The return of measles: a dangerous comeback

Katia C. Halabi

Purpose of review
Measles has reemerged as a significant global public health threat, with increasing morbidity and mortality associated with declining vaccination rates. This review summarizes current global outbreaks, history of measles, vaccination and elimination status, vaccine hesitancy, and outbreak response and lessons learned highlighting different novel digital epidemiological tools.

Recent findings
Measles continues to surge worldwide with an estimated 11 million infections in 2024, which is more than prepandemic levels. Developing and developed countries are both facing measles outbreaks, with the United States at risk of losing measles elimination status. Recent studies have showed that worldwide percentages of two-dose measles vaccination were lower than 95% that is required to interrupt measles transmission in all WHO regions. Novel epidemiological tools such as interactive simulators, real-time use of dynamic models, serosurveillance, and others are transforming measles outbreak response and enable earlier outbreak detection, tracking, and targeted public health interventions.

Summary
Vaccine hesitancy is one of the top global health threats and developing a tailored evidence-based approach is necessary to establish and maintain measles elimination.

Keywords
COVID-19 pandemic, measles outbreaks, misinformation, outbreak response, vaccine hesitancy

INTRODUCTION

Measles is resurging globally with increasing morbidity and mortality due to declining vaccination rates. Reduced vaccine uptake has been driven in part by growing vaccine hesitancy in addition to immunization disruptions imposed by the pandemic. In 2024, measles outbreaks were reported in 59 countries, resulting in a total of 359 447 [1]. These outbreaks were associated with an estimated 95 000 deaths, the majority occurring among children under the age of 5 [2]. In 2025, a total of 254 384 cases of measles were reported. As of June 2026, 133 603 cases have already been reported with outbreaks occurring across all WHO regions [1]. These trends emphasize the sustained global burden of measles and underscore that the WHO's goal of measles elimination by 2030 [3] remains elusive.

HISTORY OF MEASLES

In 910, Rhazes was the first to document a detailed description of measles differentiating it from smallpox [4]. Measles was referred to as morbilli or 'little disease' from the Latin word morbus 'disease' first introduced in the 1st century AD, and remained the standard terms for measles throughout the Middle Ages (50 AD–1500 AD) where several epidemics occurred widespread in Europe, South and East Asia, India, and China [5].

It was later in the 17th century that the epidemics in England and Scotland were reported by Thomas Sydenham who provided the modern description of the disease differentiating it from scarlet fever and smallpox [6,7].

Later, Peter Ludwig Panum provided the first comprehensive description of the epidemiology of measles during the epidemic on the Faroe Islands in 1846. He was able to identify the index case, determine the incubation period, and demonstrate high attack rates [8].

Henry Koplik (1858–1927) described the pathognomonic sign of measles, which is the bluish-white patchy pattern on the buccal mucosa which precedes the rash [9]. Subacute sclerosing panencephalitis, a

Infectious Diseases Division, Department of Pediatrics, Atlantic Health System, Goryeb Children's Hospital, Morristown, New Jersey, USA

Correspondence to Katia C. Halabi, MD, Infectious Diseases Division, Department of Pediatrics, Atlantic Health System, Goryeb Children's Hospital, Morristown, NJ 07960, USA. Tel: +973-971-6329; e-mail: katia.halabi@outlook.com

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KEY POINTS

- Measles is resurging globally and remain a public health threat.
- The COVID-19 pandemic impacted vaccination worldwide, strained the healthcare system, and disrupted public health infrastructure.
- Vaccine hesitancy is one of the top global threats per WHO.
- Barries to vaccination are multifactorial including inadequate infrastructure, healthcare and vaccine access, health inequities, vaccine hesitancy, and misinformation.
- The global measles outbreaks highlight the need for improvement in epidemiological surveillance systems to identify gaps through ongoing monitoring and continued vaccinations campaigns to achieve and sustain measles elimination.

rare severe complication of measles infection, was described in 1945 by Ludo van Bogaert [10]. By the early 20th century, the clinical manifestations of measles and its associated complications had been comprehensively described, and its profound impact on childhood health worldwide was well recognized.

PRE-VACCINE AND POST-VACCINE ERA

Measles was the leading cause of childhood mortality worldwide prior to the introduction of vaccines in 1963. Multiple factors contributed to the high mortality rates including limited understanding of the transmission, diagnosis, and treatment in addition to poor nutrition and crowded living conditions.

In 1912, measles became a nationally notifiable disease in the United States. Although data might be inconsistent, it was estimated that an average of 6000 deaths per year were attributed to measles in the early 1900s [11].

The early 1960s marked the new era with the groundbreaking introduction of live-attenuated measles vaccine, followed later by incorporation into the combined Measles, Mumps, and Rubella (MMR) vaccine with continued improvements in vaccine strain attenuation and delivery leading to substantial reductions in measles burden. However, following a major resurgence in 1988–1990 in the United States, the largest outbreak since 1977, a two-dose MMR schedule was implemented to further strengthen population immunity and further reduce incidence and fatality [11]. Prior to introduction of effective vaccination, measles epidemics occurred every 2–3 years and resulted in an estimated 2.6 million deaths each year [2].

ELIMINATION STATUS

Measles elimination is defined as a 12-month period with zero endemic cases supported by a well performing surveillance system [12]. Measles was declared eliminated from the United States in 2000. However, frequent outbreaks continue to occur with high resurgence of measles in the most recent years with the United States nearly losing its elimination status in 2019 and again is currently at risk. Other countries that lost their elimination status include Venezuela in 2018 (reverified measles free in 2023), Brazil in 2019 (reverified measles free in 2024) and most recently Canada in 2025 [12].

A DANGEROUS COMEBACK?

Pandemic: COVID-19

Several factors contributed to the rising measles cases; with COVID-19 pandemic being one of them. The pandemic impacted vaccination worldwide, strained the healthcare system, and disrupted the public health infrastructure. Most governmental and health organizations' efforts were directed towards the pandemic, which reduced the resources to combat other infections including vaccine-preventable diseases.

As of 2024, WHO reports that the global coverage with the first dose of MMR was 84%, which is slightly lower than prepandemic levels of 86% in 2019. While the number of measles deaths decreased by 88% from 780 000 to 95 000, the lowest since 2000, measles continue to surge worldwide with an estimated 11 million infections in 2024 which is nearly 800 000 more than prepandemic levels in 2019 [13]. In 2024, 59 countries reported large measles outbreaks, which are the highest since the onset of the COVID-19 pandemic [13].

Global risks

Global conflicts and difficult living conditions in many countries such as India, Yemen, Pakistan, Afghanistan, Democratic Republic of Congo, and others impacted the healthcare system and prevented the implementation of the vaccine campaigns. The world's most severe measles outbreak has been in Morocco in 2023–2025 with over 25 000 cases and 184 deaths [14]. However, vaccination rates have been dropping in developed countries as well as developing countries.

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Travel and international importations of measles from endemic countries have resulted in many outbreaks, for example, in the United States, 19% (747/3873) of cases reported between 2001 and 2019 were internationally imported cases, and 29% resulted in subsequent outbreaks [15]. However, the current increase in global outbreaks may not be solely from importations but rather from declining vaccination rates. GeoSentinel is a global surveillance network of travel and tropical medicine that monitors travel-associated illnesses [16▪▪]. Despite limitations in data, travel associated-measles did not show an uptrend between 2010 and 2025 [16▪▪]. Declining vaccination coverage is the primary driver of current measles outbreaks. Measles have resurged even in high-income countries that had once established elimination status due to the challenges in establishing and maintaining high vaccination rate of 95%. Even when overall vaccination rate is high, pockets of unvaccinated communities continue to pose a threat for outbreaks and ongoing transmission.

As of 2 July 2026, 2170 confirmed measles cases were reported in the United States with 31 new outbreaks and 93% of the confirmed cases (2019 of 2170) are outbreak-associated [17]. Ninety-two percent of the cases are unvaccinated or of unknown vaccination status [17]. MMR vaccination coverage among US kindergartners has declined from 95.2% during 2019–2020 school year to 92.5% in 2024–2025 school year hence leaving 286 000 kindergartners vulnerable to infection [17].

Vaccination

Measles remains a serious public health threat globally despite having the most effective prevention tool. The MMR vaccine is safe, effective, and cost effective. Although vaccine campaigns were implemented worldwide, there are remaining gaps in coverage attributed to health inequities, political conflicts, and vaccine hesitancy. Re-emergence of vaccine preventable diseases worldwide highlights the gaps in immunization and is a reminder of how infections do not respect borders. A global analysis conducted by Rubio for 2023 demonstrated that the worldwide percentages of two-dose measles vaccination were lower than the 95% that is required to interrupt the measles transmissions in all WHO regions [18▪▪]. The percentage of countries with two-dose measles vaccination coverage at least 95% decreased by 39.6% from 2019 to 2023 [18▪▪].

Simulation model developed to predict the re-emergence of vaccine-preventable diseases in the United States with the declining in vaccination rates estimated that measles is expected to be the first disease to return to endemicity [19▪▪].

IMPROVING VACCINATION RATES

Vaccine hesitancy is defined per WHO as delay in acceptance or refusal of vaccines, despite availability of vaccination services [20]. Vaccine hesitancy is on the top global threats identified by the WHO [21]. Addressing vaccine hesitancy includes identifying the determinants involved and developing a tailored evidence-based multifaced approach.

Measles vaccine misinformation goes back to 1998 when a study published in *Lancet* by Andrew Wakefield linked the MMR vaccine to autism. Despite the retraction of the study followed by several studies refuting this false claim, the misconception of this association persisted. This was followed by claims regarding vaccine ingredients such as thimerosal and mercury being a potential cause of autism.

Public misinformation in social and religious groups, the internet, and social media in combination with the distrust in the healthcare system has led to an increase in vaccine hesitancy. The COVID-19 pandemic exacerbated the public distrust due to the belief of governmental influence on health decisions. The rising skepticism was also coupled with the belief that natural infection is superior to vaccination highlighting the gaps in public knowledge about the consequences of the disease. Many perceive that children are getting less ill making vaccination less appealing and not recognizing that the lack of infection is a direct result of high vaccination rates and herd immunity.

Pediatricians play a vital role in re-establishing vaccine trust and are the primary advocates for children's health. Establishing empathetic conversations while acknowledging parental concerns is essential in building a trustworthy relation and improving vaccine acceptance. Providing clear and simple information to parents and having positive interactions with healthcare providers have been shown to increase parental vaccine literacy and decrease vaccine hesitancy [22▪]. Healthcare providers need tools to overcome cultural, social, and personal barriers that prevent parents from making informed decisions about vaccines.

HIGH TRANSMISSIBILITY AND EPIDEMIC POTENTIAL

The basic reproduction number (R_0) is defined as the average number of secondary infections caused by a single infected individual in a fully susceptible population [23]. It is a key epidemiological parameter used to estimate herd immunity threshold, and the level of vaccination coverage needed to achieve elimination. Measles is one of the most contagious human infectious diseases with R_0 estimated between 12 and 18 in fully susceptible populations, reflecting its extreme

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epidemic potential in the absence of immunity [23]. Due to high R_0, measles requires high level of herd immunity, at least 95%, to prevent sustained transmission. This unique characteristic results in high outbreak and epidemic potential requiring sustained high immunization coverage with even modest decline can result in resurgence and outbreaks.

OUTBREAK RESPONSE AND LESSONS LEARNED

Urgent and effective interventions are needed to address the resurgence of measles and other vaccine-preventable diseases. Novel epidemiological tools such as interactive simulators have been developed as part of outbreak response and demonstrate the impact of interventions such as vaccination, isolation, and quarantine [24]. Other tools such as real-time use of a dynamic model can also support public health response by setting expectations such as predicting outbreak size, duration, and quantifying the impact of the public health interventions [25].

Many countries battling outbreaks have shared their experiences and tools used to end the spread of measles. For example, Hong Kong was able to successfully eliminate and maintain measles elimination by providing the two-dose vaccine by establishing free and accessible vaccination sites. They also developed effective surveillance system, which resulted in timely investigation and effective control of outbreaks. It included case-based statutory notifications, acute fever and rash syndromic surveillance, laboratory surveillance (serology, PCR, genotyping), and reported suspected outbreaks [26▪▪]. They also implemented regular serosurveys for measles to identify potential gaps in the community followed by immunization and catch-up campaigns [26▪▪]. This highlights that measles serosurveillance is an essential tool that could be utilized to determine population immunity level, predict disease burden, and plan intervention.

Another study conducted by Chukwu demonstrated how data-informed forecasting and predictive modeling using Texas measles outbreak data from 2025 can mitigate resurgence of measles particularly in under immunized communities highlighting the risk of breakthrough infections, sustained transmission with immunity gaps, and recurrent outbreaks [27▪].

Several other epidemiological tools have been developed to estimate population susceptibility to measles incorporating several factors such as vaccine coverage and providing a comprehensive risk assessment. Kounchev *et al*. [28▪▪] describe Risk Index (RI), which is a dynamic tool used as indicator for risk of measles outbreak based on historical vaccine coverage as well as incorporating other factors that increase vulnerability to outbreaks such as demographics and population migration and mobility.

Another essential tool utilized during outbreak responses is the use of whole-genome sequencing. In a study conducted in Israel, whole-genome sequencing was used to differentiate sustained local transmission versus repeated importation [29▪▪]. This can be helpful to determine transmission patterns, especially in places at risk of importation resulting in subsequent clusters as opposed to a single outbreak linked to one genotype. Based on their experience, whole-genome sequencing allowed them to identify that the outbreak was a result of several different clusters and repeated importations highlighting the importance of using genomic epidemiology to improve outbreak investigations.

Further research is essential to develop a comprehensive integrated epidemiological surveillance system that can be utilized to forecast disease trends enabling timely public health interventions.

CONCLUSION

Eliminating measles will require a coordinated global response to improve vaccine availability and access, tools to address misinformation and vaccine hesitancy, improvement in health infrastructure, and established surveillance and outbreak response. Tailored action plans structured to adapt to the different emerging challenges encountered in a country or region are needed to achieve measles elimination.

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Conflicts of interest

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Papers of particular interest, published within the annual period of review, have been highlighted as:

- ▪ of special interest
- ▪▪ of outstanding interest

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The authors described their experience during the 2018–2019 measles outbreak in Israel using whole-genome sequencing to gain a better understanding of the transmission dynamics and outbreak control. The study demonstrated that the use of whole-genome sequencing allowed them to differentiate between one prolonged chain of local transmission versus many separate imported cases. This allowed them to learn that the outbreak was a result of numerous different clusters and repeated importations highlighting the importance of genomic epidemiology.

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