

Measles containing vaccine hesitancy and readiness in the post-COVID-19 era: A 7C model commentary

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Abstract: The coronavirus disease 2019 (COVID-19) pandemic exposed the fragility of global immunization programs and intensified measles vaccine hesitancy, with global measles-containing-vaccine first-dose (MCV1) coverage falling from 86% in 2019 to 81% in 2021, with the number of unvaccinated children rising to 18 million. Using the 7C model of vaccine readiness, we highlight how Confidence, Complacency, Constraints, Collective responsibility, risk Calculation, Compliance, and Conspiracy beliefs shape parental decision-making in the post-pandemic era. Declining trust, low perceived disease risk, misinformation, and service barriers threaten progress towards measles eradication. We argue that recovery requires more than restoring coverage: resilient immunization strategies must address both structural barriers and psychological drivers of hesitancy. Clinician-led communication, accessible and free vaccination services, targeted social media engagement, and transparent informational dashboards are all essential tools for achieving effective disease management. Ultimately, vaccine readiness is not only about access – it is about trust, values, and resilience. Without decisive action, measles control will remain vulnerable to future global crises.

Keywords: COVID-19, measles-containing vaccine, vaccine uptake, vaccine hesitancy, vaccination readiness

1. Introduction

The onset of the coronavirus disease 2019 (COVID-19) pandemic posed a significant challenge to global healthcare systems and disrupted routine immunization programs. Measles cases doubled in 2022 compared to 2021, while the number of unvaccinated children rose from 13 million to 18 million globally (1). After the onset of the pandemic, the proportion of children receiving their measles-containing-vaccine first-dose (MCV1) decreased from 86% in 2019 to 81% in 2021 (2). As of 2024, the global MCV1 coverage remains around 84%, indicating that passive recovery will not prevent outbreaks – well below the 95% required to achieve herd immunity (2,3). Although these declines may appear as temporary setbacks, they point to a deeper issue – worsening vaccine hesitancy.

Vaccine hesitancy is a delay or refusal of vaccines despite the availability of services (4). It significantly impacts public health and was recognized by the World Health Organization (WHO) as "one of the top ten threats to global health", due to its potential to hinder the

progress toward herd immunity against measles. The 7C model of vaccine readiness provides a framework for understanding the psychological factors influencing vaccine hesitancy (5). The components include Confidence, Complacency, Constraints, Collective responsibility, risk Calculation, Compliance, and Conspiracy. Each component is considered a spectrum that includes vaccine acceptance on one end and vaccine refusal on the other (5). We use the 7C model as a lens to interpret the pandemic's impact on measles vaccine readiness.

2. Key observations through the 7C model

i) Confidence eroded as the politicization of the pandemic blurred perceptions of MCV safety. In the 7C model, confidence is defined as beliefs that relate to attitudes towards vaccination, trust in their safety and effectiveness, as well as in the systems that deliver them (Figure 1). Perceived adverse effects remain the leading reason for delay or refusal, with evidence suggesting that parents who reject MCV overestimate side-effect risk (6).

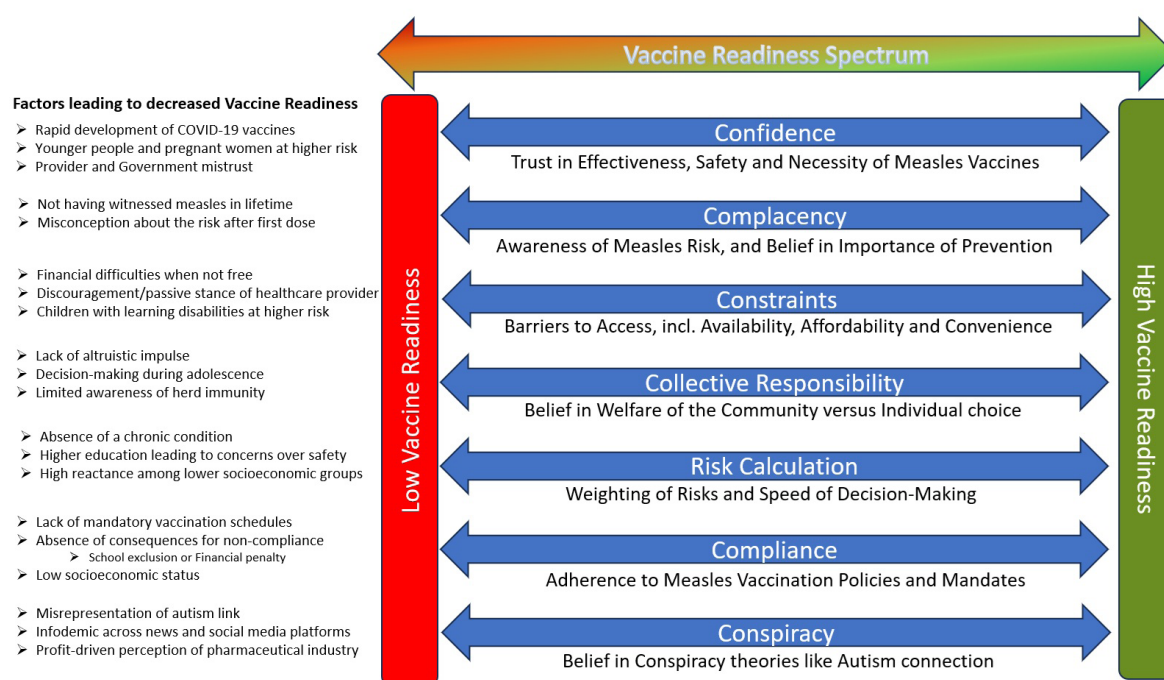


Figure 1. Measles-containing vaccine (MCV) hesitancy and readiness, and related factors.

ii) *Complacency rises when perceived disease risk is low.* Complacency refers to the level of recognized risk, perceived personal vulnerability, and severity of the disease. At the high end of the spectrum, people have minimal concern about the severity of vaccine-preventable diseases, leading to a perception that vaccination is optional or unnecessary. Complacency towards measles vaccination has emerged, particularly in regions where measles was previously well-controlled. Vaccine-hesitant parents believed the risks of vaccination were worse than measles itself, as they had never witnessed it (7). A significant number of parents in the United Kingdom under-recognized the potential severity and fatality of measles (8). In China, 20.5% of 2,178 caregivers identified complacency as a driver of vaccine hesitancy (9).

iii) *Constraints in physical and information access reduce readiness to vaccinate.* Constraints encompass systemic and individual barriers, including physical availability, geographical accessibility, affordability, or willingness to pay, and language literacy in a multiethnic context. In the United Kingdom (UK), the pandemic was associated with a significant drop in timely measles, mumps, and rubella (MMR) vaccine receipt, which increased the geographical clustering of measles susceptibility, especially in areas with historically low MMR coverage (10). Information about vaccination service availability is a distinct constraint for MCV: one in ten parents was unaware of ongoing vaccination appointments in the UK at the start of the pandemic (8). In Israel, ineffective official communication increased mistrust; service information must be paired with a clear communication strategy to counter this concern. Affordability issues create barriers to higher

immunization coverage when MCV is paid for out-of-pocket. In China, approximately 20% of parents reported the cost of out-of-pocket vaccines as a primary reason for hesitancy (9). In Sudan, approximately 12% of parents either partially vaccinated or did not vaccinate their children against measles due to vaccine availability or uncooperative vaccine providers (11).

iv) *Collective responsibility represents ethical considerations and the protections of others.* It is an individual's understanding of the broader societal benefits of vaccinations, particularly for the most vulnerable populations. The altruistic impulse to protect others significantly improves the willingness to get vaccinated (12). A unique neurobehavioral underpinning in young adults suggests that a decision-making tendency originating in adolescence may positively influence collective responsibility and, consequently, reduce vaccine hesitancy (13). The concept of herd immunity can motivate uptake but may dampen the effect of collective responsibility where local coverage is far from the threshold (3).

v) *Risk Calculation involves individuals' engagement in extensive research about vaccines, weighing risks versus benefits, potentially leading to delayed acceptance, selective vaccination, or refusal.* European countries reported lower proportions agreeing that the MMR vaccine was safe in 2022 compared to 2018 (14). A significant portion of German parents endorsed a measles vaccine mandate for children; however, lower socioeconomic status and higher levels of reactance negatively impacted vaccination intentions (15). Higher institutional trust was associated with lower reactance and more positive attitudes towards the mandate. This

suggests that trust mediates risk calculation and is therefore relevant to this component of vaccine readiness. Healthcare workers have a central role in guiding parental decisions regarding MCV risk calculation, with 96% of parents considering paediatricians their primary source of vaccination information (16).

vi) *Compliance refers to attitude toward vaccination policies and adherence to public health guidelines on vaccination* (17). It extends to support for monitoring communities and sanctioning unvaccinated individuals. In Italy, the threat of school exclusion and financial penalties for non-compliance with vaccination mandates had a positive impact on vaccination rates (18). In Germany, the 2020 measles vaccination mandate increased overall coverage but had unintended consequences; parents with lower socioeconomic status were less likely to comply (15).

vii) *Conspiracies beliefs persist. Conspiracy relates to the level of belief in conspiracy theories or trust in vaccination-related misinformation, also referred to as the infodemic.* The misrepresentation linking MCV to autism gave risk to many conspiracy theories and fostered scepticism among the general population (19). Despite conclusive evidence disproving the autism claim, fear persists and spreads via social media (6). This is confirmed by an inverse correlation between MMR vaccination coverage and internet search activity, tweets, and Facebook posts (20).

3. Policy and research implications

We argue that the COVID-19 pandemic, while primarily a health crisis, has also highlighted the fragility of vaccine confidence and public compliance. The rapid development and deployment of the COVID-19 vaccine affected public trust in vaccine safety and efficacy, and this showed the importance of transparent communication and vaccine literacy programs. Vaccine readiness is a spectrum of attitudes influenced by social, psychological, and environmental factors, as seen across the 7C model's antecedents (5). Using the model allowed us to investigate the issue from a unique perspective which can be applied in future reviews and studies. Confidence in vaccines is not merely a matter of individual assurance but a fundamental aspect of public health infrastructure, vulnerable to the effects of global and regional crises. Countries like the United Kingdom and Brazil, where measles vaccination coverage drastically fell, are examples of how swiftly gains in disease control can be reversed when public confidence decreases. To rebuild trust, transparent, clinician-led campaigns are needed to address safety concerns and counter misinformation. To raise awareness, local communities need to be educated about the severity of measles and the importance of receiving both MCV doses, especially in regions where the disease is no longer prominent. To remove barriers, vaccines need to be free, easily accessible, and accompanied by reminder systems. Through fostering social values, governments

need to promote the concept of protecting vulnerable groups by achieving herd immunity. Finally, we must strengthen policies by mandating school-entry vaccination requirements and funding catch-up campaigns whenever coverage has dropped.

Future research should focus on developing resilient immunization strategies that can withstand global crises. This involves not only addressing the immediate disruptions caused by such crises but also improving the public health systems to better prepare for future threats. The goal must extend beyond recovery: resilience of public health systems must be integral to health security. Only through a multidisciplinary approach can we restore and sustain high vaccination coverage rates, thereby protecting global health against both present and future challenges. Vaccine readiness is not just about managing diseases; it is about managing trust, expectations, and the foundational aspects of public health.

4. Conclusion and call to action

To address declining MCV uptake and rebuild public trust, we propose the following five key actions:

i) *Rebuild confidence with trusted voices.* Paediatricians and primary care providers should lead transparent communication with patients and their families. MCV has a strong safety record spanning over 60 years, and we, as physicians and public health professionals, should emphasize its importance not only for individual health but also for the population health.

ii) *Eliminate constraints.* Vaccines must remain free at the point of care. Active time-saving measures within the health system are also necessary to reduce logistical barriers, including appointment reminders, mobile vaccination units, and outreach in underserved areas.

iii) *Misconceptions must be countered.* Public health campaigns should present simple comparisons of disease risk versus vaccine risks. Parents trust personalized counselling, fact boxes, and clear framing, rather than abstract statistics.

iv) *We must overcome conspiracy narratives.* Health authorities should prioritize emotionally resonant pro-vaccine content on social media, rather than relying solely on debunking conspiracies.

v) *Use social media strategically and publish transparent data.* Sharing dashboards with MCV1 coverage at a district level increases individual and group accountability. Given that parents encounter TikTok before PubMed, health authorities should utilize social media and artificial-intelligence (AI) tools to counter recurrent myths in real time.

Funding: This work was supported by JSPS KAKENHI Grant Number 23K27850.

Conflict of Interest: The authors have no conflicts of interest to disclose.

References

1. UNICEF. The state of the world's children 2023: For every child, vaccination. UNICEF Innocenti - Global Office of Research and Foresight. Florence, Italy. 2023; p. 206.
2. WHO. Measles-containing-vaccine first-dose (MCV1) immunization coverage among 1-year-olds (%). [https://www.who.int/data/gho/data/indicators/indicator-details/GHO/measles-containing-vaccine-first-dose-\(mcv1\)-immunization-coverage-among-1-year-olds-\(-\)](https://www.who.int/data/gho/data/indicators/indicator-details/GHO/measles-containing-vaccine-first-dose-(mcv1)-immunization-coverage-among-1-year-olds-(-)) (accessed September 23, 2024).
3. Betsch C, Böhm R, Korn L. Inviting free-riders or appealing to prosocial behavior? Game-theoretical reflections on communicating herd immunity in vaccine advocacy. *Health Psychol.* 2013; 32:978-985.
4. MacDonald NE; SAGE Working Group on Vaccine Hesitancy. Vaccine hesitancy: Definition, scope and determinants. *Vaccine.* 2015; 33:4161-4164.
5. Geiger M, Rees F, Lilleholt L, Santana AP, Zettler I, Wilhelm O, Betsch C, Böhm R. Measuring the 7Cs of vaccination readiness. *Eur J Psychol Assess.* 2022; 38:261-269.
6. Wilder-Smith AB, Qureshi K. Resurgence of measles in Europe: A systematic review on parental attitudes and beliefs of measles vaccine. *J Epidemiol Glob Health.* 2020; 10:46-58.
7. Fadda M, Depping MK, Schulz PJ. Addressing issues of vaccination literacy and psychological empowerment in the measles-mumps-rubella (MMR) vaccination decision-making: A qualitative study. *BMC Public Health.* 2015; 15:836.
8. Freuds Health & Behaviour Change. MMR Childhood Vaccinations: Survey topline results. <https://khub.net/documents/135939561/174090192/2022+MMR+campaign+a+titutudinal+survey+results.pdf/8652d3a8-33fa-b7d6-6b12-81452d07394b> (accessed May 20, 2025).
9. Du F, Chantler T, Francis MR, Sun FY, Zhang X, Han K, Rodewald L, Yu H, Tu S, Larson H, Hou Z. The determinants of vaccine hesitancy in China: A cross-sectional study following the Changchun Changsheng vaccine incident. *Vaccine.* 2020; 38:7464-7471.
10. Firman N, Marszalek M, Gutierrez A, Homer K, Williams C, Harper G, Dostal I, Ahmed Z, Robson J, Dezateux C. Impact of the COVID-19 pandemic on timeliness and equity of measles, mumps and rubella vaccinations in North East London: a longitudinal study using electronic health records. *BMJ Open.* 2022; 12:e066288.
11. Sabahelzain MM, Moukhyer M, Bosma H, van den Borne B. Determinants of measles vaccine hesitancy among Sudanese parents in Khartoum state, Sudan: A cross-sectional study. *Vaccines (Basel).* 2021; 10:6.
12. Dorman C, Perera A, Condon C, Chau C, Qian J, Kalk K, DiazDeleon D. Factors associated with willingness to be vaccinated against COVID-19 in a large convenience sample. *J Community Health.* 2021; 46:1013-1019.
13. Freitas-Lemos R, Tomlinson DC, Yeh YH, Dwyer CL, Dai HD, Leventhal A, Tegge AN, Bickel WK. Can delay discounting predict vaccine hesitancy 4-years later? A study among US young adults. *Prev Med Rep.* 2023; 35:102280.
14. European Commission: Directorate-General for Health and Food Safety, Figueiredo Ad, Eagan RL, Hendrickx G, Karafillakis E, Damme, Pv, Larson HJ. State of vaccine confidence in the European Union 2022. <https://op.europa.eu/en/publication-detail/-/publication/b89452df-6958-11ed-b14f-01aa75ed71a1/language-en> (accessed May 20, 2025).
15. Neufeind J, Schmid-Küpke N, Rehfuess E, Betsch C, Wichmann O. How a generally well-accepted measles vaccine mandate may lead to inequities and decreased vaccine uptake: A preregistered survey study in Germany. *BMC Public Health.* 2022; 22:1846.
16. Loncarevic GS, Jovanovic AL, Kanazir MS, Kistic Tepavcevic DB, Maric GD, Pekmezovic TD. Are pediatricians responsible for maintaining high MMR vaccination coverage? Nationwide survey on parental knowledge and attitudes towards MMR vaccine in Serbia. *PLoS One.* 2023; 18:e0281495.
17. Giubilini A. Vaccination and herd Immunity: Individual, collective, and institutional responsibilities. In: *The Ethics of Vaccination*. Cham: Springer International Publishing. 2019; pp. 29-58.
18. D'Ancona F, D'Amario C, Maraglino F, Rezza G, Iannazzo S. The law on compulsory vaccination in Italy: an update 2 years after the introduction. *Euro Surveill.* 2019; 24: 1900371.
19. Rao TS, Andrade C. The MMR vaccine and autism: Sensation, refutation, retraction, and fraud. *Indian J Psychiatry.* 2011; 53:95-96.
20. Aquino F, Donzelli G, De Franco E, Privitera G, Lopalco PL, Carducci A. The web and public confidence in MMR vaccination in Italy. *Vaccine.* 2017; 35:4494-4498.

Received May 21, 2025; Revised August 23, 2025; Accepted August 27, 2025.

Released online in J-STAGE as advance publication September 2, 2025.

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