;**16**:e0252315. doi:10.1371/journal.pone.0252315 Google Scholar

48. ↵ Huang J, Fisher BT, Tam V, *et al*. The effectiveness of government masking mandates on COVID-19 County-level case incidence across the United States, 2020: study examines the effectiveness of US government masking mandates during a portion of the COVID-19 pandemic. *Health Aff (Millwood)* 2022;**41**:445–53. Google Scholar

49. ↵ Marchant E, Griffiths L, Crick T, *et al*. COVID-19 mitigation measures in primary schools and association with infection and school staff wellbeing: an observational survey linked with routine data in Wales, UK. *PLoS One* 2022;**17**:e0264023. doi:10.1371/journal.p

one.0264023 Google Scholar

50. ↵ Guerra DD, Guerra DJ. Mask mandate and use efficacy for COVID-19 containment in US states. *Epidemiology* 2021. doi:10.1101/2021.05.18.21257385 Google Scholar

51. ↵ Viner R, Waddington C, Mytton O, *et al*. Transmission of SARS-Cov-2 by children and young people in households and schools: a meta-analysis of population-based and contact-tracing studies. *J Infect* 2022;**84**:361–82. doi:10.1016/j.jinf.2021.12.026 CrossRef Google Scholar

52. ↵ Bundgaard H, Bundgaard JS, Raaschou-Pedersen DET, *et al*. Effectiveness of adding a mask recommendation to other public health measures to prevent SARS-Cov-2 infection in Danish mask wearers: a randomized controlled trial. *Ann Intern Med* 2021;**174**:335–43. doi:10.7326/M20-6817 CrossRef PubMed Google Scholar

53. ↵ Abaluck J, Kwong LH, Styczynski A, *et al*. Impact of community masking on COVID-19: a cluster-randomized trial in Bangladesh. *Science* 2022;**375**:eabi9069. doi:10.1126/science.abi9069 Google Scholar

54. ↵ Chikina M, Pegden W, Recht B. Re-analysis on the statistical sampling biases of a mask promotion trial in Bangladesh: a statistical replication. *Trials* 2022;**23**:786. doi:10.1186/s13063-022-06704-z Google Scholar

55. ↵ Nanque LM, Jensen AM, Diness AR, *et al*. 2022 Effect of distributing locally produced cloth facemasks on COVID-19-like illness and all-cause mortality – a cluster-randomised controlled trial in urban Guinea-Bissau. *SSRN Electron J* doi:10.2139/ssrn.4307646 Available: https://www.ssrn.com/abstract=4307646 Google Scholar

56. ↵ Høeg TB, González-Dambrauskas S, Prasad V. The United States' decision to mask children as young as two for COVID-19 has been extended into 2023 and beyond: the implications of this policy. *Paediatr Respir Rev* 2023;**47**:30–2. doi:10.1016/j.prrv.2023.04.004 CrossRef Google Scholar

57. ↵ Lipps E, Caldwell-Kurtzman J, Motlagh Zadeh L, *et al*. Impact of face masks on audiovisual word recognition in young children with hearing loss during the COVID-19 pandemic. 2021. Available: https://digitalcommons.usu.edu/jehdi/vol6/iss2/8 [Accessed 5 Apr 2022]. Google Scholar

58. ↵ Sfakianaki A, Kafentzis, GP, Kiagiadaki D. Effect of face mask and noise on word recognition by children and adults. 12th International Conference of Experimental Linguistics; doi:10.36505/ExLing-2021/12/0055/000528 Google Scholar

59. ↵ Kim Y, Thompson A. An acoustic-phonetic approach to effects of face masks on speech Intelligibility. *J Speech Lang Hear Res* 2022;**65**:4679–89. doi:10.1044/2022_JSLHR-22-00245 Google Scholar

60. ↵ Secord W, Secord W, eds. *Eliciting sounds: techniques and strategies for clinicians* 2nd ed. Clifton Park, NY: Thomson Delmar Learning, 2007: 184. Google Scholar

61. ↵ Lewkowicz DJ, Hansen-Tift AM. Infants deploy selective attention to the mouth of a talking face when learning speech. *Proc Natl Acad Sci U S A* 2012;**109**:1431–6. doi:10.1073/pnas.1114783109 Abstract/FREE Full Text Google Scholar

62. ↵ Glaspey AM, Wilson JJ, Reeder JD, *et al*. Moving beyond single word acquisition of speech sounds to connected speech development with dynamic assessment. *J Speech Lang Hear Res* 2022;**65**:508–24. doi:10.1044/2021_JSLHR-21-00188 Google Scholar

63. ↵ Ruba AL, Pollak SD. Children's emotion inferences from masked faces: implications for social interactions during COVID-19. *PLOS One* 2020;**15**:e0243708. doi:10.1371/journal.pone.0243708 Google Scholar

64. ↵ Gori M, Schiatti L, Amadeo MB. Masking emotions: face masks impair how we read emotions. *Front Psychol* 2021;**12**:669432. doi:10.3389/fpsyg.2021.669432 Google Scholar

65. ↵ Marini M, Ansani A, Paglieri F, *et al*. The impact of facemasks on emotion recognition, trust attribution and re-identification. *Sci Rep* 2021;**11**:5577. doi:10.1038/s41598-021-84806-5 Google Scholar

66. ↵ Grundmann F, Epstude K, Scheibe S. Face masks reduce emotion-recognition accuracy and perceived closeness. *PLoS One* 2021;**16**:e0249792. doi:10.1371/journal.pone.0249792 Google Scholar

67. ↵ Neal M. *Early childhood educators' perceptions of the affect of Facemasks on the social-emotional and language/literacy development of their students: Dissertation manuscript*. 2023 Available: https://www.proquest.com/docview/2827188446/fulltextPDF/2965C60428F045F2PQ/1?accountid=14026 Google Scholar

68. ↵ Pazhoohi F, Forby L, Kingstone A. Facial masks affect emotion recognition in the general population and individuals with autistic traits. *PLoS One* 2021;**16**:e0257740. doi:10.1371/journal.pone.0257740 Google Scholar

69. ↵ Harmer CJ, Goodwin GM, Cowen PJ. Why do antidepressants take so long to work? A cognitive neuropsychological model of antidepressant drug action. *Br J Psychiatry* 2009;**195**:102–8. doi:10.1192/bjp.bp.108.051193 Abstract/FREE Full Text Google Scholar

70. ↵ Powell AA, Ireland G, Aiano F, *et al*. Perceptions of adolescents on the COVID-19 pandemic and returning to school: qualitative questionnaire survey, September 2020, England. *BMC Pediatr* 2022;**22**:456. doi:10.1186/s12887-022-03420-0 Google Scholar

71. ↵ Suess T, Remschmidt C, Schink SB, *et al*. The role of facemasks and hand hygiene in the prevention of influenza transmission in households: results from a cluster randomised trial. *BMC Infect Dis* 2012;**12**:26. doi:10.1186/1471-2334-12-26 Google Scholar

72. ↵ Walach H, Traindl H, Prentice J, *et al*. Carbon dioxide rises beyond acceptable safety levels in children under nose and mouth covering: results of an experimental measurement study in healthy children. *Environ Res* 2022;**212**(Pt D):113564. doi:10.1016/j.envres.2022.113564 Google Scholar

73. ↵ Brooks JP, Layman J, Willis J. Physiologic effects of surgical masking in children versus adults. *PeerJ* 2023;**11**:e15474. doi:10.7717/peerj.15474 Google Scholar

74. ↵ Martellucci CA, Flacco ME, Martellucci M, *et al*. Inhaled Co 2 concentration while wearing face masks: a pilot study using capnography. *Environ Health Insights* 2022. doi:10.1101/2022.05.10.22274813 Google Scholar

75. ↵ Prasad V, Cifu A. A medical burden of proof: towards a new ethic. *BioSocieties* 2012;**7**:72–87. doi:10.1057/biosoc.2011.25 CrossRef Google Scholar

Supplementary materials

Supplementary Data

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Data supplement 1

Footnotes

Twitter: @shamezladhani

Correction notice: This article has been corrected since it was first published. There were two minor spelling mistakes in 'What this study adds'.

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