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The Measles Outbreak in Mumbai (2022-2023): Management, Challenges, and Gaps in Public Health Response Strategies

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Abstract

Measles is a highly contagious disease and develops from infection by Measles virus. The Measles virus is transmitted by respiratory route and before the introduction of vaccination, more than 2 million deaths were reported annually. The 2022-2023 measles outbreak in Mumbai was a significant public health challenge, exposing critical gaps in immunization coverage and outbreak preparedness in one of India's largest financial and urban centers. The present review paper examines the epidemiology of the outbreak, management strategies used, and the challenges faced in controlling the disease spread, particularly in vulnerable slum communities. The outbreak resulted in over 600 confirmed cases and 18 reported deaths, with the majority of cases occurring among unvaccinated children. The key drivers included disruptions to routine immunization during the COVID-19 pandemic, socioeconomic inequities, and vaccine hesitancy fueled by misinformation. In response, the Brihanmumbai Municipal Corporation (BMC) implemented rapid outbreak response immunization campaigns, intensified surveillance, and extensive community engagement initiatives. While these measures successfully contained the outbreak, they also had a gap and area for improvement with the need for more resilient immunization systems, robust surveillance, and proactive community involvement. The analysis of Measles outbreak data highlights the importance of sustained vaccine coverage, culturally sensitive public health messaging, and targeted outreach to high-risk populations. The outcome of a gap analysis from this outbreak provides valuable insights for strengthening future outbreak preparedness and ensuring equitable health access in urban India.

Keywords: Measles outbreak, Mumbai 2022-2023, vaccination coverage, public health response, vaccine hesitancy, outbreak management

Introduction

Measles is a highly contagious and febrile illness caused by Morbillivirus hominis, a nonsegmental, single-stranded, enveloped RNA virus, classified under the Paramyxoviridae family [1,2]. Its genome encodes six structural proteins, of which the haemagglutinin (HA) protein is responsible for virus attachment to the host cell [3]. This potentially fatal infection has an airborne transmission mechanism: through respiratory droplets, small particle aerosols, and close contact from the nose, mouth or throat of infected individuals, to others [4].

The typical incubation period of the measles is about 13 days, ranging from 7-21 days. Initially, the viral particles, from the exposed droplets, infect the CD150+ cells or binding to dendritic cells (DCs) expressing DC-SIGN+ or alveolar macrophages. The virus residing in the dendritic cells and lymphocytes transfers itself to the epithelial cells of the respiratory tract, by coughing

and sneezing [5]. Infected CD150+ lymphocytes, mostly CD4+ memory T cells, disseminate the infection systemically through both the bloodstream and the lymphatic systems, leading to clinical manifestations, post the incubation period (10-14 days) [4][6].

Thereafter, during the prodromal phase (the next 2-4 days) the viral prodrome typically consists of increasing fever, anorexia, malaise, and the classic triad of three "C's": coryza (runny nose), cough, and conjunctivitis (red and watery eyes). At this stage, Belsky-Filatov-Koplik spots may begin to appear on the mucous membrane of the cheeks. These are small 1 to 3 mm whitish-blue papules with a "grain of sand or rice" appearance on an erythematous base [6]. About 3-4 days after the initiation of physical symptoms, there is an onset of a characteristic maculopapular rash that starts developing on the face (especially around the hairline) and at the nape of the neck and then spreading downwards [7]. Measles is characterized by a polysystemic lesion, this is associated as the peak of the clinical picture. The Fever may continue or spike higher during this stage.

Measles

Measles can weaken the immune system, making the body more susceptible to other infections. 1 in 5 measles patients meet with complications, most commonly observed in those <5 and >20 years old. For example, measles pneumonia is the cause of death in 60% of cases [8] and it is a result of immunosuppression and proliferation of secondary bacterial species. Other serious complications, caused by similar consequences, include blindness, encephalitis (inflammation of the brain), acute gastroenteritis with dehydration, acute otitis media and Subacute Sclerosing Panencephalitis (SSPE)[6].

If the clinic presentation such as the set of symptoms and characteristic rash remain unclear, laboratory confirmation is required for the confirmation of measles for appropriate treatment. The most common confirmation is based on a positive serological report for antibodies to immunoglobulin M (IgM) to measles as the serum IgM levels rise about 4 times after the onset of the rash and can remain detectable for weeks. The presence of Measles can also be confirmed, even before the development of antibodies, by detecting measles virus RNA using reverse transcriptase polymerase chain reaction (RT-PCR) in blood samples, throat and nasopharyngeal swabs, or urine [9].

The virus, with a basic reproduction number (Ro) estimated to be around 12-18, can spread exponentially within vulnerable populations, causing major epidemics worldwide [2] .

Measles Outbreak in Mumbai

In the month of September 2022, the measles outbreak began in the state of Maharashtra, lasting till March 2023. In 2022 itself, Maharashtra, having recorded 3075 and 13 deaths, was the state with the most number of cases in India [10]. Within Maharashtra, the capital city of Mumbai emerged as the epicenter of the measles epidemic.

Between 17-23 September 2022, the Mankhurd area, a predominantly Muslim slum in Eastern Mumbai reported six such cases, following the onset of clinical manifestations. Of these six cases, measles IgM antibodies were found in five reported case-patients by enzyme-linked immunosorbent assay (ELISA); shortly after, the outbreak was declared to the public. The

incidence of the disease in Eastern Mumbai, displayed an upward trend with 0.83/million population while previously, being 0 in the previous three years [11].

The Brihanmumbai Municipal Corporation, Mumbai's civic governing body, confirmed 601 cases and 18 measles deaths [12] - a death within 30 days of onset of rash without any obvious causes in a person of any age within the last 90 days [11]. Further analysing the official deaths, in the initial three weeks of the outbreaks (October 26- November 15 2022) 7 of the 18 deaths were reported [13]. However, only one of out of the official deaths was from the following year of 2023 [5], this indicates the rapid decrease in the mortality rate, which was a result of government action to boost herd immunity.

The overall reported mortality rate (CFR) was ~3%, significantly higher than the average global CFR of 0.1–0.3%. Initially the disease remained concentrated at the epicentre, thereafter by November end, more and more cases started showing up in the slum pockets of Byculla, Kurla and Bandra and began decreasing in Govandi, itself. Three months following the outbreak, the M-East ward (Govandi) which had five outbreaks and fifteen cases, was surpassed by the L Ward (Kurla), which reported 14 outbreaks and 73 cases [14].

Between September 2022 to February 2023, an observational, epidemiological study was conducted by ICMR-National Institute of Epidemiology. Through an active house-to-house search for cases, initiated by the Mumbai City Municipal Corporation immediately after the outbreak confirmation, relevant data was collected to analyse the demographics and symptoms' frequency of the eastern slum outbreak, to act as a representative sample. The sample space consisted of the under-15 population, comprising 3,156 individuals residing in approximately 3,100 houses in the eastern slum. Out of which, 358 cases were identified (including 6 laboratory-confirmed cases) concluding an overall attack rate of 11.3% and case fatality rate of 1.1%.

Table 1 provides data on the attack rate % of each age group (in months) by calculating number of case divided by population (n) sample*100 for each category. As evident in Table 1, attack rates were highest in the 0–24-month age group (38.8%) and with boys (13%) with Median age of cases at 30 months (Interquartile range: 16–48 months). In terms of sex, the outbreak evidenced a male preponderance, given that males had a higher attack rate % and 100% of the deaths being of males. **Figure 1 A** and **B** represents ward wise distribution of the total number of lab confirmed Measles cases. **Table 2, Figure 2A** and **Table 3, Figure 2B** represent Measles outbreak statistics for the year 2022 and 2023 respectively. **Table 4** and **5** summarises the total number of cases for the year 2022 and 2023 respectively.

Person Characteristics	**Number of Cases**	**Population (n)**	**Attack Rate (%)**	**Number of Deaths**	**Case Fatality (%)**
Age (Months)					

0–12	76	234	32.5	0	0
13–24	85	219	38.8	2	2.4
25–60	159	648	24.5	2	1.2
61–120	32	986	3.2	0	0
120–180	6	1,069	0.6	0	0
Sex					
Male	205	1,582	13	4	2
Female	153	1,574	9.7	0	0
Total	358	3,156	11.3	4	1.1

Table 1: Distribution of case-patients by age and sex, Eastern Mumbai slum, India, September 2022–February 2023 [11]

This field research also found out that the peak, in number of cases, occurred by the end of the second week of November 2022, which coincided with the period during which the majority of cases reported onset of a fever, (132 cases, 36.9%) [11].

Sr. No.	Ward	Number of Fever with Rash (FR) Cases	Number of Lab Confir-med Measles Cases	Number of Lab Confirmed Rubella Cases	Total number of Suspected Outbreaks	Number of Positive Outbreaks	Number of Negative Outbreaks	Number of Death cases
1	BMC_WARD A	26	8	1	2	1	1	0
2	BMC_WARD B	56	10	0	2	2	0	0

3	BMC_WARD C	32	6	0	2	2	0	1
4	BMC_WARD D	67	9	0	3	1	2	0
5	BMC_WARD E	237	44	2	7	7	0	0
6	BMC_WARD F/N	370	26	0	5	4	1	0
7	BMC_WARD F/S	70	11	1	3	3	0	0
8	BMC_WARD G/N	395	12	2	4	1	3	0
9	BMC_WARD G/S	149	19	0	6	3	3	0
10	BMC_WARD H/E	301	23	2	5	5	0	0
11	BMC_WARD H/W	35	4	0	2	1	1	0
12	BMC_WARD K/E	141	14	6	8	3	5	1
13	BMC_WARD K/W	135	20	1	6	4	2	0
14	BMC_WARD L	701	89	1	15	14	1	1
15	BMC_WARD M/E	2573	134	3	9	9	0	8
16	BMC_WARD M/W	146	17	3	7	5	2	0
17	BMC_WARD N	115	19	1	7	3	4	0
18	BMC_WARD P/N	436	45	3	10	8	2	0
19	BMC_WARD P/S	81	20	3	5	3	2	0

20	BMC_WARD R/C	73	4	5	2	0	2	0
21	BMC_WARD R/N	96	7	3	5	0	5	0
22	BMC_WARD R/S	117	13	3	5	3	2	0
23	BMC_WARD S	137	16	3	5	2	3	0
24	BMC_WARD T	28	3	2	0	0	0	0
	Total	6517	573	45	125	84	41	11

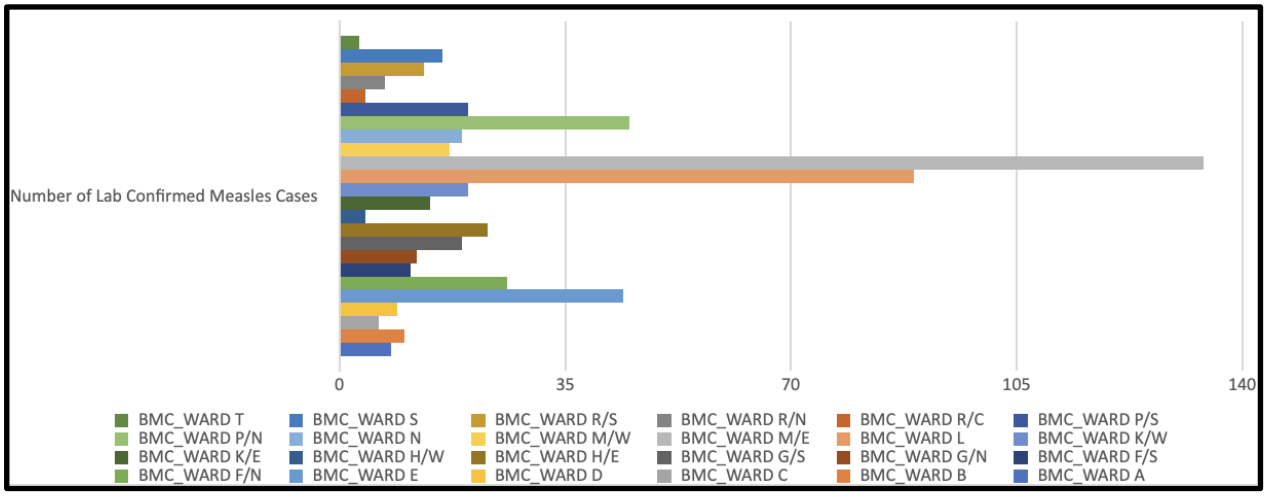
Table 2. Measles outbreak statistics for the year 2022

Sr. No.	Ward	Number Of Fever With Rash (FR) Cases	Number Of Lab Confir-med Measles Cases	Number of Lab Confirmed Rubella Cases	Total No of Suspected Outbreaks	Number Of Positive Outbreaks	Number Of Negative Outbreaks	Number of Death cases
1	BMC_WARD A	15	5	1	1	1	0	0
2	BMC_WARD B	26	2	0	0	0	0	0
3	BMC_WARD C	33	8	0	1	1	0	0
4	BMC_WARD D	33	6	1	0	0	0	0
5	BMC_WARD E	125	15	1	1	1	0	0
6	BMC_WARD F/N	129	15	1	0	0	0	2
7	BMC_WARD F/S	48	7	1	0	0	0	0
8	BMC_WARD G/N	345	13	4	4	1	3	0
9	BMC_WARD G/S	76	8	2	0	0	0	0

10	BMC_WARD H/E	133	15	3	1	1	0	0
11	BMC_WARD H/W	40	3	2	0	0	0	0
12	BMC_WARD K/E	166	24	3	2	0	2	0
13	BMC_WARD K/W	97	8	1	0	0	0	0
14	BMC_WARD L	309	18	1	0	0	0	1
15	BMC_WARD M/E	210	29	4	0	0	0	1
16	BMC_WARD M/W	52	5	2	0	0	0	0
17	BMC_WARD N	73	12	2	0	0	0	0
18	BMC_WARD P/N	283	31	0	0	0	0	0
19	BMC_WARD P/S	75	20	1	0	0	0	0
20	BMC_WARD R/C	86	14	0	1	0	1	0
21	BMC_WARD R/N	89	4	2	1	0	1	0
22	BMC_WARD R/S	159	22	2	1	1	0	0
23	BMC_WARD S	99	6	2	1	1	0	0
24	BMC_WARD T	45	4	0	0	0	0	0
	Total	2746	294	36	14	7	7	4

Table 3. Measles outbreak statistics for the year 2023

A



B

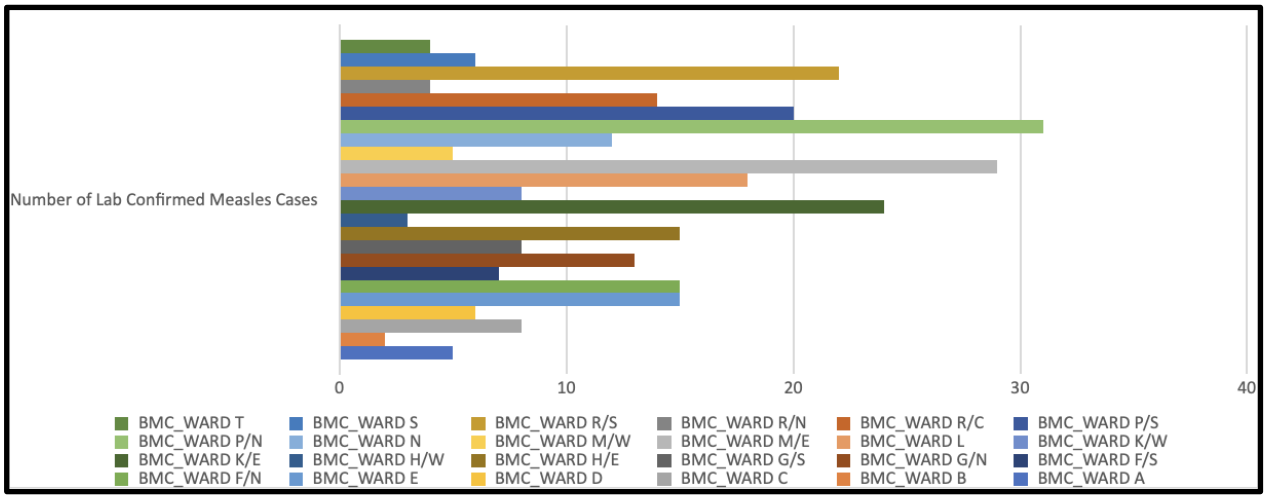
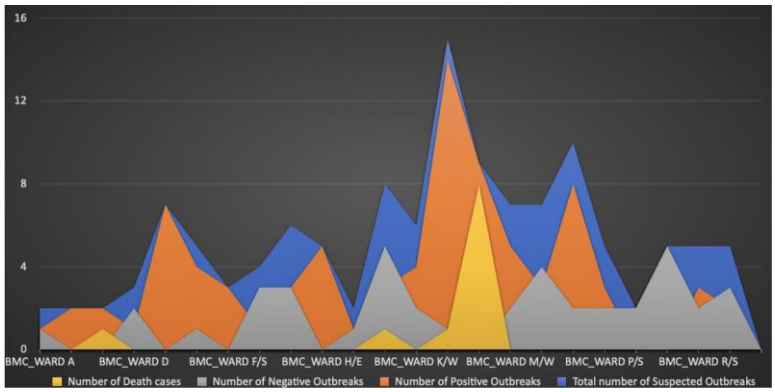


Figure 1. Ward wise distribution of lab confirmed Measles cases. The distribution of lab confirmed Measles cases in the year **A)** 2022 and **B)** 2023

A



B

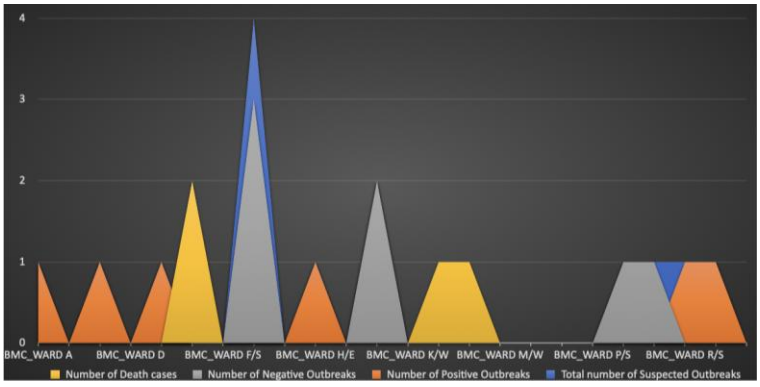


Figure 2. Measles outbreak statistics. The Measles outbreak statistics for the year **A)** 2022 and **B)** 2023

Number of Fever with Rash (FR) Cases	Number of Lab Confirmed Measles Cases	Total number of Suspected Outbreaks	Number of Positive Outbreaks	Number of Negative Outbreaks	Number of Death cases
6517	573	125	84	41	11

Table 4. The total number of cases for the year 2022

Number of Fever with Rash (FR) Cases	Number of Lab Confirmed Measles Cases	Total number of Suspected Outbreaks	Number of Positive Outbreaks	Number of Negative Outbreaks	Number of Death cases
2746	294	14	7	7	4

Table 5. The total number of cases for the year 2023

The goals of measles outbreak response

A measles outbreak is flagged if > 5 suspected cases are reported in a planning unit within four consecutive weeks. Since the M-East ward of MCGM reported six relevant cases within just a week, an outbreak was officially declared on 20 September 2022 [11]. Following the confirmation, a measles outbreak response was strategically planned and carried out by the Mumbai City Municipal Corporation. Since measles is a highly infectious air borne disease, the government had to quickly draft a plan of action to control and contain the outbreak. Daily review meetings were conducted by the Additional Municipal Commissioner Dr. Vipin Sharma and Executive Health Officer Dr. Daksha Shah, under the guidance of Municipal Commissioner Mr. Iqbal Singh Chahal, to respond effectively to the recruitment. The objectives of the immediate response aimed to prevent further transmission and minimize mortality and morbidity of the arising epidemic [15].

To understand the reasons for the resurgence and to identify the root causes of the outbreak which was necessary for carrying out an effective course of action, the health authorities conducted epidemiological investigations, tracking the transmission and analysing affected populations. It was soon discovered that majority of the affected patients were unvaccinated, or had missed vaccination doses; the ICMR study [11] on 100 measles patients discovered that 62% of the patients had not been vaccinated, and 48% of the patients did not receive both doses of the measles and rubella vaccine. The crucial observation that indicated the direct, positive correlation between vaccination failure and the outbreak. Keeping this in mind, a key aim of the response included boosting herd immunity in vulnerable areas of Mumbai by achieving

high immunization coverage to halt additional spread. Additionally, increasing public awareness and vaccine confidence were also critical goals of the mitigation efforts. Contributing factors of the vaccine hesitancy, that led to vaccine failure, were misconceptions, myths and fears about vaccine safety; which was the result of illiteracy- a common socioeconomic issue faced in urban slums. By prioritising focus on public vaccine knowledge, the BMC health department aimed to educate the public on herd immunity and vaccine effectiveness while also debunking common myths that circulate among poverty-stricken communities [16,17].

In contrast to the immediate response required for the outbreak, a pre-existing long-term mission was to achieve complete measles elimination by 2023. Mumbai was, and continues to be, committed to India's goal of measles and rubella elimination, as outlined in the National Strategic Plan for Achieving and Sustaining Measles and Rubella Elimination in India (now extended to 2026 due to the epidemics of the previous years). The main goals for achieving this mission consists of a) achieving and sustaining 95% coverage with two doses of the measles and rubella containing vaccine (MRCV), b) establishing a sensitive and timely measles and rubella (MR) surveillance system, c) Maintaining an accredited MR laboratory network, d) ensuring adequate outbreak preparedness, responding rapidly to measles and rubella outbreaks, and strengthening support and linkages to achieve the above strategies [18].

Management of outbreak and different strategies

With certain aims in mind, the civic governing body immediately began employing various strategies to eradicate the outbreak and mitigate its impact. Notably, the management of the outbreak involved high level political and administrative commitment. Review meetings were conducted by AMC with ward level commissioners to review the progress of all actions.

In each Outbreak area, an epidemic response team was activated for Outbreak Response activity (Outbreak Response Immunization), which included MOH of concerned ward, AMO (EPI), AMO Health Post, Public Health Nurses, NGO representatives and Community leaders. Each team took responsibility for their plan of action including case management, sample collection, active case search, passive Surveillance and establishment of routine immunization intensification. To ensure each team had adequate human resources, cadre health staff, from the Malaria and Surveillance department, had been repurposed for house-to-house surveys in outbreak areas. Additionally, 160 Interns from medical colleges were mobilised to outbreak areas for ACS and additional RI session training and 45 COVID 19 ward war room doctors were also trained in measles outbreak control and referral activities Furthermore, AMOs (284), HCW (820) and FLW (2800) were trained for outbreak management through physical or virtual mode. Every team also included the CHV and ASHA that visited 50-60 houses daily under the supervision of the ANM. During the active case search, 35.8 lacs houses were surveyed by the team, to identify additional fever with rash cases and vaccination status of children aged 0-5 years. The search was also conducted in each of the health facilities: private dispensaries, private hospitals and all Reporting sites; checking their records for any missed cases, and for encouragement to report each suspected measles case. This active search combined with passive surveillance; health post medical officers had sensitized more than 4000 general

practitioners in outbreak areas for reporting cases through visits and telephonic calls- to ensure an efficient system of management.

In terms of the clinical management of cases, initially, an isolation room had been set up at Shivaji Nagar Urban Health Centre in Govandi, the epicentre of the current outbreak, for patients with mild symptoms; shortly after a triage system had been created too. The severe patients were to be sent to Shatabdi Hospital in Govandi, and Rajawadi Hospital in Ghatkopar. Critical patients were referred to Kasturba Hospital in Chinchpokli [19]. Every suspected Fever with rash case was provided with two age-appropriate Vitamin A doses and referred to higher centres for any complications. The linkage of referrals was already established at special higher centres like Kasturba Hospital, Shivaji Nagar UHC, Rajawadi Hospital and BDBA Hospital. After the start of the measles outbreak, 16 new health facilities had been added to the reporting network to alleviate burdens.

Most of all, vaccination was a crucial element in handling the outbreak. Since measles is a highly infectious disease with a high R0 factor (12-18) [20], it was essential to create herd immunity amongst vulnerable populations to contain its spread, and eventually end the outbreak [21]. Having said that, BMC organized 400 additional vaccination sessions in a period of ten days, targeting unvaccinated children. Additionally, The BMC launched its main measles vaccination drive, starting December 1st 2022 onwards. The drive aimed to administer doses to more than 1,38,000 children in outbreak areas, including 1,34,833 children in the age group of 9 months to 5 years who were the receive the extra shot irrespective of their current vaccination status and around 4000 children in the age group of 6 months to 9 months who would be vaccinated for the first time; earlier than suggested in the universal vaccination programme [22]. Successfully, 82.79% of the eligible children between 9 months to 5 years of age and 89.09% of eligible children in the 6 months and 9 months had been immunised. Besides this, starting 24th December 2022, The BMC also arranged mobile teams to vaccinate children at construction sites and nomadic sites, of which 147 children from the construction sites and 148 children from nomadic sites were given measles vaccine doses. Commendably, by the beginning of 2023, 80-85% of additional measles dose coverage had been achieved [23]

Understanding the current public health policy and its implementation gaps

During the 2022–2023 measles outbreak in Mumbai, significant gaps in public health policy were exposed, primarily linked to declining vaccination coverage, pandemic-related disruptions, and systemic inequities. The outbreak began in September 2022, primarily affecting slum areas in eastern Mumbai, and continued through March 2023 [11]. Mumbai became the epicenter within Maharashtra, which reported the highest number of measles cases in India in 2022[24]. By December 2022, Mumbai had 601 confirmed cases and 18 deaths attributed to measles, with most cases clustered in densely populated, underprivileged neighborhoods. The attack rate in some slum areas reached 11.3%, with a case fatality rate of 1.1%, highest among boys aged 0–24 months. **Table 6** summarizes key policies and gaps in implementation.

Sr. No.	Policy Area	Implementation Gap	Evidence/Details
1	Vaccination Coverage	Sharp decline in coverage; only 41% of eligible children received the first dose at outbreak onset.	National goal is >95% coverage; Mumbai's two-dose coverage dropped from 82% to 41% [24].
2	Routine Immunization Disruption	COVID-19 pandemic led to missed vaccinations and weakened surveillance [11].	40 million children globally missed measles vaccine doses in 2020–2022 [10].
3	Outreach and Equity	Slum populations had lower coverage due to access barriers, vaccine hesitancy, and misinformation [12].	Clusters of cases and fatalities were concentrated in slums; religious and socioeconomic factors evident [12].
4	Surveillance and Rapid Response	Delays in outbreak detection and response; initial underreporting in some wards [25].	Door-to-door surveys and outbreak response immunization (ORI) were only ramped up after significant spread [25].
5	Vaccine Effectiveness	Two-dose vaccine effectiveness observed at only 64–70% in the outbreak cohort, possibly due to malnutrition and waning immunity [11].	Some cases occurred in vaccinated children, suggesting need for further research and potential schedule adjustment [10].

Table 6. Key Policy and implementation gaps

The major contributing factors were the impact of the pandemic. Routine immunization services were deprioritized during COVID-19, leading to a backlog of unvaccinated children and reduced herd immunity [24]. Socioeconomic disparities where slum residents faced greater barriers to accessing vaccines and healthcare, resulting in higher attack and fatality rates [26]. Vaccine hesitancy and misinformation were also observed. Lower uptake among certain religious and migrant communities, compounded by misinformation, contributed to coverage gaps. Surveillance limitations were also identified. Weak early-warning systems and incomplete data delayed targeted interventions, allowing the outbreak to propagate.

The public health response was seen when the Brihanmumbai Municipal Corporation (BMC) increased surveillance, set up isolation wards, and launched aggressive vaccination drives. By early 2023, over 100,000 children were vaccinated in response to the outbreak [12]. Outbreak

response immunization (ORI) campaigns achieved over 80% coverage in affected wards by January 2023, but these efforts were reactive rather than preventive. All reported fatalities in hospital-based studies were among unvaccinated children, underscoring the critical importance of uninterrupted, equitable immunization services.

Policy Implications and Recommendations

The outbreak highlights the need for sustained, equitable vaccine coverage above 95%, robust surveillance, and targeted outreach to vulnerable populations. There is also a call to reconsider the age for the first measles vaccine dose (potentially lowering it to 6 months) due to waning maternal antibodies and early infant vulnerability. Additionally, strengthening routine immunization, addressing vaccine hesitancy, and improving data systems are essential to prevent future outbreaks and progress toward measles elimination.

Community involvement and public awareness

When the measles outbreak hit Mumbai's M-East ward, it was clear that public awareness would make or break the response. This was one of the city's most vulnerable areas, dominated by slum settlements, and most cases were concentrated within the Muslim community. The Brihanmumbai Municipal Corporation (BMC) quickly realized that tackling misinformation and vaccine hesitancy needed community-first strategies. **Table 7** highlights various strategies for community involvement and public awareness, and how those worked.

Strategy	**How It Worked**
Engaging Religious & Community Leaders	Since a lot of hesitation came from cultural and religious concerns, the BMC reached out to imams, elders, and respected local figures. When these leaders reassured families about vaccine safety, vaccine hesitancy rates lowered, evident by the increase in number of daily doses administered
House-to-House Campaigns	Health workers went door to door in outbreak zones where they explained measles symptoms, busted myths, and focused on the unvaccinated youth. This contact helped reach even the most skeptical and doubtful families.
Support from schools and local institutions:	Schools were asked to report suspected measles cases and keep sick kids at home. At the same time, they hosted awareness sessions so children could carry the message back to their families. This also turned students into small public health messengers.
Vaccination Camps & Mobile Units	Extra vaccination camps were set up in high-risk areas, while mobile teams went to construction sites and

	nomadic settlements. This ensured no child was left out because of access issues.
Role of NGOs & Activist	Community groups highlighted how overcrowding, poor sanitation, and poverty made outbreaks worse.

Table 7. Strategies for Community involvement and public awareness

Learning from the outbreak and future perspectives

Primary lesson learnt during the current research on the measles outbreak in Mumbai was how clearly it revealed the cracks in the city's healthcare system. It wasn't just about a virus spreading, it was about gaps in immunization, weak disease surveillance, and the lack of public participation in protecting children.

It exposed major weaknesses in the city's healthcare system through its demonstration of immunization gaps and inadequate disease surveillance and insufficient public participation. The measles vaccine protection levels during the outbreak fell below expected performance when conditions were ideal. The vaccine also provided protection to less than half of children under five years old after one dose; however, protection increased to about two-thirds after two doses [27]. In older children, aged five to fifteen, the levels of protection were somewhat higher but still fell short of the reliability typically associated with measles immunization, with effectiveness ranging between roughly two-thirds and seventy percent. Its impact is closely shaped by the environment in which it is delivered and received. Factors such as chronic undernutrition, the challenges of raising children in crowded and poorly ventilated households, and the irregularities in vaccination schedules caused by service disruptions all combined to weaken the immunity of children during this period. What might look like a shortfall in the vaccine's power is, in reality, a reflection of the wider structural conditions in which these children live and the systemic barriers to achieving timely, complete immunization.

In some wards, vaccination dropped to as low as 41%, leaving around 20,000 children unprotected across Mumbai. Maharashtra recorded 165 outbreak events in 2022 alone, with Mumbai accounting for 15 child deaths. (Jain et al., 2023) [26] Nationally, India saw nearly 13,000 cases that year. Labs were overburdened and the number of specimens tested almost doubled towards the end of 2022 [28]. But all this highlighted that our system is often reactive, not anticipatory. We scramble once the outbreak is visible, instead of preventing it in the first place.

COVID-19 made the situation worse. Lockdowns, overburdened hospitals, and migration disrupted vaccine schedules and created massive immunity gaps. This overlap between two health crises showed how weak the systems are when one emergency spills into another. Protecting routine immunization services, even during big crises, has to be a priority.

Two crucial lessons are learnt. First, vaccination strategies need to be flexible, using mobile teams, catch-up drives, and even "zero-dose" vaccines for infants in high-risk zones[30]. Second, health is not only biomedical. Vaccine hesitancy, mistrust, and misinformation won't

disappear with injections alone. They require trust, dialogue, and partnerships with local leaders.

The outbreak reminded me that disease control is also about fairness. Overcrowding, poor sanitation, and undernutrition are not just living conditions; they are risk factors. If we want real resilience, we need multi-sector efforts with stronger routine immunization, real-time surveillance, better supply chains, well-trained health workers, and above all, equity and trust.

Conclusion

The present review highlighted that the 2022-2023 measles outbreak in Mumbai was an indicator of the ongoing weaknesses in urban public health systems, even in an age of advanced medical science. The outbreak began in the overcrowded slum areas of eastern Mumbai and quickly spread due to declining vaccination coverage, pandemic-related disruptions, and existing socioeconomic inequalities. The Brihanmumbai Municipal Corporation (BMC) and state health authorities in response to this implemented urgent measures. This included extensive door-to-door surveys, rapid outbreak response immunization campaigns, the establishment of isolation wards, and targeted public awareness efforts.

This outbreak more than anything revealed significant gaps in public health policy and practice. The results of this research tell us that the control of measles rests on a balance of medical prevention and the cultivation of equity among people, with trust, and resilience in public health practice.

Interestingly, an important learning was that the public trust must be treated as seriously as vaccines themselves. By engaging local leaders, fostering dialogue, and embedding equity at the center of health policy, we can move from reactive firefighting to proactive prevention. Not only was the outbreak a warning, but also a chance to rebuild. In the future looking at this research as a case study we can ensure that the next outbreak becomes not a human tragedy, but a turning point toward a more inclusive public health system.

Author's Contributions

Armaan Chahal conceptualized the study, conducted the literature review, analysed the data, and wrote and revised the manuscript.

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Conflict of Interest

The author declares no potential conflict of interest regarding the research, authorship, and publication of this article.

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