



Risk Assessment Methodology

Measles Scenario-Based Human Health Risk Assessment for the United States

Updated as of September 19, 2024

Risk Assessment Overview

Due to global and national shifts in measles transmission, the Center for Outbreak Response Innovation (CORI) conducted a scenario-based risk assessment to consider human health risks both now and in potential future scenarios. Risk assessments aim to enable structured consideration of complex scenarios, likelihoods, and consequences to determine the negative health impacts that may occur and inform decisions around future policy and operational action. Risk assessments allow policymakers to understand how the implementation of protective measures and future planning for worst-case scenarios can improve health outcomes. These assessments offer value by providing a systematic way to estimate risk with incomplete or imperfect information; this is critical because decisions must be made even in the absence of plentiful data. Therefore, the risk assessment will be updated as additional data become available.

The purpose of this document is to consider possible future developments regarding measles transmissions and describe corresponding risks to human populations in the US should a given scenario occur. In each scenario, we consider the risk to 4 distinct populations: unvaccinated people, children, healthcare workers, and the general public. In determining these risks, we consider several factors, including transmission pathways, human-to-human transmission, morbidity and mortality rates, the outbreak's current status, and potential events that could exacerbate the situation. Additionally, the assessment considers the effectiveness of preventative measures, ongoing response operations, and political factors that may influence the outbreak's progression.

Measles Special Considerations

Vaccination status of individuals and populations plays a key role in this risk assessment's scenarios. For this assessment, a well-vaccinated community is defined as having over 90% of the population vaccinated; communities with vaccination coverage at or below 90% are considered under vaccinated. The 90% threshold is used because it is the point at which [data](#) suggest that the chance of an outbreak rises to 51%, and as coverage continues to decline, the risk escalates further, according to the Centers for Disease Control and Prevention (CDC). Currently, the national vaccine coverage among kindergartners (typically ages 5 to 6) stands at [93%](#), which is slightly above this critical level, offering some protection against widespread outbreaks. The Healthy People 2030 initiative has a goal to achieve 95% vaccination coverage,



which would reduce the chance of an outbreak to approximately [29%](#). Reaching this higher level of coverage is essential to maintain herd immunity and ensure that measles outbreaks remain rare in the US. While 95% coverage is necessary for robust herd immunity, 90% serves as a critical minimum threshold, beyond which the risk of outbreaks increases substantially.

Scenarios

Five specific potential measles transmission scenarios were identified for the US based on the current national and global landscape. These scenarios are defined as follows:

Scenario 1 – Sporadic cases of measles, no outbreaks (baseline): In this scenario, the measles virus is occasionally introduced, usually by international travelers, into a community, but transmission lasts for less than 12 months. While sporadic cases can occur in any community with varying vaccination coverage, they often occur in well-vaccinated communities. Due to the high vaccination coverage, typically over 90%, continued transmission of the virus is effectively prevented through herd immunity. Public health authorities quickly identify and isolate the case, resulting in no or limited transmission, with a total of [1–2 related cases](#) that do not lead to an outbreak. This scenario represents the most common outcome, as 70% of international measles importations from [2001–2023](#) did not lead to outbreaks, thanks to robust vaccination efforts.

Scenario 2 – Development of small-to-medium outbreaks: In this scenario, small-to-medium outbreaks occur, with or without reports of sporadic cases, and do not result in sustained transmission beyond 12 months. These outbreaks may occur when measles virus is introduced to an undervaccinated community, typically with 90% or less vaccination coverage. Despite public health efforts, the lower vaccination rates create challenges in containing the virus. This leads to a small-to-medium outbreak, ranging from [3–49 related cases](#). The outbreak size is influenced by factors such as the density of the exposure setting, the effectiveness of the public health response, and chance events. For instance, a measles virus exposure at a school with an MMR vaccination rate of around 85% could result in an outbreak of 18 measles cases per 100 children exposed. However, the outbreak typically can be contained within a few weeks. From [2001–2023](#), 29% of international measles importations led to small-to-medium outbreaks.

Scenario 3 – Development of 1–2 large outbreaks: In this scenario, large outbreaks occur, with or without reports of small-to medium outbreaks and/or sporadic cases, and do not result in sustained transmission beyond 12 months. Large outbreaks typically occur in close-knit, undervaccinated settings with high population density, especially when there are pockets of unvaccinated individuals, such as migrant shelters or mass gatherings. Due to low vaccination coverage, often driven by lack of access or vaccine hesitancy, the virus spreads quickly.



This results in a large outbreak, ranging from [50 or more cases](#). Between [2001–2023](#), 88% of outbreaks larger than 50 cases occurred in undervaccinated communities. Controlling such an outbreak is particularly challenging due to the high density and low vaccination rates in the community. For example, a measles exposure in a migrant shelter where people may have low MMR vaccination coverage could trigger an outbreak of more than 50 cases that persists for several months despite extensive public health interventions, such as in the 2024 [Chicago outbreak](#). From [2001–2023](#), less than 1% of international measles importations led to large outbreaks.

Scenario 4 – Development of 3+ large outbreaks: In this situation, 3 or more large outbreaks (50+ cases) occur across different communities, with or without reports of small-to medium outbreaks and/or sporadic cases and does not result in sustained transmission beyond 12 months. These outbreaks are not connected by a shared chain of transmission but emerge independently due to various factors such as localized drops in vaccination coverage, mass gatherings, or travel-related introductions. Additionally, there may be an increase of sporadic cases in highly vaccinated communities due to widespread prevalence of the virus. This pattern of multiple unconnected outbreaks and sporadic cases presents unique challenges for public health authorities. The scattered nature of these cases indicates significant gaps in both surveillance and vaccination efforts. Effective control requires enhanced monitoring, rapid response to isolate and treat cases, and targeted vaccination campaigns to prevent the sporadic cases from initiating new outbreaks and to close immunity gaps within the population.

Scenario 5 – Sustained transmission beyond 12 months leading to loss of measles elimination status: In the fifth scenario, the virus maintains sustained transmission, regardless of vaccination coverage levels, for at least one year. The sustained transmission of the virus results in measles once again becoming endemic in the United States. The CDC defines [endemic transmission](#) as a chain of measles virus transmission that is continuous for 12 months or more within the US. Under this scenario, the US would lose its measles elimination status, which was achieved in 2000. This situation necessitates extensive public health interventions and efforts to regain control and re-establish elimination status.

Population Risk Scores

A risk score is determined for each key population across each possible scenario. Risk scores are evaluated on a 5-point scale, with scores including **low**, **low-moderate**, **moderate**, **moderate-high**, and **high** (see below).

Population Risk Scores				
Low	Low-Moderate	Moderate	Moderate-High	High



The confidence in each of these risk level assignments are based on the breadth, depth, and quality of available information. The overall confidence of each risk score determination is based on a 3-point scale, which includes low, moderate, and high. Each risk score and the confidence in the score is discussed in the Appendix. The scenarios* and their estimated risk scores** (estimated health impact) on specific populations are summarized below.

Assigning Risk Scores

Risk scores are assigned by CORI experts with over 15 years of experience in risk assessment, ensuring accurate and reliable evaluations. Each expert independently reviews evidence for each scenario, considering factors such as transmission pathways, human-to-human transmission dynamics, morbidity and mortality rates, outbreak status, potential exacerbating events, effectiveness of preventive measures, ongoing response operations, and political influences. In each scenario, the risk is assessed for four distinct populations: unvaccinated people, children, healthcare workers, and the general public. For each of these populations, the risks are carefully evaluated, and confidence levels are assigned based on the comprehensiveness and quality of the available data.

After their individual reviews, experts compare their initial risk level assessments. Any differences in these assessments are discussed, and a consensus is reached through informed debate. Risk scores are reviewed weekly to incorporate new information, with updates published if significant changes occur. At a minimum, risk scores are updated monthly to ensure they reflect the latest data.

Scenario-Based Human Health Risk Assessment for the US

*Please note: We are evaluating the risks to human health should each scenario occur, **not** the relative risk of any one scenario occurring. This risk assessment will be updated regularly.*

	Risk to unvaccinated people	Risk to children	Risk to healthcare workers	Risk to the US general public
Scenario 1 – Sporadic cases of measles, no outbreaks (baseline)	Low-Moderate	Low-Moderate	Low	Low
Scenario 2 – Development of	Moderate	Moderate	Low	Low

Measles in the United States



small-to-medium outbreaks				
Scenario 3 – Development of 1-2 large outbreaks	Moderate-High	Moderate-High	Low	Low
Scenario 4 – Development of 3+ large outbreaks	High	High	Low-Moderate	Moderate
Scenario 5 – Sustained transmission beyond 12 months leading to loss of measles elimination status:	High	High	Low-Moderate	Moderate

*CORI experts evaluate the risks to human health should each scenario occur, **not** the relative risk of any one scenario occurring.

** Our overall **confidence** in these risk scores is high given the current level and availability of information for each of these factors, historical knowledge from past outbreaks on transmission dynamics, and the availability of vaccination and treatment resources.



Appendix

Scenario 1: Sporadic introduction of measles into communities with high vaccination; outbreaks are quickly contained (baseline)

In the first scenario, we considered the risk to human health if measles is introduced sporadically into communities with high vaccination coverage and outbreaks are quickly contained.

We determined the health risk to **unvaccinated people** in this scenario to be **low-moderate**, the health risk to children to be **low-moderate**, the health risk to healthcare workers to be **low**, and the health risk to the general public to be **low**.

Our **confidence** in these risk scores is high.

To minimize the spread of measles in general, CDC recommends:

- [All children](#) receive a routine 2-dose the measles, mumps, and rubella (MMR) vaccine: the first dose at age 12 through 15 months and the second dose at age 4 through 6 years (before school entry).
- [Adults and teens](#) should also be up to date on MMR vaccinations, with either 1 or 2 doses (depending on risk factors), unless they have other presumptive evidence of immunity to measles, mumps, and rubella.
- [Healthcare personnel without presumptive evidence of immunity](#) should get 2 doses of MMR vaccine, separated by at least 28 days.

To minimize the risk of measles transmission [due to international travel](#), CDC recommends:

- Individuals DO NOT travel while sick, especially with a fever and rash.
- Individuals planning to travel outside of the US are fully vaccinated against measles at least 2 weeks prior to departure, in accordance with [CDC guidelines](#).
- Individuals traveling internationally with infants under 12 months old should ensure that their child receives an early dose of vaccine between 6 and 11 months, a second dose at 12 to 15 months, and a final dose at 4 to 6 years, in accordance with [CDC guidelines](#).
- Individuals returning to the US after international travel should monitor their health for 3 weeks and contact their local health department or provider if symptoms such as high fever, cough, or rash develop.



Scenario 2: Development of small-to-medium outbreaks

In the second scenario, we considered the risk to human health if small-to-medium measles outbreaks occur, with or without reports of sporadic cases, and do not result in sustained transmission beyond 12 months.

We determined the health risk to **unvaccinated people** in this scenario to be **moderate**, the health risk to children to be **moderate**, the risk to health risk to healthcare workers to be **low**, and the health risk to the general public to be **low**.

Our **confidence** in these risk scores is high.

To minimize the spread of measles and the potential for small-to-medium outbreaks, CDC recommends:

- Implementing all recommendations from Scenario 1.
- Provision of [post-exposure prophylaxis \(PEP\)](#) as needed to possibly provide protection or alter the progression of illness.
- Implementation of temporary, [accelerated vaccination schedules](#) at the discretion of the state and local health departments
- [Routine documentation of measles immunity status](#) among healthcare professionals to facilitate appropriate PEP or quarantine of individuals in the event of an occupational exposure

Scenario 3: Development of 1–2 large outbreaks

In the third scenario, we considered the risk to human health if 1–2 large measles outbreaks occur, with or without reports of small-to-medium outbreaks and/or sporadic cases, and do not result in sustained transmission beyond 12 months.

We determined the health risk to **unvaccinated people** in this scenario to be **moderate-high**, the health risk to children to be **moderate-high**, the risk to health risk to healthcare workers to be **low**, and the health risk to the general public to be **low**.

Our **confidence** in these risk scores is moderate due to the emphasis on sensitive surveillance and availability of public-facing timely, accurate case data necessary for detecting 1 or 2 large outbreaks, which may be limited if it is only the first or second large outbreak to occur.

To minimize the spread of measles and the potential for large outbreaks, CORI recommends:

- Implementing all recommendations from prior scenarios.



- Monitoring vaccination coverage rates within local and state jurisdictions, at the provider or clinic level, and within sub-communities that may be at increased risk of transmission due to mass gatherings (eg, schools, shelters, etc.).
- Promoting targeted vaccine messaging and mobile clinics for populations with low vaccine coverage.
- Promoting community and provider awareness of measles cases early on and through diverse media (eg, health alerts, clinician letters, and press releases).
- Building strong relationships with providers and schools (including school leadership and school nurses) to increase awareness of measles symptoms, testing, and isolation protocols.
- Enhancing communication between public health and medical leaders to share outbreak response experiences and lessons learned.

Scenario 4: Development of 3+ large outbreaks

In the fourth scenario, we considered the risk to human health if 3 or more large outbreaks (50+ cases) occur across different communities, with or without reports of small-to-medium outbreaks and/or sporadic cases, and do not result in sustained transmission beyond 12 months.

We determined the health risk to **unvaccinated people** in this scenario to be **high**, the health risk to children to be **high**, the health risk to healthcare workers to be **low-moderate**, and the health risk to the general public to be **moderate**.

Our **confidence** in these risk scores is high based on the assumption that the occurrence of multiple large outbreaks would be easily detected by surveillance and communicated to the public.

To minimize the spread of measles and the potential for multiple large outbreaks, CORI recommends:

- Implementing all recommendations from prior scenarios.
- Additional health departments consider implementing temporary, [accelerated vaccination schedules](#) at the discretion of the state and local health departments
- Possibly enhancing surveillance and active case finding in some situations and within certain populations.



Scenario 5: Sustained transmission beyond 12 months leading to loss of US measles elimination status

In the fifth scenario, we considered the risk to human health should the virus sustain transmission, regardless of vaccination coverage, for at least one year. The sustained transmission of the virus results in measles once again becoming endemic in the US.

We determined the health risk to **unvaccinated people** in this scenario to be **high**, the health risk to children to be **high**, the health risk to healthcare workers to be **low-moderate**, and the health risk to the general public to be **moderate**.

Our **confidence** in these risk scores is high based on the assumption that the occurrence of multiple large outbreaks would be easily detected by surveillance and communicated to the public.

To minimize the spread of measles and the potential for endemic measles transmission, CORI recommends:

- Implementing all recommendations from prior scenarios.
- Enhancing surveillance and active case finding in some situations and within certain populations.
- Considering implementation of more stringent requirements for MMR vaccination for children entering childcare settings.



References

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