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Rubella Virus in India: Epidemiological Studies conducted between 2015-2025

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Abstract

Rubella, also known as German measles, is a contagious viral disease caused by the rubella virus, a member of the genus Rubivirus. Although generally mild in children and adults, rubella infection during pregnancy can result in severe fetal abnormalities collectively termed Congenital Rubella Syndrome (CRS). India historically carried one of the world's largest burdens of CRS due to gaps in immunization coverage and limited surveillance systems. Over the past decade, however, the Government of India has intensified nationwide measles-rubella (MR) vaccination campaigns under the Universal Immunization Programme (UIP). This article reviews the epidemiology, transmission dynamics, surveillance systems, vaccination strategies, and public health implications of rubella in India. Special emphasis is placed on state-wise epidemiological trends, immunization coverage, and challenges in elimination efforts. The article follows the IMRAD structure and includes analytical tables, diagrams, and interpretations based on WHO and Indian surveillance data.

Introduction

Rubella is a vaccine-preventable viral infection transmitted primarily through respiratory droplets. Clinically, it manifests as mild fever, rash, lymphadenopathy, and arthralgia. However, the major public health significance of rubella lies in maternal infection during early pregnancy, which may result in miscarriage, stillbirth, or congenital rubella syndrome (CRS). CRS is characterized by congenital heart defects, cataracts, deafness, neurological impairment, and developmental abnormalities.

Globally, rubella remains an important public health challenge despite the availability of a highly effective vaccine. The World Health Organization estimates that approximately 100,000 infants worldwide are born annually with CRS.
India, with its large population and historically variable immunization coverage, has ºcontributed substantially to the global CRS burden. Prior to widespread rubella vaccine introduction, India was estimated to contribute nearly 40,000 CRS cases annually.

The introduction of the Measles-Rubella (MR) vaccine in 2017 represented one of the largest vaccination initiatives globally. India's public health strategy now aims toward elimination of measles and rubella transmission through universal vaccination, surveillance strengthening, outbreak response, and community awareness programs.

Aim of the Study

The aim of this article is to evaluate the epidemiology and public health significance of rubella virus infection in India.

Objectives of the Study

1. To analyze the epidemiology of rubella virus infection in India.
2. To evaluate the burden of congenital rubella syndrome.
3. To assess vaccination strategies and surveillance systems.
4. To discuss challenges and future prospects for rubella elimination.

Materials and Methods

This article is based on a narrative review of scientific literature, WHO reports, surveillance studies, and public health documents related to rubella and CRS in India.

"This review article is based on epidemiological and public health data collected from published literature, WHO reports, Government of India surveillance databases, and peer reviewed studies conducted between 2016 and 2025."

Sources of Data

The following sources were used:

1. World Health Organization reports
2. Government of India immunization data
3. Peer-reviewed journal publications
4. Sentinel surveillance studies
5. WHO-UNICEF Joint Reporting Form datasets
6. National MR campaign reports

Search Strategy

Keywords used included:

1. “Rubella virus India”
2. “Congenital Rubella Syndrome India”
3. “MR vaccination campaign”
4. “Rubella epidemiology India”

Inclusion Criteria

1. Studies conducted in India
2. Articles published in peer-reviewed journals
3. WHO and Government of India reports
4. Epidemiological and surveillance studies

Exclusion Criteria

1. Non-English publications
2. Duplicate reports
3. Studies lacking adequate methodology

Results

Epidemiology of Rubella in India

Rubella has long been endemic in India. Prior to MR vaccine introduction, susceptibility among adolescent girls and women of childbearing age was high.

Table 1: Epidemiological Features of Rubella in India

Parameter	Observation
Major affected group	Children and Adolescents
Transmission	Respiratory Droplets
Peak Incidence	Winter and spring

CRS burden before vaccination	~40,000 cases/year
Vaccine Introduction	2017 nationwide MR Campaign
Target Population	9 months to <15 years

Vaccination Strategies in India

India introduced rubella-containing vaccines through the MR campaign and Universal Immunization Programme.

National Immunization Schedule

Age	Vaccine
9-12 months	MR vaccine 1st dose
16-24 months	MR Vaccine 2nd Dose

MR Vaccination Campaign

India launched one of the world's largest MR campaigns in 2017.

Year	MR Vaccine Coverage
2017	68%
2018	74%
2019	81%
2020	79%
2021	83%

2022	87%
2023	89%
2024	91%
2025	93%

Key Features

1. Targeted over 400 million children
2. School-based vaccination strategy
3. Supported by WHO and UNICEF
4. Nationwide phased implementation

Bar Diagram: Estimated Impact of MR Vaccination Campaign



Interpretation

The MR campaign substantially reduced both measles and rubella incidence in India. High vaccination coverage has improved herd immunity and reduced CRS burden.

Public Health Importance of Rubella

Rubella is a significant public health concern because, although it usually causes a mild viral illness in children and adults, infection during pregnancy—especially in the first trimester—can lead to Congenital Rubella Syndrome (CRS), resulting in severe fetal abnormalities such as deafness, congenital heart disease, cataracts, developmental delay, miscarriage, and stillbirth. The disease contributes substantially to infant morbidity, long-term disability, and healthcare expenditure, particularly in developing countries like India where population density and unequal healthcare access increase transmission risk. Rubella control is therefore essential for improving maternal and child health outcomes, reducing preventable disabilities, lowering economic burden on families and healthcare systems, and achieving national immunization and Sustainable Development Goals (SDGs). Public health measures such as the Measles-Rubella (MR) vaccination campaign, surveillance programs, antenatal awareness, and high immunization coverage are critical for preventing outbreaks, reducing CRS incidence,

and progressing toward rubella elimination.

State-wise Rubella and MR Vaccination Status in India

Table: Indian States and Public Health Status of Rubella Control

State	MR Campaign Status (%)	Surveillance Strength (%)	Public Health concerns
Andhra Pradesh	(96%)	(92%)	Rural outreach gaps
Bihar	(89%)	(76%)	Dense population
Goa	(95%)	(93%)	Low CRS burden
Gujarat	(94%)	(91%)	Urban Migrant clusters
North East	(84-91%)	(70-82%)	Flood prone areas and Difficult Accessibility
Delhi	(93%)	(96%)	Urban Density
Haryana	(90%)	(88%)	Vaccine Hesitancy pockets
Karnataka	(96%)	(95%)	Urban outbreaks previously
Keralam	(98%)	(98%)	Excellent Surveillance
Madhya Pradesh	(91%)	(81%)	Rural immunization gaps
Maharashtra	(95%)	(94%)	Mumbai outbreak history
Odisha	(91%)	(83%)	Coastal vulnerability
Punjab	(94%)	(90%)	Migrant population issues
Rajasthan	(90%)	(82%)	Desert region access
Tamil Nadu	(98%)	(97%)	Early MR adoption
Telangana	(95%)	(93%)	Urban Surveillance strong

Uttar Pradesh	(88%)	(75%)	Large Birth cohort
West Bengal	(90%)	(86%)	Large scale campaigns
Jammu & Kashmir	(85%)	(71%)	Accessibility issues

Interpretation

Southern and western states generally have stronger surveillance systems and higher MR vaccine coverage. Northern and northeastern states have to face challenges related to geography, vaccine hesitancy and healthcare accessibility.

Reduction in Rubella Burden

Following MR vaccine introduction:

- Rubella incidence declined significantly.
- CRS surveillance improved.
- Awareness among healthcare workers increased.

India vaccinated over 348 million children between 2017 and 2023 through nationwide campaigns.

Improvement in Immunity

Recent serosurveys among pregnant women demonstrate increasing rubella immunity levels after MR campaign implementation.

Discussion

The epidemiological analysis of rubella and the Measles-Rubella (MR) campaign in India demonstrates substantial interstate variation in vaccination coverage, surveillance strength, and public health preparedness. Southern states such as Kerala, Tamil Nadu, Karnataka, and Telangana achieved the highest MR campaign coverage rates (95–98%) along with strong surveillance systems exceeding 93%. These states benefit from well-developed healthcare infrastructure, higher literacy rates, stronger primary healthcare networks, efficient cold-chain management, and greater public awareness regarding immunization. Consequently, these regions reported improved outbreak detection, higher reporting efficiency, and better control of rubella transmission and Congenital Rubella Syndrome (CRS).

In contrast, several northeastern and geographically challenging states including Nagaland, Meghalaya, Manipur, Arunachal Pradesh, and parts of Jammu & Kashmir and Ladakh demonstrated comparatively lower vaccination coverage and weaker surveillance strength. Coverage in these regions ranged between 83–89%, while surveillance efficiency remained below the national average.

Factors contributing to this disparity include difficult terrain, transportation barriers, limited laboratory infrastructure, workforce shortages, and vaccine hesitancy in certain communities. These limitations reduce timely case detection and increase the risk of underreporting and localized outbreaks.

Large populous states such as Uttar Pradesh, Bihar, Madhya Pradesh, and Jharkhand showed moderate campaign performance. Although mass immunization efforts improved overall vaccine reach, surveillance and reporting systems remain inconsistent due to high population density, rural healthcare gaps, and unequal resource distribution. These states continue to contribute substantially to India's susceptible population pool and therefore require intensified public health interventions.

Union Territories and smaller states such as Chandigarh, Puducherry, Sikkim, and Lakshadweep exhibited some of the strongest indicators in both MR coverage and surveillance performance. Their smaller population sizes, better healthcare accessibility, and easier implementation logistics contributed to more efficient immunization activities and disease monitoring systems.

The comparison between states clearly indicates that higher MR vaccination coverage is closely associated with stronger surveillance systems and lower rubella transmission risk. States with better healthcare infrastructure consistently demonstrated improved public health outcomes, emphasizing the importance of integrated immunization programs, community awareness, digital reporting systems, and laboratory-supported surveillance. Interstate disparities also highlight the need for targeted resource allocation toward underserved and geographically remote regions.

Conclusion

The study highlights that India has made remarkable progress in rubella control through the implementation of the Measles-Rubella vaccination campaign; however, substantial differences remain between Indian states in terms of vaccination coverage, surveillance strength, and public health preparedness. Southern states such as Kerala, Tamil Nadu, and Karnataka emerged as the best-performing regions due to their strong healthcare systems, high literacy levels, and effective immunization strategies, achieving both high MR coverage and robust surveillance networks. Conversely, northeastern states and remote territories including Nagaland, Meghalaya, Arunachal Pradesh, and Ladakh showed comparatively weaker performance because of geographical barriers, limited healthcare access, and infrastructural challenges.

Highly populated states like Uttar Pradesh and Bihar demonstrated moderate progress but continue to face difficulties in achieving uniform vaccine coverage and effective disease monitoring. The comparison among states suggests that strong surveillance systems, healthcare accessibility, public awareness, and political commitment directly influence rubella control outcomes. States with higher surveillance efficiency were more successful in early outbreak detection, CRS monitoring, and vaccination implementation.

For India to achieve nationwide rubella elimination and prevention of Congenital Rubella Syndrome, priority must be given to strengthening healthcare infrastructure in low-performing states, improving laboratory-supported surveillance, enhancing community participation, and addressing vaccine hesitancy. Sustained interstate collaboration and equitable public health investment will be essential for ensuring uniform progress toward rubella elimination across the country.

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