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Epidemiological studies of Diphtheria in India

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Abstract

Diphtheria is a highly contagious, toxin-mediated bacterial disease caused primarily by Corynebacterium diphtheriae. Although global immunization programs have significantly reduced the incidence of diphtheria, the disease remains a persistent public health concern in developing countries, particularly India. India continues to contribute a substantial proportion of the global diphtheria burden due to incomplete vaccination coverage, waning immunity among adolescents and adults, overcrowding, poor health infrastructure, and delayed diagnosis. This article reviews the epidemiology, microbiology, clinical manifestations, diagnosis, treatment, prevention, and public health implications of diphtheria in India using the IMRAD (Introduction, Methods, Results, and Discussion) structure. Tables and diagrammatic representations are included to explain disease burden, vaccination trends and demographic distribution. The article highlights the importance of surveillance systems, booster immunization, and strengthening routine immunization services to achieve effective disease control.

Keywords: Diphtheria, India, Epidemiology, Public Health, Immunization, Universal Immunization Programme, Vaccine-Preventable Disease, Corynebacterium diphtheriae

Introduction

Diphtheria is an acute infectious disease caused by toxigenic strains of Corynebacterium diphtheriae. The disease primarily affects the upper respiratory tract, though cutaneous diphtheria may also occur. The hallmark of respiratory diphtheria is the formation of a thick grayish pseudomembrane over the tonsils, pharynx, and larynx, which can lead to airway obstruction. Systemic complications occur due to the exotoxin produced by the organism, affecting the myocardium, nervous system, and kidneys.

Historically, diphtheria caused devastating epidemics worldwide before the introduction of the diphtheria toxoid vaccine in the 1920s. Mass immunization drastically reduced mortality and incidence in developed countries. However, despite the availability of effective vaccines, diphtheria continues to persist in India and other low- and middle-income countries.

India contributes significantly to the global burden of diphtheria cases. Several outbreaks have been reported from states such as Assam, Maharashtra, Kerala, Telangana, Karnataka, and Haryana. Re-emergence is associated with gaps in vaccination coverage and declining immunity in older children and adults. WHO surveillance data indicate that fluctuating immunization coverage continues to influence the epidemiology of diphtheria in India.

The Universal Immunization Programme (UIP) in India includes DPT vaccination during infancy with booster doses later in childhood. Despite this initiative, challenges such as vaccine hesitancy, migration, poor awareness, and inadequate healthcare accessibility contribute to continued transmission.

Aim:

To analyze the epidemiology and public health significance of diphtheria in India with emphasis on state-wise disease burden, vaccination coverage, surveillance systems, and preventive strategies.

Objectives:

1. To describe the epidemiological trends of diphtheria in India.
2. To evaluate state-wise distribution and burden of diphtheria.
3. To examine risk factors associated with diphtheria outbreaks.
4. To assess the role of immunization and public health interventions.
5. To discuss challenges and future strategies for diphtheria control in India.

Materials and Methods

This article is based on a narrative review of scientific literature, epidemiological reports, WHO immunization data, Indian government publications, and peer-reviewed journal articles concerning diphtheria in India.

The present review utilized epidemiological and surveillance data published between 1996 and 2024, including WHO/UNICEF Joint Reporting Form datasets, NCDC-IDSP surveillance reports, and peer-reviewed Indian public health literature

Inclusion Criteria

1. Studies related to diphtheria in India
2. Epidemiological and clinical studies
3. Immunization-related studies
4. Articles discussing outbreak investigations
5. Publications from 2000 onward

Exclusion Criteria

1. Non-peer-reviewed anecdotal reports
2. Studies lacking relevance to India
3. Duplicate data

Results

Epidemiology of Diphtheria in India

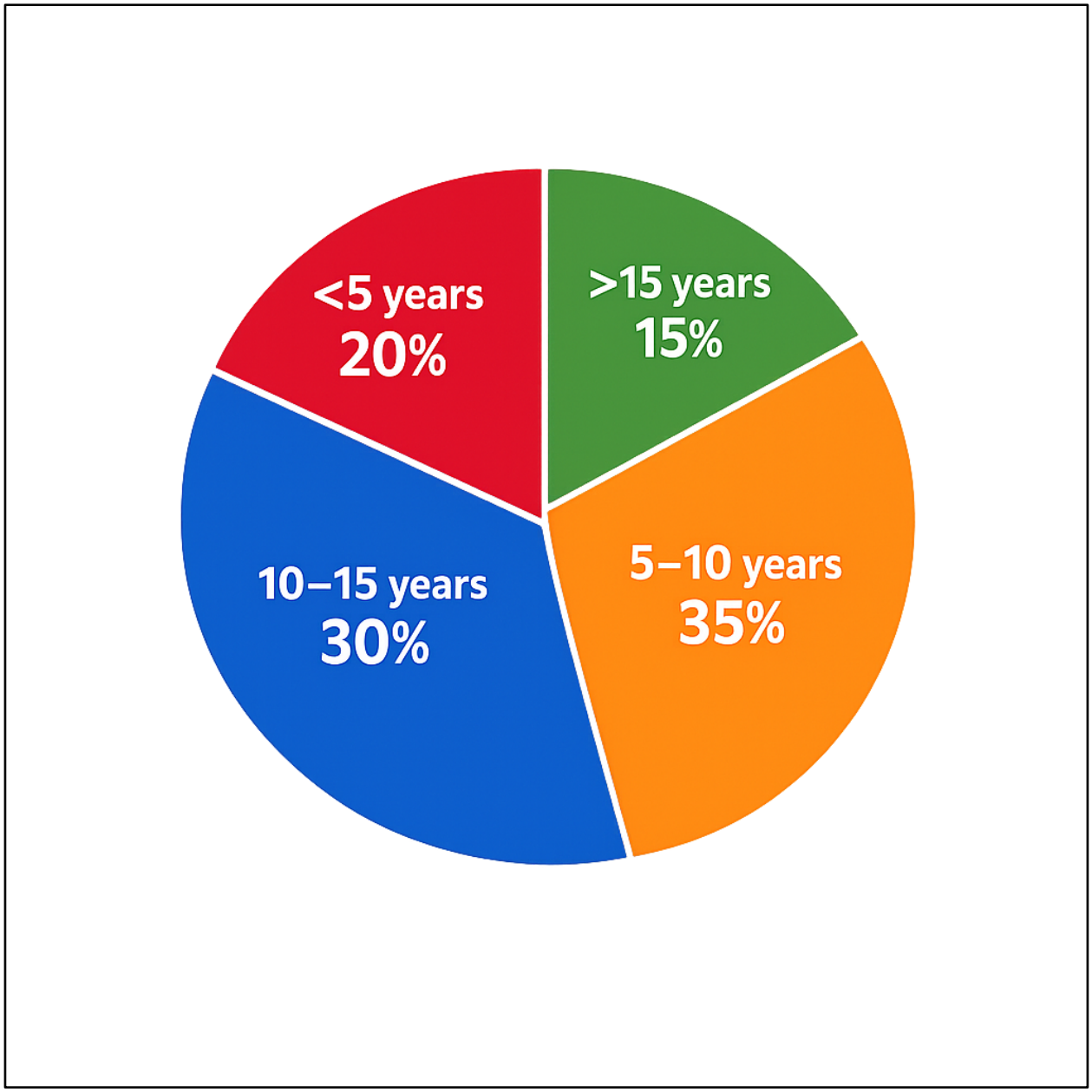
India remains one of the countries reporting the highest number of diphtheria cases globally. Outbreaks frequently occur in areas with inadequate vaccination coverage and poor socioeconomic conditions.
Immunization Data +1

Age Distribution

Recent studies indicate a shift in disease burden toward older children and adolescents due to waning immunity.

Age Group	Percentage of Cases
<5 years	20%
5-10 years	35%
10-15 years	30%
>15 years	15%

(According to WHO,UNICEF)



State wise distribution of Diphtheria in

India

The burden of Diphtheria is unevenly distributed across Indian states. High risk regions generally demonstrate lower Immunization coverage, poor sanitation, dense population and healthcare inequities

Table:- State wise Distribution of Diphtheria in India

State	Epidemiological Status	Major Risk factors	Public health Observation
Andhra Pradesh	Recurrent outbreaks (8-10%)	Incomplete Immunization	Adolescent caes common
Bihar	Moderate Burden (5-7%)	High population density	Low routine immunization
Jammu and Kashmir	Sporadic incidence (1-2%)	Remote access barriers	Limited outbreaks reporting
Arunachal Pradesh	Sporadic Cases (1-2%)	Difficult Terrain	Limited healthcare access
Assam	Endemic Pockets (7-9%)	Rural Healthcare Gaps	Booster dose deficiencies
Gujarat	Occasional outbreaks (4-5%)	Urban Migration	Need for booster monitoring
Haryana	Sporadic Cases (3-4%)	Urban crowding	Variable Immunization
Jharkhand	Endemic Risk (5-6%)	Tribal and rural disparities	Poor healthcare outreach
Karnataka	Moderate incidence (5-6%)	Urban Slums	Booster dose gaps
Keralam	Intermittent outbreaks (4-6%)	Vaccine hesitancy pockets	Adult Diphtheria reported
Madhya Pradesh	Moderate Burden (5-7%)	Rural access limitations	Immunization variability
Maharashtra	Significant outbreaks (10-12%)	Dense Urban settlements	Adolescent susceptibility

Odisha	Moderate endemicity (5-6%)	Rural population	Need for booster strengthening
Punjab	Low incidence (1-2%)	Good healthcare access	Better vaccination uptake
Rajasthan	Moderate outbreaks (4-5%)	Desert rural access issues	Uneven Immunization
Tamil Nadu	Controlled endemicity (3-4%)	Urban transmission pockets	Strong vaccination network
Telangana	High reported burden (12-15%)	Missed booster doses	Frequent adolescent outbreaks
Uttar Pradesh	High Burden (12-14%)	Population density	Immunization gaps
West Bengal	Recurrent Outbreaks (8-10%)	Dense population	High risk Urban clusters

The table demonstrates substantial geographic variation in diphtheria epidemiology across India. States with high population density, low booster immunization rates, poor healthcare access, and urban slum populations report greater disease burden. Telangana, Uttar Pradesh, Maharashtra, West Bengal, and Andhra Pradesh continue to experience recurrent outbreaks. Southern states with stronger healthcare systems generally demonstrate lower mortality despite periodic outbreaks.

Northeastern and tribal-dominated states face challenges related to geographic inaccessibility and surveillance limitations. Kerala presents an interesting epidemiological profile where vaccine hesitancy and adult susceptibility have contributed to outbreaks despite relatively advanced healthcare infrastructure.

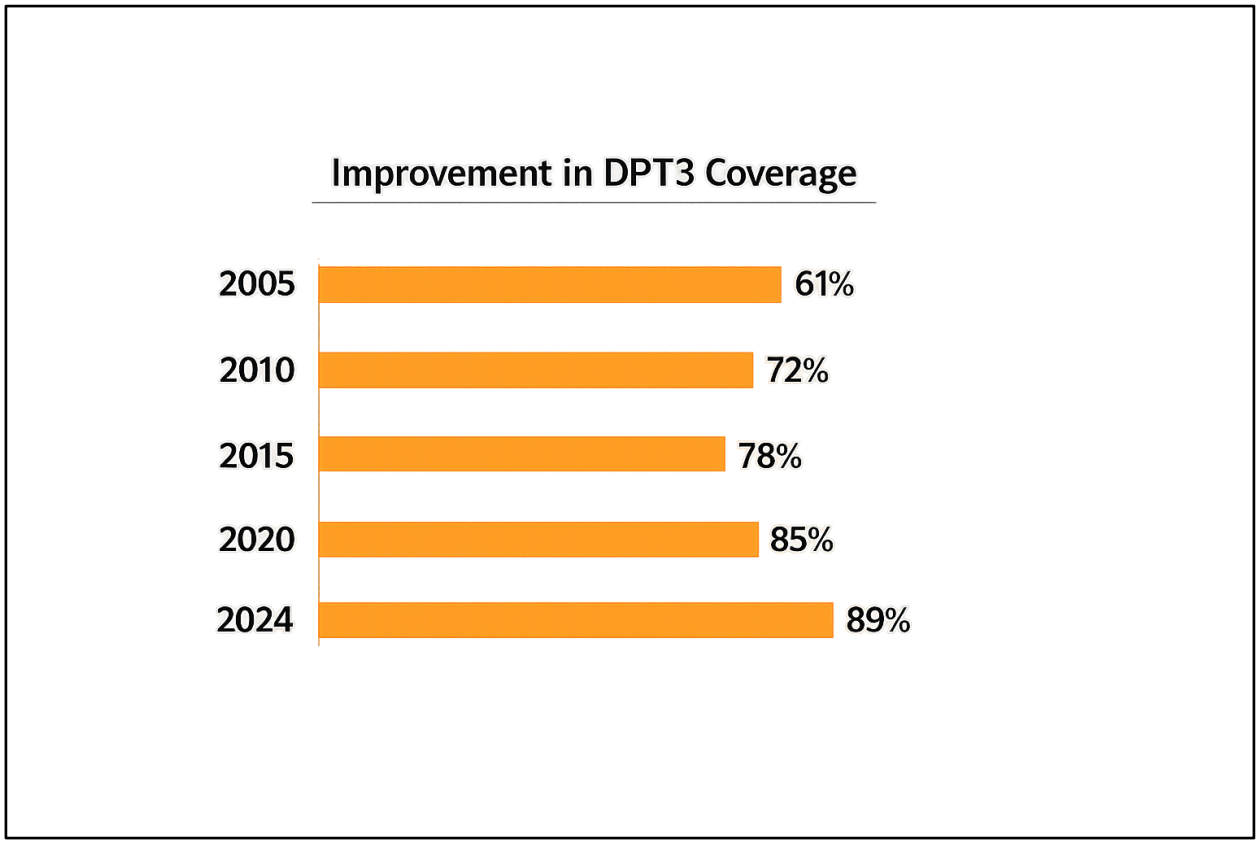
Vaccination Coverage in India

DPT3 coverage is a key indicator of immunization performance. Although national vaccination coverage has improved over time, regional disparities persist.
Immunization Data +2

Year	DPT3 Coverage (%)
2005	61
2010	72
2015	78
2020	85
2024	89

(WHO,UNICEF)

Bar Diagram: Improvement in DPT3 Coverage



Discussion

Comparison of Diphtheria Situation in India and Kyrgyzstan

India continues to report a higher burden of diphtheria compared to Kyrgyzstan because of its large population, regional disparities in healthcare access, overcrowding, migration, and incomplete immunization coverage in certain states. Recurrent outbreaks are commonly reported in states such as Telangana, Uttar Pradesh, and West Bengal. In India, waning immunity among adolescents and missed booster doses remain important public health concerns.

In contrast, Kyrgyzstan reports comparatively fewer diphtheria cases due to its smaller population and relatively better nationwide vaccine coverage through centralized immunization services. However, Kyrgyzstan also faces challenges such as rural healthcare accessibility, migration, and occasional disruptions in vaccination services.

Both countries rely on routine childhood immunization and booster vaccination for diphtheria prevention. India operates through the Universal Immunization Programme (UIP), while Kyrgyzstan follows national immunization schedules supported by WHO and UNICEF initiatives.

A major similarity between both countries is the importance of maintaining high vaccination coverage and surveillance systems to prevent outbreaks. Both nations also require continuous public awareness campaigns and booster dose compliance to maintain herd immunity.

Diphtheria remains an important vaccine-preventable disease in India despite decades of immunization efforts. The persistence of the disease highlights several public health deficiencies.

One major issue is incomplete vaccination coverage. Although national coverage rates have improved, pockets of under-immunized populations remain vulnerable. Rural communities, migrant populations, and urban slums are disproportionately affected.

Another important concern is waning immunity. Several Indian studies show that adolescents and adults lack protective antibody levels against diphtheria toxin. ﷺ This shift in age distribution suggests the need for additional booster doses beyond childhood.

Delayed diagnosis also contributes significantly to mortality. Clinicians may fail to recognize diphtheria because of declining familiarity with classical presentations. Limited availability of diphtheria antitoxin further complicates management.

The COVID-19 pandemic disrupted routine immunization services, increasing the risk of resurgence of vaccine-preventable diseases. Strengthening routine immunization is therefore essential.

India’s surveillance systems have improved through IDSP and laboratory strengthening. However, underreporting remains a challenge, particularly in remote regions.

Community Prevention Measures

1. Early case detection
2. Isolation of infected individuals
3. Contact tracing
4. Antibiotic prophylaxis for contacts
5. Health education campaigns

Future Directions

India must adopt a multi-pronged strategy to eliminate diphtheria:

1. Strengthening routine immunization
2. Ensuring booster dose compliance
3. Improving laboratory capacity
4. Increasing availability of DAT
5. Conducting serosurveillance studies
6. Enhancing public awareness
7. Improving outbreak preparedness

Conclusion

Diphtheria continues to pose a significant public health challenge in India despite the widespread availability of effective vaccines. The disease persists because of incomplete immunization, waning immunity, poor healthcare access, and delayed recognition. India has made substantial progress in improving vaccination coverage through initiatives such as the Universal Immunization Programme and Mission Indradhanush. However, outbreaks continue to occur in vulnerable populations and underserved regions.

The epidemiological shift toward older children and adolescents indicates the urgent need for stronger booster immunization policies and long-term immunity surveillance. Early diagnosis, timely administration of diphtheria antitoxin, and effective outbreak response remain essential to reducing morbidity and mortality.

Strengthening surveillance systems, improving healthcare infrastructure, addressing vaccine hesitancy, and ensuring equitable healthcare access are crucial steps toward diphtheria elimination in India. Continued public health vigilance and sustained immunization efforts are necessary to prevent future outbreaks and achieve long-term disease control.

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