International Journal of Community Medicine and Public Health
Sharma A et al. Int J Community Med Public Health. 2025 Feb;12(2):1147-1154
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20250337

Review Article

Assessing impact: a study of India's vaccine preventable diseases

Ankita Sharma[1]*, Somya Sharma[2], Divyansh Sharma[3]

[1]Health Economics, Manipal University, Jaipur, Rajasthan, India
[2]Indian Institute of Public Health (IIPH), Gandhinagar, Gujarat, India
[3]International Institute for Population Sciences (IIPS), Mumbai, Maharashtra, India

Received: 25 November 2024
Revised: 16 January 2025
Accepted: 21 January 2025

***Correspondence:**
Dr. Ankita Sharma,
E-mail: ankitasharma8764@gmail.com

ABSTRACT

The universal immunization programme (UIP) is one of the most cost-effective methods to enhance public health. It is administered by the national rural health mission under the aegis of the ministry of health and family welfare. Despite India's 50-year history of vaccines, vaccine-preventable diseases (VPDs) still cause over 5,00,000 fatalities annually. The present study assesses the UIP 's success in decreasing VPDs in India. The data from 2006 to 2018 was taken from Indiastat.com. Since the research aimed to assess the success of UIP across India, achievements under UIP for each vaccination, i.e., Bacillus Calmette-Guerin; oral polio vaccine-1, 2 and 3; diphtheria pertussis tetanus-1, 2 and 3 and measles, was compared with the cases and deaths owing to the diseases; as per NRHM division and health index (4th round) scores given by NITI Aayog, separately. Data analysis was conducted in MS excel (2019 version). Vaccination achievements varied significantly as per NRHM and NITI Aayog health index, with HFSNNE and MI regions outperforming each other's. Cases of polio and tetanus were lowest in HFSNE and LI states. Deaths due to diphtheria and measles, mirrored regional disparities with NHFSL and NI states having higher burden. To reduce mortality due to VPD in children, enhancing reporting networks and cross-border cooperation in vaccination strategies are crucial. Policy recommendations include targeted interventions, educational campaigns, infrastructure improvements, incentives, monitoring, evaluation strengthening, policy flexibility, community engagement, capacity building, research, and a phased implementation plan.

Keywords: Vaccine preventable diseases, Universal immunization programme, Full immunization, India

INTRODUCTION

Childhood vaccinations play a crucial role in preventing diseases and lowering mortality rates among children.[1] Timely administration of these vaccines is essential since they are most effective when administered before potential exposure to diseases.[2] Therefore, age becomes a critical factor in both, the formulation of the vaccination policies and their practical implementation. The epidemiology and impact of VPDs vary significantly across countries and regions, influenced in part by disparities in vaccine uptake. Factors such as geographic location, seasonal variation, population density, nutritional status, international travel, and even genetic differences can contribute to the varying burden of such diseases.[3]

Globally, since 1990, there has been a decrease in the total number of deaths among children under the age of five. However, the proportion of these deaths occurring within the first 28 days of life has increased from 41% in 2000 to 47% in 2022. During this period, neonatal deaths have declined by 44%, from 4.1 million to 2.3 million. In comparison, deaths among children aged 1 to 59 months have decreased by 56%, from 5.8 million to 2.6 million in 2022. Similarly, India has also reduced its under-five mortality rate (U5MR) by more than two-thirds since 2000.[4]

In India, UIP, a vaccination program first launched in 1985, aims to achieve the target of vaccination-for-all, and has since been a part of every health program. UIP targets a substantial number of beneficiaries annually, including 3.04 crore pregnant women and 2.7 crore newborns. The program conducts over 1.2 crore immunization sessions each year, providing free vaccines against 12 VPDs nationwide. These include diphtheria, pertussis, tetanus, polio, measles, rubella, tuberculosis, rotavirus diarrhoea, hepatitis b, meningitis and pneumonia caused by Hemophilus influenza type B, and Pneumococcal pneumonia. Additionally, Japanese encephalitis vaccine is also administered in endemic districts under the program.[5] Despite considerable gains in immunization coverage, a large number of children die from VPDs because of an increased number of parents adopting hesitant behaviour towards vaccines, with delaying or even refusing the administration of these vaccines to children. Implications of such behaviours are not only limited to individuals, but also on society in the form of outbreaks e.g. measles, chicken pox, hepatitis A, etc.[6,7]

Transforming immunization programs from mere vaccine delivery platforms to comprehensive disease control programs is imperative. Countries must adopt evidence-based policies to introduce new vaccines and enhance access to immunization services through robust system strengthening.[8] Effective solutions to boost vaccination coverage include implementing comprehensive educational campaigns that utilize video-assisted teaching, conducting face-to-face health education sessions, and disseminating vaccine information tailored to various community settings. These campaigns should involve a diverse range of personnel such as physicians, medical students, and community health facilitators. Focus of these campaigns should be on improving knowledge and promoting vaccine uptake among pregnant women, young children and their parents, and school students.[9] Strategies aimed at enhancing vaccination coverage should encompass both; supply-side interventions such as training health workers and expanding vaccine delivery sites, and demand-side approaches including awareness campaigns and incentives for vaccination.[10] By improving vaccine accessibility, reducing logistical barriers, and educating communities about the benefits of vaccination against preventable diseases, these efforts aim to achieve higher immunization rates and better public health outcomes.

From 2005 onwards, the UIP has been incorporated into the national rural health mission (NRHM), underscoring its significance in improving maternal and child health (MCH) and aligning with the objectives of the national health mission (NHM) as a comprehensive public health initiative targeting infants and pregnant women.

Therefore, the present study assesses the success of UIP across India in terms of decrease in number of VPDs.

METHODOLOGY USED

For the present study, data was taken from indiastat.com, whose inception lies in 2000. A project of Datanet India Pvt. Ltd., it provides extensive socio-economic statistics on India and its sectors across states and regions. It provides an accurate and complete compilation of secondary-level statistics of India and its states. The data related to vaccination achievement, cases and deaths provided by Indiastat was compiled from the statistics released by ministry of health and family welfare, government of India.[11]

Variable description

As per the UIP, fully immunized children refer to the children aged 0-5 years who had received all the eight prescribed vaccinations, i.e., BCG; oral polio vaccine-1, 2 and 3 (OPV); diphtheria, pertussis and tetanus-1, 2 and 3 (DPT) and measles. This study focuses on the success of UIP across India and the impact of this programme in lowering the number of VPDs.

The analysis for the present study was divided into two parts. Firstly, the division made by NRHM for its health services, i.e., high focused states North East-HFSNE (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura), high focused states non-north East-HFSNNE (Bihar, Chhattisgarh, Odisha, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Madhya Pradesh, Rajasthan, Uttar Pradesh and Uttarakhand), non-high focused states large-NHFSL (Andhra Pradesh, Goa, Gujarat, Haryana, Karnataka, Kerala, Maharashtra, Punjab, Tamil Nadu, West Bengal and Telangana) and non-high focused states small and UT-NHFSS (Chandigarh, Dadra and Nagar Haveli, Daman and Diu, Delhi, Lakshadweep, Puducherry and Andaman and Nicobar Islands).

Secondly, NITI Aayog's health index (4th round) score, which is a weighted composite index based on 24 variables categorised under the three broad categories of ‘health outcomes’, ‘governance and information’, and ‘key inputs/processes’ was used in this study. The primary purpose of this index was to develop a comprehensive health index based on significant healthcare achievements and associated indicators, which are further employed to assess healthcare systems and service delivery. This index computed health index scores and ranked the states and union territories (UTs) into various categories by considering year-to-year improvement (incremental performance) and overall performance. Special focus was given to "health outcomes" as they were crucial in evaluating the performance. The indicators selected to calculate the health index were gathered on a year-on-year basis from the existing data systems such as the sample registration survey (SRS), civil registration survey (CRS), and health management and information system (HMIS). A composite index was generated by integrating the selected

variables, focusing on assessing the state of healthcare in each state and UTs with a base year (2018-19) and a reference year (2019-2020). The variation in the index score for each state between the base year and the reference year further measured the incremental progress made by each entity. To allow for meaningful comparisons among entities, states and UTs were classified into three broad categories: larger states (20), the smaller states (8) and UTs (8). Since West Bengal did not submit the data, it was excluded from health index.

As per the health index scores calculated by NITI Aayog, the states and UTs were divided into four parts, i.e., most improved-MI (index score >4.0), moderately improved-ModI (index score >2.01 and index score <4), Least Improved-LI (index score >0.01 and index score <2), and Not Improved-NI (index score ≤0). Here, the states which improved the most included Andhra Pradesh, Assam, Chandigarh, Dadra and Nagar Haveli, Haryana, Jharkhand and Rajasthan. The moderately improved states included Daman and Diu, Karnataka, Maharashtra, Manipur, Telangana, and Tripura. The least improved states included Chhattisgarh, Gujarat, Himachal Pradesh, Jammu and Kashmir, Mizoram, and Nagaland. The states which did not improve included Andaman and Nicobar Islands, Arunachal Pradesh, Bihar, Delhi, Goa, Kerala, Lakshadweep, Madhya Pradesh, Meghalaya, Orissa, Pondicherry, Punjab, Sikkim, Tamil Nadu, Uttar Pradesh, and Uttaranchal.

To assess the success of UIP in terms of VPDs, achievements under UIP for each vaccination, i.e., BCG (for curing tuberculosis), OPV-1, 2 and 3 (for curing polio), diphtheria (for curing diphtheria), pertussis (for curing whooping cough), tetanus-1, 2 and 3 (for curing tetanus) and measles (for curing measles) was compared with the cases and deaths owing to polio, diphtheria, pertussis, tetanus (neonatal), tetanus (other than neonatal), and measles; these comparisons were done separately as per the NRHM division and health index scores given by NITI Aayog. Unavailability of data related to cases and deaths due to tuberculosis proved to be a limitation of the study. Similarly, state-wise data on deaths due to polio and whooping cough were unavailable for 2006 and 2009, respectively. Also, since India declared "polio free" on 27th March 2014, no data was available for cases and deaths owing to polio after aforementioned date. Data analysis for study carried out in MS excel 2019 version.

OBSERVATIONS

Figure 1 illustrates the achievements of vaccinations (in 000's) as per the NRHM classification and Health Index scores provided by NITI Aayog. According to the NRHM classification, the highest achievements for BCG vaccination were recorded in the HFSNNE region, peaking at 1,570,534 in 2008-09. In contrast, NHFSS exhibited the lowest achievements, reaching 220,461 in 2015-16. For the DPT vaccine, the highest achievements were noted in HFSNNE, with a peak of 13,874,752 in 2006-07, while NHFSS reported the lowest achievements, with a low of 9,134 in 2017-18. For OPV vaccination, the highest values were recorded by HFSNNE, reaching 14,322,766 in 2008-09. Conversely, NHFSS had the lowest achievements, with a low of 193,594 in 2015-16. In measles vaccination, HFSNNE recorded highest value of 14,079,333 in 2008-09, while NHFSS experienced the lowest achievement, reaching 227,730 in 2015-16.

Figure 1: Achievements of vaccinations (in 000's) as per NRHM classification and NITI Ayog health index (4th round).

Source: Author's calculation from https://www.indiastat.com/ data.

According to the NITI Aayog health index, for BCG vaccination, the highest achievements were recorded in the MI states, reaching 5,534,944 in 2006-07. Conversely, the lowest achievement was observed in the LI states, with a low of 126,390 in 2015-16. For DPT vaccination, the highest achievements were recorded in the MI states, reaching 5,171,430 in 2007-08, while the lowest achievement was noted in the LI states, with a low of 20,456 in 2017-18. For OPV vaccination, the highest achievements were recorded in the MI states, reaching 5,159,989 in 2006-07, whereas the lowest achievement was observed in the LI states, with a low of 112,455 in 2015-16. In Measles vaccination, highest achievements were recorded in the MI states, reaching 4,996,343 in 2006-07, and the lowest achievement was observed in the LI states, with a low of 196,312 in 2016-17. Figure 2 and 5 illustrate cases and deaths owing to polio, diphtheria, pertussis, tetanus (neonatal), tetanus (other than neonatal), and measles; separately as per NRHM division and health index scores given by NITI Aayog.

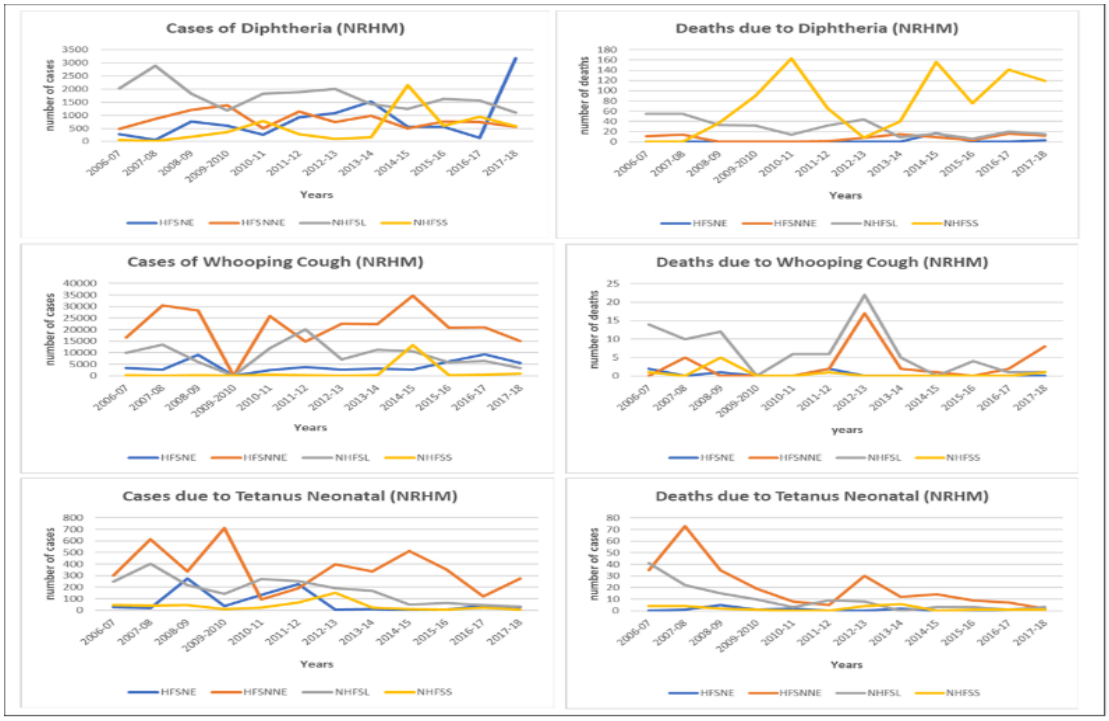

Figure 2: Cases and deaths due to vaccinations as per NRHM classification.

Source: Author's calculation from https://www.indiastat.com/data.

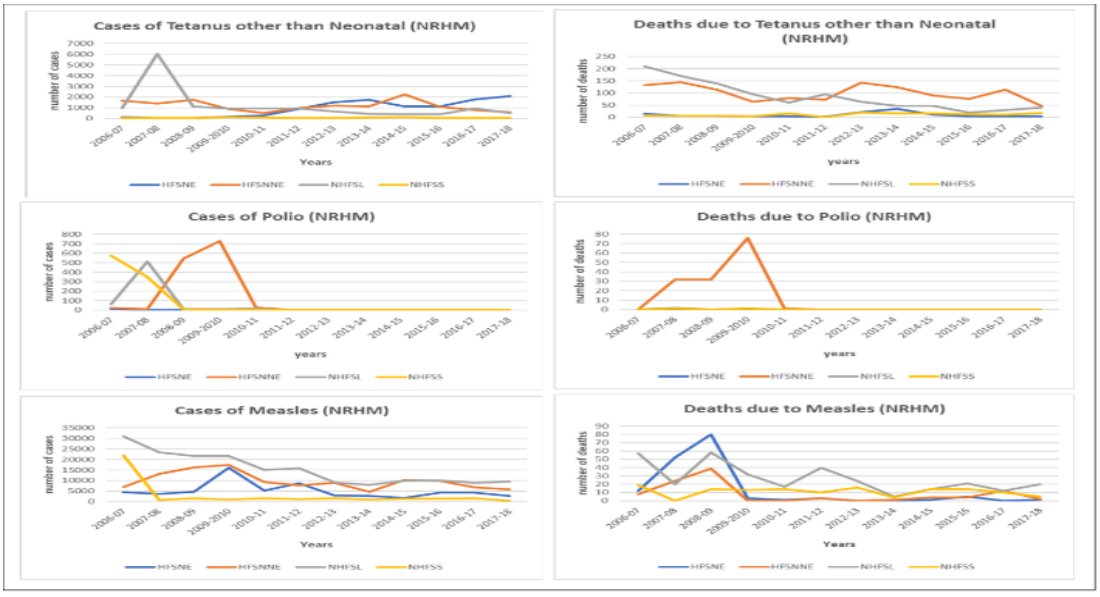

Figure 3: Cases and deaths due to vaccinations as per NRHM classification.

Source: Author's calculation from https://www.indiastat.com/data.

Figure 4: Cases and deaths due to vaccinations as per NITI Ayog health index (4th round).
Source: Author's calculation from https://www.indiastat.com/data.

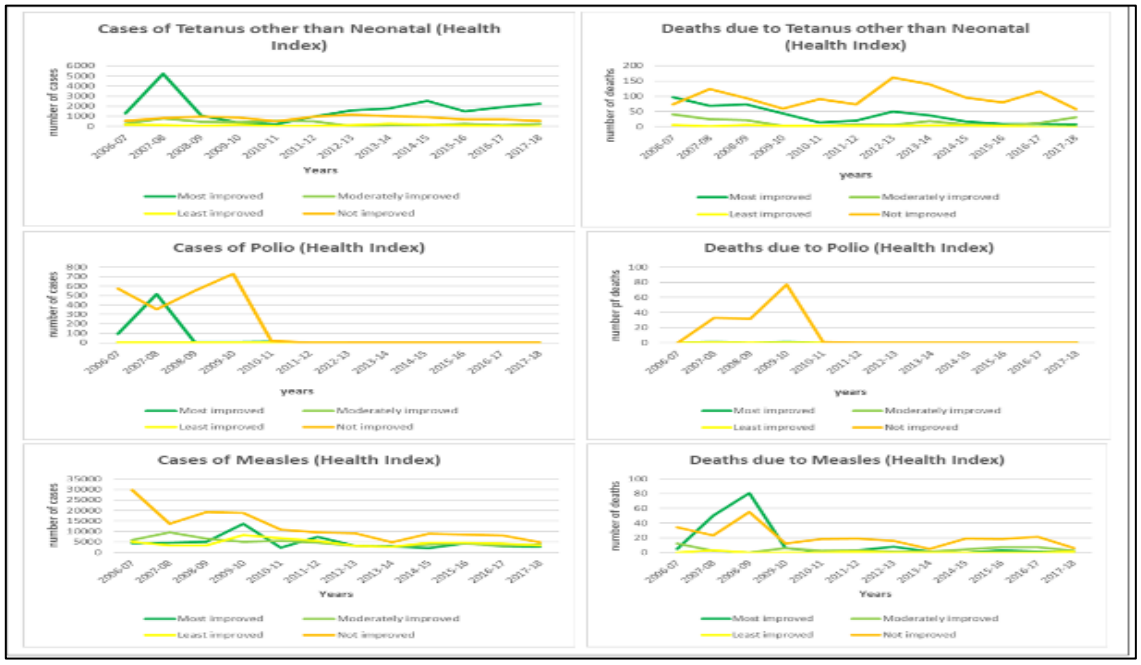

Figure 5: Cases and deaths due to vaccinations as per NITI Ayog health index (4th round).
Source: Author's calculation from https://www.indiastat.com/data.

NRHM division of states for health services

NHFSL reported the highest number of diphtheria cases, peaking at 2,881 in 2007-08, while HFSNE had the lowest with just 56 cases in the same year. For deaths due to diphtheria, NHFSL recorded the highest toll, with 55 deaths in both 2006-07 and 2007-08. In contrast, HFSNE reported zero deaths in multiple years, including 2006-07, 2007-08, and 2008-09.

In the case of whooping cough, HFSNNE reported the highest number of cases, reaching 34,659 in 2014-15. HFSNE had the lowest number of cases, with cases as low as zero in several years, including 2009-10. Similarly, for deaths due to whooping cough, HFSNNE had the highest number, with five deaths during 2007-08. HFSNE had the lowest number of deaths, with zero deaths recorded in all the years except 2006-07 and 2011-12.

For tetanus (Neonatal), HFSNNE reported the highest number, with 709 cases in 2009-10. Conversely, NHFSL had the lowest, with just 32 cases in 2017-18. In terms of deaths due to tetanus (Neonatal), HFSNNE reported the highest toll, with 73 deaths in 2007-08, while NHFSS had the lowest with zero deaths reported in several years, including 2010-11. On the other hand, Tetanus (other than neonatal), HFSNE recorded the highest number of cases, peaking at 2,099 in 2017-18; conversely, HFSNNE had the lowest with 595 cases in the same year. For deaths due to tetanus (other than neonatal), HFSNNE reported the highest number, with 145 deaths in 2007-08. Meanwhile, HFSNE had the lowest, with only 2 deaths recorded in 2011-12.

In the case of polio, HFSNNE had the highest number of cases, with 729 in 2009-10, while HFSNE had the lowest, reporting no cases across all years. A similar trend was followed for deaths due to polio, where HFSNNE reported the highest number, with 76 deaths in 2009-10. Other regions, including HFSNE, reported no deaths throughout the period.

For measles, NHFSL recorded the highest number of cases, reaching 30,870 in 2006-07, while NHFSS had the lowest, with only 510 cases in 2017-18. NHFSL also had the highest number of deaths due to measles, with 58 in 2008-09. Conversely, NHFSS reported the lowest number of deaths, with zero deaths in several years, including 2007-08 and 2017-18.

Health index scores given by NITI Aayog

For diphtheria cases, MI states reported the maximum number, reaching 3,653 cases in 2017-18; comparatively, the LI states had the lowest, with just 29 cases in the same year. In terms of deaths due to diphtheria, the NI states recorded the highest number, peaking at 163 deaths in 2010-11, whereas the LI states had the lowest death toll, with only 1 death reported in both 2016-17 and 2017-18.

For whooping cough, the NI states reported the highest number of cases, reaching 38,475 in 2014-15, while the LI states had the lowest, with 762 cases in 2017-18.

Regarding deaths due to whooping cough, the LI states recorded the highest number of deaths, with 4 deaths in 2017-18, while the MI states had the lowest number of deaths, with only 1 death recorded in both 2012-13 and 2017-18.

In the case of tetanus (neonatal), the NI states reported the highest number of cases, peaking at 533 in 2012-13, while the LI states had the lowest, with zero cases in 2017-18. For deaths due to tetanus (neonatal), a similar trend was followed, with NI states recording the highest number of deaths, with 75 deaths in 2007-08; the LI states also had the lowest number of deaths, with zero deaths reported in both 2009-10 and 2017-18.

For cases of tetanus (other than neonatal), the MI states reported the highest number of cases, reaching 5,225 in 2007-08, while the LI states had the lowest number, with just 1 case in 2017-18. In terms of deaths due to Tetanus (other than neonatal), MI states recorded the highest number with 97 deaths in 2006-07, while the LI states had the lowest number of deaths.

For polio cases, the NI states reported the highest number, reaching 731 cases in 2009-10, while the MI states had the lowest, with no cases reported in any year post 2011-12. In terms of deaths due to polio, the NI states also recorded the highest number, with 77 deaths in 2009-10. Conversely, the LI states had the lowest number, with zero deaths reported across all years.

For cases involving measles, the NI states reported the highest number, peaking at 29,727 cases in 2006-07, while the MI states had the lowest number, with 2,634 cases in 2017-18. Regarding deaths due to Measles, the NI states had the highest number, reaching 55 in 2008-09, whereas the LI states reported the lowest number, with zero deaths in most years except for 2011-12 and 2017-18.

DISCUSSION

The world health assembly formally announced the eradication of smallpox in 1980, marking the first instance of a human disease being eliminated. This achievement was made possible with two main strategies, which were vaccination and surveillance.[12] India, the world's most populous country, has 1.4 billion people, accounting for 18% of the world population.[13] Every year, up to 63 million people get driven into poverty due to rising healthcare costs. Although communicable, maternal, neonatal, and nutritional diseases have (CMNN) declined overtime, they still account for one-third of disability-adjusted life years (DALY). Compared to adults, children are more likely to suffer from CMNN illnesses; they account for 17-29% of fatalities and 14-30% of disability-adjusted life years.[14] Although, over the years there has been a noticeable increase in the incidence of certain diseases; however, the mortality rates associated with these diseases have significantly declined. The falling mortality rates can also be accrued to the expansion of morbidity of these diseases.[15] A key success story is the eradication of polio in India. Through consistent efforts of the government of India, along with other partner organizations and stakeholders, Polio cases have been non-existence since 2010-11; this made India achieve the certification of polio-free from world health organization.[16]

Following these significant achievements, the present study assessed the success of UIP across India in terms of decrease in VPDs. Key findings highlight fluctuating trends in vaccination achievements for different vaccines as per NRHM and health index (4th round). Despite these achievements, in India vaccination trends shows

fluctuations. For instance, BCG, OPV, and measles vaccinations achievements rates have seen declines, particularly since 2015-16, with regional disparities in disease prevalence and immunization achievements. While mortality rates for VPDs have decreased significantly, outbreaks of disease like diphtheria, whooping cough, and measles persist, raising concern about vaccine outreach and timelines. As per the classification by NRHM, the 18 highly focused states require continued attention to improve health outcomes, as these states still fall under the category of NI states as per the health index scores calculated by NITI Aayog.

In low- and middle-income countries, childhood vaccination offers a strong return on investment by preventing millions of fatalities and saving a substantial amount of money on medical expenses. In addition to influencing reproduction rates and contributing to demographic shifts, health interventions that lower child mortality can promote economic growth. Improved child survival is frequently associated with decreased fertility rates as replacement birth requirements decrease.[17] A study conducted by John.[18] highlighted that although the EPI has dramatically decreased VPDs in India, it still faces issues such as disease outbreaks and worries regarding vaccine timelines and quality. Other high-burden diseases like typhoid and hepatitis A are still being adequately tackled, even though it was successful in eliminating polio and produced significant economic benefits. Strengthening EPI with a research and development arm could help quantify its economic value, enhance vaccine coverage, and transform it into a comprehensive public health initiative addressing all VPDs.[18]

CONCLUSION

Given the fluctuations in the achievements of vaccinations and persistent outbreaks of VPDs as stated in the study, there is a need to enhance the reporting network and implement the targeted interventions to address these challenges effectively. Therefore, to effectively reduce mortality from VPDs among children, it is crucial to enhance the reporting network to ensure timely identification and notification of suspected cases. Additionally, cross-border cooperation in vaccination strategies and surveillance is essential for the effective eradication of these diseases. Policy recommendations include targeted interventions, educational campaigns, infrastructure improvements, incentive programs, monitoring, and evaluation strengthening, policy flexibility, community engagement, capacity building, research and innovation, and a phased implementation plan. These recommendations aim to ensure equitable access to immunization services and improve health outcomes for children aged 0-5 years. The ongoing commitment to improvement will contribute to the long-term success of the UIP and the overall health of the population.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Srivastava S, Fledderjohann J, Upadhyay AK. Explaining socioeconomic inequalities in immunisation coverage in India: new insights from the fourth National Family Health Survey (2015-16). BMC Pediatr. 2020;20(1):1-12.
2. Sauer M, Vasudevan P, Meghani A, Luthra K, Garcia C, Knoll MD, Privor-Dumm L. Situational assessment of adult vaccine preventable disease and the potential for immunization advocacy and policy in low-and middle-income countries. Vaccine. 2021;39(11):1556-64.
3. Brenzel L, Wolfson LJ, Fox-Rushby J, Miller M, Halsey NA. Vaccine-preventable diseases. Disease Control Priorities in Developing Countries. 2nd edition. 2006.
4. UNICEF. Levels and trends in child mortality. 2024. Available at: https://data.unicef.org/resources/levels-and-trends-in-child-mortality-2024/. Accessed on 10 August 2024.
5. Ministry of Health and Family Welfare, Government of India. Universal Immunization Program: Comprehensive Multi-year Strategic Plan 2018-22. In Immunization Technical Support Unit (ITSU). Immunization Division, Ministry of Health and Family Welfare, Government of India. 2018. Available at: https://itsu.org.in/wp-content/uploads/2022/03/cMYP_2018-22_final_pdf-1.pdf. Accessed on 03 July 2024.
6. Sahoo H. Coverage of child immunisation and its determinants in India. Social Change. 2012;42(2):187-202.
7. Agrawal A, Kolhapure S, Di Pasquale A, Rai J, Mathur A. Vaccine hesitancy as a challenge or vaccine confidence as an opportunity for childhood immunisation in India. Infectious Dis Therapy 2020;9:421-32.
8. Megiddo I, Colson AR, Nandi A, Chatterjee S, Prinja S, Khera A, et al. Analysis of the Universal Immunization Programme and introduction of a rotavirus vaccine in India with IndiaSim. Vaccine. 2014;32:A151-61.
9. Clarke-Deelder E, Suharlim C, Chatterjee S, Portnoy A, Brenzel L, Ray A et al. Health impact and cost-effectiveness of expanding routine immunization coverage in India through Intensified Mission Indradhanush. Health Policy Planning. 2024;39(6):583-92.
10. Parsekar SS, Vadrevu L, Jain M, Menon S, Taneja G. Interventions addressing routine childhood immunization and its behavioral and social drivers. Frontiers in Public Health. 2024;12:1364798.
11. Health Data India - Health and medical Statistics of India Year/State wise. Available at:

https://www.indiastat.com/data/health. Accessed on 15 February 2024.
12. Hinman A. Eradication of vaccine-preventable diseases. Ann Rev Publ Heal. 1999;20(1):211-29.
13. Worldometers. Countries in the world by population. Available at: http://www.worldometers.info/world-population/. Accessed on 15 August 2024.
14. Dash R, Agrawal A, Nagvekar V, Lele J, Di Pasquale A, Kolhapure S, et al. Towards adult vaccination in India: a narrative literature review. Human Vaccines Immunotherap. 2020;16(4):991-1001.
15. Crimmins EM, Beltrán-Sánchez H. Mortality and morbidity trends: is there compression of morbidity? J Gerontol Series B: Psychological Sci Social Sci. 2011;66(1):75-86.
16. World Bank Group A Polio-Free India is one of the biggest achievements in global health. World Bank. 2014. Available at: https://www.worldbank.org/en/news/feature/2014/05/29/polio-free-india-biggest-achievements-global-health. Accessed on 12 September 2024.
17. Nandi A, Summan A, Ngô TD, Bloom DE. Childhood vaccinations and the demand for children: Long-term evidence from India. World Develop. 2024;182:106692.
18. John TJ. World immunization week 2018: What lessons for India? Indian J Med Res. 2018;147(4):330-33.

Cite this article as: Sharma A, Sharma S, Sharma D. Assessing impact: a study of India's vaccine preventable diseases. Int J Community Med Public Health 2025;12:1147-54.