



TNJPHMR

Tamil Nadu Journal of
Public Health and Medical Research

www.tnjphmr.com

A Quarterly Journal from
Directorate of Public Health and Preventive Medicine

(Government of Tamil Nadu)



E-ISSN : 2583-1771



TNJPHMR

**TAMILNADU JOURNAL
OF PUBLIC HEALTH
AND
MEDICAL RESEARCH**

Tamil Nadu Journal of Public Health and Medical Research - Members of the Editorial Board

Editor-in-Chief

Dr. T.S.Selvavinayagam

Director of Public Health & Preventive Medicine
Government of Tamil Nadu

Editorial Board

Dr. Somasundaram. A

Dr. Vijayalakshmi. V

Dr. Nirmalson. J

Dr. Senthilkumar. M

Dr. Manickam. P

Dr. Vinay Kumar. K

Dr. Shanmugasundaram. V

Dr. Vidhya Viswanathan

Associate Editors

Dr. Kanagabala. B

Dr. Sridhar Lakshmipathy

Dr. Kumaravel Ilangovan

Dr. Nandhini Selvanesan

Dr. Rachna William

Dr. Sabari Selvam

Letter from the Editor's Desk

Dear Readers,

Impact on common man is important.

It is well known that currently most of the research work revolves around impact factor and citation counts. But ultimately what is important is touching the common man's life either through improved intervention or by influencing the policy change through research. Impact on common man is more important than impact factors.

We as an organisation primarily focus on implementation and the journal is mainly a platform to share the science to common man and improve our service further.

And also the publication fees is becoming prohibitive in most of the journals and it will be an challenge for the academicians / students from the low resource settings. We continue to keep this platform to address that specific challenge.

Our team officials are taking extra efforts in improving the quality of the articles and making systematic changes so that time lines and turnaround time are adhered at all levels.

***Dr. T.S.Selvavinayagam MD., DPH., DNB.,
Director of Public Health & Preventive Medicine***

CONTENTS

TNJPHMR 4(4);2024

01. Analysis of investigative workup done among children hospitalized with fever with seizures following Universal immunization in Tamil Nadu, 2023

Sushmitha S, Saradha Suresh, Somasundaram Anavarathan, Vinay Kumar K, Keerthana A, Nandhini Selvanesan, Rachna William, Ramani Sathyaniidhi Rao

07

02. Influence of Educational Interactive Intervention to Improve the Accuracy of Death Certification Among Primary Health Care Doctors in Karur and Krishnagiri, Tamil Nadu, 2024.

Abishek Stanislaus, Selvavinayagam T S, Somasundaram Anavarathan, Manju Neelavarnan

15

03. Imparting Tuberculosis (TB) Literacy Using a Youth-Friendly Puzzle Game - a Pilot Quasi-Experimental Study, Tamil Nadu, 2022-2023

Charan Kuppusamy, Priscilla Rebecca, Jeremiah Leslie, Lakshana Mariappan, Priyanka Ravi, Jeevnathi, Karikalan Nagarajan, Adhin Bhaskar, Dhanalakshmi Angamuthu

21

04. Adjunctive trimetazidine therapy improves left ventricular ejection fraction by regulating plasma asymmetric dimethylarginine and visfatin in heart failure with reduced ejection fraction: A cross sectional Observational study, Tamil Nadu, 2021-2022

Uma Maheswari G, Yamini B, Gokul Sudhakaran, Mohan Kumar R, Cecily Mary Majella Jayaraj, Kannan Radhakrishnan, Dhandapani V E, Kanchana Mala Karuppiah

27

05. A Cross-Sectional Study on the Clinical Profile of Patients with Symptoms of Acute Coronary Syndrome (ACS) who Received Loading Dose at Primary Care Facilities under Idhayam Kappom Thittam Scheme in Tamil Nadu, India, 2024

Karuna Karthikeyan, Geetha Mani, Vidhya Viswanathan, Pravin Thiagarajan, Krishnaraj K, Selvavinayagam T S

35

06. A Study on the oviposition behaviour of Aedes mosquitoes to different coloured ovitraps in different seasons of Hosur Municipal Corporation area, Tamil Nadu, 2023

Kanniyammal S, Mani S, Vijayalakshmi V, Shanthi S, Sudalaimani S, Senthilkumar M, Sampath P, Vadivelan P, Selvavinayagam T S, Prabhakaran V

40

07. Effectiveness of Surveillance of Diphtheria and Pertussis in Tamil Nadu: A Secondary Data Analysis for January – December 2023.

Kanagabala Balasubramanian, Vinay Kumar Krishnamurthy, Kumaravel Ilangovan, Ramani Satyanidhi Rao, Somasundaram Anavarathan

45

08. Evaluation of Mid Upper Arm Circumference as a Screening tool for Undernutrition among Adolescent girls in Tamil Nadu, 2019

51

Roseline F. William, Kanagabala Balasubramanian, Marytresa Jeyapriyan S, Nandhini Selvanesan, Kumaravel Ilangovan

09. Rashtriya Bal Swasthya Karyakram (RBSK) Program in Tamil Nadu - A Process Documentation

55

Shinu Priya R, Fasma L, Vinoth R, Shanmuga Sundaram V, Selvavinayagam T S

10. Rising mumps cases in India- Need for inclusion of MMR vaccine in National Immunisation Program

61

Nandhini Selvanesan, Kumaravel Ilangovan, Vinay Kumar Krishnamurthy

11. From Storm to Safety: Public Health Success Measures in Managing Cyclone Fengal

68

Subhashini K J, Priyadharshani A, Avudai Selvi R, Ramya R, Mohammed al Ossama, Bhuvana K, Ganapathy M, Senthil Kumar M, Sampath P, Selvavinayagam T S

12. SPARSH Campaign and Leprosy Case Detection: An Evaluation of Awareness - Driven Outcomes in Tiruvallur district, Tamil Nadu 2018-2024

77

Sridevi Govindarajan

13. Trends of Teenage Pregnancy in Tamil Nadu, 2019-2024

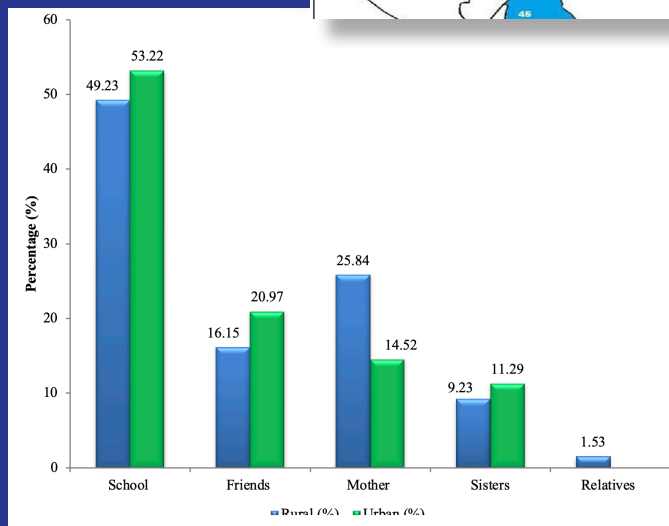
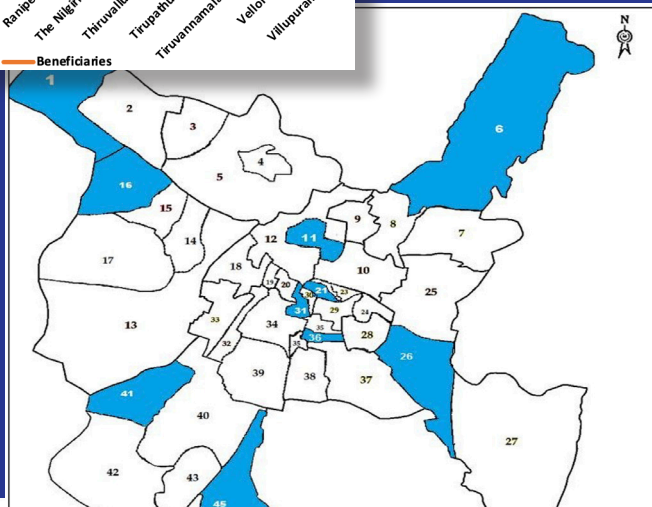
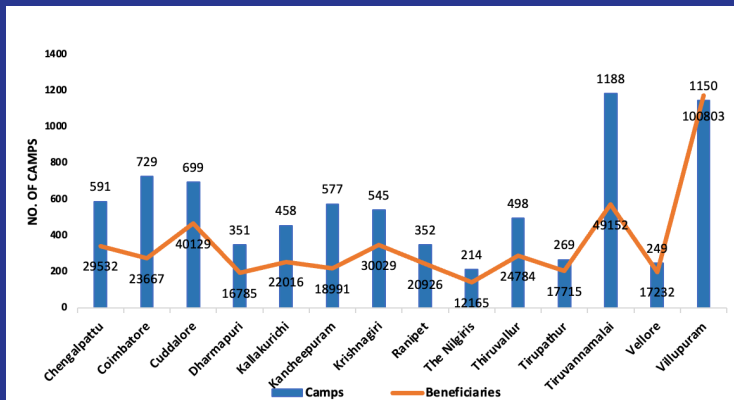
80

Vijaykumar R, Nirmalson J

14. Knowledge and attitude on menstruation- A comparative study among rural and urban adolescent girls in Chengalpattu, Tamil Nadu

84

Kanagabala Balasubramanian, Roseline F. William, Thirunaaukarasu D, Geetha Mani, Vidya D C, Gladius Jennifer H



RESEARCH IS TO SEE WHAT EVERYBODY ELSE HAS SEEN, AND TO THINK WHAT NOBODY ELSE HAS

ANALYSIS OF INVESTIGATIVE WORKUP DONE AMONG CHILDREN HOSPITALIZED WITH FEVER WITH SEIZURES FOLLOWING UNIVERSAL IMMUNIZATION IN TAMIL NADU, 2023

Sushmitha S⁽¹⁾, Saradha Suresh⁽¹⁾, Somasundaram Anavarathan⁽³⁾, Vinay Kumar K⁽³⁾, Keerthana A⁽⁴⁾, Kanagabala Balasubramanian⁽³⁾, Nandhini Selvanesan⁽³⁾, Rachna William⁽³⁾, Ramani Sathyanidhi Rao⁽⁴⁾

(1) District Residency Programme, Tagore Medical College & Hospital

(2) Member, National AEFI Committee

(3) Directorate of Public Health and Preventive Medicine

(4) Government Thoothukudi Medical College & Hospital

ABSTRACT

INTRODUCTION : The Universal Immunization Programme (UIP) provides free vaccines against 12 preventable diseases to children across India. Tamil Nadu has achieved high immunization coverage of 90.4%, according to the National Family Health Survey (NFHS). Monitoring Adverse Events Following Immunization (AEFI) is critical, with Tamil Nadu reporting 7,580 AEFI cases in 2020-2021, with around 0.2% of these involving serious adverse events. Fever with seizures, affecting 2-5% of children globally, may follow immunization, though they generally carry a low risk of long-term complications. Accurate diagnosis is crucial to prevent mismanagement. Hence, this study aims to assess investigative practices for fever with seizures post-immunization and identify areas for improvement. To estimate the proportion of children admitted with fever with seizures following routine immunization from January to December 2023 in Tamil Nadu and to assess the investigative work-up of children admitted with fever and seizures following routine immunization in Tamil Nadu

METHODS : This descriptive cross-sectional study uses secondary data of all cases of fever with seizures reported as AEFI in the SAFE-VAC portal in Tamil Nadu during 2023. The collected data were analyzed using Microsoft Excel and IBM SPSS version 29, with results presented in tables and graphs.

RESULTS: Most cases (42.9%) occurred in children aged 1 to 1.5 years, with 54.6% being male. The observed proportion of cases (4.97%) was lower than the expected rate of 10 AEFI cases per 100,000 doses. Haematological and metabolic screenings were commonly performed, while infectious disease tests and advanced imaging were underutilized, suggesting a need for more tailored diagnostic approaches.

CONCLUSION: The study provides insights into the epidemiology and investigative practices for post-immunization fever with seizures in Tamil Nadu. Although comprehensive diagnostic approaches were observed, there is room for standardization and improved protocol adherence.

KEYWORDS : Fever with seizures, Investigative workup, Post-vaccination seizures, Child Health

INTRODUCTION

Universal Immunization Programme (UIP) is a comprehensive vaccination program initiated in 1978 and expanded in 1985 to provide free vaccines against 12 vaccine-preventable diseases to all children across the country.^{1,2} The program aims to reduce morbidity, mortality, and long-term disabilities from these diseases. Under UIP, the government provides vaccination for diseases such as tuberculosis, polio, diphtheria, pertussis, tetanus, hepatitis B, Haemophilus influenzae type b, measles, rubella, Japanese encephalitis, and rotavirus diarrhea. Tamil Nadu has been a leader in implementing the Universal Immunization Programme. It has achieved a coverage rate of 90.4% for routine immunization, according to the National Family Health Survey (NFHS-

5). Tamil Nadu has also introduced newer vaccines, such as the rotavirus vaccine, into its immunization schedule ahead of the national rollout.³ Adverse Events Following Immunization (AEFI) are any untoward medical occurrences that follow immunization and do not necessarily have a causal relationship with the usage of the vaccine.⁴ These events can range from minor side effects, such as fever or pain at the injection site, to more serious adverse reactions.



Please Scan this QR Code to

View this Article Online

Article ID: 2024:04:04:01

Corresponding Author: Sushmitha S

e-mail : sushmithaa17@gmail.com

Major reactions of AEFI, although rare, can include severe allergic reactions like anaphylaxis, neurological disorders such as Guillain-Barré syndrome and seizures, and other serious complications requiring hospitalization. According to the World Health Organization (WHO), serious AEFIs occur in a small percentage of vaccine recipients and typically involve immediate medical intervention. The rate of serious AEFIs is generally low, with estimates indicating that about 0.1% to 0.5% of vaccinated individuals may experience these serious events. This statistic highlights that while minor side effects are more common, significant adverse reactions also occur.

Monitoring and investigating AEFI is crucial to ensure the safety and continued public confidence in vaccination programs. The World Health Organization (WHO) classifies AEFI into five categories: Vaccine product-related reaction, Vaccine quality defect-related reaction, Immunization error-related reaction, Immunization anxiety-related reaction, and Coincidental event. The National AEFI Surveillance Program monitors and investigates adverse events following immunization in India. During the financial year from April 2020 to March 2021, 36,306 AEFI cases were reported across India, with the majority being minor reactions. In Tamil Nadu, the state has a robust AEFI surveillance system, with 7,580 AEFI cases reported in 2020-2021, mainly consisting of minor reactions and 0.2% of these involving serious adverse events.^{5,6}

The AEFI cases are monitored and reported in the SAFEVAC (Surveillance and Action for Events Following Vaccination) portal that monitors and reports AEFIs in India. The portal serves as a centralized platform for healthcare providers to report any suspected adverse reactions to vaccines. The key features of this portal include Comprehensive data collection, real-time monitoring, Efficient investigation, and Public health decision-making.^{7,8} The cases reported in the portal will then be reviewed in the Causality assessment review meetings. The primary goal of these meetings is to determine whether the reported AEFI is likely to be related to the vaccine or immunization or if it is a coincidental event. This assessment is essential for maintaining public confidence in immunization programs and ensuring the safety and efficacy of vaccines. By conducting thorough and impartial causality assessments, India's AEFI surveillance system helps to identify and address any safety concerns associated with vaccines, ensuring that immunization programs remain safe and effective for the entire population.⁹⁻¹²

Fever with seizures are convulsions that occur in young children in association with fever, usually between the

ages of 1 month and 6 years. These seizures are often brief and are generally not associated with long-term neurological issues.¹³ They may be triggered by various factors, including infections and immunization. Globally, fever with seizures occurs in about 2-5% of all children, and the risk after immunization is generally low and studies consistently show that the benefits of vaccination far exceed these small risks.^{14,15} The data on fever with seizures specific to India is less documented than in Western countries. However, national estimates suggest the incidence aligns with global statistics, with a very small percentage of vaccinated children experiencing it.¹⁶

Fever with seizures is not frequently associated with downstream complications or severe neurologic diseases but still, some of them might need extensive investigations to rule out the other causes and prevent misdiagnosis.¹⁷ Fever with seizures can resemble serious neurological conditions like meningitis, encephalitis, or epilepsy, making diagnostic accuracy vital to ensure timely and appropriate treatment. Misdiagnosis or unnecessary investigations may lead to delayed care, increased healthcare costs, and undue family anxiety. Accurate diagnosis helps prevent missed serious cases and avoids over-treating benign conditions, ensuring optimal resource allocation and better clinical outcomes. While fever with seizures is common, research specifically focusing on those occurring post-immunization is relatively limited. This is significant because improper evaluation can impact individual clinical outcomes and public health strategies. Hence, this study would help assess the current practices of investigative workup among cases of fever with seizures and can help identify areas for improvement and standardization.

OBJECTIVES

1. To estimate the proportion of children admitted with fever with seizures following routine immunization from January to December 2023 in Tamil Nadu
2. To assess the investigative work-up of children admitted with fever and seizures following routine immunization in Tamil Nadu

METHODS

A Retrospective study using secondary data analysis was conducted among cases of fever with seizures reported as adverse events following immunization. The reported data during the year 2023 (January – December) were obtained from the Surveillance and Action for Events following Vaccination portal (SAFE-VAC). The database is based

on the data collected by the Immunization section in the Directorate of Public Health – Tamil Nadu from the medical facilities as a part of the National AEFI passive surveillance. The data was extracted from the case reporting form (CRF), the case investigation form (CIF), and the hospital records of all the cases reported as fever with seizures following immunization during 2023 through the SAFE-VAC portal. The study included all the hospitalized cases of seizures with or without fever following immunization from January 2023 to December 2023. The reported cases involving patients who left against medical advice (LAMA), and those classified as brought dead cases were excluded from the study. The Patient details, vaccine details, type of AEFI event, diagnosis, and hospitalization details were documented using a data extraction sheet and a checklist was developed for the investigations of febrile seizures as per IAP Standard Treatment Guidelines 2022 and Consensus Guidelines on Evaluation and Management of the Febrile Child in India.^{18,19} Official permission to conduct this study was obtained from the Director of Public Health and Preventive Medicine (DPH&PM), Tamil Nadu. The confidentiality and anonymity of the patient's information was maintained. The collected data were entered into Microsoft Excel software and analyzed using IBM SPSS software version 29.

RESULTS

In the study period spanning from January 2023 to December 2023, 119 cases of fever with seizures were reported to the state AEFI surveillance program.

Table 1: Age-wise & Gender-wise distribution of fever with seizure cases reported under AEFI surveillance in Tamil Nadu (January – December 2023)

S.No	Variable	Frequency (N = 119)	Percentage (%)
1.	Age-wise distribution		
	0 – 6 months	32	26.9
	6 months - 1 year	15	12.6
	1 year – 1.5 years	51	42.9
	1.5 years – 2 years	13	10.9
	> 2 years (up to 16 years)	8	6.7
2.	Gender-wise distribution		
	Male	65	54.6
	Female	54	45.4

Footnotes: the data in the table are represented in frequency (N) & percentage (%)

Most (42.9%) of the fever with seizure cases reported following immunization belonged to the age group of 1 year

to 1.5 years when compared to the rest of the age groups together with a majority of males at 54.6 % and females at 45.4% (Table 1).

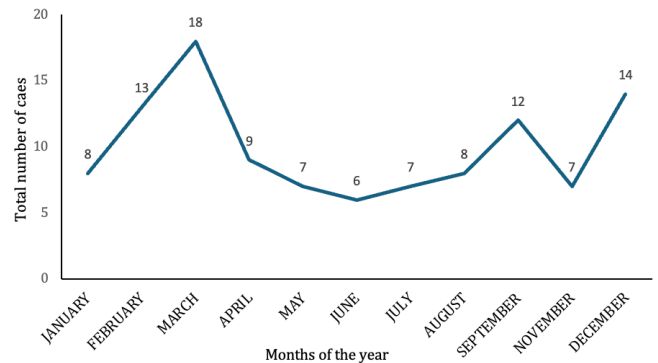
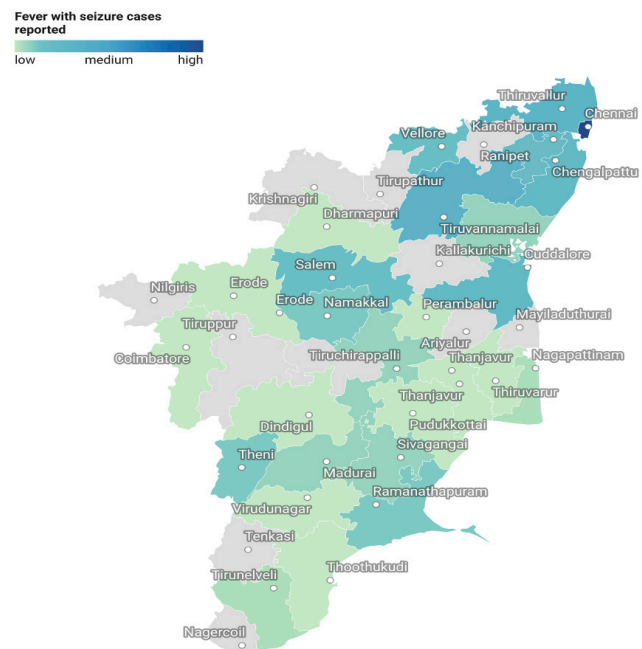


Figure 1: Month-wise trend of reported fever with seizure cases in Tamil Nadu during the year 2023

Figure 1 depicts a steady increase in the frequency of cases from January to March and a slight increase from August to September 2023. The observed cases of fever with seizure following immunization were 119 out of a total of 23,936,827 vaccination doses which when compared to an expected rate of 10 AEFI cases per 100,000 doses (equivalent to 2,394 cases), the observed proportion of fever with seizure cases is approximately 4.97% of the expected rate.



Footnotes: the data in the image are represented in frequency (N) (Low: < 10 cases, Medium: 10-25 cases, High: >25 cases)

Figure 2: District-wise distribution of fever with seizure cases reported in Tamil Nadu from January to December, 2023

Table 2: Frequency distribution of the vaccination details and adverse events of the reported fever with seizure cases in Tamil Nadu, 2023

S.No	Variable	Frequency (n)	Percentage (%)
1.	Place of vaccination		
	Outreach	61	51.3
	Government health facility	56	47.1
	Private health facility	2	1.7
2.	Source of vaccine supply		
	Government supply	117	98.3
	Private supply	2	1.7
3.	Duration between vaccination and the development of the first symptom		
	< 1 week	115	96.6
	> 1 week	4	3.4
4.	Duration between the development of symptom and hospitalization		
	Within 24 hours	103	86.6
	< 7 days	11	9.2
	> 7 days	5	4.2
5.	Place of hospitalization		
	Government	104	87.4
	Private	15	12.6
6.	Duration of hospital stay (days)		
	1 – 3	54	45.4
	4 – 6	39	32.8
	7 – 9	17	14.3
	> 10	9	7.6
7.	Outcome of the patient		
	Recovered completely	116	97.5
	Death	3	2.5

Footnotes: the data in the table are represented in frequency (N) & percentage (%)

Figure 2 illustrates the district-wise distribution of reported fever with seizure cases following universal immunization in Tamil Nadu during 2023. Overall, the distribution reflects varying intensities of reported cases across Tamil Nadu, with Chennai showing a notably higher number of incidents.

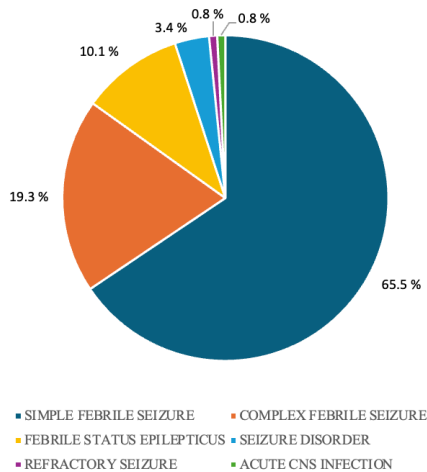


Figure 2: Distribution of Types of Seizure Diagnoses Among Children Hospitalized with Fever and Seizures Following Universal Immunization in Tamil Nadu – 2023

through outreach programs (51%), followed by vaccinations at Government Health Facilities (47%) and Private Health Facilities (2%). Among the fever with seizure cases reported following immunization, the majority source of vaccine supply was the government (98.3 %). Most cases (96.6%) developed symptoms within the first week after vaccination, while only 3.4% exhibited symptoms more than a week later. Regarding hospitalization, 87.4% of cases were treated at Government Facilities, and 12.6% received care at Private Health Facilities. Nearly 86.6% of the cases were hospitalized within 24 hours of symptom onset. Regarding hospital stays, most children (45.4%) were discharged within 1 to 3 days. About 32.8% required a hospital stay of 4 to 6 days, while 14.3% needed hospitalization for 7 to 9 days. Extended hospitalizations were less common, with 7.6% of cases requiring stays of more than 10 days. Of the total cases, 116 children (97.5%) fully recovered, but unfortunately, 3 cases (2.5%) resulted in death. The three deaths were categorized under causality classification Category C, indicating that they were due to coincidental underlying or emerging conditions, or conditions caused by factors unrelated to the vaccine. The specific diagnoses associated with these cases included status epilepticus, refractory seizures, and sepsis.

Almost 14% percent of children had a prior history of similar reaction events, while the majority, 85.7 % of children, had no such history. Almost none of the children had a history of allergies, while 1.7% were unaware of their allergy status. A proportion of children had a pre-existing illness (10.9%), had experienced an acute illness within 30 days before vaccination (5.9%), had a known family history of disease (5.0%), were on concomitant medication at the time of vaccination (4.2%), and had been hospitalized in the 30 days preceding vaccination (1.7%).

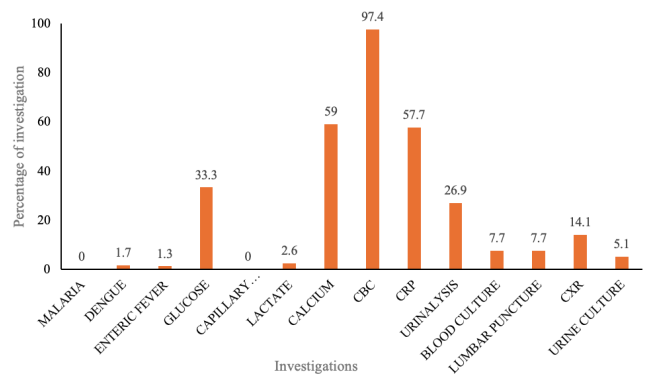


Figure 3: Distribution of Investigations Performed in Simple Febrile Seizure Cases Among Hospitalized Children Following Universal Immunization in Tamil Nadu, 2023

The highest proportion of vaccinations occurred

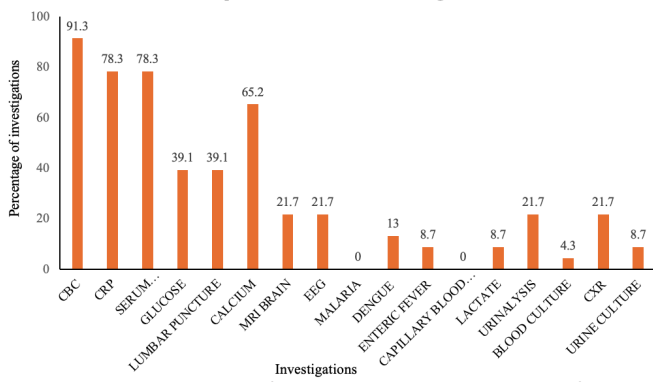


Figure 4: Distribution of Investigations Performed in Complex Febrile Seizure Cases Among Hospitalized Children Following Universal Immunization in Tamil Nadu, 2023

Table 3: Frequency distribution of investigations performed in febrile status epilepticus and other diagnosis among hospitalized children following Universal Immunization in Tamil Nadu, 2023

S.No	Investigations	Febrile Status Epilepticus (n = 12)	Others (n = 6)
1.	CBC	12 (100)	6 (100)
2.	CRP	8 (66.7)	5 (83.3)
3.	Serum electrolytes	11 (91.7)	5 (83.3)
4.	Glucose	3 (25)	3 (50)
5.	Lumbar puncture	5 (41.7)	3 (50)
6.	Calcium	11 (91.7)	5 (83.3)
7.	MRI brain	3 (25)	3 (50)
8.	EEG	3 (25)	1 (16.7)
9.	Malaria	0	0
10.	Dengue	0	1 (16.7)
11.	Enteric fever	0	1 (16.7)
12.	Capillary blood gas	0	1 (16.7)
13.	Lactate	1 (8.3)	4 (66.7)
14.	Urinalysis	4 (33.3)	2 (33.3)
15.	Blood culture	1 (8.3)	3 (50)
16.	Chest X-Ray	2 (16.7)	3 (50)
17.	Urine culture	2 (16.7)	0

Footnotes: the data in the table are represented in frequency (N) & percentage (%) (Other diagnoses include seizure disorder, Refractory seizure, and Acute CNS infection)

The majority, 65.5%, were diagnosed with simple febrile seizures. Complex febrile seizures accounted for 19.3% of cases, while febrile status epilepticus was observed in 10.1%. Seizure disorder was noted in 3.4% of the children. Both refractory seizures and acute CNS infections were rare, each contributing to 0.8% of cases.

Figures 3 and 4 represent the distribution of investigations performed in cases of simple and complex febrile seizures among hospitalized children following universal immunization. The frequency distribution of investigations performed in febrile status epilepticus and other diagnoses are represented in Table 3 which shows the most performed investigations and the least performed investigations.

Table 4: Range of investigations performed in fever with seizure cases according to their diagnoses in Tamil Nadu, 2023

S.No	Diagnosis	No. of investigations	Frequency (N)	Percentage (%)
1.	Simple febrile seizures (n =78)	0 - 5	11	47.8
		6 - 10	12	52.2
		Total	23	100
2.	Complex Febrile Seizures (n =23)	0 - 5	11	47.8
		6 - 10	12	52.2
		Total	23	100
3.	Febrile Status Epilepticus (n =12)	0 - 5	7	58.3
		6 - 10	5	41.7
		Total	12	100
4.	Others (n = 6)	0 - 5	1	16.7
		6 - 10	4	66.7
		> 10	1	16.7
		Total	6	100

Footnotes: the data in the table are represented in frequency (N) & percentage (%) (Other diagnoses include seizure disorder, Refractory seizure, and Acute CNS infection)

Table 4 depicts, that in simple febrile seizures, 92.3% of the cases had undergone up to 5 investigations and the remaining 7.7% of the cases had about 6 – 10 investigations performed to find out the focus of fever. Whereas in the case of complex febrile seizures and febrile status epilepticus the percentage of investigations was almost equally split between both ranges. The category with the remaining diagnosis had the majority of cases undergo about 6 – 10 investigations.

The most performed investigations in Simple febrile seizures were complete blood count (97.4%), serum calcium (59%), and C-reactive protein (57.7%). However, investigations for malaria, dengue, enteric fever, and capillary blood gas were among the less frequently performed investigations. For complex febrile seizures, CBC was performed in 91.3% of cases, while CRP and serum electrolytes were each assessed in 78.3%. Lumbar punctures and glucose tests were conducted in 39.1% of cases. In febrile status epilepticus, CBC was done in all cases (100%), with serum electrolytes and calcium also evaluated in 91.7%. Other investigations included lumbar punctures in 41.7%. In cases such as refractory seizures and acute CNS infections, CBC was conducted in all patients, with serum electrolytes and calcium assessed in 83.3%. These findings reflect the tailored clinical approach to investigations based on the specific seizure type following vaccination.

DISCUSSION

The Assessment of investigative work up in children hospitalized with fever and seizures following immunization in Tamil Nadu reveals several significant findings, which align with and add to the existing literature on adverse events following immunization. Of the 119 cases, 54.6% were male, while 45.4% were female. This male predominance is consistent with other studies on febrile seizures post-immunization, such as the work by Hall et al., which found

a higher incidence of febrile seizures in males following measles, mumps, and rubella (MMR) vaccination.²⁰ Macartney et al conducted a study that found that febrile seizures occur in approximately 4-5 cases per 100,000 doses of the MMR vaccine, which aligns closely with the observed rates in this study.²¹ However, a European study by Schink et al in 2014 has reported higher rates, particularly with the MMRV vaccine, where febrile seizures can occur in up to 9 per 100,000 doses, suggesting regional and vaccine-specific variability. The observed month-wise trend in this study is consistent with findings from a study conducted by Schink et al with peaks aligning with the circulation of seasonal viruses like influenza, which may exacerbate post-vaccination febrile responses.²²

The majority of the vaccines (98.3%) were administered through government sources, sources reflecting the dominant role of public healthcare in delivering immunization services in Tamil Nadu. The strong reliance on public healthcare is indicative of a well-organized Universal Immunization Programme (UIP), which has been effective in increasing vaccination coverage. Similar studies in Andhra Pradesh and Madhya Pradesh reported 95% and 96.7% reliance on public healthcare, respectively, highlighting a national trend.^{23,24} The majority of cases (96.6%) experienced symptom onset within a week of vaccination, a typical timeframe for post-vaccine reactions, aligning with Kulkarni et al. (2018), who found that over 90% of AEFI cases occurred within the first week.²⁵ In contrast, Macartney et al. (2016) noted a slightly broader window of up to 14 days, possibly due to differences in immune response or underlying health conditions among populations. A significant portion of children were admitted to government hospitals (87.4%), with most hospitalized within 24 hours of symptom onset. The median hospital stay was 1-5 days for 71.4% of cases, resulting in a high recovery rate of 97.5%. This favorable outcome can be attributed to timely medical interventions and the effective management of febrile seizures, similar to findings by Verbeek et al.²⁶

Bansal et al. (2020) found that 85% of children recovered within three days, contrasting with our findings, particularly for those hospitalized for 6-10 days.²⁷ The differences in recovery times may be influenced by factors such as the severity of the seizures and associated complications, which could vary based on healthcare access and available treatments. However, Roy et al. (2021) in West Bengal noted that 70% of children were discharged within five days, closely aligning with our results, reinforcing the notion that effective management can lead to quick recoveries.²⁸ Variations

in hospitalization duration may stem from the severity of febrile seizures and differences in regional healthcare systems' ability to deliver rapid diagnostic and therapeutic interventions. Additionally, clinical guidelines for managing post-vaccination febrile seizures may differ by region, contributing to these discrepancies in treatment outcomes. Yavuz et al. (2020) reported that among 300 children with febrile seizures, 60% had simple febrile seizures, 25% had complex febrile seizures, and 5% had febrile status epilepticus, suggesting a similar distribution pattern as compared to our findings.²⁹

Our findings show a high prevalence of complete blood count investigations, which aligns with common clinical guidelines advocating for initial screening in febrile children to rule out hematological causes of fever. This high percentage suggests that physicians prioritize identifying potential infections or hematologic conditions that could contribute to febrile episodes. Calcium levels were assessed in 59% of the children. This aligns with previous literature emphasizing the need to evaluate electrolyte imbalances, especially in cases where the clinical picture suggests potential metabolic derangements. In summary, the investigative practices for simple febrile seizures in this study highlight a significant reliance on hematological and metabolic screening, while underutilizing tests for infectious diseases like malaria and dengue. This suggests a need for more comprehensive protocols to ensure appropriate investigations in cases of febrile seizures, particularly in populations at risk for these infections.

Among children with complex febrile seizures, high rates of complete blood counts (91.3%), C-reactive protein (78.3%), and serum electrolytes (78.3%) were noted, indicating a focus on identifying infections and metabolic disturbances; however, lower rates of advanced imaging (MRI at 21.7%, EEG at 21.7%) suggest these are reserved for atypical cases, aligning with American Academy of Pediatrics guidelines.³⁰ In cases of febrile status epilepticus, a more aggressive diagnostic approach was taken, with 100% undergoing CBC and 91.7% serum electrolytes; lumbar punctures were performed in 41.7% of cases, reflecting concerns for central nervous system infections. Conversely, the low rates of malaria and dengue investigations raise concerns in endemic areas. The other diagnoses such as refractory seizures and acute CNS infections showed similarly high CBC utilization (100%), but lower lumbar puncture (50%) and MRI (50%) rates suggest selective diagnostic strategies. Overall, the emphasis on basic metabolic and infectious evaluations underscores their significance in pediatric seizure management, while the

lower utilization of advanced imaging in specific populations highlights the need for tailored diagnostic approaches.

The regional distribution of cases showed that a substantial portion was from Chennai (26.05%), with fewer cases from other districts. This is consistent with patterns of healthcare access and reporting, where urban areas tend to have better surveillance and healthcare infrastructure, leading to more reported cases.³¹

LIMITATIONS

This study, while robust in its scope, has limitations in terms of its retrospective design and reliance on secondary data. There may be underreporting of milder cases or incomplete documentation of investigations. Future studies could benefit from a prospective design and could aim to include a more detailed breakdown of vaccine types associated with febrile seizures. The study was conducted in a specific region, which may limit the applicability of the findings to other areas with different healthcare systems, or demographic characteristics.

CONCLUSION

This study offers valuable insights into the epidemiology of febrile seizures following immunization in Tamil Nadu. The management of fever with seizures in children following universal immunization necessitates a comprehensive diagnostic approach, as evidenced by the investigation patterns observed in this study in Tamil Nadu. The investigative approach was largely appropriate, although there is room for standardization and adherence to guidelines in specific investigations. These findings reinforce the safety of vaccines, with a high recovery rate.

CONFLICT OF INTEREST

None

REFERENCES

1. Lakshmi, J. K., Nair, M., Tripathy, J. P., Harries, A. D., Hariharan, R., Abejirinde, I. O. O., ... & Rao, S. (2019). Universal immunisation programme in India: the wheels have turned, but can the job be finished? *BMJ Global Health*, 4(Suppl 4), e001569.
2. Ministry of Health and Family Welfare. (2022). Universal Immunization Programme (UIP). Retrieved from [https://main.mohfw.gov.in/organisation/departments/department-health-and-family-welfare/universal-immunization-](https://main.mohfw.gov.in/organisation/departments/department-health-and-family-welfare/universal-immunization-programme-uip)

[programme-uip](https://main.mohfw.gov.in/organisation/departments/department-health-and-family-welfare/universal-immunization-programme-uip)

3. Parashar, U. D., Bresee, J. S., & Glass, R. I. (2013). The global burden of diarrhoeal disease in children. *Bulletin of the World Health Organization*, 91(3), 146-146A.
4. World Health Organization. (2013). Causality assessment of an adverse event following immunization (AEFI): user manual for the revised WHO classification. World Health Organization.
5. Directorate of Public Health and Preventive Medicine. (2021). Annual Report 2020-2021. Government of Tamil Nadu.
6. Ministry of Health and Family Welfare. (2021). National Adverse Events Following Immunization (AEFI) Surveillance Program: Annual Report 2020-2021. Government of India.
7. Ministry of Health and Family Welfare, Government of India. SAFEVAC Portal.
8. <https://safevac.mohfw.gov.in/>
9. National Health Mission, Government of India. Adverse Events Following Immunization (AEFI). <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9970920/>
10. World Health Organization. Adverse Events Following Immunization (AEFI). <https://pubmed.ncbi.nlm.nih.gov/30026925/>
11. Ministry of Health and Family Welfare, Government of India. National AEFI Surveillance and Response Operational Guidelines. <https://mohfw.gov.in/sites/default/files/Revised%20AEFI%20Guidelines%20Execute%20Summary.pdf>
12. World Health Organization. Causality Assessment of Adverse Events Following Immunization (AEFI). <https://pubmed.ncbi.nlm.nih.gov/30026925/>
13. Patel N, Ram D, Swiderska N, Mewasingh LD, Newton RW, Offringa M. Febrile seizures. *BMJ*. 2015;351:h4240.
14. Vestergaard M, Obel C, Henriksen TB, Christensen J, Madsen KM, Ostergaard JR, et al. The Danish National Hospital Register is a valuable study base for epidemiologic

- research in febrile seizures. *J Clin Epidemiol.* 2006;59(1):61-66.
15. Duffy J, Weintraub E, Hambidge SJ, Jackson LA, Kharbanda EO, Klein NP, et al. Febrile seizure risk after vaccination in children 6 to 23 months. *Pediatrics.* 2016;138(1):e20160320.
16. Shankar P, Raghunath CN, Kalra V. Febrile seizures in Indian children: prevalence and risk factors. *J Pediatr Neurosci.* 2014;9(1):17-21.
17. Aaberg KM, Gunnes N, Bakken IJ, Lund Søråas C, Berntsen A, Magnus P, et al. Incidence and prevalence of childhood epilepsy: a nationwide cohort study. *Pediatrics.* 2017;139(5):e20163908
18. Indian Academy of Pediatrics. Guidelines for management of febrile seizures. *Indian Pediatr.* 2022;59(5):325-332.
19. Mahajan P, Batra P, Thakur N, Patel R, Rai N, Trivedi N, Fassel B, Shah B, Lozon M, Oteng RA, Saha A, Shah D, Galwankar S. Consensus Guidelines on Evaluation and Management of the Febrile Child Presenting to the Emergency Department in India. *Indian Pediatr.* 2022;59(8):675-688.
20. Hall JG, et al. Risk of febrile seizures after MMR vaccination: A population-based study. *Journal of Pediatrics.* 2020.
21. Macartney K, McRae J, Buttery J, Crawford N, Gold M, Marshall H, et al. Febrile seizures following measles and varicella vaccines in young children in Australia. *Vaccine.* 2016;34(37): 5272–5278. doi: 10.1016/j.vaccine.2016.07.019.
22. Schink T, Holstiege J, Kowalzik F, Zepp F, Garbe E. Risk of febrile seizures and other adverse events after simultaneous vaccination with measles, mumps, rubella, and varicella: A systematic review. *Vaccine.* 2014;32(29): 3144–3151. doi: 10.1016/j.vaccine.2014.04.032.
23. Jain R, Shrivastava AK, Gupta A. Adverse events following immunization surveillance and vaccine supply analysis in Andhra Pradesh. *Indian J Public Health.* 2020;64(2):162-6
24. Rajendran P, Singh V, Kumari S. Role of public healthcare in routine immunization coverage: Insights from Madhya Pradesh. *J Trop Pediatr.* 2021;67(4)
25. Kulkarni V, Agarkhedkar S, Kulkarni P, Ganjare M, Bhattad V, Dhotre K. Adverse events following immunization: Surveillance in pediatric population. *Indian J Public Health.* 2018;62(1):9-14.
26. Verbeek NE, et al. Long-term outcome of febrile seizures. *European Journal of Pediatrics.* 2016.
27. Bansal S, Singh R, Gupta N, et al. Duration of hospital stay and clinical outcomes in children with febrile seizures post-immunization. *Indian Pediatr.* 2020;57(9):815-819.
28. Roy A, Nandi S, Das A. Adverse events following immunization: hospital admission, duration of stay, and outcomes in a tertiary care hospital in West Bengal. *J Clin Diagn Res.* 2021;15(3)
29. Yavuz A, Ceylan G, Erbatur S, et al. Epidemiological and clinical features of febrile seizures: a multi-center study in Turkey. *Seizure.* 2020;75:78-83. doi:10.1016/j.seizure.2019.11.007.
30. American Academy of Pediatrics, Subcommittee on Febrile Seizures. Febrile seizures: guideline for the neurodiagnostic evaluation of the child with a simple febrile seizure. *Pediatrics.* 2011;127(2):389-394.
31. Patel V, Parikh R, Nandraj S, et al. Assuring health coverage for all in India. *Lancet.* 2015;386(10011):2422-2435.

INFLUENCE OF EDUCATIONAL INTERACTIVE INTERVENTION TO IMPROVE THE ACCURACY OF DEATH CERTIFICATION AMONG PRIMARY HEALTH CARE DOCTORS IN KARUR AND KRISHNAGIRI, TAMIL NADU, 2024.

Abishek Stanislaus ⁽¹⁾, Selvavinayagam T S ⁽¹⁾, Somasundaram Anavarathan ⁽¹⁾, Manju Neelavarnan ⁽¹⁾

(1) Directorate of Public Health and Preventive Medicine

ABSTRACT

INTRODUCTION : Accurate and complete medical certification of cause of death certificates (MCCD) are crucial for the medico-legal handling of individual cases of death. Currently the quality of cause of death certification in forms has been poor. Object of this intervention was to assess the knowledge and enhance the professional skills of the trainees for certifying causes of death.

METHODS : We conducted a quasi-experimental intervention study among doctors in a two days training in two districts in Tamil Nadu 2024 with a before and after design without a control group conducted. Form 4A which is used by registered medical practitioners for certifying non- institutional deaths was filled by doctors before and after cause of death training which was audited using the Bloomberg Medical Certification of Cause of Death MCCD assessment tool was entered in Excel and analyzed using Statistical Package for the Social Sciences (SPSS). All variables were compared using proportions, differences and Mc Nemar's & Fischers exact test for ToT and DLT for completeness, correctness, and minor & major errors.

RESULTS : Overall completeness in filling form 4A increased by 30% in Training of Trainers (ToT) and 19% in District Level Training (DLT). The most notable improvements were in the capture of cause of death (96% in ToT, 98% in DLT) and time intervals (96% in ToT). Legibility errors decreased by over 20% in both systems (ToT: 45%, DLT: 44%). The most significant reduction was in the error of "incorrect or clinically improbable chain of events," which decreased from 57% to 19% in ToT and from 65% to 12% in DLT. When comparing major and minor errors, records with major errors decreased from 57% to 19% in ToT and from 65% to 12% in DLT. Minor errors decreased from 84% to 51% in ToT and from 99% to 58% in DLT. Overall, records with any type of error reduced significantly in both groups (ToT: from 98% to 55%, DLT: from 100% to 58%).

CONCLUSION : The intervention resulted in significant improvements in both the completeness of death certification records and the reduction of errors. These findings highlight the importance of training and its methodology for certifiers in ensuring high-quality and accurate cause-of-death certificates.

KEYWORDS : Medical Certification of Cause of Death, Quasi-experimental study

INTRODUCTION

Mortality statistics are a fundamental component of civil registration and vital statistics (CRVS) and are crucial for public health and policy-making for several reasons such as public health surveillance, resource allocation, policy development, identifying disparities, and epidemiological research.¹ Medical Certification of cause of death (MCCD) is one of the reliable sources for mortality statistics. The gold standard for cause-of-death reporting is for a medical practitioner to certify the cause using the rules and procedures outlined in the International Classification of Diseases, now in its eleventh revision (ICD-11) but ICD-10 is currently used in India.² In India as per the Registration of Birth and Death Act, Section 10(3) states that under sub-section (2) a certificate as to the cause of death shall be obtained, in the event of the death of any person who, during his last illness was attended by a medical practitioner, the medical practitioner shall, after the death of that person, forthwith issue without

charging any fee, to the person required under this Act to give information concerning the death, a certificate in the prescribed form stating to the best of his knowledge and belief the cause of death; and the certificate shall be received and delivered by such person to the Registrar as the time of giving information concerning the death as required by this Act.¹ Accurate and complete death certificates are crucial for the medico-legal handling of individual cases of death.³ There are two MCCD forms collected in India. Form 4 is used to collect cause of death for institutional deaths and Form 4A is used for non-institutional deaths.¹



Please Scan this QR Code to

View this Article Online

Article ID: 2024:04:04:02

Corresponding Author: Abishek Stanislaus

e-mail :abishekstanislausuhc@gmail.com

The main sections of the form 4A are:

- Part I: This section is for immediate, intermediate, and underlying conditions directly leading to death, known as the primary cause of death.
- Part II: This section records other significant conditions contributing to death but not directly related to the primary cause of death listed in Part I.
- Other Sections: These include the patient's demographic details, the degree of certainty with which the certifier completes the MCCD, the timing of events, the manner of death, and the personal details of the certifier.

Part I captures the sequence of conditions directly causing death. It begins with the immediate cause of death (the final/terminal disease or condition directly resulting in death) on line (i), which is due to (results from) the antecedent (intermediate) condition recorded on line (ii), which in turn results from the underlying cause of death (the disease or condition that initiated all events resulting in death) on line (iii). The condition listed on the lowest line of Part I (iii) is the underlying cause of death. This is considered the initial domino that triggered all subsequent events leading to death and is used for statistical mortality analysis by ICD-10. In Part II, other significant conditions contributing to death but not directly related to the underlying cause are recorded.¹

Despite its inclusion in medical school undergraduate curricula, the training for documenting death certification is not provided and holds little practical significance at the early stage of medical education.⁴⁻⁶ Although completing death certificates is a routine and well-standardized task for most physicians, a critical review reveals that these documents frequently contain numerous errors.^{7,8}

Research from other regions has revealed that the clinical information recorded on death certificates often fails to construct a logical cause of death. Furthermore, up to 10% of these certificates are completed poorly, and only 55% meet the minimum required standards.⁹ Hence, to assess the knowledge and enhance the professional skills in our setting, we conducted a study among the doctors of Karur and Krishnagiri districts by training for certifying causes of death during June 2024.

METHODS

We carried out a quasi-experimental intervention study with a before and after design without a control group. The intervention consisted of two training courses conducted for master trainers – Training of Trainers followed by district-level training for primary healthcare doctors employed in the Department of Public Health and Preventive Medicine

(DPH&PM) at Karur and Krishnagiri districts in June 2024. A total of 60 trainees participated in the training of trainers. The participants for the Trainer of Trainers (ToT) were block-level primary health care doctors from the DPH&PM from Karur and Krishnagiri districts, Medical Colleges, Indian Council of Medical Research – National Institute of Epidemiology (ICMR-NIE), WHO, and training institutes (Institute of Public Health, Health & Family Welfare Training Centre, Health Manpower Development Institute). The doctors from the training of trainers have served as master trainers and conducted the district-level training (DLT) at Krishnagiri and Karur for the doctors of each primary health center from the same district. 102 trainees participated in district-level training who were from each primary health centre from Karur and Krishnagiri districts.

Training methodology: The training was structured in such a way that a pre-test was given along with form 4A with a case scenario and the doctors were asked to fill the form. The training was tailor-made specifically for the doctors emphasizing the importance of MCCD and how to use it based on the previous experiences in the field and training done under the District CRS Approach program. The scenario for form 4A was taken from the Physician Manual on Medical Certification of Cause of Death provided by the Office of Registrar General of India. The trainees were trained on Medical Certification of cause of death for 2 days through PowerPoints (4 hours), group work(4 hours) and hands-on training (2 hours) elaborating the contents of MCCD and the pitfalls while writing MCCD, discussion of case studies with different scenarios, and how to write the cause of death in the prescribed MCCD form in English language and were provided with training manuals for future reference. The doctors after the training will be provided with a cause of death form in their PHC from the history collected by their concerned Health Inspectors from the field. The doctors were requested to fill out a post-test along with form 4A with the same case scenario at the end of the training. The Form 4A from the pre and post-test of Training of trainers and district-level training were collected as hard copies by the State Nosologist from the State Bureau of Health Intelligence (SBHI) section of the Directorate of Public Health and Preventive Medicine. Each form 4a was assessed using the Bloomberg MCCD assessment tool manually. It was noted in ToT out of 60 participants pre-test was received from 51 participants only and post test was received from 47 participants only. All 102 participants from District Level training provided the pre-test and post-test.

The form 4A after assessment using the tool mentioned above was entered in MS Excel and analysed using SPSS. The variables such as gender, age, cause of death, time intervals, and practitioner details were compared with pre-test and post-test using proportions for completeness and correctness. The errors in form 4 A were categorized as major and minor errors.

The major errors (Mechanism of death listed without an underlying cause & Improper sequencing) and minor errors (Abbreviations, Absence of time intervals, Absence of Age, address, date & time of deceased) were compared. The differences of percentages between pre-test and post-test were compared for both ToT and DLT. The pre-test and post-test of ToT were compared using Mc Nemar's test and Fischer's exact test.

Our study got approved by Institutional Ethics Committee of Tamil Nadu Public Health department; we maintained privacy and confidentiality in such a way that no personal data was used or revealed during analysis or report preparation & presentation.

RESULTS

The intervention was carried out among 162 participants (ToT-60(37%), DLT-102(63%)). A total of 302 records of which 98(32%) ToT records (51 pre- test, 47 post-test and 22 records not received) and 204 (68%) (Krishnagiri:130(64%), Karur:74(36%)) DLT records were audited.

The completeness of the variables (age, gender, date, time and address of deceased, name, date and signature of certifier, cause of death, part 2, time intervals availability) were assessed for all these records. Six errors (multiple causes, abbreviations, illegibility, Incorrect or clinically improbably chain of events, impossible underlying cause, certifier name not legible) from form 4A was assessed.

It was noted that completeness for all the variables in ToT had increased in the post-test when compared with the pre-test. The certifier's name was least captured (57%) in the post-test among all the variables in ToT. The cause of death and time interval variable was captured higher (96%) in the post-test in ToT. Overall completeness was improved by 30% in ToT and statistically significant. It was noted that one error "impossible underlying cause entered in the lowest used line of part 1" was nil among the available records captured. Legibility was the most noted error in pre-test of ToT(71%) which improved by more than 26% in ToT(45%). The error "incorrect or clinically improbably chain of events leading to death in part 1" was improved the highest among

all errors in ToT (pre-test-57%, post-test-19%).

Overall errors among certification have improved by 38% in post-test by 26%(ToT). It was noted that the records with at least one major error reduced in ToT (pre-test-57%, post-test-19%) and records with at least one minor error also reduced in ToT (pre-test-84%, post-test-51%). The records when taken with any one of the major or minor errors was noted that error reduced by 43% in ToT (pre-test-98%, post-test-55%) and statistically significant (Table 1).

Table 1: Completeness of variables & errors in the form 4A captured during pre-test and post-test of the ToT

Variable	ToT		% Diff	p-value
	Pre-test (n=51)	Post-test (n=47)		
Completeness of variables in the form 4A				
Age of deceased recorded n(%)	40(78%)	39(83%)	5	<0.001
Gender of deceased recorded n(%)	38(75%)	36(77%)	2	0.002
Date of Death of deceased recorded n(%)	44(86%)	42(89%)	3	<0.001
Time of Death of deceased recorded n(%)	44(86%)	44(94%)	8	0.3218
Address of Death of deceased recorded n(%)	36(71%)	40(85%)	14	0.001
Date of certification recorded n(%)	24(47%)	30(64%)	17	0.791
Name of Certifier recorded n(%)	16(31%)	27(57%)	26	0.374
Signature of Certifier recorded n(%)	27(53%)	33(70%)	17	0.289
Cause of death recorded in form n(%)	48(94%)	45(96%)	2	1
Part 2 recorded in form n(%)	28(55%)	40(85%)	30	0.044
The time interval of any illness recorded in any of line n(%)	33(65%)	45(96%)	31	0.0001
The time interval of any illness recorded in all line n(%)	9(18%)	39(83%)	65	0.824
Overall certification without missing any variables	2(4%)	16(34%)	30	0.0001
2.Errors noted in the form 4A				
Multiple causes recorded in any line in Part 1 n(%)	18(35%)	9(19%)	16	<0.001
Abbreviation used in entries in any of the lines n(%)	27(53%)	15(32%)	21	0.2
Illegible Handwriting recorded in form n(%)	24(47%)	15(32%)	15	0.09
Incorrect or clinically improbably chain of events leading to death in part 1 n(%)	29(57%)	9(19%)	38	0.031
Impossible underlying cause entered in the lowest used line of part 1 n(%)	0(0%)	0(0%)	0	<0.001
Certifier name, not legible n(%)	36(71%)	21(45%)	26	0.405
Overall certification with any one of the above-mentioned errors n(%)	50(98%)	34(72%)	26	0.0001
3. Major & Minor Errors noted in the form 4A				
At least one Major errors n(%)*	29(57%)	9(19%)	38	0.031
At least one Minor errors n(%)**	43(84%)	24(51%)	33	0.008
Overall certification with any one of the above-mentioned errors (Major or Minor)	50(98%)	26(55%)	43	0.0001

* Major errors - Mechanism of death listed without an underlying cause & Improper sequencing

** Minor errors - Abbreviations, Absence of time intervals, Absence of Age, address, date & time

It was noted that completeness for all the variables in DLT increased in the post-test when compared with the pre-test. The time interval in all lines was the least captured (57%) in the post-test in DLT, and it was one of the highest variables that was improved in the post-test by 51%. The cause of death variable was captured higher (98%) in DLT.

Overall, completeness was improved by 19% in DLT, and this improvement was statistically significant. It was noted that one error “impossible underlying cause entered in the lowest used line of part 1” was nil among the available records captured. Legibility was the most noted error in the pre-test of DLT(74%) which improved by 30% in DLT(44%).

Table 2: Completeness of variables & errors in the form 4A captured during pre-test and post-test of the DLT

Variable	DLT		% Diff	p-value
	Pre-test (N=102)	Post-test (n=102)		
Completeness of variables in the form 4A				
Age of deceased recorded n(%)	75(74%)	87(85%)	11	0.05
Gender of deceased recorded n(%)	70(69%)	88(86%)	17	0.001
Date of Death of deceased recorded n(%)	81(79%)	97(95%)	16	0.000
Time of Death of deceased recorded n(%)	80(78%)	91(89%)	11	0.03
Address of Death of deceased recorded n(%)	86(84%)	92(90%)	6	0.2
Date of certification recorded n(%)	46(45%)	75(74%)	29	0.000
Name of Certifier recorded n(%)	25(25%)	63(62%)	37	0.000
Signature of Certifier recorded n(%)	58(57%)	81(79%)	22	0.000
Cause of death recorded in form n(%)	92(90%)	100(98%)	8	0.02
Part 2 recorded in form n(%)	39(38%)	83(81%)	43	0.000
The time interval of any illness recorded in any of line n(%)	38(37%)	95(93%)	56	0.000
The time interval of any illness recorded in all line n(%)	6(6%)	58(57%)	51	0.000
Overall certification without missing any variables	2(2%)	32(31%)	29	0.000
2.Errors noted in the form 4A				
Multiple causes recorded in any line in Part 1 n(%)	48(47%)	37(36%)	11	0.1
Abbreviation used in entries in any of the lines n(%)	63(62%)	52(51%)	11	0.06
Illegible Handwriting recorded in form n(%)	48(47%)	36(35%)	12	0.08
Incorrect or clinically improbably chain of events leading to death in part 1 n(%)	66(65%)	12(12%)	54	0.000
Impossible underlying cause entered in the lowest used line of part 1 n(%)	0(0%)	0(0%)	0	0.000
Certifier name, not legible n(%)	75(74%)	45(44%)	30	0.000
Overall certification with any one of the above-mentioned errors n(%)	101(99%)	86(84%)	15	0.000
3. Major & Minor Errors noted in the form 4A				
At least one Major errors n(%)*	66(65%)	12(12%)	53	0.000
At least one Minor errors n(**)	101(99%)	59(58%)	41	0.000
Overall certification with any one of the above-mentioned errors (Major or Minor)	102(100%)	59(58%)	42	0.000

* Major errors - Mechanism of death listed without an underlying cause & Improper sequencing, ** Minor errors - Abbreviations, Absence of time intervals, Absence of Age, address, date & time of deceased.

The error “incorrect or clinically improbably chain of events leading to death in part 1” was improved by 54%, the highest among all errors in DLT (pre-test-65%, post-test-12%). Overall errors among certification have improved in post-test by 15%(DLT).

It was noted that the records with at least one major

error reduced in DLT (pre-test-65%, post-test-12%), and records with at least one minor error also reduced in DLT (pre-test-99%, post-test-58%).

The records when taken with any one of the major or minor errors was noted that error reduced in DLT (pre-test-100%, post-test-58%)

DISCUSSION

This study aimed to assess the completeness and accuracy of death certification records through a training intervention. A total of 162 participants were included, and 302 death certification records were audited before and after the intervention. The results indicated a significant improvement in both the completeness of recorded variables and the reduction of errors in death certification. Effective utilization of electronic media, coupled with self-study resources and reinforced through interactive learning and audit/feedback mechanisms, is essential for achieving broad coverage and fostering significant improvements in the accuracy and reliability of cause-specific mortality data(10). The intervention in the form of interactive workshops, and seminars has proved to be a successful way to improve the cause of death certification process(11)(12)(13)(14) and the same has been noted in our study.

The completeness of key variables such as age, gender, date, time, and address of the deceased, as well as information about the certifier and cause of death, showed significant improvement following the intervention. In the ToT records, overall completeness increased by 30%, while the DLT records showed a 19% improvement. This suggests that the intervention was effective in enhancing the documentation of critical information, ensuring more accurate and reliable death certificates. This will in turn improve the quality of cause of death reporting which will help the district and state to have better mortality indicators. In both ToT and DLT, the most notable improvements were observed in the capture of the **cause of death** and **time interval** variables, with both variables achieving a high capture rate of 96% or more in post-test records. This is a positive finding, as accurate recording of these variables is crucial for public health data, mortality statistics, and epidemiological research. However, certain areas showed relatively lower rates of improvement. The **certifier's name** was the least captured variable in the ToT (57%) post-test, and the **time interval** was the least captured in the DLT (57%) post-test. These persistent gaps highlight areas that might require additional focus in future interventions, such as encouraging certifiers to include all required details systematically.

The intervention demonstrated a significant reduction in errors across both ToT and DLT groups. Legibility was one of the most common errors in the pre-test, affecting 71% of ToT records and 75% of DLT records. Following the intervention, the incidence of illegibility decreased dramatically, with improvements of over 20% in both groups (45% in ToT, and 44% in DLT). This suggests that improving legibility through training and standardization may be an effective strategy for ensuring the accuracy of death certification. Of particular note, the error concerning the “incorrect or clinically improbable chain of events” was significantly reduced. In the ToT group, this error decreased from 57% in the pre-test to just 19% in the post-test, and in the DLT group, it decreased from 65% to 12%. A study done during 2009 comparing various interventions undergone to improve quality of MCCD has reported that seminars and interactive workshops helps in decreasing the error proportions in writing cause of death (10). This improvement suggests that the intervention successfully addressed a critical issue in death certification, ensuring that the chain of events leading to death is both plausible and properly documented.

The analysis of major and minor errors revealed that both types of errors decreased substantially following the intervention. Major errors, such as listing the mechanism of death without an underlying cause or improper sequencing of events, were reduced in both ToT (from 57% pre-test to 19% post-test) and DLT (from 65% pre-test to 12% post-test). This is a noteworthy improvement, as such errors can significantly affect the quality and utility of death data. Similarly, the occurrence of minor errors, such as missing time intervals, age, address, or the certifier's name, also showed a marked reduction. In ToT records, the rate of minor errors decreased from 84% to 51%, and in DLT records, it decreased from 99% to 58%. These reductions suggest that the intervention helped certifiers pay closer attention to the details of the death certification process.

LIMITATIONS

The pre-post assessment of the participants immediately after the intensive focused training only captures short-term changes in the knowledge or skills of the participants. It does not assess the long-term retention of knowledge, cognitive changes, or sustained improvement in clinical decision-making. In this intervention, participants evaluated their learning which can lead to self-report bias, where individuals could have overestimated their cognitive or improvement in clinical decision-making due to the nature of the training or desire to appear competent.

CONCLUSION

The intervention resulted in significant improvements in both the completeness of death certification records and the reduction of errors. These findings highlight the importance of training and its methodology for death certifiers in ensuring high-quality and accurate documentation of cause-of-death certificates. By addressing the gaps in documentation and reducing errors, such type of interventions can enhance the reliability of mortality data, which is essential for health policy planning, epidemiological studies, and public health strategies. It is recommended to extend the evaluation period beyond pre- and post-training to assess long-term retention and sustained impact. Follow up with participants several months after training to evaluate how well they've applied the learned decision-making skills in real-world settings.

CONFLICT OF INTEREST

None

REFERENCES

1. Physicians Manual on Medical Certification of Cause of Death. Office of The Registrar General, India Government of India, Ministry of Home Affairs, 2 A, Man Singh Road, New Delhi. Available from: https://ncdirindia.org/emor/Download/Physician's_Manual_MCCD.pdf.
2. Rasika Rampatige, Lene Mikkelsen, Bernardo Hernandez, Ian Riley, Alan D Lopez, Systematic review of statistics on causes of deaths in hospitals: strengthening the evidence for policy-makers Bull WHO 2014(92):807–816
3. Huffman GB. Death certificates: why it matters how your patient died. Am Fam Physician 1997; 56:1287e8, 90.
4. Maudsley G, Williams EM. Death certification by house officers and general practitioners — practice and performance. J Public Health Med 1993;15(2):192-201.
5. Pain CH, Aylin P, Taub NA, Botha JL. Death certification: production and evaluation of a training video. Med Educ 1996;30(6):434-9.
6. Barber JB. Improving the accuracy of death certificates. J Natl Med Assoc 1992;84(12):1007-8.

7. Assessment of Medical Certification of Cause of Death in Two Institutions (X & Y) of a District from Tamil Nadu, 2022. (2023). *Tamil Nadu Journal of Public Health and Medical Research*, 3(4), 36–37. <https://tnjphmr.com/article/pdf/547.pdf>
8. Tai DYH, El-Bilbeisi H, Tewari S, Mascha EJ, Wiedemann HP, Arroliga AC: A study of consecutive autopsies in a medical ICU. A comparison of clinical cause of death and autopsy diagnosis. *Chest* 2001, 119:530-536.
9. Tuffin R, Quinn A, Ali F, Cramp P. A review of the accuracy of death certification in the intensive care unit and the proposed reforms to the Coroner's system. *J Iran Chem Soc*. 2009(10):134–137
10. Aung E, Rao C, Walker S. Teaching cause-of-death certification: lessons from international experience. *Postgrad Med J*. 2010 Mar;86(1013):143-52. doi: 10.1136/pgmj.2009.089821. PMID: 20237008.
11. Lakkireddy DR, Basarakodu KR, Vacek JL, et al. Improving death certificate completion: a trial of two training interventions. *J Gen Intern Med* 2007;22:544e8.
12. Myers KA, Farquhar DR. Improving the accuracy of death certification. *CMAJ* 1998;158:1317e23.
13. Myers KA, Eden D. Death duties: workshop on what family physicians are expected to do when patients die. *Can Fam Physician* 2007;53:1035e8.
14. Villar J, Perez-Mendez L. Evaluating an educational intervention to improve the accuracy of death certification among trainees from various specialties. *BMC Health Serv Res* 2007;7:183.

ORIGINAL ARTICLE

IMPARTING TUBERCULOSIS (TB) LITERACY USING A YOUTH-FRIENDLY PUZZLE GAME - A PILOT QUASI-EXPERIMENTAL STUDY, TAMIL NADU, 2022-2023

Charan Kuppusamy ⁽¹⁾, Priscilla Rebecca ⁽²⁾, Jeremiah Leslie ⁽¹⁾, Lakshana Mariappan ⁽³⁾, Priyanka Ravi ⁽¹⁾, Jeevnathi ⁽³⁾, Karikalan Nagarajan ⁽²⁾, Adhin Bhaskar ⁽²⁾, Dhanalakshmi Angamuthu ⁽²⁾

(1) SRM Institute of Science and Technology, India

(2) Indian Council of Medical Research -National Institute for Research in Tuberculosis

(3) Anna Adarsh College for Women, India

ABSTRACT

INTRODUCTION : Considering the lack of participatory awareness interventions to enhance TB literacy, we co-created and implemented a TB puzzle game for adolescents and assessed its impact on TB knowledge. We aimed to co-create and implement a TB puzzle game-based intervention study in the private schools of Chennai, an Indian megacity, to impart TB literacy to adolescents and evaluate its outcomes in terms of TB literacy.

METHODS : We utilized the PRODCUES framework to co-create a crossword puzzle game to impart TB literacy. We used a quasi-experimental design to evaluate its usefulness in improving TB literacy among high school students in a metropolitan city. The study involved 11th and 12th-grade school students from Chennai who were divided into intervention and control arm. A TB crossword puzzle was used to impart TB literacy in intervention arm A and TB awareness pamphlets were used for the same in control arm B. A total of twenty engaging puzzles were developed which were related to 1) Interesting facts about TB (fig. 1.1), 2) Symptoms of TB (fig. 1.2), 3) Dos and Don'ts for TB (fig. 1.3), and 4) Treatment of TB (fig. 1.4). Puzzles were developed with an engaging and easy-to-follow language style. Puzzles were interlaced with hints to intrigue the participants to solve them using relatable concepts and facts. TB literacy levels were measured using a standardised scale before and after the intervention in both arms.

RESULTS : The baseline TB literacy scores in intervention arm A and control arm B were 15 (IQR 14, 18) and 6 (IQR 4, 7) respectively. The average score of completion of TB crossword puzzles out of 20 was 17 (max 20 and min 4) and was completed in 20 minutes on average.

CONCLUSION : The improvement in TB literacy achieved through game-based puzzles was found to be much higher among students as compared to routine IEC intervention.

KEYWORDS : Literacy, Puzzle, Intervention, Tuberculosis, Students, Games

INTRODUCTION

Public health interventions for the younger age population are considered important as they are helpful to improve awareness and knowledge on health-related issues. Especially Information Education and Communication (IEC) intervention for improving awareness and knowledge on important public health issues among the young age population has the potential to bring in positive behavior change at an early stage of life. Structured IEC interventions also help to evolve preventive health measures among the young age population, especially in settings like schools and colleges where they could be accessed easily in an organized way.¹ India accounts for one-fourth of the global tuberculosis (TB) burden, of which 10% is suffered by children and 32% burden by the age group between 15-29.² Despite the decade-long efforts to generate awareness about TB, still, TB remains a mostly misunderstood and stigmatized disease. The basic knowledge and literacy about TB have remained low which

in turn leads to poor health-seeking behavior and delays in care.³

Public health intervention to improve TB literacy among young adolescents and the young population has not received sufficient attention in India. There has not been sufficient focus on age-specific IEC intervention for TB in general. Few interventions that were conducted in research mode among school students have shown that age-appropriate IEC intervention could improve TB knowledge.^{4,5} However, the limitation of the present interventions to improve TB awareness in India and globally was that all these interventions were provider-driven and lacked self-



Please Scan this QR Code to

View this Article Online

Article ID: 2024:04:04:03

Corresponding Author: Karikalan Nagarajan

e-mail : karikalan.n@icmr.gov.in

participation and agency from the learners or subjects. Such a provider-driven approach could be the reason that most TB awareness interventions are not sustained in the long term and lead to poor TB awareness levels in the community in the long run. Hence there is a felt need to develop and test a participatory intervention for improving TB literacy which would be driven by the agency of the learner i.e. the community at risk and vulnerable to TB which is more driven by their interest and demand. In this background, we aimed to develop a puzzle game-based activity

We aimed to co-create and implement a TB puzzle game-based intervention study in the private schools of Chennai, an Indian megacity, to impart TB literacy to adolescents and evaluate its outcomes in terms of TB literacy.

METHODS

The ethics committee of the School of Public Health, SRM Institute of Science and Technology, Tamil Nadu had approved this study which was aimed at evaluating a TB puzzle-driven awareness intervention in high school settings. Between June 2022 and June 2023, we implemented and evaluated a participatory game-based TB puzzle intervention to improve TB knowledge among students in the private schools of a metropolitan city, in South India. This study was conducted among high school students who were aged 14-17 years and presently enrolled in 11th and 12th grade in a registered school in the city. School students at this age were chosen considering the need for developing age-specific TB IEC interventions in the study setting. The study primarily aimed at evaluating the preliminary efficacy of a game-based intervention for improving TB treatment literacy and secondarily assessed the designing and implementation aspects of this first-of-kind game-based intervention in the TB awareness context.

Intervention designing

We used the PRODCUES framework (Problem Exploration, Objective Intervention implementation Design, end Users, Co-creators, Evaluation, and Scale-up) for prioritizing the research problem and further designing the game-based intervention study (Table 1)

Problem Exploration and identification:

As a first step, the study team undertook a desk review of the gaps in the existing TB IEC intervention for adolescents and youth. A team of researchers, including experienced social behavioral researchers, social workers, teacher and students with expertise and exposure in outreach activities and conducting intervention studies among school

students, collaborated to develop TB awareness interventions through discussions and brainstorming sessions on the barriers and challenges in imparting TB literacy for the younger age population, especially to school students. With a literature review and shared experiences of experts and intended beneficiaries (TB patients of different ages) it was identified that the conventional IEC interventions for TB are not age-specific in India. All the available IEC interventions for improving TB literacy were provider-driven and lacked self-participation and agency from the learners or subjects. During the formative phase, a series of informal interviews and discussions were done with TB researchers from the institute, TB program workers part of NTEP, school teachers, and students of a few selected schools to get insights about their needs, preferences, dislikes likes, and barriers in terms of health literacy concerning TB. Inputs were gained about the different forms of TB sensitization, messages, and the different modes of communication and engagement were inquired, and explored. Proposed new types of TB literacy communication and interventions were inquired and their relevancy based on field adaptability and resource constraints were assessed.

Objective setting and Intervention Designing:

Based on the insight from the explorative phase, it was concluded that developing participatory & engaging crossword puzzle-based games for imparting TB literacy would be a rational choice. It was aimed to develop this puzzle game to have the features of built-in motivation concepts and rewarding experiences for the subjects.

Crossword puzzles are a widely recognized form of the game which is played across all age groups including the young population. The puzzles are playable and don't involve many resources for either the provider and also the gamers. Crossword puzzles are known to have the attributes of nurturing interests in a particular topic of puzzle and stimulating motivation and curiosity about the subject while solving the puzzle which in this case is about TB. Solving a puzzle also remains an in-built rewarding phenomenon for gamers. It also concurred that crossword puzzles can improve the student's ability to focus and their working memory towards the topic of interest i.e. TB literacy. It was also observed that TB literacy which comprised of categorical factors about TB could be easily adopted in the form of crossword puzzles.

A proof-of-concept crossword puzzle game that could be played using a puzzle interface was developed with gaming principles and features. Further, a series of co-creation exercises were undertaken to develop a game

that would be appropriate for adolescents and youngsters and which would fulfill the criteria of the objectives. We conducted three co-creation and consultation workshops with the student community, TB researchers, and teachers to evolve a TB puzzle game iteratively.

A total of twenty engaging puzzles questions were developed which were related to 1) Interesting facts about TB (fig. 1.1), 2) Symptoms of TB (fig. 1.2), 3) Dos and Don'ts for TB (fig. 1.3 and 4) Treatment of TB (fig. 1.4). Puzzles were developed with an engaging and easy-to-follow language style. Puzzles were interlaced with hints to intrigue the participants to solve them using relatable concepts and facts.

Intervention Evaluation:

We used a quasi-experimental design in which we provided a crossword puzzle-based intervention to engage and educate the students on TB literacy in comparison to a routine TB-IEC pamphlet-based intervention.

For the study, we selected 11th and 12th-grade students from English medium classes at two private schools in the city. Of the four classes selected, two classes were allocated as intervention arm A in which the crossword puzzle was used. The other two classes were allocated as intervention arm B in which TB-IEC pamphlets were used which contained the same facts and information as the TB crossword puzzle but in a narrative paragraph form in English. We enrolled 50 students from each of the four classes based on the willingness of the students. As the study was conducted as part of the routine educational activity oral consent was obtained from students and teachers.

To avoid spillover and contamination between intervention arm A and B classes were engaged separately in terms of place and time. Each enrolled student was provided a Unique ID and the purpose of the study was explained beforehand as per the intervention status (A or B).

Implementation of puzzle game:

A team of two researchers (trained social worker with master's degree in Social Work and student trainees pursuing Masters in Public Health) along with class teachers, explained to the students in the intervention arm A, that they would be given a crossword puzzle sheet with four puzzle pages which would have a total of 20 questions. Students were instructed to try to complete these puzzles by themselves and by using the hints which are given beneath the page. Students were explained that this was not a test to check their ability to solve puzzles but only to create awareness about an important public health problem in the country. Students were requested not to discuss with others about puzzles and were monitored by the class teacher. A time period of 30

minutes was given for the students which was extended for individual students as requested. After this, the students were asked to stop the activity. Further, the researchers made an interactive session with the students to know their level of engagement and answers to the puzzle. Answers to the puzzle were given to the students and they were asked to verify their responses. No marks were given but students were asked about the usefulness of the activity in knowing about TB and their feedbacks were noted. All puzzle sheets were collected back by the researcher at the end of the session.

Implementation of standard IEC intervention using a pamphlet:

A similar team of researchers and class teachers explained to the students of the intervention arm B that they would be provided an information pamphlet about infectious disease and they were requested to read the pamphlet individually. The pamphlet consisted of all the information and facts about TB which the TB puzzle game had but in the form of an essay. Students were asked to take 30 minutes to read the pamphlet. Post the reading session a discussion was conducted by the researchers on the content of the pamphlet and students were asked to clarify their doubts about TB and related facts. A duration of 30 minutes was used for this intervention.

Intervention evaluation:

Before the initiation of the intervention on both arms, initially, students were asked to undergo a test on TB literacy using a standardized tool which consisted of 13 Multiple-choice Questions on TB symptoms, preventive measures, treatment aspects, risk factors, diagnosis, etc. The total score of the tool was 20 with maximum weight given to the TB symptom-related questions. Students were provided 15 minutes to complete the TB literacy test and further the intervention was provided in both arms as follows. After completing the intervention, an end-line assessment was conducted using the same TB literacy tool after a 15-day interval. This timeframe allows students sufficient opportunity to reflect on the training content and engage in discussions with peers or family. The 15-day gap also serves as an initial measure of the training's effectiveness in fostering sustained awareness. Post activity the teachers and students were provided the softcopy of the puzzle and pamphlet for further reference and use.

Sample size:

The sample size was calculated based on the estimate of overall TB literacy level as 30% and expected an absolute increase in TB literacy level following the puzzle intervention by 20% and a percentage difference of 50%. With an

assumed alpha value of 0.05 and power of 0.80, the sample size estimated was 190 which was rounded to 200 with 100 in the intervention A and Intervention arm B.

Data collection and Statistical analysis:

All data were collected in questionnaires and puzzles were also given in paper format. For each student age, gender, and class of study was collected along with TB literacy information. Data were compiled using Excel and analyzed using STATA crop 15.1.

Participants’ characteristics and intervention uptake were described using frequency, mean, median, IQR, and standard deviation. Tests of normality were conducted to the distribution of outcome variables (i.e. TB literacy) Two-sample Wilcoxon rank-sum (Mann-Whitney) test was used to test for a significant difference in TB literacy between the two groups (who underwent TB puzzle as compared to those who underwent TB pamphlet exercise). Wilcoxon signed-rank test was used to test significant differences within the same groups before and after intervention. The effect size which is the magnitude of difference in the TB literacy scores resulting from the two interventions A (crossword puzzle-based intervention) and B (pamphlet-based intervention) was calculated and significance was reported at 0.05 level of significance.

RESULTS

A total of 200 students were enrolled in the study of which 100 were in the intervention arm A (for TB crossword puzzle) and 100 in the intervention arm B (standard IEC intervention using pamphlet) from four classes of two different private girls’ educational institutions from the city. Of the 200 students, 100 were from high school grade and 100 were first-year graduate school. All the students were of female gender.

Table 1: Steps used for intervention development using the PRODCUES framework

Problem Exploration and identification	Conventional IEC interventions for TB awareness and literacy are provider-driven and lack self-participation and agency. Lack of self-initiative and motivation toward public health literacy. Involvement of public health experts in conventional IEC which are limited and resource-intensive
Objective	To develop a game TB IEC intervention which would be (1) Participatory & engaging for subjects, (2) Features In-built motivation concepts & rewarding
Intervention implementation Design, end) Users	Co-creation, students, researchers, TB patients, the general community, and program stakeholders
Co-creators	Adolescents, TB patients, students, researchers, teachers
Evaluation	Non-randomized experimental study to assess efficacy and implementation aspects
Scale up	Will be sustained in the implementation districts based on the study outcomes

Table 2 The mean age of the participants was 18 (min 14 to max 18). Of the total TB crossword puzzles (n=20), which were played by the students the average score of completion was 17 (min 4 to max 20) (SD 4.6). The median baseline TB literacy for the intervention groups A and B were 4 (IQR: 2, 5) and 3 (IQR: 2, 6) respectively, and end-line TB literacy scores for the intervention groups A and B were 15 (IQR: 14, 18) & 6 (IQR: 4, 7) respectively.

Table 2- TB literacy scores of students

Group	n	Test score Median (IQR)	
		Before	After
Intervention A (PB puzzle arm)	100	4 (2,5)	15(14, 18)
Intervention B (TB pamphlet arm)	100	3 (2,6)	6 (4, 7)

Table 3: Within and between-group comparison of TB literacy score among the participants.

	Within group comparison		
	Effect size	Z value	p-value
Intervention A	0.87	-8.7	<0.001
Intervention B	0.51	-5.22	<0.001
Between-group comparison			
	Effect size	Z value	p-value
Baseline	0.02	-0.3	0.762
End line	0.87	-12.25	<0.001

Table 3 Wilcoxon rank-sum (Mann-Whitney) test showed that there was no significant difference in the baseline TB literacy score had an effect size of 0.02, z = -0.303, p = 0.762) between intervention groups A and B, but a significant difference was noted in the end line TB literacy score with an effect size of 0.87 (z = -12.2, p<0.001) between intervention arm A and intervention group B signifying improved TB literacy score among those who underwent TB crossword puzzle.

Wilcoxon signed-rank test shows a significant change in TB literacy score from baseline to end-line among participants who underwent standard IEC intervention using a pamphlet with an effect size of 0.51 (z = -5.1 p <0.001). However, participants who underwent the TB puzzle game had a larger change in literacy scores with an effect size of 0.87 (z = -8.7, p<0.001).

DISCUSSION

To our knowledge, this is the first game-based participatory intervention study in the context of imparting TB awareness and literacy in India. The results highlight a significantly high impact of TB puzzle-based games in improving TB literacy among adolescents and young students.

The effect size achieved through game-based puzzles was found to be much higher (0.87) as compared to (0.51) routine IEC intervention. The impact of the present TB literacy using puzzle games was found to be relatively higher as compared to another type of TB IEC intervention which was tested among the school population in India. For example, a study among school students using TB Ambassador achieved a 40-60% increase in TB literacy in a metropolitan city which was relatively lower than our estimates.⁶

Similarly, a simple intervention of using an essay competition as the mode of imparting TB awareness among school students was tested in 2010 (Vellore district) and was found to be effective only with a mean difference of 3-4%.⁴ Another study conducted in Bangalore India used visual health education intervention with pictorial presentation and found that the TB literacy score increased from 8.77 % to 14.95 % from pre-education to post-education which was again a moderate effect.⁷

In addition to the effectiveness aspect, the TB puzzle intervention was different from other previously tested interventions in terms of its participatory and self-driven nature rather than a provider-driven teaching method. During the intervention implementation, we found a high receptiveness and demand from students towards playing the puzzle game as compared to the standard IEC intervention. Also, we found that all the participants completed the TB puzzle in 20 minutes which was less than the other school-based IEC interventions.

The successful designing and implementation of this puzzle-based intervention is a key finding of this study. Using the PRODCUES framework, we addressed gaps in existing TB IEC interventions for adolescents.

The co-creation process with TB researchers, teachers, and students ensured the intervention was relevant, age-appropriate, and engaging. The implementation showed feasibility, with active participation, timely completion (average 20 minutes), and no dropouts. These results demonstrate the potential of participatory, game-based interventions to improve health literacy in resource-limited settings.

The importance of game-based TB puzzle intervention was that each student was nudged in such a way that they participated in the intervention and completed it without dropping out in the middle. The combination of puzzles which combined disease information and general facts about TB using interesting probes made the entire exercise participatory and rewarding. The findings of this study need to be interpreted from a broader perspective in

which games are being increasingly used for public health issues involving behavioral change, knowledge building, health care access and utilization, etc. Games are being recognized as vital tools that could improve participation and the self-driven interest of the community. Such features of games-based intervention are important for the suitability of community-based health interventions like TB awareness building. Also, games are less resource-intensive methods of activity due to their participatory nature and thus would be a feasible option for conducting mass-level public health interventions (like TB IEC intervention).

LIMITATIONS

This study was conducted as a quasi-experimental study in limited schools which could have led to selection bias of the population. But since the study was aimed as a proof of concept to estimate the preliminary efficacy such concerns were not considered.

Further to estimate the effectiveness of game-based intervention a larger cluster randomized trial could be a logical next step of this study. Another limitation of this study is that the tool used for data collection was developed with input from experts and designed to align closely with the study objectives was not formally validated prior to its application.

CONCLUSION

Imparting TB literacy through game-based intervention was feasible and resulted in significant improvement of TB literacy among adolescents in the present study. Game-based interventions could be of importance for imparting TB awareness to the younger age population. Adopting games to improve TB awareness and literacy at the mass level could be evaluated through large-scale community-based studies.

ACKNOWLEDGMENTS

The authors would like to thank the school management for the support in carrying out the study in their respective schools, student interns pursuing Master of Social Work and Master of Public Health.

CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

FUNDING STATEMENT

Not Available

REFERENCES

1. Bonnie RJ, Stroud C, Breiner H, National Research Council (U.S.). Committee on Improving the Health S, National Research Council (U.S.). Board on Children Y, Institute of Medicine (U.S.). Investing in the health and well-being of young adults. 501 p.
2. National Tuberculosis Elimination Programme Annual Report India TB Report 2020 Central TB Division. Available from: www.tbcindia.gov.in
3. Nautiyal RG, Mittal S, Awasthi S, Singh RK. Knowledge about tuberculosis among pulmonary tuberculosis patients: A cross-sectional study from Uttarakhand. *J Family Med Prim Care*. 2019 May;8(5):1735–40.
4. Gopichandran V, Roy P, Sitaram A, Karthick, John K. Impact of a simple educational intervention on the knowledge and awareness of tuberculosis among high school children in Vellore, India. *Indian Journal of Community Medicine*. 2010;35(1):174.
5. Gothankar JS. Tuberculosis awareness program and associated changes in knowledge levels of school students. *Int J Prev Med*. 2013 Feb;4(2):153–7.
6. Rebecca BP, Angamuthu D, Watson B, Beena ET, Balaguru S, Premkumar J, et al. Can Students Learn from Their Co-Students About Tuberculosis? Outcomes from Student-Friendly Quasi-Experimental Intervention Study in India. *Indian J Community Med*. 2022;47(4):527–30.
7. Vanaja K, Banu R, Reddy L, Kumar PC, Srinivas C, Rajani T, et al. A study on knowledge and awareness about tuberculosis in senior school children in Bangalore, India. *Indian J Tuberc*. 2016 Jul;63(3):192–8.

ORIGINAL ARTICLE

ADJUNCTIVE TRIMETAZIDINE THERAPY IMPROVES LEFT VENTRICULAR EJECTION FRACTION BY REGULATING PLASMA ASYMMETRIC DIMETHYLARGININE AND VISFATIN IN HEART FAILURE WITH REDUCED EJECTION FRACTION: A CROSS SECTIONAL OBSERVATIONAL STUDY, TAMIL NADU, 2021-2022

Uma Maheswari G ⁽¹⁾, Yamini B ⁽¹⁾, Gokul Sudhakaran ⁽²⁾, Mohan Kumar R ⁽³⁾, Cecily Mary Majella Jayaraj ⁽⁴⁾, Kannan Radhakrishnan ⁽⁵⁾, Dhandapani V E ⁽¹⁾, Kanchana Mala Karuppiah ⁽¹⁾

- (1) Department of Cardiology, SRM Medical College Hospital and Research Center, Kattankulathur
 (2) Department of Biotechnology, SRM Institute of Science and Technology, Kattankulathur
 (3) Interdisciplinary Institute of Indian System of Medicine, SRM Institute of Science and Technology, Kattankulathur
 (4) Department of Cardiology, Tamil Nadu Government Multi Super Speciality Hospital, Omandurar
 (5) Department of Cardiology, Government Chengalpattu Medical College & Hospital, Chennai
 (6) Department of Medical Research, SRM Medical College Hospital and Research Center, Kattankulathur

ABSTRACT

INTRODUCTION : Adjunctive Trimetazidine (TMZ) is known to improve symptoms of heart failure (HF), but its mechanistic effects on cardioprotection are not fully understood. This study evaluated whether adjunctive TMZ therapy improves left ventricular ejection fraction (LVEF) and alters plasma biomarkers in patients with heart failure with reduced ejection fraction (HFrEF) compared to standard HF therapy (STD).

METHODS : In this single-center observational study, 60 HFrEF patients were divided into two groups: TMZ + STD (n = 30) and STD alone (n = 30). LVEF was assessed by echocardiography, and biomarkers including visfatin, asymmetric dimethylarginine (ADMA), nicotinamide adenine dinucleotide (NAD⁺), reduced and oxidized glutathione (GSH and GSSG), and sirtuin1 (sirt1) mRNA were measured. Correlations between LVEF and biomarkers were analyzed.

RESULTS : LVEF was significantly higher in the TMZ + STD group compared to STD alone. Plasma levels of visfatin, ADMA, and GSSG decreased, while NAD⁺, GSH, and sirt1 mRNA levels increased in the TMZ + STD group. Negative correlations were observed between LVEF and visfatin, ADMA, and GSSG, while positive correlations were found with NAD⁺, GSH, and sirt1 mRNA.

CONCLUSION : Adjunctive TMZ therapy enhances cardiac function by improving LVEF and modulating biomarkers associated with oxidative stress, inflammation, and myocardial remodeling. These findings suggest TMZ's potential to optimize biomarker profiles and provide cardioprotection in HFrEF patients.

KEYWORDS : Heart failure; LVEF; Oxidative stress; Asymmetric Dimethylarginine; Visfatin; Echocardiography

INTRODUCTION

Excess oxidative stress (OS), inflammation and cellular senescence (CS), which are key contributors to Heart Failure (HF) pathogenesis, reinforce each other to form a vicious circle, to drive disease progression.¹ Biomarkers that contribute to HF progression include circulating levels of visfatin (adipocytokine/extracellular-visfatin/extracellular-nicotinamide-phosphoribosyltransferase, eNAMPT), asymmetric-dimethylarginine (ADMA), nicotinamide-adenine-dinucleotide (NAD⁺), sirtuin1 (sirt1), and glutathione (GSH and GSSG).²⁻⁷

In HF, plasma ADMA is elevated. Excess ADMA, via impaired nitric oxide and up-regulated free-radical production, reduces intracellular functions of cardiomyocytes

and endothelial cells, leading to cardiac remodeling, fibrosis and HF progression.⁸ Up-regulated circulating visfatin, a biomarker of OS, inflammation and endothelial damage, triggers CS in HF.^{9,10} Circulating and intracellular NAD⁺ are decreased in HF11, due to impaired NAD⁺-biosynthesis/salvage of NAD⁺ or over-activation of NAD⁺-consuming enzymes. Sirt1, a NAD⁺-dependent deacetylase-enzyme, regulates pathophysiological mechanisms of myocardial



Please Scan this QR Code to

View this Article Online

Article ID: 2024:04:04:04

Corresponding Author: Kanchana Mala Karuppiah

e-mail : mkarupiya@gmail.com

remodeling and HF, including, inflammation and energy metabolism. Intracellular sirt1-deficiency occurs under excess OS and/or inflammation. Hence, depending on the extent of free radicals and/or stress triggers, sirt1 can positively or negatively regulate myocardial remodeling through de-acetylation and redox-sensitive molecules.¹² Reduced antioxidants, due to down-regulated enzymatic and non-enzymatic antioxidants and diminished redox state (reduced to oxidized glutathione – GSH:GSSG ratio), drive HF pathogenesis.⁶ The prognosis of HF is poor despite advances in prevention and therapeutic strategies. Because, although it's clear that OS and inflammation drive HF, current HF treatments are not mechanism-based.¹ As an adjuvant to conventional HF therapy, the anti-anginal drug trimetazidine (TMZ) improves LV function.¹³ The purpose of the study is to characterize the additive effects of TMZ (TMZ+STD) on circulating biomarkers and LVEF, in HFrEF, in comparison with standard-HF-therapy (STD).

METHODS

Study Design and Participants : This was a single-center, observational, cross-sectional study conducted at the outpatient facility of the Department of Cardiology, SRM Medical College Hospital and Research Center, Kattankulathur, India. Patients were enrolled between June 2021 and June 2022 using convenience sampling.

Participant's inclusion and exclusion criteria: The study included a total of 60 patients diagnosed with heart failure (HF) with reduced ejection fraction (HFrEF, EF <45%) through echocardiography with a documented history of consuming standard HF therapy, with trimetazidine (TMZ) (n=30) and without adjunctive TMZ (n=30). Patients were excluded if they had recent acute coronary syndrome (<6 months), significant valvular heart disease, chronic kidney disease, or any active systemic illness. Baseline demographic and clinical characteristics are summarized in Table 1.

Ethical approval was obtained from the institutional ethics committee at SRM Institute of Science and Technology (SRMIST), Kattankulathur. Written informed consent was obtained from all participants before enrolment. The study adhered to the ethical principles outlined in the Declaration of Helsinki.

Study Procedures:

Echocardiography

Echocardiographic assessments were performed at enrollment using the Epiq 7c ultrasound system. Left ventricular ejection fraction (LVEF) was determined using the Biplane Simpson's method. Additional echocardiographic

indices, including global longitudinal strain (GLS) and left ventricular mass index (LVMI), were evaluated. A detailed list of echocardiographic parameters is provided in Table 2.

Table 1. Baseline demographic and clinical characteristics of enrolled patients, Department of Cardiology, SRM Medical College Hospital and Research Center, June 2021 and June 2022, Tamil Nadu

Parameters	TMZ + STD (n = 30)	STD (n = 30)	P Value
Gender, Male (%) [§]	67 %	50 %	NS
Age (years)*	55.96 ± 8.72	55.96 ± 8.72	NS
Height (cm)*	160.1 ± 7.74	164.27 ± 7.73	NS
Weight (Kg)*	67.2 ± 12.88	75.93 ± 12.8	NS
Heart Rate (bpm)*	78.13 ± 9.19	77.8 ± 8.26	NS
Systolic BP (mmHg)*	124.33 ± 17.55	133.67 ± 15.42	NS
Diastolic BP (mmHg)*	75.67 ± 11.94	76.17 ± 10.96	NS
CAG – Normal (%) [§]	70 %	46 %	NS
CAG – SVD (%) [§]	30 %	26 %	NS
CAG – DVD (%) [§]	0 %	26 %	NS
Antiplatelet [§]	73 %	50 %	NS
Statins [§]	70 %	53 %	NS
ACE inhibitors [§]	26 %	30 %	NS
Beta blockers [§]	63 %	40 %	NS
Diuretics [§]	56 %	40 %	NS
Trimetazidine [§]	100 %	0 %	NS

P values for differences between the groups (TMZ + STD and STD) were calculated for categorical variables (§) [by using Chi-square tests] and for continuous variables (*) . Data are presented as mean ± standard deviation.

ACE inhibitor – angiotensin converting enzyme inhibitor, BP – blood pressure, CAG – coronary angiogram, DVD – double vessel disease, NS – non-significant, SVD – single vessel disease, STD – standard heart failure therapy, TMZ + STD – trimetazidine and standard heart failure therapy

Biomarker Analysis

Peripheral blood samples were collected under standardized conditions. Plasma and blood cells were separated for further analysis.

ADMA and NAD+ Quantification

Plasma samples were ultrafiltered using 3-kDa filters. Asymmetric dimethylarginine (ADMA) and nicotinamide adenine dinucleotide (NAD+) were quantified simultaneously using reverse-phase high-performance liquid chromatography (HPLC) with dual wavelengths¹⁴. Data acquisition and analysis were performed using Lab Solution Software.

GSH and GSSG Quantification

Glutathione (GSH) and oxidized glutathione (GSSG) levels were quantified using HPLC equipped with a photodiode array detector¹⁵.

Table 2. Echocardiographic characteristics of enrolled patients, Department of Cardiology, SRM Medical College Hospital and Research Center, June 2021 and June 2022, Tamil Nadu

Parameters	TMZ + STD (n = 30)	STD (n = 30)	P Value
LVEF (%) – Simpson	36.7 ± 4.19	33 ± 4.03	P < 0.05
LV mass (g)	228.63 ± 43.05	230 ± 26.81	P < 0.05
EDV (mL)	167.47 ± 43.75	125 ± 33.19	NS
ESV (mL)	109.67 ± 29.33	73 ± 30.74	NS
SV (L/min)	57.8 ± 24.87	52 ± 26.44	NS
CO (L/min)	4.41 ± 1.87	3.2 ± 1.55	NS
LVIDD (cm)	5.64 ± 0.27	5.7 ± 0.31	P < 0.05
LVIDS (cm)	4.57 ± 0.36	4.9 ± 0.33	P < 0.05
E (cm/s)	0.69 ± 0.19	0.6 ± 0.22	NS
A (cm/s)	0.55 ± 0.25	0.8 ± 0.2	NS
E/A	1.73 ± 1.27	0.75 ± 0.61	P < 0.05
e' Septal (cm/s)	0.05 ± 0.01	0.05 ± 0.01	NS
E/e' Septal	14.43 ± 5.15	12 ± 5.5	NS
e' Lateral (cm/s)	0.06 ± 0.01	0.06 ± 0.01	NS
E/e' Lateral	10.76 ± 3.06	10 ± 4.21	NS
GLS (%)	-9.26 ± 5.23	-11.27 ± 2.21	P < 0.05

Data are presented as mean ± standard deviation.

A – atrial systole, CO – cardiac output, E – early rapid filling in diastole, e' – early diastolic filling velocity, E/e' – ratio of transmitral blood flow velocity to tissue doppler velocity, EDV – end-diastolic volume, ESV – end-systolic volume, LVEF – left ventricular ejection fraction, LVIDD – left ventricular internal dimension in diastole, LVIDS – left ventricular internal dimension in systole, LV mass – left ventricular mass, NS – non-significant, SV – stroke volume, STD – standard heart failure therapy, TMZ + STD – trimetazidine and standard heart failure therapy.

Visfatin Quantification

Plasma visfatin concentrations were measured using a commercially available enzyme-linked immunosorbent assay (ELISA) kit (Catalog #E-EL-H1763). Concentrations were calculated by interpolating optical density (OD) values against the standard curve.

RNA Isolation and qRT-PCR

Total RNA was extracted from blood cells using the TRIzol reagent protocol. RNA purity and concentration were

assessed with a NanoDrop-2000c spectrophotometer. Complementary DNA (cDNA) was synthesized using the PrimeScript RT reagent kit.

Quantitative reverse transcription polymerase chain reaction (qRT-PCR) was performed on a LightCycler-480 system with TB Green Premix Ex Taq II. Relative gene expression was calculated using the 2- $\Delta\Delta C_t$ method, normalized to the expression of GAPDH as a housekeeping gene.

Primer Sequences:

Sirt1:

Forward: 5'-TCAGCTCTGGGATGACCTT-3'

Reverse: 5'-ACCATCAAGCCGCCTACTAATCTG-3'

GAPDH:

Forward: 5'-TTCAGCTCTGGGATGACCTT-3'

Reverse: 5'-CTCATGACCACAGTCCATGC-3'

Statistical analysis : Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables as frequencies and percentages. Group comparisons were conducted using unpaired t-tests for continuous variables and the chi-square test for categorical variables. Relationships between variables were evaluated using Pearson's correlation coefficient. A p-value <0.05 was considered statistically significant. Statistical analyses and graphical data representations were performed using GraphPad Prism 5.0 software.

RESULTS

Changes in the association between LVEF versus circulating concentrations of biomarkers were assessed between those who received TMZ as an add-on-therapy for STD and those who received STD alone, in HFrEF.

Sixty patients were included in the study; 30 each, in STD or TMZ+STD. Patients' history showed both groups were taking the respective drugs for at least 6 months before recruitment. LVEF was lower in STD than TMZ+STD (Table 2). Global longitudinal strain (GLS) was lower in STD than in TMZ+STD. In STD, LV mass-index was increased than in TMZ+STD.

In TMZ+STD, NAD⁺, GSH and sirt1 were higher, in contrast to decreased visfatin, ADMA and GSSG (Fig.1). As in Table 3, the correlation of ADMA, GSH, NAD⁺, visfatin and sirt1 with EF, in STD, was significant. In TMZ+STD, a significant correlation exists between ADMA and visfatin, with EF. There was a strong negative correlation between ADMA and visfatin with EF in both groups. In STD, a strong positive correlation is observed between NAD⁺, GSH and sirt1, however, a moderate positive correlation exists in TMZ+STD.

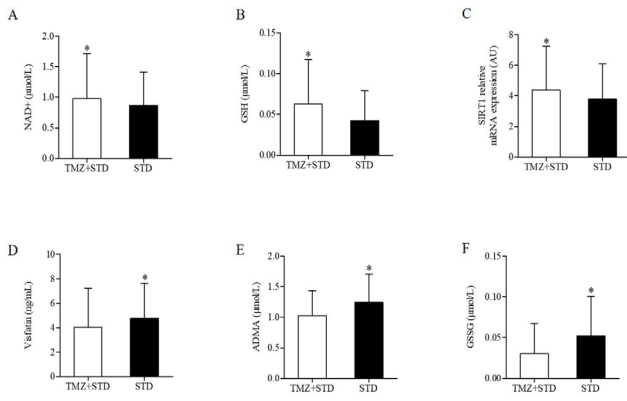


Figure 1. Changes in the (A) circulating levels of nicotinamide adenine dinucleotide (NAD+), (B) plasma levels of reduced glutathione (GSH), (C) relative sirt1 mRNA expression in peripheral blood cells, (D) circulating levels of visfatin, (E) plasma levels of asymmetric dimethylarginine (ADMA) and (F) plasma levels of oxidised glutathione (GSSG), between the two groups (TMZ+STD and STD). Data are expressed as mean \pm SD (* P <). TMZ + STD – trimetazidine and standard heart failure therapy; STD – standard heart failure therapy, sirt1 – sirtuin1.

Table 3. The correlation of circulating biomarkers in patients with HF_{rEF}, Department of Cardiology, SRM Medical College Hospital and Research Center, June 2021 and June 2022, Tamil Nadu

Biomarkers	STD (n=30)	TMZ + STD (n=30)
	EF%	EF%
Sirt1	r = 0.7539	r = 0.6175
	p < 0.00001	p = 0.0002
NAD+	r = 0.7294	r = 0.6062
	p < 0.00001	p = 0.0003
ADMA	r = -0.8979	r = -0.8667
	p < 0.00001	p < 0.00001
GSH	r = 0.8419	r = 0.6852
	p < 0.00001	p = 0.00002
GSSG	r = -0.3756	r = -0.6607
	p = 0.04	p = 0.00007
Visfatin	r = -0.7471	r = -0.7614
	p < 0.00001	p < 0.00001

Asymmetric dimethylarginine (ADMA), nicotinamide adenine dinucleotide (NAD+), oxidized glutathione (GSSG), reduced glutathione (GSH), sirt1 – sirtuin1, STD – standard heart failure therapy, TMZ + STD – trimetazidine and standard heart failure therapy.

DISCUSSION

Our study finds that TMZ+STD-mediated changes elicit additive effects to STD and enhance LVEF by regulating specific biomarkers associated with disease-driving mechanisms. In line with our findings, reports²⁻⁷ show altered levels of visfatin, ADMA, NAD+, sirt1, and glutathione (GSH and GSSG) in HF. How could TMZ+STD influence circulating biomarkers to render cardioprotection? Potentially through TMZ-mediated sirt1-activation and sirt1-mediated events. TMZ is a sirt1 activator with anti-inflammatory and anti-oxidant effects¹⁶; selected biomarkers are associated with inflammation and OS, hence the observed TMZ+STD-mediated effects.

Following TMZ+STD-mediated sirt1-activation, multiple sirt1-mediated mechanisms/molecules, under excess OS and/or inflammation¹⁷ could have influenced HF-associated pathophysiological events, such as myocardial remodelling¹², levels of ADMA¹⁴, oxidants and antioxidants. Among the biomarkers, visfatin and ADMA are negatively correlated with EF. ADMA is a well-studied molecule and studies show the direct influence of ADMA on cardiac structure and function.⁸ However, visfatin is a complicated molecule¹⁸ with a disease-altering capacity. Reports on visfatin are controversial, be it pathophysiological or therapeutic mechanisms.¹⁹ So far, under excess OS, cells secrete multi-fold levels of visfatin and plasma visfatin is associated with disease-driving mechanisms.² Hence, normalizing plasma visfatin concentration is considered for therapeutic benefits. As our observations on TMZ+STD show a significant negative correlation between visfatin and EF, we wanted to understand how TMZ could alter visfatin concentration, which in turn improves EF. We propose three pathophysiological events (Fig.2) that connect TMZ-circulating visfatin-EF.

Protein-protein interaction network

To identify visfatin (NAMPT) interacting partners, an in-silico prediction analysis was carried out using STRING-database.²⁰ Predicted protein-protein-interaction (PPI)-network (Fig.3) shows that sirt1 and NAD+-biosynthesis-associated proteins are binding partners of visfatin/NAMPT.

Excess OS alters PPI-association,²¹ which causes protein structure modification (oligomer to dimer/monomer) and changes in the composition of PPI assembly. Further, changes in structure and PPI assembly in alpha-B-crystalline²² promote the formation of dimers and monomers from oligomers and increase its activity. In HF, excess OS generates more oxidants and less sirt1,⁵ which could modulate the visfatin/NAMPT-PPI network to facilitate

more monomer formation. Besides, sirt1 and visfatin are functionally interrelated²³ and sirt1-deficiency exists in HF.⁵ Thus, visfatin/NAMPT-PPI-network allows us to suggest that in HF, excess OS shifts the catalytically-active dimeric visfatin to catalytically-inactive, pro-inflammatory monomer,²⁴ which alters enzyme activity/function of visfatin/NAMPT; modifies the affinity between interacting-proteins and perturbed composition of visfatin/NAMPT-PPI-network.

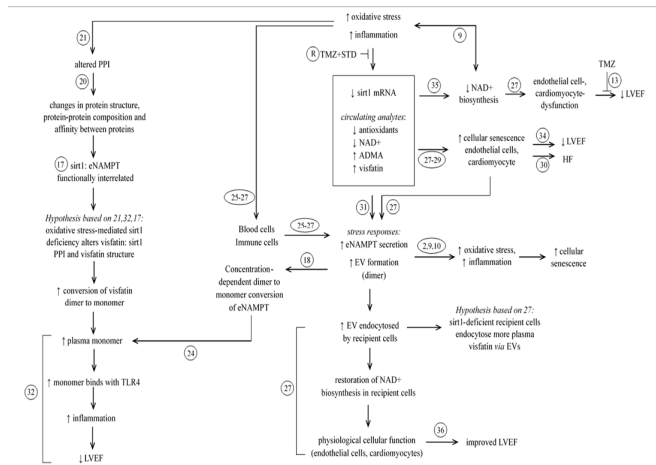


Figure 2. Potential pathophysiological mechanisms that link trimetazidine (TMZ) – circulating visfatin (eNAMPT) – left ventricular ejection fraction (LVEF) in heart failure. ADMA – asymmetric dimethylarginine, EV – extracellular vesicles, NAD+ – nicotinamide adenine dinucleotide, NAMPT – nicotinamide phosphoribosyltransferase, PPI – protein-protein-interaction, R – results from this study, sirt1 – sirtuin1, STD – standard HF therapy, TMZ – trimetazidine, TLR4 – toll-like receptor4, Numbers indicate the respective references.

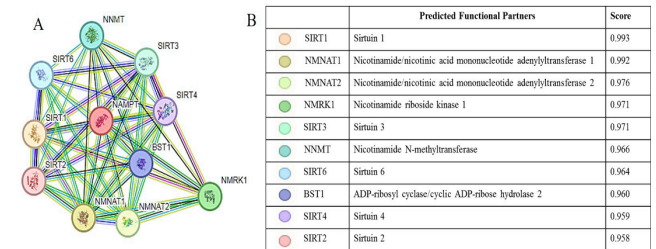


Figure 3. In silico results show (A) human NAMPT (visfatin) protein-protein interaction network and (B) the confidence scores of predicted functional partners indicating the strength of true interaction, based on STRING database 2023.

If excess OS alters PPI assembly, could TMZ(+STD) counter such modifications? Our observation demonstrates that TMZ-mediated sirt1 up-regulation optimizes visfatin and sirt1. This could facilitate the formation of physiological

visfatin/NAMPT-PPI-network and normal NAD+ biosynthesis, to improve EF.

Endocytosis

Excess OS and inflammation, besides causing sirt1-deficiency, trigger more visfatin secretion from several cells²⁵ (endothelial-, blood- immune-cells and cardiomyocytes), as a stress-compensatory mechanism. Hence, excess plasma visfatin is a stress-response effect, which suggests plasma visfatin could have physiological and pathological functions.²⁶ Dimeric visfatin, packed within extracellular vesicles, gets endocytosed by recipient cells to increase NAD+ in other tissues,²⁶ to prevent diabetes and to extend lifespan. Based on these studies, we propose that, in HF, where OS is up-regulated, more plasma visfatin facilitates sirt1-deficient cells to endocytose plasma visfatin (as extracellular vesicles) to normalize intracellular sirt1. This, in turn, increases cellular functions and improves EF. Here, TMZ+STD could address sirt1 deficiency by optimizing intracellular and circulating sirt1, to facilitate physiological cellular functions in cardiomyocytes and endothelial cells, to improve EF.

Prevention of the formation of senescent cells

In HF, more oxidants degrade sirt1 and NAD+; NAD+-depletion accelerates OS and CS;²⁷⁻²⁹ and excess cardiomyocyte-senescence contributes to pathogenesis.³⁰ Sirt1-deficient-senescent-cells secrete dimeric visfatin/eNAMPT, implying, pathologically senescent-cells are sources of plasma visfatin/eNAMPT.³¹ Secretory molecules/extracellular vesicles from senescent cells (non-myocytes) accelerate cardiomyocyte-senescence.³² These reports suggest that OS-mediated sirt1-deficiency could be a stress-stimuli that triggers extracellular-vesicle formation and thus, elevated circulating visfatin. Hence, in HF, plausibly, more senescent cells contribute to increased plasma visfatin. Results show that TMZ+STD up-regulates sirt1. Sirt1-restoration could have prevented normal cells from becoming senescent, thus, leading to reduced plasma visfatin.

The presence of healthier cells, rather than senescent cells, could have improved myocardial function. One report shows that the conversion of dimeric visfatin to monomer is concentration-dependent. Plasma visfatin exists as a dimer at low physiological concentrations (~1ng/ml); at pathological concentrations (~5ng/ml), the dimer converts to monomer.³³ Results show that TMZ+STD reduced visfatin than STD. Based on these reports and our results, TMZ+STD could influence the rate of visfatin conversion, dimer to monomer. Attenuated pro-inflammatory monomeric visfatin could have improved EF in TMZ+STD.

Results demonstrate cytoprotective effects;

TMZ+STD reduces ADMA and improves antioxidants. Mitigated ADMA improves cardiac function³⁴ while augmented GSH restores cell death mechanisms.⁷ Thus, TMZ+STD could improve EF through ADMA and antioxidants. Together, cumulative effects of TMZ+STD on biomarkers have altered OS, and pro-inflammatory- and CS mechanisms to render cardioprotection. The cross-sectional design precluded establishing causal relationships between TMZ + STD-mediated biomarker alterations and improvements in LVEF. The study had a small sample size, limiting the generalizability of the findings.

Hence, it should be considered a pilot study. Direct enzyme activity of circulating visfatin or sirt1 in peripheral blood cells was not measured. Instead, NAD⁺ concentrations (a surrogate marker for sirt1 activity) and sirt1 mRNA expression levels were assessed. The lack of healthy controls limited the ability to assess the baseline influence of HF on the studied biomarkers. These limitations emphasize the need for future longitudinal studies with larger cohorts, including healthy controls and patients in earlier stages of HF, are essential to evaluate TMZ's role in preventing disease progression and its impact on biomarkers such as asymmetric dimethylarginine (ADMA) and visfatin.

CONCLUSION

Adjunctive therapy with trimetazidine (TMZ) significantly improved ejection fraction compared to standard heart failure (HF) therapy alone, indicating its potential to enhance cardiac function by modulating key biomarkers in patients with heart failure with reduced ejection fraction (HFrEF). These findings highlight the potential of TMZ to target mechanisms related to oxidative stress, inflammation, and myocardial remodeling.

CONFLICT OF INTEREST

None

REFERENCES

1. Aimo A, Castiglione V, Borrelli C, Saccaro LF, Franzini M, Masi S, et al. Oxidative stress and inflammation in the evolution of heart failure: From pathophysiology to therapeutic strategies. *Eur J Prev Cardiol.* 2020 Mar;27(5):494-510.
2. Beiras-Fernandez A, Reinwand S, Kretz S, A. Beiras, A. Moritz, I. Werner. Modulation of Nesfatin, Visfatin and Resistin in Patients Undergoing Heart Transplantation. *J*

Hear Lung Transplant 2016 Apr;35:S189.

3. Dückelmann C, Mittermayer F, Haider DG, Altenberger J, Eichinger J, Wolzt M. Asymmetric-dimethylarginine enhances cardiovascular risk prediction in patients with chronic heart failure. *Arterioscler Thromb Vasc Biol.* 2007 Sep;27(9):2037-42.
4. Wang DD, Airhart SE, Zhou B, Shireman LM, Jiang S, Melendez-Rodriguez C, et al. Safety and Tolerability of Nicotinamide Riboside in Heart-Failure With Reduced Ejection Fraction. *JACC Basic Transl Sci.* 2022 Sep 14;7(12):1183-1196.
5. Akkafa F, Halil-Altıparmak I, Erkus ME, Aksoy N, Kaya C, Ozer A, et al. Reduced SIRT1 expression correlates with enhanced oxidative stress in compensated and decompensated heart failure. *Redox Biol.* 2015 Dec;6:169-173.
6. Campolo J, De-Maria R, Caruso R, Accinni R, Turazza F, Parolini M, et al. Blood glutathione as independent marker of lipid peroxidation in heart failure. *Int J Cardiol.* 2007 Apr 12;117(1):45-50.
7. Tan M, Yin Y, Ma X, Zhang J, Pan W, Tan M, et al. Glutathione system enhancement for cardiac protection: pharmacological options against oxidative stress and ferroptosis. *Cell Death Dis.* 2023 Feb 16;14(2):131.
8. Guo X, Xing Y, Jin W. Role of ADMA in the pathogenesis of microvascular complications in type-2-diabetes-mellitus. *Front Endocrinol (Lausanne).* 2023 Apr 21;14:1183586.
9. Romacho T, Valencia I, Ramos-González M, Vallejo S, López-Esteban M, Lorenzo O, et al. Visfatin/eNamp1 induces endothelial-dysfunction in vivo: a role for Toll-Like Receptor 4 and NLRP3 inflammasome. *Sci Rep.* 2020 Mar 25;10(1):5386.
10. Peiró C, Romacho T, Carraro R, Sánchez-Ferrer CF. Visfatin/PBEF/Namp1: A New Cardiovascular Target? *Front Pharmacol.* 2010 Nov 23;1:135.
11. Robson A. Restoration of NAD⁺ levels as a therapy for HFrEF. *Nat Rev Cardiol.* 2021 May;18(5):307.
12. Wang Y, Zhao R, Wu C, Liang X, He L, Wang L, et al. Activation of the sirtuin silent information regulator-1 pathway inhibits pathological myocardial remodeling. *Front*

- Pharmacol. 2023 Feb 10;14:1111320.
13. Fragasso G, Palloshi A, Puccetti P, Silipigni C, Rossodivita A, Pala M, et al. A randomized clinical trial of trimetazidine, a partial free fatty-acid-oxidation-inhibitor, in patients with heart failure. *J Am Coll Cardiol.* 2006 Sep 5;48(5):992-8.
 14. Raj V, Natarajan S, Marimuthu C, Chatterjee S, Ramasamy M, Ramanujam GM, et al. Cholecalciferol and metformin protect against lipopolysaccharide-induced endothelial dysfunction and senescence by modulating sirtuin-1 and protein-arginine-methyltransferase-1. *Eur J Pharmacol.* 2021 Dec 5;912:174531.
 15. Yap LP, Sancheti H, Ybanez MD, Garcia J, Cadenas E, Han D. Determination of GSH, GSSG, and GSNO using HPLC with electrochemical detection. *Methods Enzymol.* 2010;473:137-47.
 16. Chen J, Lai J, Yang L, Ruan G, Chaugai S, Ning Q, et al. Trimetazidine prevents macrophage-mediated septic myocardial dysfunction via activation of the histone deacetylase sirtuin-1. *Br J Pharmacol.* 2016 Feb;173(3):545-61.
 17. Hwang JW, Yao H, Caito S, Sundar IK, Rahman I. Redox regulation of SIRT1 in inflammation and cellular senescence. *Free Radic Biol Med.* 2013 Aug;61:95-110.
 18. Imai SI. The NAD World 2.0: the importance of the inter-tissue communication mediated by NAMPT/NAD⁺/SIRT1 in mammalian aging and longevity control. *NPJ Syst Biol Appl.* 2016 Aug 18;2:16018.
 19. Uma-Maheswari G, Yamini B, Guru A, Velayutham M, Dhandapani VE, Karuppiah KM, et al. Trimetazidine with an adjuvant-therapy to normalize the circulating visfatin concentration: Future perspective and mechanistic strategies. *J King Saud Univ - Sci* 2023 Dec;35:102950.
 20. Szklarczyk D, Kirsch R, Koutrouli M, Nastou K, Mehryary F, Hachilif R, et al. The STRING database in 2023: protein-protein-association networks and functional enrichment analyses for any sequenced genome of interest. *Nucleic Acids Res.* 2023 Jan 6;51(D1): D638-D646.
 21. Sharma C, Kim SR. Linking Oxidative-Stress and Proteinopathy in Alzheimer's Disease. *Antioxidants (Basel).* 2021 Jul 30;10(8):1231.
 22. Eronina TB, Mikhaylova VV, Chebotareva NA, Tugaeva KV, Kurganov BI. Effect of Betaine and Arginine on Interaction of α B-Crystallin with Glycogen Phosphorylase-b. *Int J Mol Sci.* 2022 Mar 30;23(7):3816.
 23. Imai S, Yoshino J. The importance of NAMPT/NAD⁺/SIRT1 in the systemic regulation of metabolism and ageing. *Diabetes Obes Metab.* 2013 Sep;15 Suppl 3(0 3):26-33.
 24. Camp SM, Ceco E, Evenoski CL, Danilov SM, Zhou T, Chiang ET, et al. Unique Toll-Like Receptor 4 Activation by NAMPT/PBEF Induces NF κ B-Signaling and Inflammatory Lung Injury. *Sci Rep.* 2015 Aug 14;5:13135.
 25. Di-Stefano M, Galassi L, Magni G. Unique expression pattern of human nicotinamide-monomucleotide-adenylyltransferase isozymes in red blood cells. *Blood Cells Mol Dis.* 2010 Jun 15;45(1):33-9.
 26. Grolla AA, Travelli C, Genazzani AA, Sethi JK. Extracellular nicotinamide-phosphoribosyltransferase, a new cancer metabokine. *Br J Pharmacol.* 2016 Jul;173(14):2182-94.
 27. Kuehnemann C, Hu KQ, Butera K, Patel SK, Bons J, Schilling B, et al. Extracellular Nicotinamide-Phosphoribosyltransferase Is a Component of the Senescence-Associated-Secretory-Phenotype. *Front Endocrinol.* 2022 Jul 14;13:935106.
 28. Massudi H, Grant R, Guillemin GJ, Braidy N. NAD⁺ metabolism and oxidative stress: the golden nucleotide on a crown of thorns. *Redox Rep.* 2012;17(1):28-46.
 29. Alegre GFS, Pastore GM. NAD⁺ Precursors Nicotinamide-Mononucleotide (NMN) and Nicotinamide-Riboside (NR): Potential Dietary Contribution to Health. *Curr Nutr Rep.* 2023 Sep;12(3):445-464.
 30. Evangelou K, Vasileiou PVS, Papaspyropoulos A, Hazapis O, Petty R, Demaria M, et al. Cellular-senescence and cardiovascular diseases: moving to the "heart" of the problem. *Physiol Rev.* 2023 Jan 1;103(1):609-647.
 31. Han L, Long Q, Li S, Xu Q, Zhang B, Dou X, et al. Senescent

Stromal Cells Promote Cancer Resistance through SIRT1 Loss-Potentiated Overproduction of Small Extracellular Vesicles. *Cancer Res.* 2020 Aug 15;80(16):3383-3398.

32. Sayers SR, Bevil RL, Fine NH, Huang GC, Choudhary P, Pacholarz KJ, et al. Structure-functional changes in eNAMPT at high concentrations mediate mouse and human beta-cell dysfunction in type-2 diabetes. *Diabetologia.* 2020 Feb;63(2):313-323.

33. Achan V, Broadhead M, Malaki M, Whitley G, Leiper J, MacAllister R, et al. Asymmetric-dimethylarginine causes hypertension and cardiac dysfunction in humans and is actively metabolized by dimethylarginine-dimethylaminohydrolase. *Arterioscler Thromb Vasc Biol.*

2003 Aug 1;23(8):1455-9.

34. Redgrave RE, Dookun E, Booth LK, Camacho-Encina M, Folaranmi O, Tual-Chalot S, et al. Senescent cardiomyocytes contribute to cardiac dysfunction following myocardial infarction. *NPJ Aging.* 2023 Jun 14;9(1):15.

35. Imai SI, Guarente L. It takes two to tango: NAD⁺ and sirtuins in aging/longevity control. *NPJ Aging Mech Dis.* 2016 Aug 18;2:16017.

36. Chen MS, Lee RT, Garbern JC. Senescence mechanisms and targets in the heart. *Cardiovasc Res.* 2022 Mar 25;118(5):1173-1187.

A CROSS-SECTIONAL STUDY ON THE CLINICAL PROFILE OF PATIENTS WITH SYMPTOMS OF ACUTE CORONARY SYNDROME (ACS) WHO RECEIVED LOADING DOSE AT PRIMARY CARE FACILITIES UNDER IDHAYAM KAPPOM THITTAM SCHEME IN TAMIL NADU, INDIA, 2024

Karuna Karthikeyan⁽¹⁾, Geetha Mani⁽¹⁾, Vidhya Viswanathan⁽²⁾, Pravin Thiagarajan⁽²⁾, Krishnaraj K⁽²⁾, Selvavinayagam TS⁽²⁾

(1) Karpaga Vinayaga Institute of Medical Sciences & Research Centre, District Residency Programme

(2) Directorate of Public Health and Preventive Medicine

ABSTRACT

INTRODUCTION : Idhayam Kappom Thittam Scheme is a significant health initiative by Government of Tamil Nadu aimed at providing immediate cardiac care to patients at primary care facilities before referral to higher facilities in-order to prevent mortality due to acute cardiac illness. The study aims to evaluate the clinical outcomes of those patients with symptoms of Acute Coronary Syndrome receiving cardiac loading doses under the scheme. It also seeks to compare clinical outcomes based on time taken for administration of loading dose and time taken to reach higher centres.

METHODS : A secondary data analysis was conducted using data collected from all Health Unit Districts (HUDs) containing the line list of patients with symptoms of Acute Coronary Syndrome (ACS) including chest pain who were referred to higher centers from Primary Health Centers (PHCs) or Health Sub-centers (HSCs) after administration of cardiac loading dose. Data was coded and analyzed using Microsoft Excel and SPSS version 29.

RESULTS : The study analysed 6,493 patients, reporting that 97.7% of the patients remained alive and stable after referral following treatment with a cardiac loading dose at primary care facilities. Only 2.2% of the patients expired while 0.1% died along the route. The average time taken to administer the loading dose was 13.09 minutes, and the average time taken to reach a referral centre was 46.25 minutes. Also, arrival at referral centres within 60 minutes of acute chest pain was associated with higher survival. Other patients with comorbid conditions, including diabetes and coronary artery disease, had higher mortality rates.

CONCLUSION : This study affirms the effectiveness of early cardiac intervention at primary care centres under the Idhayam Kappom Thittam scheme. Giving a cardiac loading dose before referral significantly improved survival rates of patients, especially those who were taken to a facility with advanced care within the first 60 minutes, highlighting areas of success and identifying opportunities for improvement, contributing to the enhancement of more such programs and policies in Tamil Nadu and India.

KEYWORDS : Chest pain, Loading dose, Referral time, Myocardial infarction

INTRODUCTION

Cardiovascular diseases (CVDs), particularly Acute Myocardial Infarction (AMI), represent one of the leading causes of morbidity and mortality worldwide, with approximately 17.9 million deaths annually attributed to CVDs, according to the World Health Organization. Low- and middle-income countries bear a disproportionate share of this burden, accounting for over 75% of these deaths. India, in particular, faces a significant challenge, where ischemic heart disease, including acute Myocardial Infarction (MI), is a major contributor to mortality, with an estimated incidence rate of 64.37 per 100,000 people and only about 60% of patients receiving timely treatment.²

In developing countries, healthcare systems often face constraints in managing the growing prevalence of

Non-Communicable Diseases (NCDs) such as CVDs due to limited resources and infrastructure.² Strengthening Primary Health Care (PHC) systems is crucial for both preventing and managing these diseases, as PHC services are essential for early detection, risk factor management, and providing long-term care.² However, in many developing countries, PHC facilities are ill-equipped to handle the rising burden of cardiovascular diseases, including MI, which increases the pressure on secondary and tertiary healthcare services.³



Please Scan this QR Code to

View this Article Online

Article ID: 2024:04:04:05

Corresponding Author: Karuna Karthikeyan

e-mail : karsana1204@gmail.com

One critical determinant of outcomes in MI cases is the time it takes for patients to seek medical attention. In developing countries, pre-hospital delays are often attributed to a combination of factors such as lack of awareness of symptoms, socio-economic barriers, and inadequate Emergency Medical Services (EMS).⁴ Timely intervention is essential for improving survival rates in acute MI cases, as early treatment—such as the administration of thrombolytics or Percutaneous Coronary Intervention (PCI)—significantly reduces mortality.⁶ The lack of well-organized EMS in many low-resource settings contributes to these delays, leading to poorer outcomes for patients.⁵

One proven early intervention for acute MI is the administration of a cardiac loading dose, i.e., the administration of aspirin, clopidogrel, and atorvastatin in the pre-hospital setting, which has been shown to reduce mortality and improve recovery outcomes.⁷ Despite its efficacy, this simple intervention is not widely adopted in many low- and middle-income countries due to gaps in training, awareness, and access to emergency care.⁷

Government of Tamil Nadu had launched an initiative of providing the cardiac loading doses at Primary Health Centers (PHCs)/ Health sub-centers (HSCs) called "Idhayam Kaapom Thittam" program to prevent deaths caused by cardiac illness. The program was launched on June 27, 2023. Patients reporting to the Primary Health Centers PHCs or HSCs with symptoms of acute coronary syndrome will be referred for ECG service, followed by telephonic consultation with the district nodal cardiologist. Following the telephonic consultation, emergency cardiac loading dose drugs containing Aspirin 150mg - 2 tablets, Clopidogrel 75mg - 4 tablets, and Atorvastatin 10mg - 8 tablets, a total of 14 tablets will be provided and the patient will be referred to secondary/tertiary care facilities for further management.¹

This study aims to evaluate the outcomes of patients who had presented with chest pain and received cardiac loading doses at Primary Health Centers (PHCs) and Health sub-centers (HSCs) under the Idhayam Kappom Thittam Scheme in Tamil Nadu. By targeting early interventions at the PHC level and enhancing public awareness of the importance of timely treatment, the management of acute MI in resource-limited settings can be significantly improved, reducing mortality and alleviating the burden on healthcare systems. The primary objective of this study is to evaluate the clinical outcomes of patients with chest pain who have received cardiac loading doses at PHCs or HSCs before referral to higher centres under the Idhayam Kappom Thittam Scheme in Tamil Nadu between June 2023 and August 2024.

METHODS

This is a cross-sectional study with secondary data analysis of the Idhayam Kappom Thittam program. The data included in this study were the individuals reported with symptoms of Acute Coronary Syndrome (ACS) including chest pain from June 2023 to August 2024 at Primary health centers and Health sub-centers. Permission to conduct this study was obtained from the Directorate of Public Health and Preventive Medicine (DPH&PM), Tamil Nadu. The variables include age, gender, address, co-morbidities, date of reporting of symptoms, details of administration of the cardiac loading dose, referral and investigations like Echo Cardiogram, followed by the patient outcome. Of 9,108 data that was collected, 2615 data were incomplete and were excluded, retaining 6493 data for analysis. All patient data were anonymized to ensure confidentiality. The data were systematically coded and entered into Microsoft Excel. Statistical analysis was performed using SPSS software, version 29. Continuous variables were represented as medians with interquartile ranges (IQR) and categorical variables were presented as frequencies and percentages. Descriptive statistics were used to outline patient demographics and clinical characteristics. Chi-Square test was used to identify associations between co-morbidities, time of arrival at the referral institute, and patient outcomes.

Operational definitions: (1) **Time to administer cardiac loading dose:** The time taken from the arrival of the patient with symptoms of Acute Coronary Syndrome like acute chest pain to the Primary Health Centers and Health Sub-centers to the administration of the cardiac loading dose. (2) **Time taken to reach the referral institute:** The time taken for the patient to be transferred from the Primary Health Centers and Health Sub-centers to a secondary or tertiary care facility after receiving the cardiac loading dose. (3) **Alive and stable:** Patients who, after being referred to and treated at secondary or tertiary care facilities (either medically or surgically), are now stable and either discharged or under follow-up care. (4) **Expired:** Patients who died after referral and treatment at secondary or tertiary care facilities. (5) **Expired during transit:** Patients who died during transport from the primary care facility to the secondary or tertiary care facility while being referred.

RESULTS

The age and gender distribution of the 6,493 study participants is given in Figure 1. Of the total 6,493 participants, 3,287(50.6%) are within the 45-60 years age group, followed by 2073(32%) over 60 years and 4,248(65.4%) are males.

Figure 2 depicts the distribution of patients with acute chest pain who received cardiac loading doses at PHCs or HSCs, by Health Unit District (HUD).

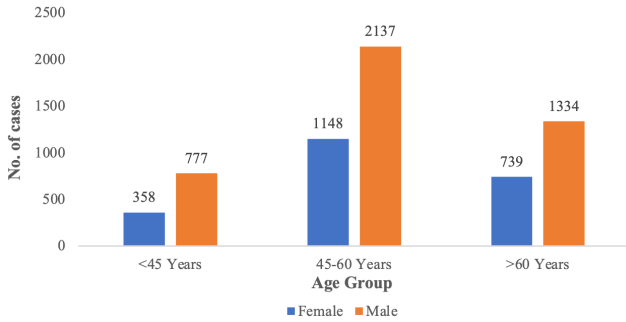


Figure 1. Age and gender-wise distribution of the individuals with Acute Coronary Syndrome (ACS) who received cardiac loading doses at PHCs and HSCs, Tamil Nadu, June 2023 and August 2024 (N=6493)

The clinical characteristics like co-morbidities, symptoms at presentation, diagnosis, and patient outcomes of the study participants are given in Table 1. 2829(43.6%) participants had hypertension and (1396)21.5% of the participants had diabetes. Among the symptoms presented, chest pain was reported by 4964(76.5%) participants followed by palpitations in 708(10.9%). Of the 6,493 individuals who had received cardiac loading dose and referred to higher facilities, 5846(90%) were diagnosed with myocardial infarction while 647(10%) had gastritis. About 97.7% of the patients were alive and stable, 2.2% had died, and a minuscule number of 0.1%, died during transit.

Table 1. Distribution of study participants according to co-morbidities, presenting symptoms, diagnosis and patient outcomes (N=6493), Tamil Nadu, June 2023 and August 2024 (N=6493)

Variables	Frequency (N=6493)	Percentage (%)		
1. Hypertension with duration	Present	<1 year	609	9.38
		1-5 years	1491	22.96
		5-10 years	602	9.27
		>10 years	127	1.96
		Total	2829	43.57
	Absent	3664	56.43	
2. Diabetes mellitus with duration	Present	<1 year	327	5.04
		1-5 years	653	10.05
		5-10 years	360	5.55
		>10 years	56	0.86
		Total	1396	21.5
	Absent	5097	78.5	
3. Symptoms	Chest pain	4964	76.5	
	Pain radiating to neck/jaw/arm/shoulder	428	6.6	
	Palpitations	708	10.9	
	Sweating	306	4.7	
	Fatigue	87	1.3	
	4. Diagnosis at secondary & Tertiary care facilities	Myocardial infarction	5846	90
Gastritis	647	10		
5. Patient outcomes	Alive and stable	6346	97.7	
	Expired	143	2.2	
	Expired during transit	4	0.1	
	6. Previous H/O CAD	Present	266	4.1
Absent	6227	95.9		

The time taken to administer the loading dose varied from 5 to 50 minutes with a median (IQR) of 10(5) minutes and the time to reach the referral institute varied from 15 to 90 minutes with a median (IQR) of 45(30) and shown in Table 2

Table 2: Time taken to administer loading dose and time taken to reach referral centres among the individuals with Acute Coronary Syndrome (ACS) who received cardiac loading doses at PHCs and HSCs, Tamil Nadu, June

Variable	Minimum time (in minutes)	Maximum time (in minutes)	Median (IQR)
Time taken to administer loading dose	5	50	10(5)
Time taken to reach referral institute	15	90	45(30)

Table 3 depicts the associations between patient outcomes and comorbidities like diabetes mellitus, duration of diabetes, history of CAD, and time taken to reach the referral institute. Diabetic patients had a mortality of 3.2% versus non-diabetic patients who accounted for 1.9%, and the difference was statistically significant (p = 0.009). Patients who had diabetes for more than 10 years had a mortality of 12.5%, while those who had diabetes for less than one year had a mortality of only 1.8% (p < 0.001). A previous history of CAD was associated with considerably higher mortality of 6.4% compared to patients who did not have a previous history of CAD, whose mortality rate was 2%. The other critical factor was the time to reach the referral institute; patients who came within 60 minutes had a better survival rate than those delayed by more than 60 minutes with a mortality rate of 6.1% (p < 0.001).

Table 3. Association between co-morbidities, time taken to reach referral institute and patient outcomes among the individuals with Acute Coronary Syndrome (ACS) who received cardiac loading doses at PHCs and HSCs, Tamil Nadu, June 2023 and August 2024 (N=6493)

Variables	Alive and stable n (%)	Expired n (%)	Total n (%)	Chi square (p value)	
Diabetes mellitus	Present	1350 (96.7)	46 (3.3)	1396 (100)	0.009
	Absent	4996 (98)	101 (2)	5097 (100)	
Duration of diabetes mellitus	<1 year	321 (98.2)	6 (1.8)	327(100)	<0.001
	1-5 years	633 (96.9)	20 (3.1)	653(100)	
	5-10 years	347 (96.4)	13 (3.6)	360(100)	
	>10 years	49 (87.5)	7 (12.5)	56(100)	
Previous H/O CAD	Present	249 (93.6)	17 (6.4)	266(100)	<0.001
	Absent	6097 (97.9)	130 (2.1)	6227(100)	
Time taken to reach the referral institute	<60 minutes	5014 (98.8)	60 (1.2)	5074(100)	<0.001
	>60 minutes	1332 (93.9)	87 (6.1)	1419 (100)	

(p-value <0.05 is considered statistically significant)

DISCUSSION

This study puts forward the importance of early interventions for acute MI, where facilities are limited. The “Idhyam Kappom Thittam” scheme involves the delivery of cardiac loading dose to patients presenting with acute chest pain or other symptoms of ACS at PHCs or HSCs before referring them to higher centres and has very optimistic results for outcomes. This is very essential as CVDs, especially acute myocardial infarction, is one of the leading causes of death worldwide, responsible for approximately 17.9 million deaths per year, most of which take place in low and middle-income countries.¹

The cardiac loading dose intervention of administering aspirin, clopidogrel, and atorvastatin has already been shown to decrease mortality and increase recovery rates in acute coronary syndromes.^{6,7} The results are consistent with earlier studies that postulated early administration of antiplatelet drugs like aspirin and clopidogrel would obtain a marked improvement in outcomes with patients by reducing the formation of thrombus and limiting myocardial damage.⁷ This prehospital intervention is highly critical for efficacy in the setting where access to facilities with advanced healthcare is limited and often is in an underdeveloped state.⁵

Demographics data of the study population indicates that most of the patients were males and aged between 45 to 60 years old. This follows the epidemiological trends globally whereby, men who are into the middle ages form the most common demographic group to suffer acute coronary syndromes than women.³ Other comorbidities established included hypertension at 43.6% and diabetes at 21.5%. These are well documented to be the risk factors for CVDs including MI, and these impose appreciable risk of adverse outcomes during coronary events.⁸ The results that the mortality rate among diabetics (3.2%) was higher than among nondiabetics (1.9%) align with other studies, which have shown that diabetes mellitus worsens the severity of coronary artery disease and impacts survival adversely following MI.²

The study also draws attention to the “golden hour” in managing acute MI. The average time taken for the cardiac loading dose was 13.09 minutes, and that taken to transfer the patients to a secondary or tertiary care centre was 46.25 minutes. Such results are of importance because arrival at the referral institute within 60 minutes of ischemia marked a drastically higher survival rate among the affected patients than those who were delayed.⁵ Similar findings about delayed treatment beyond the first hour have been seen in previous studies where delays can potentially increase mortality in

patients with acute coronary syndrome.⁴ All this points to rapid transport with immediate intervention and properly coordinated emergency medical services in rural and semi-urban areas.

Another very important point from the study was the relationship between comorbidities and patient outcomes. It revealed that the patients were exposed to higher levels of mortality. Known diabetics had a significantly higher mortality rate compared to patients who did not have diabetes. Similarly, people with CAD also had a higher death rate. This is in congruence with some published articles as it tends to describe the major risks from both diabetes and CAD in posing a threat for adverse outcomes in acute MI.^{8,6} Though this study found no statistically significant association between hypertension and patient outcomes, it is possible that many patients with hypertension were already diagnosed and receiving appropriate treatment, which may have helped reduce its impact on acute MI outcomes.

LIMITATIONS

Outcomes were assessed only during the short period since referral; survival and recurrence of MI events were not observed. Further experiments on a well-designed study and follow-up observations over a longer period may provide an opportunity to understand the scheme's long-term effectiveness.

CONCLUSION

This study affirms the usefulness of early cardiac intervention at primary care centres under the Idhayam Kappom Thittam scheme. Giving a cardiac loading dose before referral significantly improved survival rates of patients, especially those who were taken to a facility with advanced care within the first 60 minutes after arrival. The scheme fills the vacant space concerning emergency care in resource-poor settings as it allows for timely intervention that can minimize myocardial infarction-related deaths.

It stresses the importance of treating acute heart conditions together with other co-morbid conditions such as diabetes and CAD to improve the outcome.

CONFLICT OF INTEREST

None

REFERENCES

1. Thiagarajan P, Jeevagan A, Viswanathan V. Idhayam K A Apom Thittam (Ikt) – A Government Of Tamilnadu Initiative

To Prevent Death Due To Cardiac Illness - A Descriptive Study. 2024;4(2).

2. Haque M, Islam T, Rahman NAA, McKimm J, Abdullah A, Dhingra S. Strengthening Primary Health-Care Services to Help Prevent and Control Long-Term (Chronic) Non-Communicable Diseases in Low- and Middle-Income Countries. *RMHP*. 2020 May;Volume 13:409–26.

3. Chandrashekhar Y, Alexander T, Mullasari A, Kumbhani DJ, Alam S, Alexanderson E, et al. Resource and Infrastructure-Appropriate Management of ST-Segment Elevation Myocardial Infarction in Low- and Middle-Income Countries. *Circulation*. 2020 Jun 16;141(24):2004–25.

4. Chowdhury IZ, Amin MdN, Chowdhury MZ, Rahman SM, Ahmed M, Cader FA. Pre hospital delay and its associated factors in acute myocardial infarction in a developing country. Nakamura M, editor. *PLoS ONE*. 2021 Nov 24;16(11):e0259979.

5. Frampton J, Devries JT, Welch TD, Gersh BJ. Modern Management of ST-Segment Elevation Myocardial Infarction. *Current Problems in Cardiology*. 2020 Mar;45(3):100393.

6. Ramanujam P, Aschkenasy M. Identifying the Need for Pre-hospital and Emergency Care in the Developing World : A Case Study in Chennai, India. 2007;55.

7. Djarv T, Swain JM, Chang WT, Zideman DA, Singletary E. Early or First Aid Administration Versus Late or In-hospital

Administration of Aspirin for Non-traumatic Adult Chest Pain: A Systematic Review. *Cureus* [Internet]. 2020 Feb 3 [cited 2024 Sep 11]; Available from: <https://www.cureus.com/articles/26253-early-or-first-aid-administration-versus-late-or-in-hospital-administration-of-aspirin-for-non-traumatic-adult-chest-pain-a-systematic-review>

8. Dalal JJ, Almahmeed W, Krittayaphong R, Nicholls SJ, Soomro K, Yeo KK, et al. Consensus Recommendations of the Asia Pacific Cardiometabolic Consortium on Secondary Prevention Strategies in Myocardial Infarction: Recommendations on Pharmacotherapy, Lifestyle Modification and Cardiac Rehabilitation. *J Asian Pac Soc Cardiol*. 2023 Jan 20;2:e01.

9. Sidhu NS, Rangaiah SKK, Ramesh D, Veerappa K, Manjunath CN. Clinical Characteristics, Management Strategies, and In-Hospital Outcomes of Acute Coronary Syndrome in a Low Socioeconomic Status Cohort: An Observational Study From Urban India. *Clin Med Insights Cardiol*. 2020 Jan;14:117954682091889.

10. Pakhare A, Kumar S, Goyal S, Joshi R. Assessment of primary care facilities for cardiovascular disease preparedness in Madhya Pradesh, India. *BMC Health Serv Res*. 2015 Jun;15(1):408.

11. Sinha PK, Zubair N, Kumar K. A single centre study of clinico-epidemiologic profile, course during treatment and outcome in patients presenting with ST-elevationmyocardial infarction at A.N.M.M.C.H. Gaya, Bihar. *Journal of Cardiovascular Disease Research*. 2022;(01).

ORIGINAL ARTICLE

A STUDY ON THE OVIPOSITION BEHAVIOUR OF AEDES MOSQUITOES TO DIFFERENT COLOURED OVI TRAPS IN DIFFERENT SEASONS OF HOSUR MUNICIPAL CORPORATION AREA, TAMIL NADU, 2023

*Kanniyammal S⁽¹⁾, Mani S⁽¹⁾, Vijayalakshmi V⁽¹⁾, Shanthi S⁽²⁾, Sudalaimani S⁽²⁾
Senthilkumar M⁽²⁾, Sampath P⁽²⁾, Vadivelan P⁽²⁾, Selvavinayagam T S⁽²⁾, Prabhakaran V⁽²⁾*

(1) Institute of Vector Control and Zoonoses, Hosur

(2) Directorate of Public Health and Preventive Medicine

(3) Hosur Municipal Corporation, Krishnagiri

ABSTRACT

INTRODUCTION : This study investigates the oviposition behavior of *Aedes aegypti* mosquitoes concerning different colored ovitraps across pre- and post-monsoon seasons in Hosur Municipal Corporation, Tamil Nadu.

METHODS : A cross-sectional design was employed, involving the placement of seven colored ovitraps (black, red, orange, blue, yellow, violet, and green) in 50 houses per selected ward, with observations collected weekly during pre-monsoon and post-monsoon during 2023. Eggs were counted, and species were identified in a controlled laboratory setting.

RESULTS : The results demonstrate a significant preference for black ovitraps, which exhibited the highest positivity and egg count in both seasons, followed by red and orange traps. Notably, indoor settings accounted for the majority of oviposition events across seasons (64.75%-65.86%), emphasizing the importance of indoor breeding sites. Seasonal variations had minimal impact on oviposition patterns, suggesting that urban microclimatic conditions in Hosur might buffer environmental fluctuations.

CONCLUSION : These findings underscore the efficacy of black-colored ovitraps as a reliable vector surveillance tool. The study highlights the need for targeted indoor vector control measures, such as source reduction and habitat modification, to effectively combat dengue in urban settings. Further research into additional environmental and behavioral factors influencing *Aedes* oviposition is recommended to enhance control strategies. By optimizing ovitrap design and placement, public health programs can strengthen mosquito surveillance and mitigate the burden of vector-borne diseases like dengue.

KEYWORDS : Oviposition, Entomology, *Aedes*, Mosquito

INTRODUCTION

Dengue is a vector-borne viral disease endemic in five of six WHO regions (Africa, Americas, South-East Asia, Western-Pacific and Eastern Mediterranean). It poses a major international public health concern. Since 2023, WHO has recorded an incidence of 5 million cases and more than 5000 dengue-related deaths in more than 80 countries/territories and five WHO regions.¹ The four related but distinct dengue viruses (DENV-1, DENV-2, DENV-3 and DENV-4) belong to the genus *Flavivirus* (family *Flaviviridae*) and are circulating in disease-endemic settings in a human-to-mosquito transmission cycle. In 2024, Tamil Nadu has reported 19138 cases and seven deaths as of 31st October.² *Aedes aegypti*, a mosquito, is the main dengue vector in many endemic countries, including India. The vision of this mosquito plays a principal role in adult mosquito biology, including the location of hosts, food sources, mating, resting sites, and oviposition (egg-laying) sites. Adult female mosquitoes lay eggs on the inner walls of containers with water above the waterline. Mosquitoes only need a small amount of water to lay eggs. Bowls, cups, fountains, tires, barrels, vases, and any

other container storing water make a great “nursery.”³

Controlling the primary mosquito vector, *Aedes aegypti* is one of the key strategies to prevent dengue outbreaks in many low- and middle-income countries. Vector control management includes removing potential breeding sites, reducing vector populations, and minimizing individual exposure. This involves vector control strategies for larvae and adults (i.e., environmental management and source reduction), especially monitoring water storage practices, draining and cleaning household water storage containers weekly, and larvicide in non-potable water using larvicides at correct dosages. Implementing preventive measures targeting critical locations at specific times requires efficient vector surveillance tools and methods sensitive enough to predict or detect sudden mosquito population growth in real time.



Please Scan this QR Code to

View this Article Online

Article ID: 2024:04:04:06

Corresponding Author: Kanniyammal S

e-mail : skanniyammal11@yahoo.in

Hence, understanding their oviposition behaviour is crucial for developing effective vector surveillance and control strategies.

Ovitrap are a simple, inexpensive, and widely used sensitive tool for detecting the presence of *Ae. Aegypti* by attracting to lay eggs.⁴ The design of these traps, particularly their color, significantly influences their effectiveness. Studies have demonstrated that *Aedes* mosquitoes exhibit color preferences when selecting oviposition sites. For instance, research conducted in western Rajasthan, India, revealed that red-colored ovitraps had the highest positivity (92.7%), followed by black and blue traps.⁵

Similarly, a study in Chennai indicated that black and blue ovitraps attracted more *Aedes* eggs compared to red, orange, and white ones.⁶ Seasonal variations also play a pivotal role in *Aedes* mosquito dynamics. Monitoring in Jaipur from August 2021 to July 2022 showed significant seasonal fluctuations in *Aedes* populations, with peaks correlating with specific environmental conditions.⁷

While existing studies have explored the impact of ovitrap color on *Aedes* oviposition and noted seasonal population trends, the current study aims to understand the oviposition behavior of *Aedes* mosquitoes concerning various colored ovitraps across different seasons in the Hosur Municipal Corporation area. By analyzing the preferences and seasonal patterns, this research seeks to enhance the understanding of *Aedes* oviposition ecology, thereby contributing to the optimization of vector surveillance tools and the development of more effective, seasonally tailored vector control strategies in the region.

METHODS

This is a cross-sectional study carried out in two seasons of the year i.e. the pre-monsoon and post-monsoon. Considering the rainy days and possible disturbance of breeding sites during rainy days, hence data collection was not during the monsoon season i.e. July to September 2023.

Hosur is a developing industrial urban area. The growth of urbanization is very marked with rise in the number of residential areas and industries. Located on the NH connectivity between Chennai and Bangalore are the two capital cities of the states Tamil Nadu and Karnataka and there by the population movement is throughout the year. The area is vulnerable due to the migratory population to this area from other urban cities. Almost all wards have breeding sources for *Aedes* mosquitoes both during pre-monsoon and post-monsoon periods, the climate in the Hosur area is very conducive to the proliferation of the mosquitoes and

longevity. The Hosur area has contributed 24.32% to 54.73% of the total cases of the district, Krishnagiri during the past 5 years.

The secondary data about the number of dengue cases reported month-wise and year-wise for each ward was collected from the health section of Hosur Municipal Corporation for the period from 2017 to 2022. Based on the reported number of cases, 10 wards were selected for study (Figure 1). All the wards are represented equally and the sample selection is made by probability sampling by Systematic simple random sampling. One in a fifth was selected as per the random sample. The following wards were selected. Ward No: 1, 6, 11, 16, 21, 26, 31, 36, 41 and 45 (Table 1). Then 50 houses in each ward were selected for the fixing of coloured ovitraps.

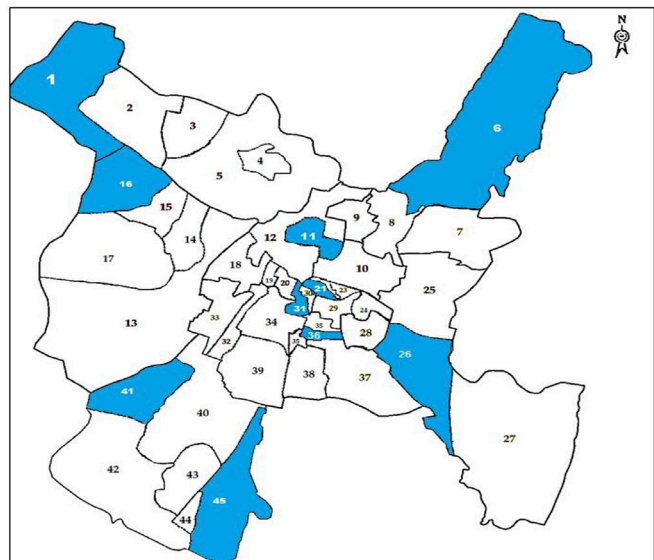


Figure 1: Hosur Municipal Corporation Area showing the study location

Table 1: Wards selected for the study in Hosur Municipal Corporation

Ward No	Ward Name	Ward No	Ward Name
1	Zuzuvadi	26	Parvathi Nagar
6	KCC Nagar	31	Raju street, Immambada
11	New Vasanth Nagar	36	Anthivadi
16	Arasanaty	41	R.K.Hudco
21	Kothur	45	Mathigiri

In each experimental house, seven different colored ovitraps were placed (Figure 2). The ovitraps were left for seven days. After a week, the paddles were removed and *Ae.aegypti* eggs on the walls of the ovitraps were gently dislodged and the water was filtered using a fine strainer. The number of eggs

on the paddle and the walls was counted. Each ovitrap was cleaned well and refilled with water and a new paddle was used each time. During the study, eggs were allowed to hatch and develop into adults, in the laboratory, for species identification.



Figure 2: Different Coloured Ovitrap

The ovitraps designed for this study are a small plastic containers (Trap) of 20 cm in diameter having approximately 750ml water holding capacity, with wide-mouth were used. The ovitraps were of seven colours viz. black, green, orange, yellow, violet, blue and red (Figure 2). In each house, seven different coloured ovitraps were laid at different locations, i.e. bedrooms, bathrooms, kitchen store, lobby, etc (Both indoor and outdoor). Each coloured ovitrap was given an identification number for households and a separate number for its location-specific placement. Mosquito eggs were counted and identified after the collection of the traps at weekly intervals. These experiments were carried out covering pre and post-monsoon of the study area, Hosur. The collected data were pooled for the number of eggs laid in different colour traps.

We employed the following formulas to derive the prevalence of *A. Aegypti* mosquito population, intensity of oviposition, and the proportion of coloured ovitraps positivity.

1. Prevalence = Total positive ovitraps / Total ovitraps installed
2. Intensity = Total no. of *Ae. aegypti* eggs collected / Total positive ovitraps
3. % Positivity of coloured ovitrap = Total positive ovitraps / Total ovitraps installed X 100

RESULTS

The observation of the present study of different coloured ovitraps revealed the black ovitraps had the highest positivity (33/168) followed by orange (29/168) and red (26/168) in the pre-monsoon period. During the post-monsoon period, highest positivity observed in black (30/128), followed by red (25/128) and orange (18/128). The violet, yellow and green ovitraps yielded less than 18 during October through December (i.e. post-monsoon period). The details are shown in Table 2. The breeding site preference by *Ae. aegypti* was found to be 64.75% indoor and 35.25% outdoor during the pre-monsoon period and it was 65.86% indoor and 34.14% outdoor during post post-monsoon period.

During the pre-monsoon period, 50% of the black bowls were found to be attractive. The ovipositing sites preference was 38.59% and 71.4% respectively for outdoor and indoor during pre-monsoon. The same was observed as 65.8 % and 35.3 % respectively for indoors and outdoor during post post-monsoon period. The result showed that black-coloured ovitraps fetched the highest percentages of eggs than other colours (Table 3).

Table 2: Positivity of Different Coloured Ovitrap during the Study Period

Pre Monsoon Period							
Bowl colour	No of bowls installed	No of bowls positive	No. of eggs	Prevalence	Intensity	Mean egg density	% Positivity of colour ovitrap
Red	250	26	523	0.1	20	2	10
Blue	250	18	379	0.07	21	2	7
Violet	250	21	418	0.08	20	2	8
Green	250	23	583	0.09	25	2	9
Orange	250	29	540	0.12	19	2	12
Yellow	250	18	334	0.07	19	1	7
Black	250	33	1673	0.13	25	3	13
Total	1750	168	4450	0.1	26	3	10
Post Monsoon Period							
Bowl colour	No of bowls installed	No of bowls positive	No of eggs	Prevalence	Intensity	Mean egg density	% Positivity of colour ovitrap
Red	250	25	551	0.1	22	2	10
Blue	250	16	278	0.06	17	1	6
Violet	250	10	195	0.04	20	1	4
Green	250	14	245	0.06	18	1	6
Orange	250	18	364	0.07	20	1	7
Yellow	250	15	418	0.06	28	2	6
Black	250	30	1254	0.12	42	5	12
Total	1750	128	3305	0.07	26	2	7

Table 3: Proportion of eggs collected from each coloured ovitraps during Pre & Post Monsoon seasons, Hosur Municipal Corporation, 2023

Ovitraps Colour	Pre-monsoon	Post-monsoon
	No of positive eggs collected (%)	No of positive eggs collected (%)
Red	523 (12)	551 (17)
Blue	379 (9)	278 (8)
Violet	418 (9)	195 (6)
Green	583 (13)	245 (7)
Orange	540 (12)	364 (11)
Yellow	334 (8)	418 (13)
Black	1673 (38)	1254 (38)
Total	4450	3305

DISCUSSION

This study highlights the oviposition behavior of *Aedes aegypti* in response to different colored ovitraps and seasonal variations in the urban landscape of Hosur Municipal Corporation. Key findings indicate that black-colored ovitraps attracted the highest number of eggs in both pre-monsoon and post-monsoon periods, followed by red and orange traps. Notably, oviposition occurred predominantly in indoor environments during both seasons.

The preference for black-colored ovitraps aligns with global and regional literature, where black is consistently identified as the most attractive color for gravid *Aedes* mosquitoes. Studies by Hoel et al. (2011) and Rina et al. (2014) corroborate our findings, underscoring the utility of black ovitraps in vector surveillance, even in areas with low mosquito density.⁸ The consistent indoor breeding preference observed in this study mirrors the findings of Hasini et al. (2015), emphasizing the necessity for targeted interventions in indoor environments to disrupt breeding cycles.⁹

This study also offers novel insights into the negligible impact of seasonal variations on oviposition behavior in this region. While previous studies, such as those conducted in Jaipur, reported significant seasonal influences on mosquito dynamics, the urban microclimatic conditions of Hosur might buffer such fluctuations, leading to relatively stable oviposition patterns. This finding suggests that continuous vector control measures are essential throughout the year, regardless of seasonal changes.

We acknowledge the limitations, as first, while the study employed a systematic sampling method across selected wards, the generalizability of the findings to other urban or rural settings requires further investigation. Second, the study did not explore potential environmental, temperature variations, or chemical attractants that could

interact with color preferences. Future research could address these aspects to refine the application of ovitraps in diverse ecological settings.

CONCLUSION

The study underscores the significance of ovitraps color and placement in optimizing *Aedes aegypti* surveillance and control. Key conclusions are 1. Black-colored ovitraps are the most effective in attracting *Aedes* mosquitoes, suggesting their potential as a standard surveillance tool, 2. Indoor breeding preference necessitates rigorous indoor vector control measures, such as source reduction measures, 3. Awareness on avoiding indoor water containers in dark colors.

By leveraging these insights, public health programs can enhance the efficiency of mosquito surveillance and contribute to reducing the burden of vector-borne diseases like dengue in urban settings.

ACKNOWLEDGEMENT

The authors thank Mrs. M. Mangayarthilagam, Lab Technician and the all Field Assistants (Mrs. N. Yamuna, Mrs. V. Kalaiselvi, Mrs. A. Gayathri, Mrs. U. Dhivya, Mrs. M. Senthamil chelvi and Mrs. S. Johnsirani) of Institute of Vector Control and Zoonoses, Hosur, District Health officer of Krishnagiri, City Health officer and field staff of Hosur Municipal Corporation and especially to the Domestic Breeding Checkers (DBC's) for the support and help rendered during my period of study. The guidance of Dr. Shanmugapriya, Veterinary Assistant Surgeon, IVCZ, Hosur is thankfully acknowledged. The services of Dr. G. Narayanasamy, formerly Reader, Institute of Vector Control and Zoonoses, Hosur are thankfully remembered for proper guidance and preparation of this script. The support provided by the Officials of the Directorate of Public Health and Preventive Medicine, Chennai is gratefully acknowledged.

CONFLICT OF INTEREST

None

REFERENCES

- Dengue and severe dengue [Internet]. [cited 2024 Dec 21]. Available from: <https://www.who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue>
- DENGUE SITUATION IN INDIA: National Center for Vector Borne Diseases Control (NCVBDC) [Internet]. [cited

- 2024 Dec 21]. Available from: <https://ncvbdc.mohfw.gov.in/index4.php?lang=1&level=0&linkid=431&lid=3715>
3. CDC. Mosquitoes. 2024 [cited 2024 Dec 24]. Life Cycle of Aedes Mosquitoes. Available from: <https://www.cdc.gov/mosquitoes/about/life-cycle-of-aedes-mosquitoes.html>
 4. Yap HH. Distribution of *Aedes aegypti* (Linnaeus) and *Aedes albopictus* (Skuse) in small towns and villages of Penang Island, Malaysia--an ovitrap survey. *Southeast Asian J Trop Med Public Health*. 1975 Dec;6(4):519–24.
 5. Kumawat R, Singh KV, Bansal SK, Singh H. Use of different coloured ovitraps in the surveillance of *Aedes* mosquitoes in an arid-urban area of western Rajasthan, India. *J Vector Borne Dis*. 2014 Dec;51(4):320–6.
 6. Malarvizhi B, Zehra A, Poonguzhali G. Dengue vector (*Aedes aegypti*) control in south Chennai using ovitraps through community participation. *Int J Mosq Res*. 2023 Jan 1;10(5):58–63.
 7. Kumawat N, Prajapat R, Meena P, Meena S. Seasonal prevalence of dengue vector mosquito *Aedes aegypti* Linn in Jaipur city, Rajasthan, India. *J Vector Borne Dis*. 2023 Oct;60(4):421–6.
 8. Hoel DF, Obenauer PJ, Clark M, Smith R, Hughes TH, Larson RT, et al. Efficacy of Ovitrap Colors and Patterns for Attracting *Aedes albopictus* at Suburban Field Sites in North-Central Florida. *J Am Mosq Control Assoc*. 2011 Sep;27(3):245–51.
 9. Jayathilake TAHDG, Wickramasinghe MB, de Silva BGDNK. Oviposition and vertical dispersal of *Aedes* mosquitoes in multiple storey buildings in Colombo district, Sri Lanka. *J Vector Borne Dis*. 2015 Sep;52(3):245.

EFFECTIVENESS OF SURVEILLANCE OF DIPHTHERIA AND PERTUSSIS IN TAMIL NADU: A SECONDARY DATA ANALYSIS FOR JANUARY – DECEMBER, 2023.

*Kanagabala Balasubramanian⁽¹⁾, Vinay Kumar Krishnamurthy⁽¹⁾, Kumaravel Ilangovan⁽²⁾,
Ramani Satyanidhi Rao⁽¹⁾, Somasundaram Anavarathan⁽¹⁾*

(1) Directorate of Public Health & Preventive Medicine

(2) John Snow India Private Limited

ABSTRACT

INTRODUCTION: Surveillance of vaccine-preventable diseases (VPDs) such as diphtheria and pertussis are vital for monitoring immunization program effectiveness. This study evaluates the performance of Tamil Nadu's surveillance system using data from the Vaccine Preventable Diseases Surveillance Information Management System (VSIMS) for 2023.

METHODS: A cross-sectional analysis of suspected diphtheria (n=101) and pertussis (n=57) cases reported in Tamil Nadu during January-December 2023 was conducted. Indicators assessed included timely notification, investigation, sample collection, active case search (ACS), and follow-up. Performance was benchmarked against targets in the Diphtheria, Pertussis, and Neonatal Tetanus Surveillance Field Guide.

RESULTS: Timely notification exceeded the 80% target for both diseases, with 89.1% for diphtheria and 89.5% for pertussis cases. Timely investigations were conducted in 93.1% and 91.2% of diphtheria and pertussis cases, respectively. Adequate sample collection surpassed targets but was predominantly limited to single specimens. However, ACS performance was suboptimal, with only 33.7% for diphtheria and 17.5% for pertussis cases. Follow-up documentation was notably poor (27.7% for diphtheria, 8.8% for pertussis).

CONCLUSION: While the performance of the Diphtheria and Pertussis surveillance system in Tamil Nadu aligns with national targets for notification and investigation, ACS and follow-up documentation require significant improvement. Strengthening these areas is essential for identifying clustering, ensuring timely public health responses, and achieving Immunization Agenda 2030 goals.

KEYWORDS: Surveillance, Vaccine Preventable Diseases, Effectiveness, Diphtheria, Pertussis, Indicators, Evaluation

INTRODUCTION

Immunization is the foundation of the primary health care system and an indisputable human right. Vaccination against childhood communicable diseases has contributed significantly in achieving Sustainable Development Goals (SDGs) by reducing mortality and morbidity among children.¹ Under the Universal Immunization Programme (UIP), Govt of Tamil Nadu provides 11 Vaccines to children and pregnant mothers against the 12 Vaccine Preventable Diseases, namely, Poliomyelitis, Diphtheria, Pertussis, Tetanus, Measles, Rubella, Tuberculosis, Hepatitis B, Hemophilus Influenza type B (Hib), Rotavirus, Pneumococcal and Japanese Encephalitis, the latter being given in 14 selected endemic districts.² In children <1 year old, Diphtheria, Pertussis, Tetanus, Hepatitis B, Hib are provided as pentavalent vaccine. Children in the age group of 1-7 years receive diphtheria, pertussis and tetanus in the form of DPT. In addition, for adolescents and pregnant women, tetanus and diphtheria (Td) vaccine is given as a standalone vaccine.³ The progress and impact of vaccination programmes can be effectively

assessed by surveillance for Vaccine Preventable Diseases (VPDs).¹

Immunization Agenda 2030 envisions a world where everyone, everywhere, at every age, fully benefits from vaccines to improve health and well-being. Surveillance for VPDs forms part of wider infectious and non-infectious public health surveillance and is one of the strategic priorities for achieving Immunisation agenda 2030.⁴ VPDs under surveillance in India are Polio, Measles, Rubella, Diphtheria, Pertussis, Neonatal tetanus, Tuberculosis, Bacterial Meningitis, Acute Hepatitis B, Japanese Encephalitis and Typhoid. Currently, surveillance of six VPDs namely, Polio, Measles, Rubella, Diphtheria, Pertussis, and Neonatal tetanus are focussed in India, supported by WHO.⁵



Please Scan this QR Code to

View this Article Online

Article ID: 2024:04:04:07

Corresponding Author: Vinay Kumar K

e-mail : kvinay0809imm@gmail.com

VPD surveillance system in India has been established with technical, operational and monitoring support from WHO-NPSN and encompasses more than 51,000 Reporting Sites (RS). The RS network includes Reporting Units (RU) and Informer Units (IU). All RUs are required to report suspected VPD cases or death due to VPDs immediately. In addition, all RUs are required to send weekly reports including nil reports with details of cases reported in the past one week to the District Health Officer, who also functions as District Immunization Officer. Informer Units (IU) such as hospitals and clinics with single practitioners, facilities with traditional healers or faith healers that are likely to encounter suspected VPD cases should also report cases to the DIO/SMO, but are not mandated to send weekly reports. Currently, there are approximately 1,308 RUs functional in Tamil Nadu. All the VPD cases are updated in Vaccine Preventable Diseases Surveillance Information Management System (VSIMS).

Diphtheria and Pertussis are life-threatening VPDs. Their incidence has gradually declined globally due to effective immunization programs.^{6,7} However, diphtheria continues to be a public health problem in India, with 10 Indian states accounting for most of the reported cases since 2000 largely attributed to low vaccination coverage and waning vaccine immunity in adults.^{8,9} Diphtheria, an acute infectious disease of the respiratory tract caused by toxigenic strains of *Corynebacterium diphtheriae*, spreads from person to person through respiratory droplets or direct contact with respiratory secretions. Complications of Diphtheria include myocarditis, neuritis, Pneumonia, respiratory insufficiency, and death. Most cases of diphtheria develop in non-immunized individuals. The attack rate, severity of disease and risk of complications are much lower in immunized patients.¹

Pertussis, also known as whooping cough, is a highly contagious disease caused by the bacterium *Bordetella pertussis*. It is clinically characterized by intense cough paroxysms lasting for weeks, often accompanied by inspiratory whooping and post-tussive emesis. The most common complication is secondary bacterial pneumonia, which causes pertussis-related deaths. Neurological complications such as seizures and encephalopathy also occur as a result of hypoxia from coughing or possibly from toxins. Infants are at the highest risk for developing pertussis-related complications.¹

A case definition has been established by a set of criteria to report suspected cases of that disease for public health surveillance. It enables consistent reporting of cases by the reporting network and improves specificity of reported

cases. A suspected case of diphtheria is defined as an illness of the upper respiratory tract characterized by the following: laryngitis or nasopharyngitis or pharyngitis or tonsillitis and adherent membranes of tonsils, pharynx, larynx and/or nose.¹ A suspected case of pertussis is defined as a person of any age with a cough lasting ≥ 2 weeks, or of any duration in an infant or any person in an outbreak setting without a more likely diagnosis and with at least one of the following symptoms on observation or parental report: paroxysms (i.e. fits) of coughing inspiratory whooping, post-tussive vomiting, or vomiting without other apparent cause, apnoea in infants (< 1 year of age) or clinician suspicion of pertussis.¹

As part of VPD Surveillance, Monitoring, and supervision are important tools for establishing and maintaining efficient surveillance and response systems. Monitoring and review of key performance indicators are essential to assess the quality of the surveillance system against set norms and standards. Implementation of a surveillance system without a periodic review of the performance indicators will result in no improvements in the system, thus leading to an increased risk of failure. Hence, this study attempted to assess the performance of the Diphtheria and Pertussis Surveillance system in Tamil Nadu using the Vaccine Preventable Diseases Surveillance Information Management System (VSIMS) data for January - December 2023.

METHODS

A cross-sectional study was conducted using secondary data on Diphtheria and Pertussis Surveillance. All the suspected Diphtheria and Pertussis cases reported in the Vaccine Preventable Diseases Surveillance Information Management System (VSIMS) portal during the period January - December 2023 have been included for analysis. The data containing details on the date of onset of symptoms, notification, investigation, date and number of samples collected, Active Case Search (ACS), and follow-up was extracted in Excel format from the VSIMS portal.

Qualitative variables are expressed as proportions. All the key performance indicators were compared with the Diphtheria, Pertussis, and Neonatal Tetanus Surveillance Field Guide 2020 released by the Ministry of Health and Family Welfare (MoHFW), Government of India, supported by WHO.¹ Monitoring indicators recommended in the Surveillance Field Guide are i) Proportion of suspect cases with timely notification ii) Proportion of suspected cases with timely investigation iii) Proportion of cases with adequate sample collection iv) Proportion of rejected cases v)

Proportion of timely ACS in the community vi) Timeliness of weekly reporting and vii) Completeness of weekly reporting presented in Table 1.

Table 1: Timelines of activities to be conducted for suspect

	% of Timely notification	% of Timely investigation	% of Suspect cases with adequate sample	% of Timely active case search (ACS)
Diphtheria	within 7 days of onset of first symptom	within 48 Hrs of case notification	within 4 weeks of onset of first symptom	within 7 days of investigation
Pertussis	within 4 weeks of onset of first symptom			

RESULTS

This study analysed 101 reported suspect Diphtheria cases and 57 suspect Pertussis cases, reported in Tamil Nadu through the VSIMS portal during January – December 2023. The key monitoring indicators compared in this study are i) Proportion of suspect cases with timely notification ii) Proportion of suspected cases with timely investigation iii) Proportion of cases with adequate sample collection iv) Proportion of timely ACS in the community. Other components of Surveillance like final classification of cases, follow up and outcome updation in portal were also analyzed.

i. Timely notification: Among the 101 suspected Diphtheria cases, 90 (89.1%) cases were notified within 7 days of onset of sore throat. Out of the 57 suspected Pertussis cases, 51 (89.47%) cases were notified within 4 weeks of onset of cough. Target set for timeliness for notification of Diphtheria and Pertussis is >80% (Fig 1).

ii. Timely investigation: Out of 101 Diphtheria suspect cases, 94 (93.06%) cases were investigated within 48 hours of notification, and of the 57 suspected Pertussis cases, timely investigation done in 52 (91.23%) cases. Target for timely investigation is >80% (Fig 2).

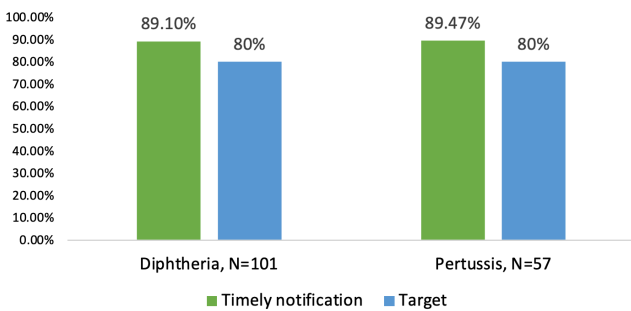


Figure 1: Timeliness of Notification of suspected Diphtheria & Pertussis cases, Jan-Dec 2023, Tamil Nadu

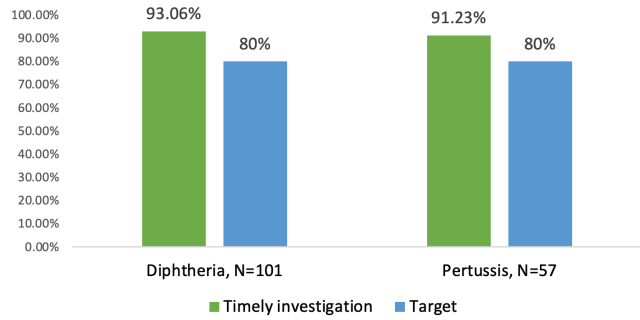


Figure 2: Timeliness in investigation of suspected Diphtheria & Pertussis cases, Jan-Dec 2023, Tamil Nadu

iii) Proportion of cases with adequate Sample collection:

For Diphtheria, 2 samples of Throat Swab or pieces of membrane within 4 weeks of onset of sore throat. For Pertussis, 2 samples of nasopharyngeal swabs within 4 weeks of the onset of Cough and 1 serum sample within 12 weeks of the onset of Cough. Among the 101 Diphtheria cases, 1 sample has been collected for 97 (96.04%) cases and 2 samples have been collected for 1 (0.99%) of suspected Diphtheria cases. Among the 57 Suspected Pertussis cases, 1 sample has been collected for 51 (89.47%) suspected cases and 2 samples have been collected for 1 (1.75%) of suspected Pertussis cases (Fig 3). The adequacy of sample collection is determined by the timeliness of sample collection. Among 97 (96.04%) of Diphtheria cases and 49 (85.96%) of Pertussis cases, adequate sample collection was taken. The target for adequate sample collection is >80% (Fig 4).

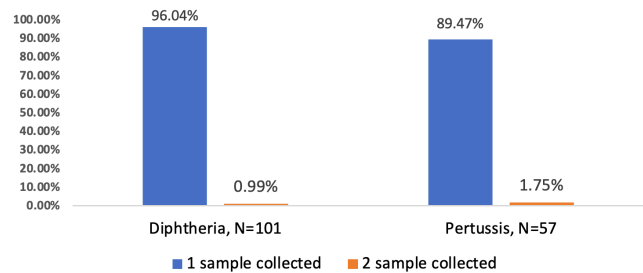


Figure 3: No. of samples collected among suspected Diphtheria & Pertussis cases, Jan-Dec 2023, Tamil Nadu

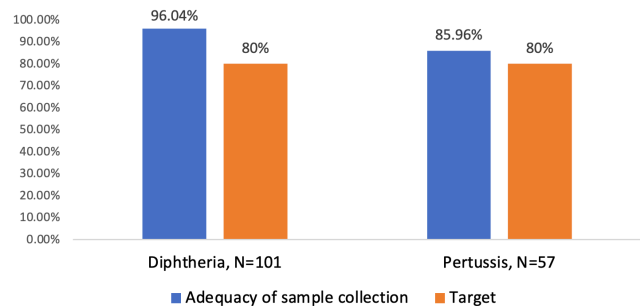


Figure 4: Timeliness of sample collection among suspected Diphtheria and Pertussis cases Jan-Dec 2023, Tamil Nadu

i) Proportion of Timely Active Case Search (ACS) in the community: ACS should be conducted soon after identification of suspected cases, preferably within 7 days of investigation. Among the 101 suspected Diphtheria cases, ACS has been conducted for 34 (33.66%) cases, and among the 57 Pertussis cases, ACS was conducted for 10 (17.54%) cases (Fig 5). Timely ACS has been conducted for 28 (27.72%) suspected Diphtheria cases and 5 (8.77%) suspected Pertussis cases. Target for timeliness in ACS is >80% (Fig 6)

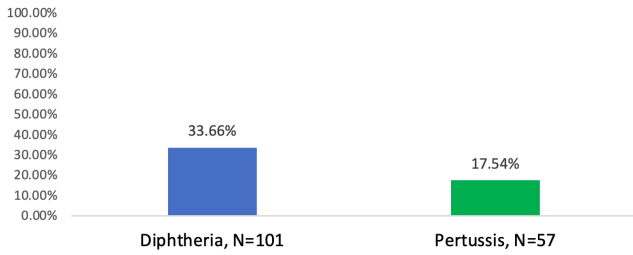


Figure 5: Active Case Search (ACS) Conducted for suspected Diphtheria & Pertussis cases, Jan-Dec 2023, Tamil Nadu

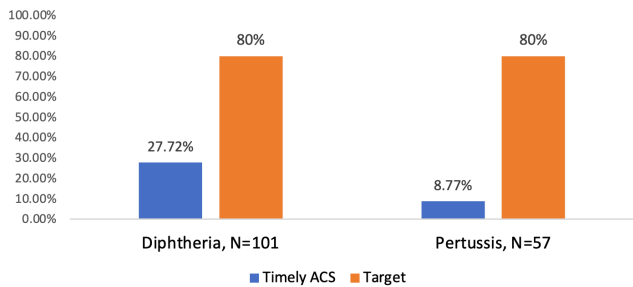


Figure 6: Timeliness in conducting Active Case Search (ACS) conducted for suspected Diphtheria & Pertussis cases, Jan-Dec 2023, Tamil Nadu

ii) Follow up of cases: Telephonic follow-up of suspect cases after 60 days from the date of onset of symptoms needs to be done and outcomes to be updated. Follow-up has been updated for 28 (27.72%) suspect Diphtheria cases and 5 (8.77%) Pertussis cases (Fig 7).

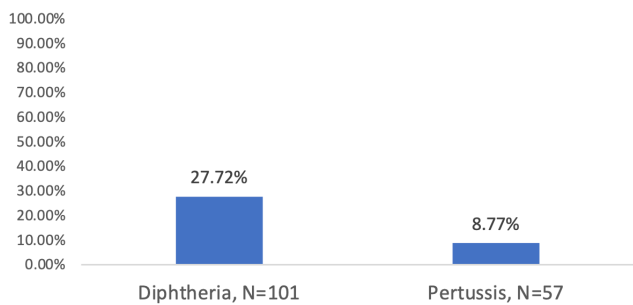


Figure 6: Timeliness in conducting Active Case Search (ACS) conducted for suspected Diphtheria & Pertussis cases, Jan-Dec 2023, Tamil Nadu

iii) Final Classification & outcome of cases: Of the 101 reported suspect Diphtheria cases, one case is positive for Diphtheria following laboratory testing and the outcome status is alive. The remaining 100 cases are clinically compatible cases, of these cases, the outcome has been updated for only 48 (48%) cases and as alive. All the suspected Pertussis cases are clinically compatible cases and no lab-confirmed cases. The outcome has been updated as alive for only 15 (26.32%) cases.

DISCUSSION

101 suspected Diphtheria and 57 suspected Pertussis cases were analyzed for performance against the monitoring indicators as per the Surveillance guidelines.¹ The key performance indicators are timely notification, investigation, timely sample collection, conducting ACS and follow-up.

All suspected cases of Diphtheria and Pertussis cases having a date of onset within the past 3 months should be notified. However, the ideal time for notification is within 7 days of onset of sore throat for Diphtheria and 4 weeks of the onset of cough for Pertussis. This indicator is most crucial in determining the speed and quality of a surveillance system and offers many advantages, a) Sample collection during the early phase of disease increases the probability of laboratory confirmation, early detection of impending outbreaks and case management and b) Timely public health interventions can reduce the morbidity and mortality rates. Timelines in the notification of suspected Diphtheria and Pertussis cases exceed the target of >80%.

Timeliness in investigation determines the alertness of the surveillance system to respond to notified cases. All notified cases should be investigated within 48 hours of notification. Timelines in the investigation of notified suspect Diphtheria and Pertussis cases exceed the target of >80%. Appropriate laboratory testing should be done in all suspect cases to confirm or rule out the suspicion. If no testing is done, it means that monitoring is inadequate or ineffective. Hence, a target of collecting samples in ≥80% of suspected cases of diphtheria and pertussis was set in the guideline. Even though two samples are recommended for both diseases, less than 2% of suspect cases had 2 samples collected. However, one sample has been collected on time, and this exceeds the set target (>80%).

The occurrence of a diphtheria case in the community indicates gaps in Routine Immunization (RI) coverage and the build-up of a susceptible cohort. Due to the high attack rate of these diseases, there is a very high probability of finding additional cases among contacts of

diphtheria and pertussis cases. Hence, ACS in response to the identification of diphtheria and pertussis cases in the community is very important. A thorough ACS in the community will identify any clustering of cases and timely interventions have the potential to curtail the outbreaks and reduce case morbidity and mortality. Mortality to diphtheria increases with the severity of local disease, the extent of pseudo-membrane, and the delay between onset of local disease and administration of antitoxin. However, ACS was conducted in 33.66% of Diphtheria suspect cases and 17.54% of pertussis suspect cases. This needs to be focused, on to achieve the target (>80%) set by MoHFW.

Telephonic follow-up of suspect cases after 60 days from the date of onset of symptoms need to be done and outcomes to be updated. However, the outcome status was updated in 48.51% and 26.32% of suspect Diphtheria & Pertussis cases respectively. This need to be updated in the portal for all cases. Only one suspected case of Diphtheria and nil suspected case of Pertussis are positive following laboratory testing. The remaining cases are clinically compatible cases. The outcome status in follow-up has been updated, however, this need to be updated for all the cases. As the suspect definition for Public Health Surveillance includes clinician suspicion of Diphtheria and Pertussis, a greater number of finally classified clinically compatible cases reflects an effective surveillance system that ensures potential cases are identified and managed promptly.

Overall, the surveillance of Diphtheria and Pertussis in the State aligns fairly well with timely notification, timely investigation, and final classification of cases. However thorough ACS which helps in identifying the clustering of cases demands attention. Even though the outcome was updated in positive Diphtheria cases, updating needs to be improved for clinically compatible cases also. As this study analyzed the data available in the VSIMS portal, whether shortfalls in indicators are actual shortfalls at the field level or insufficient documentation in the portal needs to be ascertained.

CONCLUSION

The proportion of suspected Diphtheria & Pertussis cases notified and investigated within the timeline exceeds the target set by MoHFW. Timely sample collection exceeds the target; however, this was with a single specimen. The occurrence of Diphtheria cases in a community indicates gap in RI coverage and the build-up of suspected cohorts, due to the high attack rate of these diseases. Hence ACS has to be updated for all the suspect cases to reduce morbidity. Follow

up after 60 days from the onset of symptoms and outcome status need to be updated, which was less. Thus, Tamil Nadu is performing aligned with the surveillance guidelines by MoHFW, thus paving way for achieving the strategic priority of Immunization agenda 2030. Nevertheless, the gaps identified in sample collection, ACS, and follow up need to be improved.

CONFLICT OF INTEREST

None

REFERENCES

1. Surveillance for Diphtheria, Pertussis and Neonatal Tetanus - Field Guide 2020. Ministry of Health and Family Welfare, Government of India.
2. Health and Family Welfare Department. Policy Note 2024-2025. Demand No. 19. Ministry of Health and Family Welfare, Government of Tamil Nadu. [Internet]. 2024. Available from: https://cms.tn.gov.in/sites/default/files/documents/hfw_e_pn_2024_25.pdf
3. National Health Mission [Internet]. 2024 [cited 2024 Oct 12]. Immunization: National Health Mission, Ministry of Health and Family Welfare, Government of India. Available from: <https://nhm.gov.in/index1.php?lang=1&level=2&sublinkid=824&lid=220>
4. Global strategy for comprehensive Vaccine-Preventable Disease (VPD) surveillance [Internet]. [cited 2024 Dec 31]. Available from: [https://www.who.int/publications/m/item/global-strategy-for-comprehensive-vaccine-preventable-disease-\(vpd\)-surveillance](https://www.who.int/publications/m/item/global-strategy-for-comprehensive-vaccine-preventable-disease-(vpd)-surveillance)
5. Routine Immunization. Manual for Medical Officers. Ministry of Health and Family Welfare, Government of India, 2024. [Internet]. [cited 2024 Dec 31]. Available from: <https://mohfw.gov.in/?q=Organisation/Departments-of-Health-and-Family-Welfare/immunization>
6. Truelove SA, Keegan LT, Moss WJ, Chaisson LH, Macher E, Azman AS, et al. Clinical and Epidemiological Aspects of Diphtheria: A Systematic Review and Pooled Analysis. *Clin Infect Dis*. 2020 Jun 24;71(1):89–97.
7. Carrasquilla G, Porrás A, Martínez S, DeAntonio R, Devadiga R, Cáceres DC, et al. Incidence and mortality of

pertussis disease in infants <12 months of age following introduction of pertussis maternal universal mass vaccination in Bogotá, Colombia. *Vaccine*. 2020 Oct;38(46):7384–92.

8. Murhekar M. Epidemiology of Diphtheria in India, 1996–2016: Implications for Prevention and Control. *Am Soc Trop*

Med Hyg. 2017 Aug 2;97(2):313–8.

9. Phalkey RK, Shukla S, Shardul S, Ashtekar N, Valsa S, Awate P, et al. Assessment of the core and support functions of the Integrated Disease Surveillance system in Maharashtra, India. *BMC Public Health*. 2013 Dec;13(1):575.

EVALUATION OF MID UPPER ARM CIRCUMFERENCE AS A SCREENING TOOL FOR UNDERNUTRITION AMONG ADOLESCENT GIRLS IN TAMIL NADU, 2019

*Roseline F. William⁽¹⁾, Kanagabala Balasubramanian⁽²⁾, S. Marytresa Jeyapriya⁽¹⁾,
Nandhini Selvanesan⁽²⁾, Kumaravel Ilangovan⁽³⁾*

(1) Karpaga Vinayaga Institute of Medical Sciences and Research Center, Tamil Nadu

(2) Directorate of Public Health and Preventive Medicine

(3) John Snow India Private Limited, New Delhi

ABSTRACT

INTRODUCTION : Body mass index (BMI) in anthropometry is a well-established indicator to assess the nutritional status. However the use of BMI as an indicator in the field level is limited as it involves multiple instruments. Mid-Upper Arm Circumference (MUAC) is used in severely malnourished children to identify with morbidity and those at risk of mortality. This study aims to assess the diagnostic accuracy of MUAC for undernutrition among adolescent girls compared with BMI as the gold standard.

METHODS : A community-based cross-sectional study was conducted among adolescent girls aged 10-19 years in Chengalpattu district, Tamil Nadu. Nutritional status was assessed based on comparison with standard cut-offs for BMI and MUAC. The diagnostic accuracy of MUAC compared with BMI was assessed using the proportion of true positives, false positives, true negatives, and false negatives using a 2 × 2 table. A correlation between BMI and MUAC was also expressed.

RESULTS : MUAC was 79.25% sensitive to detecting undernutrition and has 84.5% specificity to identifying those who were not undernourished. The correlation between BMI and MUAC was found to be 0.88.

CONCLUSION : MUAC can be used in settings where undernutrition prevalence is high.

KEYWORDS : Mid upper arm circumference, Body Mass Index, Screening, Undernutrition, Malnutrition

INTRODUCTION

Adolescents are individuals between 10 and 19 years of age.¹ Globally there are 1.2 billion adolescents. In India, adolescents contribute to 18% of the population.² UNICEF reports that half of India's adolescents (63 million girls and 81 million boys) are either thin, overweight obese or short. More girls suffer from shortness than boys.³ To break India's intergenerational cycle of malnutrition, there is a need to focus on adolescent girls before they become mothers.⁴

Body mass index (BMI) in anthropometry is a well established indicator to assess the nutritional status.⁵ However the use of BMI as an indicator in the field level has limitations as it involves multiple instruments like accurate weighing scales and stadiometers.⁶

Mid-upper arm circumference (MUAC) measures the arm muscle and fat area. MUAC is used in severely malnourished children to identify morbidity and those at risk of mortality. However, it is not used as an indicator for screening undernutrition among adolescents because of changes in the skeletal muscle and subcutaneous fat of this particular population.⁶ Further, BMI can be affected by factors that mask overall body mass, like trunk edema due

to protein-energy malnutrition, whereas MUAC is unaffected by this.⁷ In resource-poor field settings, the availability of standardized well-calibrated equipment to measure weight and height and calculation of BMI or BAZ (BMI for age z-score) by field workers without field charts are difficult.⁷ In order to use MUAC in the field, there is a need to assess its diagnostic accuracy for undernutrition compared with BMI. Hence we conducted this study to assess the diagnostic accuracy of MUAC for undernutrition among adolescent girls compared with BMI as the gold standard in two peripheral training centers of a tertiary care teaching hospital in Chengalpattu district, Tamil Nadu.

METHODS

Study design and setting: This was a community-based cross-sectional study conducted in two Field practice areas



Please Scan this QR Code to

View this Article Online

Article ID: 2024:04:04:08

Corresponding Author: Kanagabala Balasubramanian

e-mail : kanagabala2693@gmail.com

of the Rural and Urban Health Training Center of Karpaga Vinayaga Institute of Medical Sciences & Research Center, Chengalpattu, Tamil Nadu in April – October 2019.

Study population: Adolescent girls aged 10-19 years residing in the field practice areas of the two Peripheral Health Training Centers of Karpaga Vinayaga Institute of Medical Sciences & Research Center, Chengalpattu district, Tamil Nadu.

Sample size: In a study by Dasgupta A⁸, the prevalence of undernutrition based on MUAC was 60%. With this prevalence and Absolute precision of 7%, the sample size derived was 196 adolescent girls.

Data collection: After obtaining ethical clearance from the ethical committee and taking permission from the concerned authorities from urban and rural field practice areas, house to house visit was made. After getting consent (from the mother if the girl is <12 years old or from the mother and the participant if she is >12 years old), anthropometric measurements were taken using standard techniques. Weight to the nearest 0.1 kg was recorded using a mechanical weighing scale with minimal clothing. Height was taken barefoot to the nearest 0.1 cm using a non-stretchable measuring tape. MUAC was measured in the right arm at the midpoint between the acromion and olecranon process to the nearest 0.1cm with a non-stretchable measuring tape. BMI was calculated using the formula weight (kg)/height (m²). Nutritional status was assessed based on comparison with standard cut-offs for BMI and MUAC. BMI z-score was categorized based on WHO - BMI cutoff for girls as normal (5th to 95th centile), underweight (<5th centile) and overweight/obese (>95th centile).⁹ MUAC was compared with Center for Disease Control and Prevention (CDC) anthropometric reference data on MUAC for female children and adolescents as normal (5th to 95th centile), underweight (<5th centile) and overweight/obese (>95th centile).¹⁰

Statistical methods: Descriptive statistics were calculated as mean and standard deviation. Diagnostic accuracy of MUAC compared with BMI was assessed using sensitivity, specificity, negative predictive value, positive predictive value, positive and negative likelihood ratio, whose values were calculated using the proportion of true positives, false positives, true negatives, and false negatives using a 2 × 2 table. Correlation between BMI and MUAC was used to establish relationship between BMI and MUAC.

Ethical approval: Ethical clearance was obtained from the Institutional Ethics Committee of Karpaga Vinayaga Institute of Medical Sciences and Research Center.

RESULTS

This study was conducted among 196 adolescent girls. Among them, 14 girls were >95th centile according to BMI. Hence, only 182 adolescent girls whose BMI was <95th centile were included for analysis.

Table 1: Steps used for intervention development using the PRODCUES framework

Parameter	Mean	Standard deviation
BMI	24.19 kg/m ²	3.245
MUAC	18.51cm	3.12

Table 1 shows the mean BMI and MUAC of adolescent girls. The mean BMI was 24.19±3.24 kg/m² and the mean MUAC was 18.51 ±3.12 cm.

Table 2: Distribution of study participants in relation to nutritional status based on BMI and MUAC, April – October 2019

Nutritional status	BMI	MUAC
Undernutrition	53 (29.1%)	62 (34.1%)
Normal	129 (70.9%)	120 (65.9%)
Total	182 (100%)	182 (100%)

According to BMI, 53 (29.1%) girls were undernourished and according to MUAC, 62 (34.1%) girls were undernourished (Table 2).

Table 3: Comparison of MUAC cut-off with BMI as the gold standard for undernutrition, April – October 2019

Undernutrition MUAC	Undernutrition BMI		Total
	Yes	No	
Yes	42 (TP)	20 (FP)	62 (TP+FP)
No	11 (FN)	109 (TN)	109 (FN+TN)
Total	53 (TP+FN)	129 (FP+TN)	182 (TP+FP+FN+TN)

*TP= True Positive, FP= False Positive, TN=True Negative, FN= False Negative

To compare the undernutrition status with MUAC and BMI, table 3 shows that 42 were true positive (undernourished in both BMI and MUAC), 109 were true negative (negative for undernourishment by BMI and MUAC), 20 were false positive (undernourished by MUAC, while normal by BMI) and 11 were false negative (normal by MUAC, while undernourished by BMI).

Table 4: Validity of MUAC as a screening tool

Measures	Results
Sensitivity	79.25%
Specificity	84.5%
Positive predictive value	67.74%
Negative predictive value	90.83%
Positive likelihood ratio	5.11
Negative likelihood ratio	0.25

Table 4 presents the results of using MUAC as a screening tool. MUAC was 79.25% sensitive to detect undernutrition, 84.5% specificity to identify those who were not undernourished. The yield of a test that is, positive predictive value was 67.74%. The predictive value of a negative test was 90.83%. The positive likelihood ratio was 5.11. The negative likelihood ratio was 0.25.

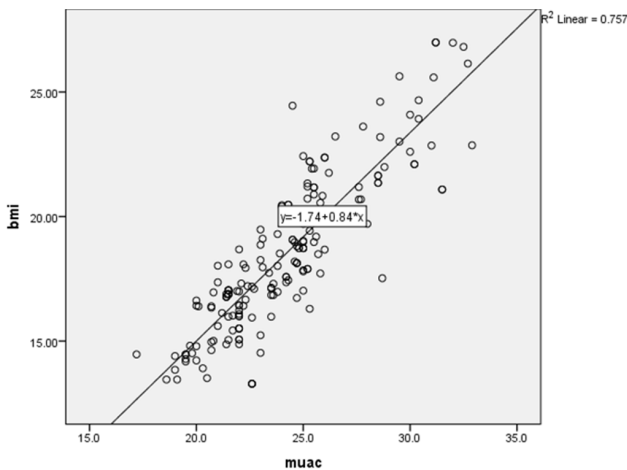


Figure 1: Scatter plot showing correlation between BMI and MUAC

Correlation between BMI and MUAC was found to be 0.88 ($p < 0.000$), which signifies strong positive linear relationship. (Figure 1)

DISCUSSION

Since more than half of the adolescent population do not have normal nutritional status, a simple tool to measure their nutritional status in the field level is important. MUAC is one such tool to assess nutritional status. In this study, 34.1% girls were undernourished according to MUAC, while a study done among adolescent boys by Dasgupta A8, reported the prevalence of undernutrition by MUAC as 60.3%.

In the present study, regarding the use of MUAC as a screening tool, MUAC has 79.25% sensitivity to detect undernutrition, which is lower than Dasgupta A8, who reported 94.6% sensitivity. Among adolescents in Tanzania, the sensitivity of MUAC compared to BMI was 35% based on the Nutrition Assessment, Counseling, and Support (NACS) tool⁷. Positive predictive value was 67.74% in this study, while Dasgupta A8 reported as 93.5%. This difference could be because, positive predictive value is highly dependent on prevalence. The prevalence of undernutrition by BMI was 29.1% in this study, while it was 48% in the above study. The positive predictive value among adolescent girls in urban slums of Pune by Jayakumar A6 was 29.62%. The yield (positive predictive value) of a test that is number of cases detected is very important in low resource settings.

MUAC was positively correlated with BMI in this current study ($r=0.88$, $p < 0.001$), which is similar to studies done by Dasgupta A8 (0.88, 0.001) and Sethi V11 (0.78) at Chhattisgarh and Odisha.

CONCLUSION

MUAC can be used in settings where the undernutrition prevalence is high. Given that MUAC and BMI are positively correlated, MUAC can be used in settings where BMI measurement is not feasible. This study used the MUAC cut-offs given by the Center for Disease Control (CDC) which is based on the United States population, which might underestimate undernutrition in Indian settings. Hence, standard MUAC cut offs for detecting undernutrition need to be developed for developing countries.

CONFLICT OF INTEREST: None

REFERENCES :

1. World Health Organization. Programming for adolescent health and development. WHO Technical Report Series No.886, 1996:2.
2. Anthony L. The state of the world's children 2011-adolescence: an age of opportunity. United Nations Children's Fund (UNICEF); 2011.
3. Half of India's adolescents are malnourished: UNICEF. Nov 2019. Available at <https://www.nuffoodsspectrum.in/news/49/5867/half-of-indias-adolescents-are-malnourished-unicef.html>. accessed on March 2020

4. Press Information Bureau. Government of India. Breaking Inter-generational Cycle of Malnutrition & Optimising the IYCF Practices. Available at <https://pib.gov.in/newsite/printrelease.aspx?relid=170335>. Accessed on March 2020.
5. Sultana T, Karim MN, Ahmed T, Hossain MI. Assessment of under nutrition of Bangladeshi adults using anthropometry: can body mass index be replaced by mid-upper-arm-circumference?. *PloS one*. 2015;10(4).
6. Jeyakumar A, Ghugre P, Gadhawe S. Mid-Upper-Arm Circumference (MUAC) as a Simple measure to assess the nutritional status of adolescent girls as compared with BMI. *ICAN: Infant, Child, & Adolescent Nutrition*. 2013 Feb;5(1):22-5.
7. Lillie M, Lema I, Kaaya, S. et al. Nutritional status among young adolescents attending primary school in Tanzania: contributions of mid-upper arm circumference (MUAC) for adolescent assessment. *BMC Public Health* 19, 1582 (2019).
8. Dasgupta A, Butt A, Saha TK, Basu G, Chattopadhyay A, Mukherjee A. Assessment of malnutrition among adolescents: Can BMI be replaced by MUAC. *Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine*. 2010 Apr;35(2):276.
9. World Health Organization. Growth reference 5-19 years. BMI for age 5-19 years. Available at https://www.who.int/growthref/who2007_bmi_for_age/en/.
10. Center for Disease Control. Anthropometric reference data for children and adults: United States, 2011-14. Available at https://www.cdc.gov/nchs/data/series/sr_03/sr03_039.pdf. Accessed on Feb 2019.
11. Sethi V, Gupta N, Pedgaonkar S, Saraswat A, Singh KD, Rahman HU, de Wagt A, Unisa S. Mid-upper arm circumference cut-offs for screening thinness and severe thinness in Indian adolescent girls aged 10–19 years in field settings. *Public health nutrition*. 2019 Aug;22(12):2189-99.

PROGRAM PROCESS DOCUMENTATION

RASHTRIYA BAL SWASTHYA KARYAKRAM (RBSK) PROGRAM
IN TAMIL NADU- A PROCESS DOCUMENTATION*Shinu Priya R⁽¹⁾, Fasna L⁽¹⁾, Vinoth R⁽²⁾, Shanmuga Sundaram V⁽¹⁾, Selvavinayagam T S⁽¹⁾***(1) Directorate of Public Health and Preventive Medicine****ABSTRACT**

INTRODUCTION : Rashtriya Bal Swasthya Karyakram (RBSK) program in Tamil Nadu has significantly advanced child health services by focusing on early identification and management of health conditions. Launched to address the “4Ds” – Defects at Birth, Developmental Delays, Diseases, and Deficiencies – in children from birth to 18 years, RBSK has made notable strides in improving child survival and reducing morbidity. Tamil Nadu has pioneered several innovations within the RBSK framework, including the integration of real-time GPS monitoring for vehicle tracking, digital screening through the Tamil Nadu Education Management Information System (TN EMIS) app, and Newborn Screening or Delivery Point Screening to detect birth defects early. These innovations have streamlined the screening process, ensured accountability, and enhanced follow-up care through effective data management and interdepartmental collaborations. By maintaining transparency through Advanced Tour Programme (ATP) updates and addressing challenges through strategic initiatives, the state has ensured that health services reach even the most remote areas. With the continuous innovation in child health services, Tamil Nadu’s RBSK program has set a high standard for public health initiatives. This paper highlights the significant innovations introduced in Tamil Nadu’s RBSK program and discusses their effect on improving early detection, intervention, and long-term child health outcomes.

KEYWORDS : Child health, RBSK, Screening, Care Continuum, Referral, Primary care

INTRODUCTION

Child health is a cornerstone of public health, reflecting the overall health and well-being of a nation. Recognizing the importance of early diagnosis and intervention in mitigating childhood morbidity and mortality, the Government of India launched the Rashtriya Bal Swasthya Karyakram (RBSK) in 2013. This program targets the early identification and management of conditions categorized under the “4Ds”—Defects at Birth, Developmental Delays including Disabilities, Diseases, and Deficiencies—in children aged 0 to 18 years.¹

Since its launch, RBSK has made remarkable strides in enhancing healthcare access and outcomes for children across the country. The program employs a comprehensive screening model implemented at Anganwadi Centres, schools, and healthcare facilities to identify a wide range of health conditions. Beyond detection, RBSK ensures referral, free medical and surgical care, and follow-up services through District Early Intervention Centres (DEICs) and fostering a continuum of care.^{2,3}

Tamil Nadu has emerged as a frontrunner in implementing the RBSK program. With strong public health infrastructure, the state ensures comprehensive coverage of newborns at delivery points, children aged 6 weeks to 6 years at Anganwadi Centres, and school-going children up to 18 years

in government and government-aided schools. The RBSK program in Tamil Nadu has embraced a series of innovative approaches to overcome challenges in implementation and improving its reach and effect. These innovations, including the adoption of digital tools, real-time monitoring systems, targeted health camps, and interdepartmental collaborations, have transformed the program into a robust model for child health services.

This article explores the innovations introduced in the RBSK program by the state of Tamil Nadu like Tamil Nadu Education Management Information System (EMIS) app, GPS-enabled vehicles, Face Recognized attendance system, uniform advanced tour programme throughout the state and delivery point newborn screening enabled in PICME 2.0.

RBSK in Tamil Nadu:

Tamil Nadu is a pioneer in reducing Infant Mortality Rate (IMR) and Childhood Mortality through the implementation of MCH services and immunization



Please Scan this QR Code to

View this Article Online

Article ID: 2024:04:04:09

Corresponding Author: Shinu Priya R

e-mail : shinupriya08@gmail.com

programs at the Primary Health Care level. However, there is an ongoing need for improvement in child survival, which can be achieved through early detection and timely management of illnesses, thereby reducing child morbidity and mortality. Under the RBSK program, screening for 30 medical conditions is conducted at two levels:

1. Facility Level: All newborns are screened by medical officers and their teams at delivery points. Any newborn found with defects is referred to the District Early Intervention Centre (DEIC) for further management.

2. Community Level: Screening is carried out at Anganwadi Centres (AWC) for preschool children under 6 years of age, and at Government and government-aided schools for children aged 6 to 18 years, by RBSK teams.

Current RBSK Human Resource (HR) status in Tamilnadu

The RBSK program operates with 770 dedicated teams across Tamil Nadu, with two teams assigned to each block (one male and one female). Each team is equipped with a branded vehicle to conduct screenings at Anganwadi canters and Government and Government aided schools. In the Greater Chennai Corporation, 15 RBSK teams are responsible for screening children, while the remaining 35 teams cover other corporations in Tamil Nadu. Each RBSK team constitutes a Medical Officer, a Staff Nurse or Sector Health Nurse (SHN), a Driver (hired), and a pharmacist proficient in data management. The RBSK teams follow uniform screening schedule throughout the year as follows

- The first round of Anganwadi screening is carried out from April to June.
- School screening was carried out from July to December.
- The second round of Anganwadi screening is carried out from January to March.

RBSK Intervention Indicators and Coverage in Tamilnadu

During the year April 2023- March 2024, 89% (33,97,080) and 94% (35,88,769) of Anganwadi children are covered by the RBSK team in the first and second rounds of screening respectively. 98% (65,35,816) of Government and Government aided school children are covered by the RBSK team during the year 2023-24. In the current financial year (2024-2025), 98% (37,48,915) and 40% (15,34,700) of Anganwadi children are covered by the RBSK team in the first and second rounds of screening respectively. 80% (55,73,776) of Government and Government school children are covered by the RBSK team during the year 2024-25. The

details of screening, medical management given and referral details are entered in Education Management Information System (EMIS) portal by the RBSK team. So far April 2024 to Dec 2024 78% of Anganwadi children phase-1 and 74% of Government and Government aided school children screening details are captured in the EMIS portal and remaining will be covered in the coming months.

Management and Outcomes of Children Identified with 4Ds

The children identified with 4D's are referred to District Early Interventional Centres (DEIC). The cumulative outcome of the RBSK program is presented in Table 1. The DEIC team consists of a Paediatrician, Medical officer, Staff Nurses, Optometrists, speech therapists and physiotherapists to provide support to the referred children. The purpose of DEIC is to provide referral support to children detected with health conditions during screening by the RBSK team, who require tertiary care services. The early intervention centres are established at all Government Medical College Hospitals and there are 35 DEICs established across the state.

Table 1: Cumulative outcome of the RBSK program, FY 2021 – 2024 and FY April 2024 – December 2024.

S.no	Year	2021-24	2024-25
1	Total children screened	3,50,48,298	1,09,19,465
2	Total children suspected with		
	D1(Defects at birth)	40,232	11,517
	D2(Deficiencies)	2,00,494	48,948
	D3(Diseases)	9,54,131	2,66,043
	D4(Development delays including disabilities)	3,21,413	1,09,426
3	No. of children referred to DEIC	9,85,248	2,99,416
4	Children Confirmed (7 Major Conditions)	24713	8135
5	Children Medically Managed (7 Major Conditions)	16246	6108
6	Children Needed Surgery (7 Major Conditions)	8467	2027
7	Surgery Done (7 Major Conditions)	8363	1813

Congenital Heart Diseases (CHD), Rheumatic Heart Diseases (RHD), Club Foot, Cleft Lip and Palate, Congenital Cataract, Congenital Deafness, and Neural Tube Defects (NTD) are the seven major disease conditions among children referred for surgeries to tertiary care centres by the RBSK team.

During the year 2024-25, 11517 children are diagnosed with these conditions. Among them, 6108 children are medically managed, and 1813 underwent surgery. Approximately 97% of the identified children (7921) receive complete treatment for their illness and are under regular follow-up by the RBSK team. The treatment details of these children are entered into the EMIS portal to facilitate monitoring by the RBSK team at the field level.

Innovations in Tamil Nadu's RBSK Program

1. FRAS System for Attendance and Monitoring

In Tamil Nadu, the Face Recognized Attendance System (FRAS) is employed to track the daily attendance and activities of RBSK teams. The teams are stationed at their respective Block PHCs, and their attendance is recorded daily in the FRAS system, ensuring accountability and punctuality. The system is monitored by the Block Medical Officer (BMO) at the block level and the District Health Officer (DHO) at the district level. By tracking attendance through FRAS, the program ensures that health service providers remain active in the field from 9 AM to 4 PM, enhancing the efficiency of health screenings and interventions. Additionally, the movements of RBSK vehicles are monitored in real-time via GPS and Android tablets, enabling better monitoring of team activities.

2. Transparent Monthly Advanced Tour Programme (ATP) Updates

In To promote transparency and public access to RBSK activities, the Advanced Tour Programme (ATP) of all RBSK teams is updated monthly on the Tamil Nadu Directorate of Public Health and Preventive Medicine (TNDPHPM) website, ensuring transparency (Figure 1). The website displays the scheduled visits of RBSK teams to Anganwadi Centers and Government and Government-Aided Schools to public visibility. The website also provides the CUG numbers of medical officers for direct contact, ensuring public access to necessary information. These updates are available in the following link: <https://www.tndphpm.com>. This initiative ensures the public, Anganwadi Centres, Government and Government aided schools is well-informed about the teams' schedule and community involvement in the health screening process.

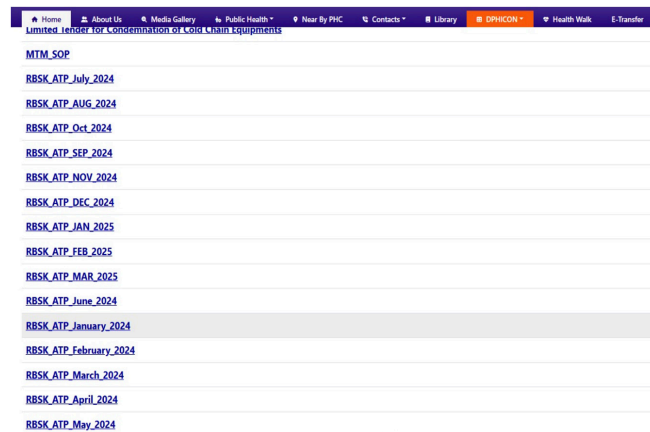


Figure 1: ATP of RBSK uploaded in TNDPHPM website for visibility to public and stakeholders

3. Real-Time GPS Monitoring of RBSK Vehicles

A key innovation in the Tamil Nadu RBSK program is the real-time GPS monitoring of RBSK vehicles, facilitated through the RBSK GPS portal by a vendor agency (Figure 2). Each RBSK vehicle is equipped with a GPS device, which tracks the vehicle's location in real time, using latitude and longitude coordinates. This system helps to prevent route deviations, optimize logistical efficiency, and ensure RBSK teams visit the designated screening sites as scheduled (Figure 3).

To enhance further functionality, automated daily reports are generated by the GPS system and sent to the headquarters. ATP deviations, less distance travelled, and offline status of the vehicle are reviewed at multiple levels to ensure smooth program operations. When a vehicle deviates from the scheduled ATP, the details are shared with District Health Officers (DHOs) and District Training Team Medical Officers (DTTMOs) for review, and corrective actions are taken in weekly DHO review meetings. The status of GPS devices, including active and offline statuses, idle vehicle times, and distance covered, is monitored continuously through the Glovision GPS website, ensuring timely interventions based on real-time data.

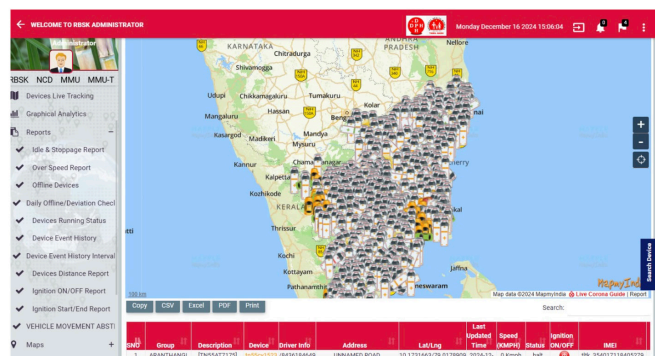


Figure 2: RBSK GPS portal Homepage

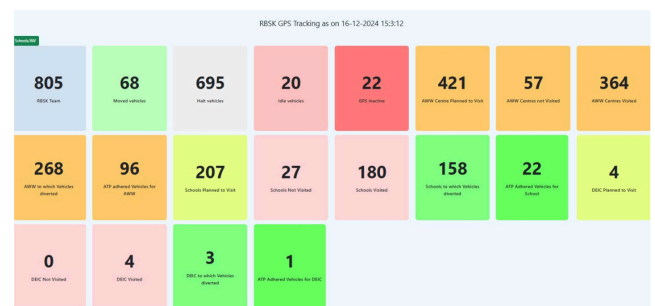


Figure 3: Real time GPS monitoring of RBSK team

4. Newborn Screening (Delivery Point Screening)

Tamil Nadu has made significant strides in ensuring that all newborns are screened for birth defects through

newborn screening, also known as delivery point screening. As part of the Rashtriya Bal Swasthya Karyakram (RBSK) program, the focus is on identifying visible birth defects within 48 hours of delivery. Early detection allows for timely interventions, ensuring the timely intervention and improving the child survival.

The screening is conducted in all health facilities from Primary Health Centers to Medical College Hospitals and private hospitals within 48 hours of delivery of the newborn. A detailed screening checklist has been incorporated into the PICME portal, where identified defects are immediately recorded (Figure 4).

If a defect is found, the newborn is referred to a District Early Intervention Centre (DEIC) or a higher-level medical facility for further care. A Delivery Point Screening Card is issued to the mother, indicating the newborn's health status and serving as a record for follow-up care (Figure 5). This card serves both as a record and a referral form for any required follow-up care, ensuring that no newborn is missed and that they receive timely care.

The screening in RBSK is focused only on Government and Government-aided schools, which left a gap in identifying conditions, e since many children attend private schools. To address this gap, whether the infant is born in Government or private health institutions, they are all screened for birth defects and followed up.

To monitor the process, all health institutions conducting deliveries are required to update newborn delivery details, screening results, and referral information in the PICME 3.0 portal. After discharge, Village Health Nurses follow up with the newborns through postnatal visits, using the data available in the PICME data in coordination with the RBSK team. This approach bridges the gap between estimated and actual disease conditions, ensuring better identification and management in the future.



Figure 4: Newborn screening in PICME portal



Figure 5: Newborn screening card issued to the mother

TN EMIS App for Digital Screening and Tracking

One of the key innovations in the RBSK program in Tamil Nadu is the integration of the Tamil Nadu Education Management Information System (TN EMIS) App, developed by the School Education Department with an added health component (Figure 6). This digital platform incorporates a 49-question primary screening questionnaire completed by school teachers, as seen in the TN EMIS portal and related pages (Figures 7 and 8). The questionnaire includes nine sets of screening components focused on eye screening, along with 39 general health-related queries, ensuring a comprehensive health assessment. Children flagged during the primary screening are referred to the RBSK Mobile Health Teams for confirmation and management. In addition to school-based screenings, RBSK doctors also use the TN EMIS app to screen children at Anganwadi Centers, entering the health data directly into the portal (Figure 9). This enables a unified tracking system for all children across different age groups, ensuring that no child is missed. The app supports real-time data entry and tracking, allowing for efficient follow-up and

comprehensive monitoring of children's health outcomes. By centralizing health data from both schools and Anganwadi Centres, the TN EMIS app enhances coordination among various stakeholders, improves the referral process, and strengthens the overall efficiency of the RBSK program, ensuring timely interventions and a streamlined approach to child health services.

Future directions:

To augment the effectiveness of services for children, the Directorate of Public Health and Preventive Medicine, Tamil Nadu has decided to implement the following interventions in child health in future.

1. To establish infirmary rooms in higher secondary schools to provide privacy during health examinations conducted by RBSK teams, ensuring a comfortable and dignified environment for students.
2. RBSK Medical Officers will conduct health and wellness session during school assemblies to raise awareness about the program and its health benefits.
3. Saturdays will be dedicated to referrals to District Early Intervention Centres (DEICs) for further evaluation and management of identified health conditions.
4. Additionally, State-level Coordination Committee meetings will be conducted thrice a year, and District-level meetings will be held quarterly, involving all key stakeholders, including the School Education Department (SED), Integrated Child Development Services (ICDS), and National Health Mission (NHM). These meetings aim to ensure effective communication, foster collaboration, and address any challenges in program implementation promptly.

Effect of Innovations

These innovations have transformed RBSK into a dynamic and inclusive program, enhancing its reach and efficiency. The adoption of digital tools has streamlined data management and improved response times. Real-time GPS tracking ensures accountability.

Challenges and Future Directions

Despite these advancements, challenges such as resource constraints, staff shortages, and logistical issues persist. Addressing these barriers through capacity building, with proper allocation of resources, and stakeholder engagement will be crucial. Scaling up innovations like the TN EMIS app and GPS monitoring to a national level can further strengthen child health services.

CONCLUSION

Tamil Nadu's implementation of the Rashtriya Bal Swasthya Karyakram (RBSK) program showcases the state's unwavering commitment to child health and well-being. Through its innovative strategies, including real-time GPS monitoring, PICME portal integration, and transparent monthly ATP updates, Tamil Nadu has significantly improved early detection, intervention, and follow-up care for children

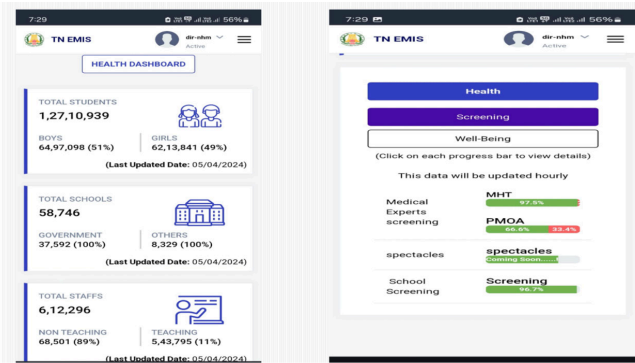


Figure 6: TN EMIS portal

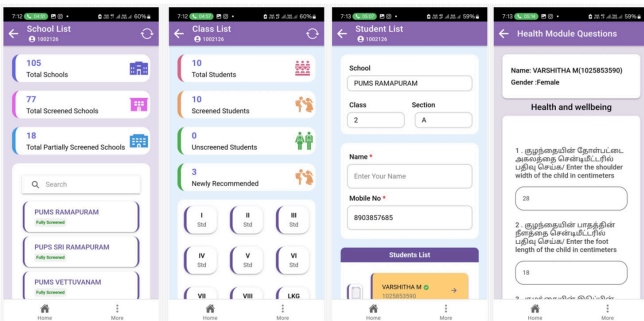


Figure 7: TN EMIS-School screening page in the portal



Figure 8: Questionnaire tool used by teachers and Medical officers for screening children

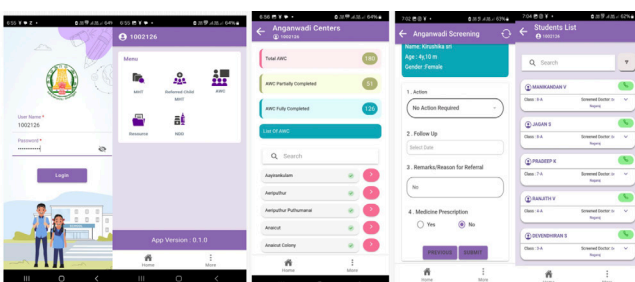


Figure 9: TN EMIS -Anganwadi screening page in portal

across the state. The program's success is attributed to the effective use of technology, streamlined systems, and the collaboration of various departments, ensuring that no child is left behind, whether in urban or rural areas. With the Delivery Point Screening initiative, Tamil Nadu has further advanced its efforts to address health issues at the very beginning of a child's life. The state's model of proactive healthcare, combined with its focus on continuous improvement, has set a high standard for public health initiatives in India. Moving forward, sustained innovation and robust execution will be key to maintaining these achievements and ensuring a healthier, more prosperous future for the children of Tamil Nadu.

CONFLICT OF INTEREST

None

REFERENCES

1. Ministry of Health and Family Welfare. Operational guidelines: Rashtriya Bal Swasthya Karyakram (RBSK) Child Health Screening and Intervention Services under NRHM. Ministry of Health and Family Welfare, Government of India; February 2013.
2. Rameshbabu B, Kumaravel K, Balaji J, Sathya P, Shobia N. Health conditions screened by the 4D's approach in a District Early Intervention Centre (DEIC) under Rashtriya Bal Swasthya Karyakram (RBSK) Program. *Pediatr Oncall J.* 2019;16:73-8. doi: 10.7199/ped.oncall.2019.48.
3. Singh AK, Kumar R, Mishra CK, et al. Moving from survival to healthy survival through child health screening and early intervention services under Rashtriya Bal Swasthya Karyakram (RBSK). *Indian J Pediatr.* 2015;82:1012-8. doi: 10.1007/s12098-015-1823-2.

PERSPECTIVES

RISING MUMPS CASES IN INDIA- NEED FOR INCLUSION OF MMR VACCINE IN NATIONAL IMMUNISATION PROGRAM

Nandhini Selvanesan⁽¹⁾, *Kanagabala Balasubramanian*⁽¹⁾, *Kumaravel Ilangovan*⁽²⁾,
Vinay Kumar Krishnamurthy⁽¹⁾

(1) Directorate of Public Health and Preventive Medicine

(2) John Snow India Private Limited, New Delhi

INTRODUCTION

Mumps is an acute disease of children and young adults, caused by a paramyxovirus of which there is only a single serotype.¹ Humans are the only known natural host for the mumps virus and the virus spreads through respiratory droplets or direct contact with an infected person's saliva.² Mumps is frequently reported in children aged 5-9 years of age, although both adolescents and adults may be affected.¹

Incubation period of mumps usually ranges from 16 to 18 days, while it can even extend up to 25 days. Non-specific prodromal symptoms include headache, low-grade fever, myalgia, anorexia, and malaise. The normal presentation of mumps is parotitis, or swelling of the parotid gland, or other salivary gland enlargement that lasts for around five days. Both unilateral and bilateral parotitis are possible.¹ People with mumps are infectious from 2 days before through 5 days after parotitis onset.³ Although, natural infection with this virus is thought to confer lifelong protection⁴, mumps virus reinfections do seem to occur.⁵ Complications of mumps occur with or without parotitis or other salivary gland swelling and generally encompass conditions such as orchitis, oophoritis, mastitis, pancreatitis, hearing impairment, meningitis, and encephalitis. Nephritis, myocarditis and other sequelae like paralysis, seizures, cranial nerve palsies, and hydrocephalus have also been reported occasionally. Complications associated with mumps are usually more common among adults than children.⁶ Despite its generally low mortality rate, the potential to cause profound morbidity and complications underscores the importance of preventive measures, with vaccination emerging as the most effective solution.⁷

Global and Indian Disease Burden:

Globally, there is a substantial mumps case burden, particularly among countries where the vaccine is not routinely administered. With 100–1,000 cases per 1,00,000 people reported in countries without routine mumps

immunization programs, the mumps incidence worldwide is still rather high.⁸

A study on the disease burden of seven vaccine-preventable diseases in Shandong province, China, from 2013 to 2017 reported that mumps had a relatively low disease burden both at the population level (0.43 DALYs per year) and at the individual level (0.27 DALYs per 100 infections).

India has a high disease burden, as evidenced by the reports of both cyclic outbreaks and sporadic cases from every part of the nation. Mumps resulted in many outbreaks in India. According to the IDSP and IAP-web-based network, between September 2009 and May 2015, 2892 mumps cases were reported.⁹ Between July and September 2017, IDSP documented 15 outbreaks and 260 cases of mumps within the region.¹⁰ Mumps is a significant public health concern in India, yet insufficient data from various regions underestimate its actual burden.¹¹

India reported 764 mumps cases between 2021-22 as per Global Health Observatory (GHO) data repository, indicating a substantial burden of mumps, particularly affecting children.¹² The rising number of mumps cases in India among children in Maharashtra, Uttar Pradesh, Odisha, and Rajasthan, is a concerning trend.¹³⁻¹⁵ The fact that this surge has been observed after 4-5 years raises questions about the factors contributing to the resurgence of the disease in these regions. In October and November 2023, mumps outbreaks in Idukki and Palakkad in Kerala, Sivagangai in Tamil Nadu, Udupi in Karnataka, and Rajnandgaon in Chhattisgarh, served as poignant reminders of the challenges posed by this infectious disease.¹³

In Tamil Nadu, During the year 2021-22, only 61



Please Scan this QR Code to

View this Article Online

Article ID: 2024:04:04:10

Corresponding Author: Nandhini Selvanesan

e-mail : preethiselvanesan@gmail.com

cases of mumps were reported. In the year 2022-23, we saw a slight increase with 129 number of cases of mumps. In 2023-24 there was a dramatic increase compared to the previous two years, a totally 1,091 cases of mumps were reported during this period. This increase in incidence could be attributed to outbreak of mumps in 2023-24.¹⁶

Mumps orchitis and Male infertility:

Orchitis is the most common complication of mumps in post-pubertal men, affecting about 20%-30% of cases: 10%-30% are bilateral. Orchitis usually occurs 1-2 weeks after parotitis.¹⁷ Of the affected, 30%-50 % show a degree of testicular atrophy. Within the first few days of infection the virus attacks the testicular glands, leading to parenchymal inflammation, separation of seminiferous tubules, and perivascular interstitial lymphocyte infiltration. The tunica albuginea forms a barrier against oedema, and the subsequent rise in intratesticular pressure leads to pressure-induced testicular atrophy.¹⁸

Adamopoulos et al.¹⁹ studied the effects of mumps orchitis on Leydig cell function and found low testosterone levels, elevated luteinizing hormone levels and an exaggerated pituitary response to luteinizing hormone-releasing hormone (LHRH) stimulation in the acute phase. Whilst basal testosterone concentrations returned to normal after several months, mean basal follicle stimulating hormone and luteinizing hormone concentrations remained significantly increased at 10 and 12 months after the acute phase.

The causal link between mumps orchitis and anti-sperm antibodies has been unclear. Although the antibodies were suspected to impair fertility, Kalaydjiev et al.²⁰ demonstrated that both the incidence and the level of serum anti-sperm antibodies among mumps orchitis patients were low, and did not support the hypothesis of an enhanced humoral immunity against spermatozoa.

Mumps orchitis rarely leads to sterility but it may contribute to subfertility. It can also lead to oligospermia, azoospermia, and asthenospermia (defects in sperm movement). Unilateral disease can significantly, but only transiently, diminish sperm count, mobility, and morphology. Impairment of fertility is estimated to occur in about 13% of patients, while 30%-87% of patients with bilateral mumps orchitis experience infertility.²¹

Vaccine efficacy and safety:

Live attenuated mumps vaccines based on live attenuated virus strains including the Jeryl-Lynn, RIT 4385, Leningrad-3, Leningrad-Zagreb, Urabe Am9, S79, Rubini,

and others, have been available since the 1960s. However, due to the low level of seroconversion obtained with the Rubini strain, WHO has recommended that this strain should not be used in national immunization programmes. These vaccines are produced by growing the virus in cell cultures or in embryonated chicken eggs. The virus is then purified, formulated with a stabilizer such as gelatine or sorbitol and lyophilized. Mumps vaccines are available as a monovalent vaccine, a bivalent measles-mumps vaccine, or as a trivalent measles-mumps-rubella vaccine (MMR).²² The mumps vaccine, commonly administered as part of the measles, mumps, and rubella (MMR) combination, has shown high efficacy in preventing mumps and its complications. One dose of MMR vaccine is 93% effective against measles, 78% effective against mumps, and 97% effective against rubella. Two doses of MMR vaccine are 97% effective against measles and 88% effective against mumps. The vaccine is well-tolerated, with adverse events being rare and mild.²³

Global Impact of Mumps Vaccination Programs:

According to WHO, mumps was adopted in the vaccination schedule of 57% of the member countries (110 countries) in 2005.²⁴ Many countries did not introduce mumps vaccine into their national programs until immunization coverage with BCG, poliovirus, diphtheria-pertussis-tetanus, and measles vaccines exceeded 80%, often above 90%. Countries that introduced mumps vaccine into their immunization programs exhibited a rapid decline in mumps morbidity. Countries administering MMR vaccine at high coverage levels reported sharp reductions in mumps incidence.²⁵ MMR vaccine simultaneously provides protection for measles, mumps and rubella.

The mumps vaccine, as part of the MMR vaccine, has been instrumental in significantly reducing the incidence of the disease since its introduction in 1967 in the United States.²⁶ The success of vaccination programs has been noteworthy, with the incidence of mumps dropping to less than 0.1 case per 100,000 people in many developed countries by 2001.²⁷ This achievement demonstrated the effectiveness of widespread immunization in controlling the disease, marking a substantial triumph in public health.²⁸

At the end of 2007, 114 countries were administering mumps vaccine, compared with 104 countries at the end of 2002. However, as of 2012, 120 (62%) countries have adopted routine mumps vaccination in their NIPs.²⁹ The reduction in mumps incidence varies from 88% to 97% in countries adopting single or two doses of vaccine, respectively.³⁰ A recent meta-analysis in China found the overall vaccine

effectiveness for mumps-containing vaccine (either one dose or two doses) to be 85% (95% CI 76%-90%) from cohort studies and 88% (95% CI 82%-92%) from case-control studies.³¹

MMR was introduced in state immunization program of Delhi in 1999 as a single dose administered between 15-18 months of age (MMR-I).²³ There is no effectiveness data available from India since mumps is not part of NIP and only few states and Union Territories are providing mumps vaccine in form of MMR vaccine.¹² Though the MMR vaccine is offered by private sector, the coverage and field-efficacy data are not available. Yadav, et al.³³ reported high mumps seropositivity rates (96-100%) with use of single dose of MMR vaccine in Delhi children. In another Indian study conducted amongst 1-10 year old children in Pune, a single dose of MMR (with Leningrad-Zagreb mumps virus strain) was able to maintain mumps-specific IgG (seropositivity rate) in 95% after 6 years.³⁴

The National Immunization schedule:

Choice of vaccines in National Immunization Schedule warrants careful decision and periodic reviews. In 1978, India adopted the Expanded Programme on Immunization (EPI) promoted by World Health Organization (WHO). In 1985, EPI was renamed as Universal Immunization Program (UIP). Measles vaccine is administered at 9 months of age considering the morbidity and mortality caused by the disease. Poor immune response to measles vaccine is noted in infants less than one year of age, which necessitates administration of second dose for immune protection.³⁵ Though one dose of mumps vaccine confers 88%-98% protection in the community, accumulated global experience has shown that 2 doses of mumps vaccine are required for a long-lasting protection.³⁶ Measles-Mumps-Rubella (MMR) vaccine in a two dose schedule has successfully eliminated measles, mumps and rubella from many developed countries.³⁷

However, the Government of India (GoI) has announced its decision to include the rubella vaccine in the form of a bivalent Measles-Rubella (MR) vaccine in its Universal Immunization Program (UIP).³⁸ The two-dose MR vaccine shall be provided at 9 months in place of the stand-alone measles vaccine, and at 16-24 months along with the first booster of the Diphtheria-Tetanus-Pertussis (DTP) vaccine.³⁹ The main reasons why GoI has not considered mumps for inclusion in the National Immunization Program are: a) the disease is not considered a serious public health issue, b) lack of published data on the community burden

of mumps, and c) lastly the higher cost of the MMR vaccine in comparison to MR vaccine.⁴⁰ However, this is not the fact rather many outbreaks of mumps have been witnessed. The replacement of the MR (Measles, Rubella) vaccine with the MMR vaccine within the national immunization schedule (NIS) is suggested as a prospective remedial action, supported by extensive research on mumps-containing vaccines conducted in India.⁴¹

Factors contributing to resurgence of mumps:

Several factors may have contributed to this recent rise in mumps cases across India. In India, children are offered the MR vaccine in a two-dose strategy for children at 9 and 15 months to cover measles and rubella but not mumps.⁴² MMR vaccine is only available in the private sector in India and remains out of bounds for over 80% of the children of the country.⁴³ One of the important reasons for mumps resurgence in India, which has predominantly a naive child population due to the absence of mumps component in UIP, is because prior to introduction of vaccination, mumps was an epidemic disease, with a cycle of 4-5 years.⁴⁴ Additionally, overcrowding, inadequate sanitation, and limited and remote access to healthcare facilities in certain regions may facilitate the rapid spread of the virus.⁴⁵

Challenges and Opportunities in Implementing MMR Vaccination:

Funding is identified as a key challenge for achieving measles and rubella elimination targets. SAGE working group in 2013 found that the vaccine requirement of combined vaccine will increase directly in proportion to decrease in measles only vaccine. Moreover, there is no anticipated shortage in the supply of combined vaccine, and can be completely obviated by the planned phase-out of measles-only vaccines and gradual introduction of combined vaccine.⁴⁶

Ensuring vaccine security (defined as the consistent availability of high-quality vaccines at affordable price) requires robust collaboration with industry and stakeholders. The introduction of the combined MMR vaccine is estimated to increase the cost per dose by approximately INR 37.89 -INR 51.42.⁴¹ However, given the inevitability of cyclical mumps outbreaks in the absence of vaccination and the existing burden of rubella, the inclusion of the MMR vaccine in the immunization schedule should be prioritized.

Measles with higher secondary attack rate and mortality is given priority amongst the vaccine preventable diseases. States have been advised to boost immunity against

measles by providing two doses of measles vaccine. One given at 9 months of age as a part of national immunization schedule and the second measles vaccine dose administered through catch up campaign or as MMR vaccine. States with immunization coverage more than 80% administer second dose in routine immunization by MMR or measles vaccine.⁴⁷

Mumps appears to pose a notable public health challenge in India, yet it often goes unnoticed due to the lack of a robust surveillance and documentation system. Also, it is still not a notifiable disease. The Indian Academy of Pediatrics (IAP) has argued very strongly for the inclusion of the MMR vaccine instead of the MR vaccine because the children may get extra protection using the same logistics and operational feasibility.

Cost-effectiveness analysis:

Data from industrialized countries have proved the cost-effectiveness of mumps when translated to reduced school- and work-absenteeism and reduction in associated long term complications and costs of associated hospitalization. As per an economic analysis of mumps vaccination in US, the average cost per case of mumps prevented was \$3614, which was greater than costs incurred with prevention of single measles case (\$2207). The total annual costs averted by MMR vaccination was \$ 7,878,378,382 with a benefit-to- cost ratio of 0.49.⁴⁸ Similarly, the additional benefit of routine mumps vaccination exceeded additional costs of vaccine in a cost-effectiveness analysis in Japan.⁴⁹

CONCLUSION

Although mumps is generally a benign and self-limiting disease, the potential for missed complications cannot be overlooked. Epidemiological shifts in the affected age group and inadequate treatment practices can lead to significant harm to patients. The occurrence of repetitive mumps outbreaks in the community and the epidemiological transition of disease affecting older age group with a higher risk of complications emphasize the need for an effective vaccination policy of MMR vaccine in India.

Given the potential complications of mumps orchitis, including subfertility, oligospermia, and infertility, vaccination is essential in preventing these outcomes. The MMR vaccine significantly reduces the incidence of mumps and its complications, including orchitis. Therefore, widespread vaccination is crucial to protect reproductive health and minimize long-term fertility issues.

Vaccination, particularly the Measles-Mumps-Rubella (MMR) vaccine, has proven to be an effective

and cost-effective solution in preventing mumps and its complications. The success of mumps vaccination in other countries demonstrates its potential to reduce disease incidence, school and work absenteeism, and the associated healthcare costs. The inclusion of the MMR vaccine in India's National Immunization Program could significantly decrease the burden of mumps, especially among children and young adults, while preventing severe complications such as orchitis and infertility.

Although the cost of the MMR vaccine is a concern, economic analyses show that the long-term benefits, including reduced healthcare expenditures and fewer complications, far outweigh the initial investment. The cost-effectiveness of mumps vaccination has been demonstrated in other countries, and similar benefits could be expected in India. Given the high burden of disease, the inclusion of the MMR vaccine in India's immunization schedule should be a priority for improving public health outcomes and reducing the financial burden on families during outbreaks.

Just because of the lack of proper documents and studies in India when such evidence is already available elsewhere in the world, we cannot neglect one of the major vaccine-preventable diseases, for which an effective vaccine exists. The use of the MR vaccine in place of the MMR vaccine is considered a 'missed opportunity' to target a significant VPD that also has a significant impact on child health. By ensuring access to and promoting the uptake of the MMR vaccine, we can effectively mitigate the risk of mumps outbreaks, safeguard public health, and foster a healthier future for all individuals across the nation.

CONFLICT OF INTEREST

None

REFERENCES

1. Pinkbook: MUMPS. Centers for Disease Control and Prevention; 2021 [cited 2024 May 14]. Available from: <https://www.cdc.gov/vaccines/pubs/pinkbook/mumps.html>
2. Gouma S, Durand ML, van Binnendijk RS. Mumps and other types of viral parotitis. In: Infections of the Ears, Nose, Throat, and Sinuses. Durand ML, Deschler DG (Eds). Springer Cham. 2018. Pp 279-89.
3. Paul S, Bhatia V, Sahoo J, Subba SH, Mahajan PB. Investigating mumps outbreak in Odisha, India: An opportunity to assess the health system by utilizing the

Essential Public Health Services Framework. The American Journal of Tropical Medicine and Hygiene. 2017 May 3;96(5):1215–21. doi:10.4269/ajtmh.15-0593

4. World Health organization. Mumps vaccines. Accessed on Nov 29, 2024. Available from: <https://www.who.int/teams/health-product-policy-and-standards/standards-and-specifications/vaccine-standardization/mumps#:~:text=Live%20attenuated%20mumps%20vaccines%20based,been%20available%20since%20the%201960s>

5. Dubey AP, Banerjee S. Measles, mumps, rubella (MMR) vaccine. Indian J Pediatr. 2003;70:579-84.

6. Marlow M, Haber P, Hickman C, et al. Mumps. In: Epidemiology and Prevention of Vaccine Preventable Diseases. The Pink Book: Course Textbook. Hall E, Wodi AP, Hamborsky J, Morelli V, Schillie S (Eds). Centre for Disease Control and Prevention. 14th edition. 2021. Pp 225-38. Accessed on Jan 11, 2024. Available from: <https://www.cdc.gov/vaccines/pubs/pinkbook/mumps.html>.

7. Gut JB, Lablache C, Behr S, et al. Symptomatic mumps virus reinfections. J Med Virol. 1995;45:17-23.

8. World Health Organization. Global Health Observatory Data Repository. Mumps - Reported cases by country. Accessed on Jan 11, 2024. Available from: https://apps.who.int/gho/data/view.main.1540_53

9. Mumps virus vaccines. Wkly Epidemiol Rec. 2007;82(7):51-60. [PubMed] [Google Scholar]

10. Vaidya SR, Hamde VS. Is it right time to introduce mumps vaccine in India's Universal immunization program? Indian Pediatr. 2016 Jun;53:469-73. [PubMed] [Google Scholar] 5

11. Kadri SM, Rehman SU, Rehana K, Brady AH, Chattu VK. Should mumps be higher up on the public health agenda in India? A concern for global health security. Med Sci (Basel). 2018 Aug 7;6(3):62. [PubMed] [Google Scholar]

12. Vashishtha VM, Yadav S, Dabas A, et al. IAP Position Paper on Burden of Mumps in India and Vaccination Strategies. Indian Pediatr. 2015;52:505-14.

13. Integrated Disease Surveillance Programme. Weekly outbreaks. Accessed on Jan 11, 2024. Available from: <https://idsp.mohfw.gov.in/index4.php?lang=1&level=0&linkid=406>

&lid=3689.

14. India.com, Dec 23, 2023. Mumps outbreak in India: symptoms and precautions to protect your kids from this deadly virus. Accessed on Jan 11, 2024. Available from: <https://www.india.com/health/mumps-outbreak-in-indiasymptoms-and-precautions-to-protect-your-kids-from-this-deadly-virus-6606668/>.

15. Hindustan Times, Nov 14, 2023: Pal S. Mumps outbreak in Mumbai's poorer areas causes worry. Accessed on Jan 11, 2024. Available from: <https://www.hindustantimes.com/cities/mumbai-news/mumps-outbreak-in-mumbai-spoorer-areas-causes-worry-101699902457945.html>.

16. Narmatha K, Abinaya P, Mathivanan SR, Logaraj M. Epidemiology of Reported Mumps Cases in Tamil Nadu, April 2021 to March 2024. TNJ Public Health and Medical Research. 2024 Oct 14; 4(3). Available from: <https://tnjphmr.com/article.php?articleid=602>

17. Barták V. Sperm count, morphology and motility after unilateral mumps orchitis. J Reprod Fertil. 1973 Mar;32(3):491-4. doi: 10.1530/jrf.0.0320491. PMID: 4692345.

18. Bertschat FL, Alexander M. Infertility after mumps orchitis. Munch Med Wchnschr 1981;123: 606-8 [PubMed] [Google Scholar]

19. Adamopoulos DA, Lawrence DM, Vassilopoulos P, Contoyiannis PA, Swyer GI. Pituitary-testicular interrelationships in mumps orchitis and other infections. BMJ 1978;i: 1177-80 [DOI] [PMC free article] [PubMed] [Google Scholar]

20. Kalaydjiev S, Dimitrova D, Tsvetkova P, Tsvetkov D. Serum sperm antibodies unrelated to mumps orchitis: Mumps orchitis and sperm antibodies. Andrologia. 2001 Mar 3;33(2):69–70.

21. Casella R, Leibundgut B, Lehmann K, Gasser TC. Mumps orchitis: report of a mini-epidemic. J Urol 1997;158: 2158-61 [DOI] [PubMed] [Google Scholar]

22. World Health Organization. Mumps [Internet]. Geneva: World Health Organization; [cited 2024 Dec 30]. Available from: <https://www.who.int/teams/health-product-policy-and-standards/standards-and-specifications/norms-and-standards/vaccine-standardization/mumps>

23. Gomber S, Arora SK, Das S, Ramachandran VG. Immune response to second dose of MMR vaccine in Indian children. *Indian J Med Res.* 2011;134:302-6.
24. World Health Organization. Global status of mumps immunization and surveillance. *Weekly Epidemiol Rec.* 2005;80:417-24.
25. Measles, mumps, and rubella – vaccine use and strategies for elimination of measles, rubella, and congenital rubella syndrome and control of mumps: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep.* 1998;47:1-57.
26. Hayden GF, Preblud SR, Orenstein WA, Conrad JL. Current status of mumps and mumps vaccine in the United States. *Pediatrics.* 1978;62:965-9.
27. Pomeroy LW, Magsi S, McGill S, Wheeler CE. Mumps epidemic dynamics in the United States before vaccination (1923-1932). *Epidemics.* 2023;44:100700.
28. Rubin SA, Kennedy RB. Paramyxoviruses: Mumps. In: Kaslow RA, Stanberry LR, LeDuc JW, editors. *Viral Infections of Humans.* Springer; 2022.
29. Peltola H, Davidkin I, Paunio M, Valle M, Leinikki P, Heinonen OP. Mumps and rubella eliminated from Finland. *JAMA.* 2000;284(19):2643-7.
30. World Health Organization. Countries Using Mumps Vaccine in National Immunization Schedule, 2012. Available from: http://www.who.int/immunization/monitoring_surveillance/burden/vpd/surveillance_type/passive/mumps/en/. Accessed January 6, 2015.
31. Wang H, Hu Y, Zhang G, Zheng J, Li L, An Z. Meta-analysis of vaccine effectiveness of mumps-containing vaccine under different immunization strategies in China. *Vaccine.* 2014;32(44):4806-12.
32. Yadav S, Thukral R, Chakravarti A. Comparative evaluation of measles, mumps and rubella vaccine at 9 & 15 months of age. *Indian J Med Res.* 2003;118:183-6.
33. Raut SK, Kulkarni PS, Phadke MA, Jadhav SS, Kapre SV, Dhare RM, et al. Persistence of antibodies induced by measles-mumps-rubella vaccine in children in India. *Clin Vaccine Immunol.* 2007;14:1370-1.
34. Gans H, Yasukawa L, Rinki M, De Howitz R, Forghani B, Beeler J. Immune responses to measles and mumps vaccination of infants at 6, 9 and 12 months. *J Infect Dis.* 2001;184:817-26.
35. Galazka AM, Robertson AE, Kraigher A. Mumps and mumps vaccine, a global review. *Bull World Health Organ.* 1999;77:3-14.
36. Peltola H, Heinonen O, Valle M, Paunio M, Virtanen M, Karanko V, et al. The elimination of indigenous measles, mumps and rubella from Finland by a 12 year two-dose vaccination program. *N Engl J Med.* 1994;331:1397-402.
37. Government of India. The three new vaccines including indigenously developed rotavirus vaccine to be provided to all Indian children. 2014 Jul 3 [cited 2024 Feb 26]. Available from: https://www.pmindia.gov.in/en/news_updates/three-new-vaccines-including-indigenously-developed-rotavirus-vaccine-to-be-provided-to-all-indian-children-fourth-vaccine-for-adults-to-protect-against-japanese-encephalitis-to-be-introduced-in-high-p/
38. Vashishtha VM, Yadav S, Dabas A, Bansal CP, Agarwal RC, Yewale VN, Thacker N, Kamath SS, Mehta PJ. IAP position paper on burden of mumps in India and vaccination strategies. *Indian Pediatr.* 2015 Jun;52:505-14. [PubMed] [Google Scholar]
39. Bhatnagar N, Kaur R, Gupta M, Sharma D. Introducing combined measles, mumps and rubella vaccine in Chandigarh, India: Issues and concerns! *Indian Pediatr.* 2014 Jun;51(6):441-3.
40. World Health Organization. Mumps Virus Vaccines: WHO Position Paper. *Weekly Epidemiological Record* No. 7, 2007, pp 51-60. Accessed on Jan 11, 2024. Available from: <https://www.who.int/publications-detail-redirect/WHOWER8207-51-60>
41. Universal Immunization Programme (UIP). Ministry of Health and Family Welfare, GOI. Accessed on Jan 11, 2024. Available from: <https://main.mohfw.gov.in/?q=MajorProgrammes/universal-immunization-programme-uip>

42. Vaidya SR, Hamde VS. Is it the right time to introduce mumps vaccine in India as Universal Immunization Program? *Indian Pediatr.* 2016;53:469-73.
43. Choi KM. Reemergence of mumps. *Korean J Pediatr.* 2010;53:623-8.
44. SAGE Working Group on Measles and Rubella. Status Report on Progress towards Measles and Rubella Elimination. Available from: http://www.who.int/immunization/sage/meetings/2013/november/Status_Report_Measles_Rubella21Oct2013_FINAL.pdf. Accessed March 10, 2014
45. World Health Organization. Global Advisory Committee on Vaccine Safety, 16-17 December 2002. *Wkly Epidemiol Record.* 2003;78:17-20.
46. Available From: <http://indiatoday.intoday.in/story/chandigarh-residents-per-capita-income/1/186614.html>. Accessed November 17, 2024.
47. Zhou F, Reef S, Massoudi M, Papania MJ, Yusuf HR, Bardenheier B, et al. An economic analysis of the current universal 2-dose measles-mumps-rubella vaccination program in the United States. *J Infect Dis.* 2004;189 (Suppl 1):S131-45.
48. Sugawara T, Ohkusa Y, Taya K, Oikawa K, Haneda N, Kikuchi K, et al. Cost-effectiveness analysis of routine mumps immunization in Japan. *Kansenshogaku Zasshi.* 2007;81:555-61.
49. Indian Pediatrics. Mumps vaccination in India: Current status and future perspective. *Indian Pediatr.* 2014 Jun;51(6):441-3. Available from: <https://www.indianpediatrics.net/june2014/june-441-443.htm>
50. Paul S, Mahajan PB, Sahoo J, Bhatia V, Subba SH. Investigating Mumps Outbreak in Odisha, India: An Opportunity to Assess the Health System by Utilizing the Essential Public Health Services Framework. *Am J Trop Med Hyg.* 2017 May;96(5):1215-1221. doi: 10.4269/ajtmh.15-0593. PMID: 28500809; PMCID: PMC5417219.

FIELD ACTION REPORT

FROM STORM TO SAFETY: PUBLIC HEALTH SUCCESS MEASURES IN MANAGING CYCLONE FENGAL

Subhashini K J⁽¹⁾, Priyadharshani A⁽¹⁾, Avudai Selvi R⁽¹⁾, Ramya R⁽¹⁾, Mohammed al Ossama⁽¹⁾, Bhuvana K⁽¹⁾, Ganapathy M⁽¹⁾, Senthil Kumar M⁽¹⁾, Sampath P⁽¹⁾, Selvavinayagam T S⁽¹⁾

(1) Directorate of Public Health and Preventive Medicine

ABSTRACT

INTRODUCTION : Cyclone Fengal, which struck Tamil Nadu and Puducherry on November 30, 2024, highlighted the critical connection between natural disasters and public health. With wind speeds of 70–90 km/h and heavy rainfall, the cyclone severely impacted 14 districts, particularly Tiruvannamalai, Villupuram, Krishnagiri, and Cuddalore resulting in 12 fatalities, significant property damage, and widespread flooding. Proactive public health measures mitigated the disaster's immediate and long-term effects. The Tamil Nadu government implemented a comprehensive disaster management strategy, emphasizing preparedness, disease surveillance, and rapid response. Key initiatives included advisory teams, district-level control rooms, and task-specific units for medical aid, vector control, and water quality management. Enhanced disease surveillance enabled the early detection and prevention of outbreaks like Acute Diarrheal Disease (ADD). From December 1 to 13, 2024, over 7,870 medical camps provided care to more than 423,000 beneficiaries in the most affected districts. Mobile medical units delivered critical services, including minor ailment treatment, disease detection, and antenatal care for high-risk pregnancies. Vector control activities and water quality management through chlorination minimized the risks of mosquito-borne and waterborne diseases. Choropleth mapping and trend analysis guided resources to high-risk zones, while public awareness campaigns and chemoprophylaxis further strengthened the response. This coordinated, data-driven approach underscores the importance of scalable disaster management strategies to safeguard public health and build resilience in vulnerable regions.

KEYWORDS : Cyclone Fengal, Disaster Preparedness, Public Health Interventions, Disease Surveillance

INTRODUCTION

Cyclones and floods are natural disasters that often occur in tandem, particularly in coastal regions. These cyclones can lead to flooding, both due to the direct impact of intense rainfall and the overflow of rivers and seas caused by the storm surge. Flooding exacerbates the destruction caused by cyclones, displacing communities, damaging infrastructure, and leading to loss of life. The combination of high winds and water can make these disasters devastating, highlighting the importance of early warning systems, preparedness, and resilient infrastructure to reduce the impact of such events.

Tamil Nadu, located along the south-eastern coast of India, is highly susceptible to cyclones due to its proximity to the Bay of Bengal, a region prone to frequent cyclonic activity. Cyclones in the state generally occur during the pre-monsoon period (April to June) and the post-monsoon season (October to December), with the northeast monsoon season being particularly critical for the formation and impact of these storms.^{1,2,3} The devastating 2015 flood was a critical event for Chennai, with rainfall exceeding significantly above normal in just a few days and claiming 420 deaths state wide and widespread destruction of property. Cyclone

Gaja, a severe storm, struck Tamil Nadu on November 16, 2018, causing widespread damage. Originating in the Bay of Bengal, it made landfall near Vedaranyam in Nagapattinam district with winds up to 120 km/h, impacting several districts and disrupting lives, infrastructure, and livelihoods. The disaster highlighted the vulnerability of coastal regions. Cyclone Michaung, in early December 2023 brought heavy rainfall to Tamil Nadu, particularly affecting Chennai, which recorded 46 cm of rainfall over two days (December 3-4), causing widespread flooding extending to the southern Tamil Nadu, including Tenkasi, Tirunelveli, Thoothukudi, and Kanyakumari, on December 17. These areas experienced up to 93 cm of rainfall in Kayalpattinam, Thoothukudi, over two days (December 17-18), intensifying the impact of the cyclone.⁴

Cyclone Fengal, which made landfall on November 30, 2024, with wind speeds of 70 to 90 km/h,



Please Scan this QR Code to

View this Article Online

Article ID: 2024:04:04:11

Corresponding Author: Subhashini K J

e-mail : dr.subhashini215@gmail.com

caused widespread devastation across Tamil Nadu and Puducherry, leading to significant loss of life and property. The cyclone affected 14 districts in Tamil Nadu, including Tiruvannamalai, Villupuram, Krishnagiri, Kallakurichi, Cuddalore, Ramanathapuram, Dharmapuri, Tiruvallur, Chengalpattu, Kancheepuram, Ranipet, Tirupathur, Vellore, Coimbatore, and Nilgiris, with the most severe impact felt in Tiruvannamalai, Villupuram, Krishnagiri, and Cuddalore. Intense rainfall persisted from November 30 to December 2, 2024. This was particularly notable in Uthangarai and Pochampalli in Krishnagiri. The cyclone claimed at least 12 lives in Tamil Nadu, including seven from a landslide in Tiruvannamalai and three from electrocution in Chennai. The deluge inundated over 129,000 hectares of crops, with 80,520 hectares of standing crops in Villupuram severely impacted. Additionally, 26 State Highways suffered damage, prompting immediate restoration efforts. While the coastal areas were largely protected due to precautionary measures, 4,906 people were relocated to 67 relief centres over two days, highlighting the swift and effective emergency response to the crisis.^{5,6,7}

Beyond physical destruction, flooding has significant public health implications. Floodwaters frequently disrupt essential services such as water supply, sanitation, and healthcare access, leading to outbreaks of communicable diseases. Contaminated water sources contribute to waterborne diseases like diarrhoea and cholera, while overcrowded relief centres heighten the risk of airborne illnesses such as Influenza and Pneumonia. Additionally, stagnant floodwaters create ideal conditions for mosquito breeding, triggering vector-borne diseases like dengue and malaria. These public health challenges emphasize the critical role of an effective healthcare system in preventing and managing disease outbreaks during and after flooding events.⁸

This article explores Tamil Nadu's response to the 2024 floods, focusing on public health measures and disaster preparedness strategies. By documenting the experiences of the state and its districts, the paper aims to provide insights into effective flood management practices, highlighting the importance of integrating health interventions into broader disaster resilience frameworks.

Public Health Interventions:

Several Public Health Interventions were implemented to address impending potential outbreaks following a disaster, including:

1. Proactive Preparedness ahead of Cyclone Fengal
2. Timely communication and response to Cyclone Fengal

alert

3. Establishment of State-level advisory and monitoring Team
4. Establishment of District control room at the district level
5. Reactivation of the dedicated Helpline for emergency support
6. Risk assessment and stratification of affected blocks in the flood affected districts
7. Deployment of Task-Specific Teams for Post-Flood Public Health Management
8. Disease surveillance and outbreak prevention

1. Proactive Preparedness ahead of Cyclone Fengal

With the onset of the Northeast monsoon, a comprehensive "Assessment of Health Facilities" was carried out across 14 coastal districts to strengthen emergency preparedness and disaster response mechanisms. This included evaluating the capacity and readiness of existing healthcare infrastructure to manage potential crises, such as floods and disease outbreaks. Alternate health facilities were identified and strategically mapped to provide seamless healthcare services in areas where Primary Health Centres (PHCs) were likely to be affected by flooding.

2. Timely Communication and Response to Cyclone Fengal Alert

Once the weather alert for Cyclone Fengal was issued by the Regional Meteorological Centre, India Meteorological Department (IMD), Chennai the information was promptly communicated from the State Headquarters to the Districts. Immediate action was taken to notify and alert the concerned districts, ensuring all relevant authorities, including the State and District Disaster Management Authorities, State Disaster Response Force, Police and Fire Departments, Municipal Administration, and the Rural and Panchayat Raj Department, were kept informed and mobilized without delay. This swift communication enabled the districts to initiate appropriate preparedness measures, including monitoring, evacuations, and deployment of resources, to mitigate the impact of the cyclone and safeguard public safety

3. Establishment of State-Level Advisory and Monitoring Team

To effectively manage and address the health challenges posed by the Fengal Cyclone, a State-Level Advisory and Monitoring Team was established. This team, comprising the Director, Additional Directors, and Joint Directors of Public Health and Preventive Medicine, was tasked with providing strategic guidance and on-ground support. Key responsibilities included coordinating health interventions through District Health Officers, overseeing medical camps, monitoring potential disease outbreaks,

ensuring water chlorination, implementing vector control measures, maintaining the availability of medical supplies, and addressing other public health concerns in affected areas. The State team collaborated closely with District authorities to facilitate timely communication and swift responses, significantly mitigating the cyclone's health impact on the population. The Director, along with the Additional and Joint Directors, conducted daily review meetings from the state headquarters with the District Health Officers (DHOs) of the most affected districts. These meetings aimed to assess the situation comprehensively and address the specific needs and requirements of each district. Additionally, in response to the cyclone, funds were requested from the State Disaster Management Authority, Tamil Nadu and National Health Mission, Tamil Nadu.

4. Establishment of District Control Room at the District level

The District administration constituted the District Control Room under the chairmanship of the District Collector and comprising key stakeholder departments in Flood rescue and recovery activities such as Revenue, Health, Police, Electricity and Water Boards, in close coordination with the State Disaster Response Force. The Directorate of Public Health and Preventive Medicine swiftly implemented Epidemic prevention and control measures. The District Emergency Operation Centre, Public Health Control Room, and 104/108 medical helplines were activated. On December 1, 2024, District Control Room was set up at the respective District Collector Offices to coordinate various flood related rescue and recovery operations, with the Public Health Team primarily monitoring the diseases incidence in the flood-affected areas. Field activities were coordinated, including data collection from Mobile Medical Units, Static Camps, and the Integrated Health Information Platform (IHIP).

5. Reactivation of the Dedicated Helpline for Emergency Support

A District Public Health Control Room was set up in all flood-affected districts within the District Collectors' Office, comprising officials from key departments, including Health, Municipalities/Corporations, Electricity, Fire and Safety, Police, Public Works, and Highways. The existing Disaster helpline (1077) was reactivated, with extensive publicity through media channels to ensure prompt assistance. Managed by the District Disaster Team, the helpline received calls from the public, and the relevant officials were promptly notified to take appropriate action. Additionally, the team gathered information on critical needs such as electricity restoration, waterlogging issues, and food distribution.

6. Risk Assessment and Stratification of Affected Blocks in the flood affected districts

Following an assessment of the damage by the Revenue Department, Mobile Medical Teams were strategically deployed to areas with the most severe impact for disease surveillance. Among the 14 affected districts, Tiruvannamalai (including Cheyyar), Villupuram, Krishnagiri, and Cuddalore were particularly hard-hit. Within these four districts, 14 blocks were identified as the most severely impacted. The teams monitored the number of illnesses reported at the Medical camps, and based on this data, the affected areas were categorized by their risk of disease outbreaks. These high-risk blocks were placed under continuous surveillance to monitor for any potential outbreaks.

7. Deployment of Task-Specific Teams for Post-Flood Public Health Management

The Directorate of Public Health and Preventive Medicine appointed personnel in the cadre of Additional Directors and Joint Directors of Public Health and Preventive Medicine to oversee the district public health activities and supervise the monitoring of medical camps, vector control, and chlorination activities. Additionally, officials in the cadre of District Health Officers were tasked with monitoring field activities. They promptly organized and provided all necessary logistics within 1-2 days. Their responsibilities encompassed overseeing all medical camps, vector control efforts, and chlorination activities. Virtual Coordination Meetings were conducted on daily basis with block teams for issuing necessary instructions regarding post flood disease control measures. The data analysed for identifying clusters of ADD/AFI/ARI helped in planning of camps in the affected sites. The daily coordination meeting also enabled the district public health team to be aware of ongoing field difficulties and solving the logistics issues, wherever necessary.

The block teams contributed insights for planning outbreak prevention activities in the subsequent days and prioritizing high-risk areas based on available reports. Furthermore, the field monitoring team ensured the administration of chemoprophylaxis to vulnerable populations in flood-affected regions and distribution of Non-Communicable Disease (NCD) drugs to beneficiaries through medical teams. To address specific needs, task-specific teams were formed, including flood response teams, vector control teams, and water analysis teams. These teams were allocated specific functions, and based on their reported data, the District Authorities promptly initiated epidemic prevention and disease control measures.

7.1 Flood Response Medical teams:

With the onset of the North East monsoon, and the anticipated rise in rainfall and diseases such as vector-borne illnesses, Acute Respiratory Infections (ARI), fever, leptospirosis, diarrheal diseases, typhoid, and dysentery, 1,000 special monsoon medical camps were established across the state to support affected communities. These camps, which began on October 15, 2024, are still operational, continuing to provide essential healthcare throughout the monsoon period. As of December 22, 2024, a total of 79,765 camps have been conducted, serving 42,21,823 beneficiaries. In the 14 districts affected by Cyclone Fengal, the number of medical camps was increased based on risk stratification and specific needs.

The flood response Medical teams comprised a Medical Mobile Unit consisting of one Medical Officer, one Staff Nurse/ Pharmacist, one Health Inspector, and a dedicated driver, each equipped with their own Medical Mobile Unit vehicle. These teams were instructed to carry essential medications for disease control and prevention. In addition to the existing Medical Mobile Teams, more teams were mobilized from nearby districts and deployed in the flood affected blocks.

At the medical camp, several measures were implemented:

- i) Socio-demographic details of patients were documented.
- ii) Treatment for minor ailments.
- iii) Patients presenting with fever had their blood samples collected for serologic tests to detect diseases such as complete blood count, Leptospirosis, Dengue, Malaria.
- iv) Cases of Acute Diarrheal Diseases (ADD) requiring stool sample collection for Cholera/typhoid/Hepatitis A and E investigation was done.
- v) **Chemoprophylaxis** - Food handlers / health care workers were provided with chemoprophylaxis, including Doxycycline 200 mg, Metronidazole 400 mg, and Albendazole 400 mg. Additionally, individuals in high-risk areas received Doxycycline 200 mg / Azithromycin 500mg tablets as Chemoprophylaxis and children received chemoprophylaxis as per the weight.
- vi) **Injury** management included administering TT (Tetanus Toxoid) injections at the campsite, along with wound cleaning and minor dressing.
- vii) **Antenatal Care** - As a precautionary measure for the cyclone, all high-risk mothers (near EDD) were transferred to CEMONC centres a day before the cyclone. Additionally, pregnant women in hard-to-reach areas were moved to safer PHC/CHC facilities. Daily visits by VHNs were conducted to monitor antenatal mothers, addressing any concerns. Mobile medical camps also visited ANC patients at the campsites,

and high-risk cases were referred to higher-level centres for further care.

viii) **Non – Communicable Diseases** - Monitored the health status of Non-communicable disease patients, those in need of palliative care, and ensure compliance with medication refills for patients with non-communicable diseases including Injection Insulin. Medications were given to NCD patients, even for persons taking treatment in private sector. Drugs were diverted from non-flood affected areas depending on the demand.

ix) **Follow-up** calls were conducted for patients seen at the medical camps, with specific attention given to monitoring and mapping cases of fever, acute diarrheal disease (ADD), acute respiratory infections, skin diseases, and injuries to identify any clustering trends.

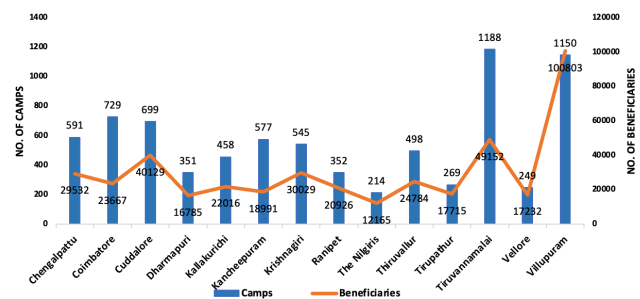


Figure 1: Distribution of Medical Camps and Beneficiaries in the fourteen Cyclone Fengal-affected Districts of Tamil Nadu between December 1 and 13, 2024

In the 14 flood affected districts, between 1st and 13th December, 7,870 medical camps were conducted with 4, 23,926 beneficiaries. 3,914 fever cases, 40,898 ARI cases and 412 ADD cases were treated during the period.

7.2 Vector control teams were deputed with Regional Entomology teams along with Senior and Junior Entomologists to oversee vector control activities in the flood affected areas.

Vector control activities included:

- i) Source reduction efforts targeted the elimination of mosquito breeding habitats by ensuring the proper disposal or removal of open containers that could collect water. Additionally, areas of artificial water stagnation, both indoors and outdoors, were addressed. These actions played a pivotal role in breaking the mosquito breeding cycle.
- ii) For anti-larval control, Temephos - larvicide, was applied to water containers that could not be emptied or drained. This step effectively targeted mosquito larvae, preventing their development into adults.
- iii) To control adult mosquito populations, both indoor and

outdoor fogging operations were conducted. Indoor spaces were treated with Pyrethrum-based fogging, which is known for its effectiveness against adult mosquitoes in enclosed areas. Outdoor fogging utilized Technical Malathion, a potent chemical for large-scale vector control.

iv) Due to a limited availability of fogging machines, resources were strategically deployed from various districts to maximize coverage and ensure effective implementation of the fogging operations. This coordinated effort was integral to minimizing mosquito populations and reducing the risk of vector-borne diseases.

v) Oil balls, made of sawdust or hay soaked in used oil and wrapped in jute cloth, are dropped into stagnant waters. The oil forms a film on the water surface, blocking oxygen supply to mosquito larvae and preventing breeding. Additionally, bleaching powder balls are used in stagnant waters to prevent Leptospirosis.

vi) Areas with increased House Index were analysed by the District team and focussed for intensified control measures.

Table 1: Deployment of Task specific teams to the most flood affected districts of Tamil Nadu between December 1 and 13, 2024

District	Vector control- Regional Entomologist Teams	Vector control- Senior/Junior Entomologist Teams	Chief Water Analyst Teams	Chlorination teams
Tiruvannamalai (Including Cheyyar)	1	10	2	74
Villupuram	1	17	1	18
Krishnagiri	1	1	1	40
Cuddalore	0	3	0	4
Total	3	31	4	136

7.3 Water Analysis team:

Water Analyst teams were deployed to flood-affected areas to assess the water distribution system alongside local body officials and the Tamil Nadu Water Supply and Drainage (TWAD) Board. They identified waterline leakages and ensured the cleaning of Overhead Tanks (OHTs) before resuming regular water supply. Temporary water supply through tanker lorries and tractors was chlorinated at the outset, teams thoroughly checked water sources to ensure safety and quality. They had coordinated with local panchayat members and BDO for chlorinated water supply. They also,

i) Reported drinking water pipe leakages and unsanitary supply to the District Authorities with follow-ups.

ii) Monitored chlorination levels and devised action plans for chlorination in affected areas.

iii) Tested water quality in supply tanks and private sources for contamination, ensuring proper chlorination.

iv) Collected water samples from taps, hand pumps, overhead tanks, and portable sources to test residual chlorine levels.

v) Prioritized water sampling in flood-affected areas with acute diarrheal disease (ADD) or fever cases.

vi) Sent water samples for bacteriological analysis to detect contamination.

vii) Chlorinated water sources under supervision of Chief Water Analyst team.

viii) Inspected water-supplying lorries for rust or debris and ensured proper chlorination.

A total of 8,912 water sources were inspected by the team for adequate chlorination during the control measure activities, and 7272 (81.6%) sources were found to be adequately chlorinated in the 14 Fengal cyclone affected districts. Appropriate measures were taken to chlorinate the water sources with nil chlorination.

8. Disease surveillance and Outbreak prevention

The expected surge in diseases following the floods, includes vector-borne diseases such as dengue, chikungunya, and malaria, along with influenza, pneumonia, and waterborne illnesses like cholera, dysentery, gastroenteritis, typhoid, hepatitis A, and leptospirosis, were closely monitored. Daily trend analysis of reported diseases helped identify vulnerable populations, prioritize high-risk areas, and plan targeted healthcare interventions for the following day.

i) **ADD (Acute Diarrhoeal Diseases) case approach** – Whenever ADD cases were reported, a clear history was first taken to differentiate food borne from water borne ADDs.

- **Food Borne** – Food samples were collected wherever available, advised to dispose the suspected food and treat the cases symptomatically in case of cluster.

- **Water Borne** – The affected areas were checked for pipeline leakages and the issues identified were rectified. Alternate chlorinated drinking water supply was given through tanker Lorries. Super chlorination was done at all operational water sources and storage sites to ensure adequate chlorination at household and community levels. Disinfection activities were carried out in and around the households of affected individuals.

All symptomatic patients were treated and Chemoprophylaxis was given to all those who shared the suspected water source. IEC regarding Handwashing and boiling of drinking water was done regularly in all affected areas. Water analyst teams were deployed to visit all affected areas for strict monitoring of water quality.

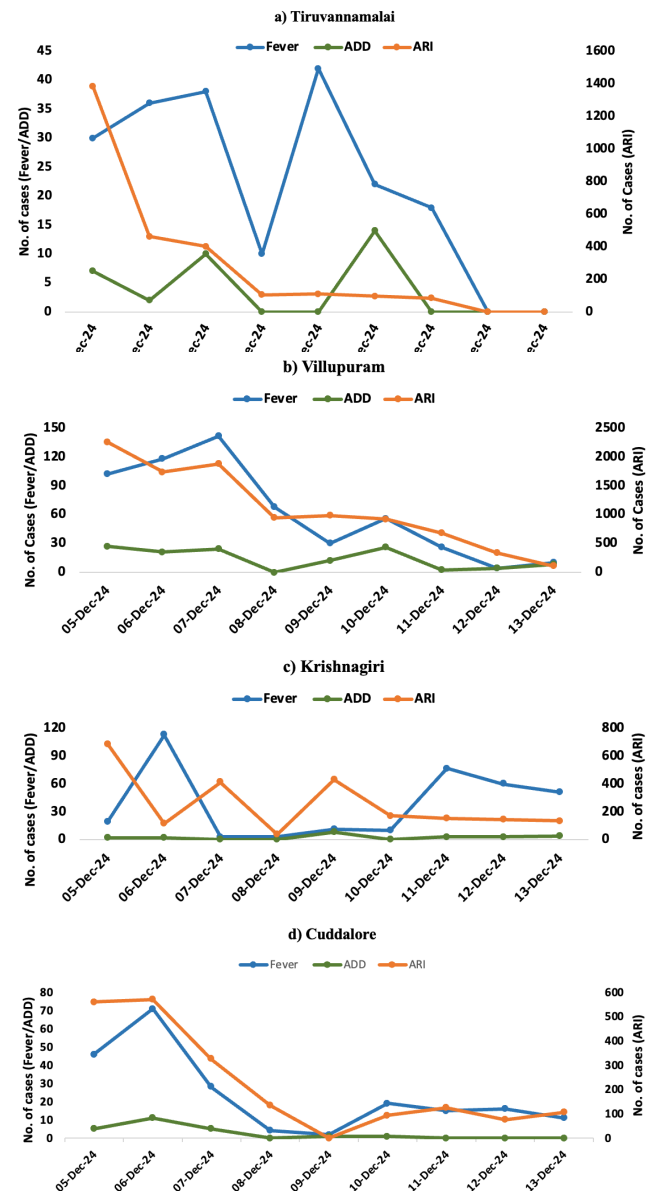
ii) **Acute Febrile Illnesses/ Fever and Acute Respiratory Illnesses (ARI)** - After active case search, clusters were identified to provide symptomatic management to patients,

and blood samples from these febrile patients were transported to the District Public Health Lab through Integrated Essential Laboratory Services (IELS). Flu like symptoms were managed with T. Oseltamivir and necessary prophylaxis was given to close contacts. Source reduction for vector control, along with fogging and anti-larval measures were implemented in necessary areas.

The four districts most severely impacted—Tiruvannamalai (including Cheyyar), Villupuram, Krishnagiri, and Cuddalore—were placed under intensified surveillance. Disease surveillance data was collected from both the medical camps and the Integrated Health Information Platform (IHIP portal) to assess the actual burden of diseases reported during this period. Trend analysis of these diseases helped identify potential outbreaks early, allowing for timely public health interventions and the implementation of appropriate measures.

Figure 2: Trend analysis of Fever, ADD and ARI in the four most Cyclone Fengal affected Districts of Tamil Nadu between December 1 and 13, 2024

Choropleth mapping served as a useful tool to visualize and analyze the spatial distribution of data to understand the disease prevalence. It helped track the geographical spread of diseases, identify hotspots, and prioritize interventions in high-risk areas.



Source: IHIP portal and Medical Camp Google sheet report

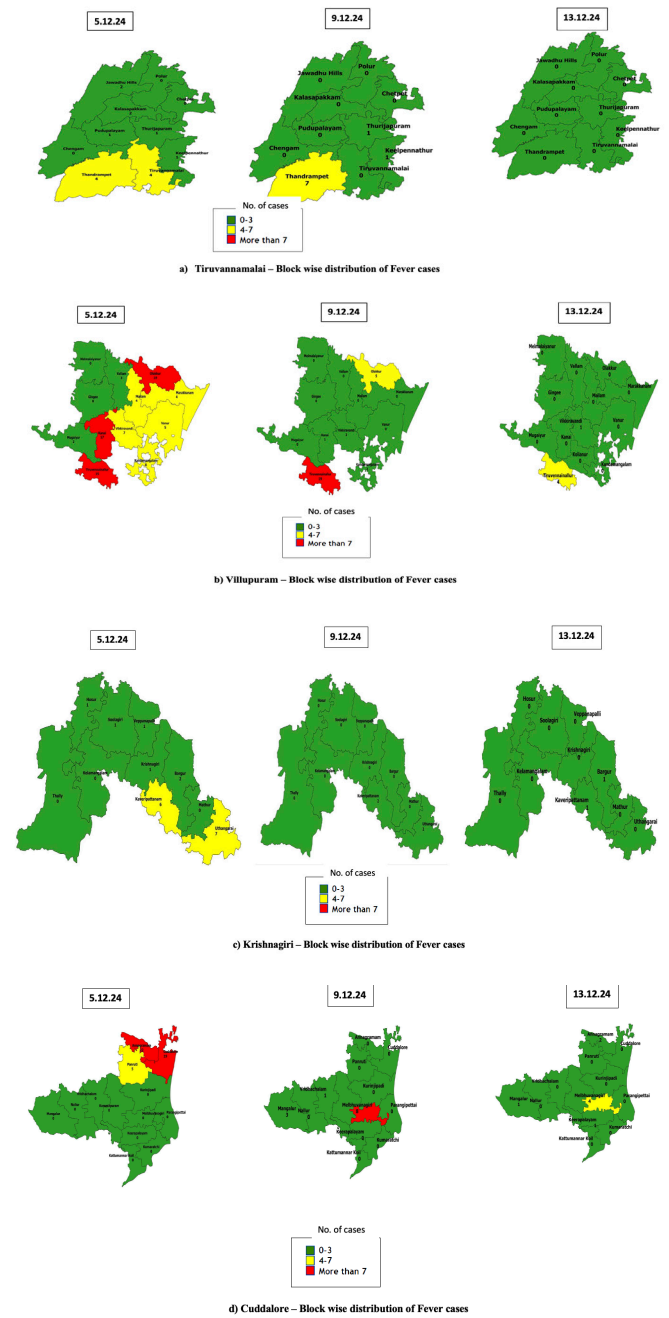


Figure 3: Choropleth mapping of Fever cases in the 4 most Cyclone Fengal affected Districts of Tamil Nadu between December 1 and 13, 2024

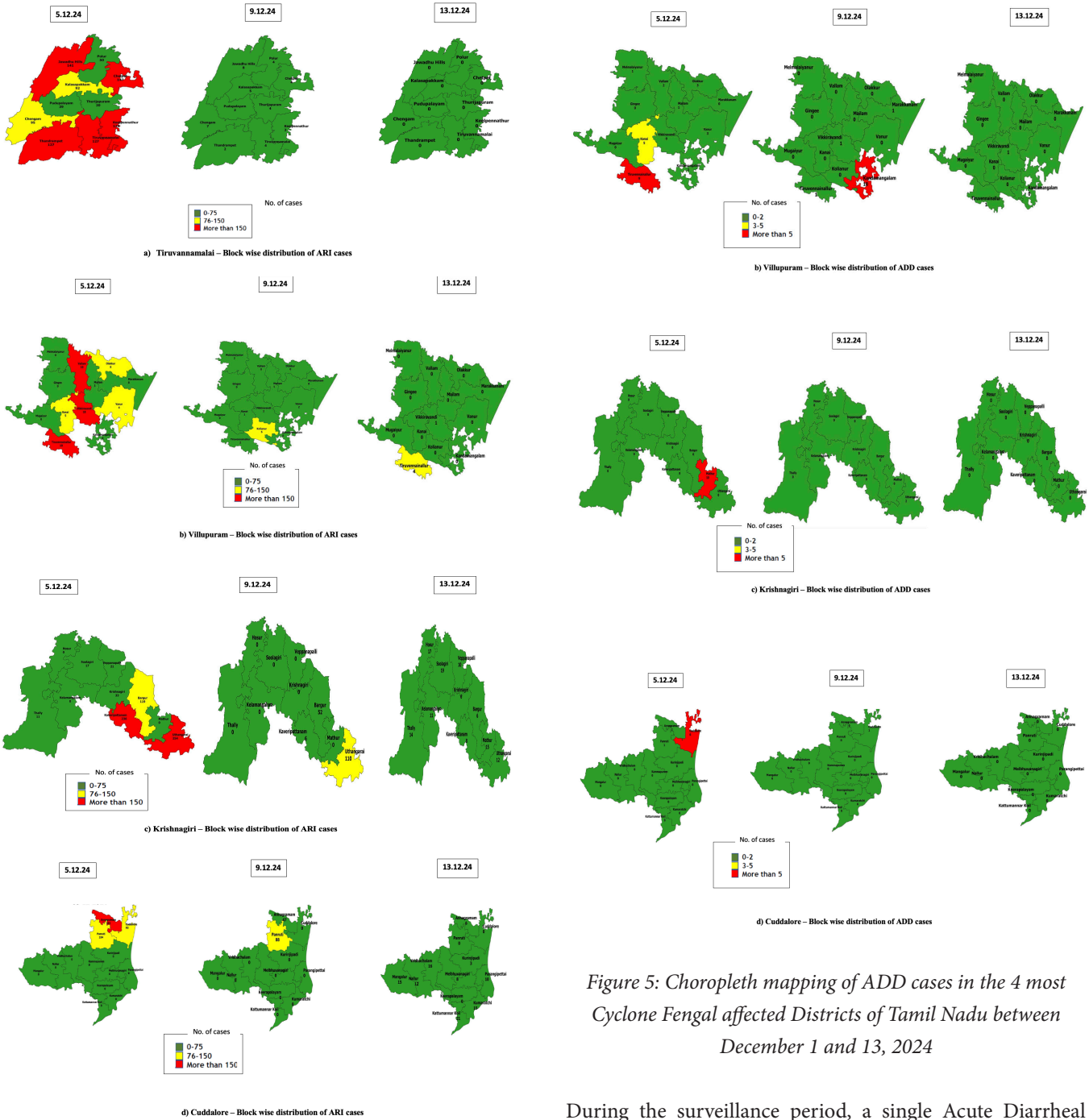


Figure 4: Choropleth mapping of ARI cases in the 4 most Cyclone Fengal affected Districts of Tamil Nadu between December 1 and 13, 2024

Figure 5: Choropleth mapping of ADD cases in the 4 most Cyclone Fengal affected Districts of Tamil Nadu between December 1 and 13, 2024

During the surveillance period, a single Acute Diarrheal Disease (ADD) outbreak was detected in Villupuram district, attributed to a pipeline leakage. Active surveillance enabled the identification of case clustering on Day 1 itself. Bacteriological analysis of water samples confirmed the presence of coliform organisms. The outbreak was effectively controlled within 5 days, with a total of 10 cases reported. As a result of the strict control measures implemented by the Health Department, no further outbreaks were reported in the remaining districts.

The public health interventions during Cyclone Fengal showed a strong and proactive approach to managing the disaster and health challenges. The timely communication of alerts, establishment of State and District-level control

mechanisms, deployment of task-specific teams, and comprehensive disease surveillance measures played a pivotal role in safeguarding the health of affected communities. The collaborative efforts of various departments, strategic risk stratification, and the mobilization of resources ensured a seamless response to emerging health challenges.

DISCUSSION

The Public Health response to the Cyclone Fengal and floods in Tamil Nadu highlighted an integrated and systematic approach to disaster management, emphasizing early preparedness, coordinated action, and data-driven interventions. These measures ensured timely control of potential health risks and highlighted the importance of strengthening public health systems in disaster-prone areas. One of the most critical steps taken was the establishment of Advisory and Monitoring systems at both State and District levels. Such centralized structures facilitate efficient decision-making, resource allocation, and monitoring. Evidence from prior research supports the effectiveness of such command systems in disaster response. For instance, in a conference paper by Kaur et al. (2018) on disaster management during floods in Bihar highlighted the importance of command systems in ensuring timely coordination among health departments and local authorities.^{9,10}

Disease surveillance played a pivotal role in the prevention and control of outbreaks. Utilizing data from medical camps and Integrated Health Information Platform (IHIP) enabled the identification of high-risk areas and trends in disease outbreaks. The National Centre for Disease Control (NCDC), New Delhi, emphasize that robust surveillance systems reduce delays in detecting and managing outbreaks, particularly for vector-borne and waterborne diseases in flood-hit regions and has been proved effective in the 2015 Chennai floods.^{4,11} In the flood affected districts, measures like real-time monitoring and choropleth mapping of illnesses were instrumental in planning targeted interventions. Vector control and water quality management were crucial in preventing outbreaks of diseases like malaria, dengue, and cholera. These activities included anti-larval measures, fogging, and chlorination of water sources. A systematic review by Mohajervatan et al. (2021) underscored the necessity of such interventions in reducing the incidence of vector-borne diseases during and after floods.¹² Similar efforts in Tamil Nadu during the 2015 Chennai floods significantly reduced mosquito populations and prevented major outbreaks, as documented by Selvavinayagam et al.¹³

The formation of task-specific teams ensured the

efficient execution of activities ranging from medical camps to risk stratification of affected areas. The deployment of external medical teams from neighbouring districts was crucial in providing immediate care. Research by Paterson et al. (2018) on flood responses in Southeast Asia emphasizes the importance of mobilizing multidisciplinary teams for emergency healthcare delivery.¹⁴

Public health communication also played a vital role, particularly in educating the population about safe hygiene practices, water purification, and disease prevention. WHO guideline on 'Communicating risk in public health emergencies' advocates that public awareness campaigns can significantly mitigate the risk of outbreaks during disasters by fostering community participation in preventive measures.¹⁵

Despite the success of these interventions, challenges such as network disruptions and logistical constraints during the initial days highlight the need for further investment in resilient communication and resource systems. Additionally, while Tamil Nadu's response was exemplary, it is imperative to evaluate the cost-effectiveness and scalability of such interventions for wider implementation in flood-prone areas.

LIMITATIONS

One of the limitations to note is, while analysing data for disease surveillance, we have incorporated case numbers from both the IHIP portal and the Special Medical Camps conducted across districts. It is important to note that the number of reported cases may fluctuate due to the varying frequency of camps conducted daily. To provide a clearer understanding of the disease burden and to identify trends in case reporting, we have relied on aggregate figures. These aggregate figures, while offering valuable insights, may still reflect variations influenced by the number of camps scheduled.

CONCLUSION

These Public Health interventions not only mitigated the immediate health impacts of the disaster but also demonstrated the importance of preparedness, coordination, and data-driven decision-making in minimizing potential outbreaks and ensuring community resilience in the face of future calamities. Despite the initial challenges, proactive preparedness contributed to the relatively low number of reported cases in the affected districts. Proactive preparedness, effective arrangement of logistics, protocols, and disease surveillance kept reported cases significantly low. This highlights the importance of comprehensive guidelines and ready Disaster Response Teams in mitigating impacts

and preventing outbreaks during disasters. With the growing impact of climate change on natural disasters, proactive preparation is essential. However, ensuring the availability of resources, particularly financial ones, is crucial to addressing the immediate impacts of cyclones while other necessary resources are being mobilized. A dedicated revolving fund for disaster management would ensure financial readiness, enabling swift and effective responses to mitigate cyclone impacts.

CONFLICT OF INTEREST

None

REFERENCES

1. Floods | NDMA, GoI [Internet]. [cited 2024 Dec 17]. Available from: <https://ndma.gov.in/Natural-Hazards/Floods>
2. The secretariat [Internet]. [cited 2024 Dec 17]. Urban Flooding: A Crisis Of Climate Change, Urban Planning, And Outdated Drainage Systems. Available from: <https://thesecretariat.in/article/urban-flooding-a-crisis-of-climate-change-urban-planning-and-outdated-drainage-systems>
3. Sam AS, Abbas A, Surendran Padmaja S, Raghavan Sathyan A, Vijayan D, Kächele H, et al. Flood vulnerability and food security in eastern India: A threat to the achievement of the Sustainable Development Goals. *International Journal of Disaster Risk Reduction*. 2021 Dec 1;66:102589.
4. Study on impacts of Climate Change in light of Floods and Inundation in Chennai(December 2022), Chennai, India: SEEDS
5. Record rain in Puducherry, parts of Tamil Nadu as Cyclone Fengal unleashes chaos [Internet]. *The Indian Express*. 2024 [cited 2024 Dec 18]. Available from: <https://indianexpress.com/article/india/cyclone-fengal-record-rain-in-puducherry-parts-of-tamil-nadu-9700981/>
6. Deccan Herald [Internet]. [cited 2024 Dec 18]. Explained | Why Cyclone Fengal dumped “historic” levels of rain in Tamil Nadu’s interior areas. Available from: <https://www.deccanherald.com//india/tamil-nadu/explained-how-cyclone-fengal-dumped-historic-rains-in-tamil-nadus-interior-areas-3300402>
7. Bureau TH. Cyclone Fengal: Crops on 80,520 hectares damaged in Villupuram district: T.N. Minister. *The Hindu* [Internet]. 2024 Dec 4 [cited 2024 Dec 18]; Available from: <https://www.thehindu.com/news/national/tamil-nadu/cyclone-fengal-crops-in-80520-hectares-damaged-in-villupuram-district-tn-minister/article68945518.ece>
8. Saatchi M, Khankeh HR, Shojafard J, Barzanji A, Ranjbar M, Nazari N, et al. Communicable diseases outbreaks after natural disasters: A systematic scoping review for incidence, risk factors and recommendations. *Progress in Disaster Science*. 2024 Oct 1;23:100334.
9. Selvavinayagam TS, Vadivelan P, Senthil Kumar M, Kumarasamy P, Subramaniam S, Mohan A, Mathivanan SR, Regina K. Adapting to adversity: public health flood response strategies following twin disasters. *Tamil Nadu J Public Health Med Res*. 2024;4(1):[51-57]. Available from: <https://tnjphmr.com/article/pdf/569.pdf>
10. Kaur A, Ghawana T, Kumar N. Preliminary Analysis of Flood Disaster 2017 in Bihar and Mitigation Measures. In: Rao PJ, Rao KN, Kubo S, editors. *Proceedings of International Conference on Remote Sensing for Disaster Management*. Cham: Springer International Publishing; 2019. p. 455–64.
11. National Centre for Disease Control, Director General of Health Services. *Public Health Guidelines for Flood events*. MoHFW, GoI; 2019.
12. Mohajervatan A, Tavakoli N, Khankeh H, Raeisi AR, Atighechian G. Health sector’s flood response plan: A comprehensive review. *Environ Health Eng Manag*. 2021 Jul 26;8(3):169–78.
13. Selvavinayagam T. Learning from Chennai floods to mitigate epidemic. *International Journal of Health System and Disaster Management*. 2016 Oct 1;4(4):114–114.
14. Paterson B, Charles A. Community-based responses to climate hazards: typology and global analysis. *Climatic Change*. 2019 Mar 1;152(3):327–43.
15. World Health Organization. *Communicating risk in public health emergencies: a WHO guideline for emergency risk communication (ERC) policy and practice* [Internet]. Geneva: World Health Organization; 2017 [cited 2024 Dec 18]. 57 p. Available from: <https://iris.who.int/handle/10665/259807>

SHORT ARTICLE

SPARSH CAMPAIGN AND LEPROSY CASE DETECTION: AN EVALUATION OF AWARENESS - DRIVEN OUTCOMES IN TIRUVALLUR DISTRICT, TAMIL NADU 2018-2024

Sridevi Govindarajan ⁽¹⁾

(1) Directorate of Medical and Rural Health Services ((Leprosy))

ABSTRACT

INTRODUCTION : Leprosy, a chronic infectious disease known for thousands of years, has long been associated with significant stigma. The disability resulting from delayed detection impacts not only the affected individual but also their family. To address this stigma and enhance awareness, the Sparsh Leprosy Awareness Campaign (SLAC) was launched under the National Leprosy Eradication Programme (NLEP) on 30th January 2017, coinciding with Anti-Leprosy Day. The campaign, celebrated as a fortnight event until 13th February, aims to increase awareness and reduce stigma. This study evaluates the impact of the Sparsh campaign on leprosy case detection in Tiruvallur district, Tamil Nadu, India, from 2018 to 2024.

METHODS : A descriptive cross-sectional study was conducted to analyse the number of new leprosy patients detected during and one month after the Sparsh campaign. Data for February and March from 2018 to 2024 were extracted from monthly progress reports.

RESULTS : Between 2018 and 2024, 1,172 new leprosy patients were reported in Tiruvallur district, of which 223 were detected during the Sparsh campaign. Out of the 223 patients, 125 of them self-reported and 98 paucibacillary leprosy patients were detected during the campaign.

CONCLUSION : Awareness campaigns have demonstrated effectiveness in facilitating early detection of leprosy, emphasizing the importance of Information, Education, and Communication (IEC) activities. We recommend targeted awareness initiatives focusing on vulnerable population and high-endemic areas to promote self-reporting and reduce delays in diagnosis.

KEYWORDS : SPARSH, leprosy case detection, campaign

INTRODUCTION

Leprosy is a chronic infectious disease caused by a bacterium called *Mycobacterium leprae*. It primarily affects the skin and peripheral nerves, the initial manifestations being hypopigmented patches with a definite loss of sensation. Early detection and prompt treatment prevents disabilities. If left treated it slowly causes nerve damage in the face, hands and legs causing permanent disabilities. It is a highly stigmatised disease leading to the exclusion of leprosy affected persons from society.

Hence, in order to address the issue of high level of stigma attached to leprosy and to increase awareness about various aspects of leprosy, a nationwide campaign called "Sparsh leprosy awareness campaign" (SLAC) was introduced under National Leprosy Eradication Programme (NLEP) on 30th January 2017 being the death anniversary of Mahatma Gandhi, celebrated as National Anti-Leprosy day every year, to honour his services offered towards persons affected with leprosy.

In order to provide necessary impetus, prototypes of message of District Magistrate, appeal of Grama

Sabha Pramukh and pledge of Grama Sabha members were prepared on theme of early case detection and stop discrimination. In addition, the guidelines of SLAC and a 'Sparsh package' encompassing IEC materials, including video spots, audio spots and posters were prepared. All the prototypes, guidelines and 'Sparsh package' were shared with all states with instructions to distribute to all Grama Sabhas before 30th January. Further, for better organisation and management special committees at various levels i.e., State, District and Block level were formed.

The major activities undertaken in Grama Sabha were: Message from District Magistrate on Leprosy, appeal in Grama Sabha by the concerned Panchayat leader to all members to stop discrimination against persons affected with leprosy and undertaking of pledge by all Gram Sabha



Please Scan this QR Code to

View this Article Online

Article ID: 2024:04:04:12

Corresponding Author: Sridevi Govindarajan

e-mail : sridevidoctor2020@gmail.com

members to not to discriminate persons affected with leprosy. In addition to the execution of Grama Sabha meetings as per suggested activities mentioned above, States celebrated the SLAC fortnight using innovative IEC activities to spread awareness regarding the disease in the community. The campaign was an output of cooperation and coordination of Health Department with allied sectors like Panchayat Raj Institutions, Rural Development, Urban Development, Human Resource Development, Women and Child Development and Social Justice and Empowerment and Agriculture. This drive is being carried out successfully every year since 2017.

In 2018, dissemination of IEC message through NLEP mascot 'Sapna' was implemented (Figure 1). 'Sapna' is a concept designed and developed keeping in mind a common girl living in community, who will help to spread awareness in the community, through key IEC messages, 'Sapna' will be a local school going girl who is from the same locality preferably. This turned out to be of tremendous success in spreading awareness. In our study we have analysed the number of new cases detected during the campaign and compared it across with other months of the year to show the impact of awareness driven case detection and reduction of stigma.



Figure 1: 'Sapna' the mascot

METHODS

Study setting: Tiruvallur district is located in the Northeastern part of Tamil Nadu along the state border. It has a population of 24,95,152 (projected population of 2024 based on 2011 Census data) spread across 14 sub-districts. It has 34.9 percent of rural and 65.1 percent of urban population (Census 2011). Its geographic location, being situated along the state border and in close proximity to the Chennai metropolitan area, makes it prone to significant migration and a transient population, further complicating its public health landscape and leprosy control efforts.

Study design, data collection and analysis: We did secondary data analysis for the reference period from 2018 to 2024. We extracted the data from the treatment registers

and monthly progress reports from the district. We analysed the number of leprosy patients detected during the months of February and March which falls during and post Sparsh campaign for the reference period 2018-2024. We compared it with the number of patients reported during the rest of the months in the year. We also analysed in the aspect of clinical form of leprosy and mode of detection of the leprosy patients reported during Sparsh Campaign.

RESULTS

Overall, 1172 new leprosy patients were reported in Tiruvallur district during 2018-2024, out of which 223 were detected during the SLAC. Among the 223, 125 leprosy patients self-reported during this period. 98 Paucibacillary leprosy and 125 Multibacillary leprosy patients were detected. 71 were detected during ACLF campaign in high endemic areas in 2018, 145 during LCDC in 2018-19, and 32 during Active case detection and surveillance campaign in 2021-2022. Out of the total 1172 new leprosy patients detected, 471 were detected during the campaign months (Table 1).

Table 1 Average number of new leprosy patients detected during campaign months compared to non-campaign months, 2018-2024, Tiruvallur district, Tamil Nadu, India

Year	Average number of new cases detected during campaign months		Average number of new cases detected during non-campaign months
	SPARSH Campaign	Other case detection campaigns	
2018	19	36	12
2019	19	25	10
2020	26	-	8
2021	20	17	7
2022	17	15	11
2023	13	16	11
2024	13	-	9

DISCUSSION

This study highlights the pivotal role of awareness campaigns, such as the Sparsh campaign, in facilitating the early detection of leprosy. Over the period from 2018 to 2024, a total of 1,172 new leprosy patients were reported in Tiruvallur district, with 223 detected during the targeted campaign months of February and March. Notably, 125 patients self-reported their condition, indicating the campaign's success in raising awareness and empowering individuals to seek timely medical attention. Additionally, 98 paucibacillary leprosy cases were identified through active case-finding efforts, further underscoring the importance of structured outreach programs in detecting otherwise unnoticed cases. The number of new cases detected was also high in the months of July and August in 2018 during which

the active case finding in high endemic areas campaign was done. In 2019 also the number of new leprosy patients was high during the Leprosy Case Detection Campaign (LCDC).

The Sparsh campaign's approach, which integrated Information, Education, and Communication (IEC) strategies, appears instrumental in addressing the stigma associated with leprosy and encouraging community participation. By actively engaging with vulnerable populations, the campaign not only improved case detection rates but also likely contributed to the prevention of secondary complications through early diagnosis and treatment. This aligns with previous studies highlighting the effectiveness of IEC strategies in promoting early health-seeking behaviour in endemic areas.^{1,2}

Despite these successes, gaps remain. While 125 individuals self-reported, it is imperative to explore barriers that might prevent others from doing so, such as fear of social exclusion or lack of awareness about early symptoms. Furthermore, the detection of 98 paucibacillary cases during active case-finding suggests the need for continuous surveillance and expanded reach beyond campaign periods. Future efforts should prioritize targeted, community-based interventions, especially in high-risk areas. Strengthening

IEC activities, fostering partnerships with local stakeholders, and incorporating technological innovations could enhance outreach and improve early detection.³ Addressing these challenges comprehensively could significantly reduce the disease burden and contribute to the global goal of eliminating leprosy as a public health concern.⁴

CONFLICT OF INTEREST

None

REFERENCES

1. Rao PS, John AS. Awareness and attitudes toward leprosy in a community in rural India. *Indian J Lepr.* 2016;88(1):1–13.
2. WHO. Global Leprosy Strategy 2016–2020: Accelerating towards a leprosy-free world. World Health Organization; 2016.
3. Nicholls PG, Smith WC, Das L, et al. Prevention of disability in leprosy: Results from a cohort study in India. *BMJ Glob Health.* 2020;5:e002124.
4. Lockwood DN, Suneetha S. Leprosy: Too complex a disease for a simple elimination paradigm. *Bull World Health Organ.* 2005;83(3):23

SHORT ARTICLE

TRENDS OF TEENAGE PREGNANCY IN TAMIL NADU
(2019-2024)Vijaykumar R ⁽¹⁾, Nirmalson J ⁽¹⁾⁽¹⁾ Directorate of Public Health and Preventive Medicine**ABSTRACT**

INTRODUCTION : Teenage pregnancy is a global social and public health challenge that affects millions of girls worldwide. It has detrimental effects on the physical, emotional, and social well-being of adolescents, as well as on their educational and economic prospects. This paper aims to examine the trends in teenage pregnancy in Tamil Nadu from 2019 to 2024, and the distribution of teenage pregnancies across districts in Tamil Nadu.

METHODS : A descriptive cross-sectional study design was employed to analyze the trends in teenage pregnancy. The study utilized data from the HMIS portal. A total of 49,93,093 records of antenatal mothers in the HMIS portal from April 2019 to March 2024 were included in the analysis. Data analysis involved descriptive analysis using Microsoft Excel to determine the prevalence of teenage pregnancies and their distribution across different districts in Tamil Nadu.

RESULTS : The study identified 62,870 teenagers with a cumulative teenage pregnancy rate of 1.3%. The rates of teenage pregnancy over the years are 2019-20 at 1.1%, 2020-21 at 1.3%, 2021-22 at 1.3%, 1.1% in 2022-23 and 2023-24 at 1.5%. Among the districts, Nagapattinam is at 3.3%, followed by Theni at 2.4% and Perambalur at 2.3%. Kancheepuram, Virudhunagar, Nagercoil, and Chennai have the lowest teenage pregnancy rates, ranging from 0.4% to 0.7%.

CONCLUSION : The findings reveal that teenage pregnancy remains a significant concern across districts in Tamil Nadu. It is important to recognize that the challenge of teenage pregnancy requires a holistic approach. While the existing interventions have made significant strides, there is a need for greater emphasis on school-based sex education, behavioural change communication, and community participation. Encouraging active involvement from communities, parents, and other stakeholders will foster a more comprehensive and sustainable approach.

KEYWORDS : Teenage, Pregnancy, HMIS, Adolescent Health, Sex education

INTRODUCTION

UNICEF defines “teenage pregnancy” as conceiving between the ages of 13–19 years old. However, in everyday speech the term teenage pregnancy is often used to describe young women who become pregnant when they have not yet reached legal adulthood, the age of which varies across the world.¹ UNICEF definition of teenage pregnancy will be used for this article. Teenage pregnancy is one of the most critical social and public health problems both in developed and developing countries.

Worldwide, around 16 million girls between the ages of 15 and 19 years, and two million girls under age 15 years become pregnant every year. Globally in 2022, an estimated 13 per cent of adolescent girls and young women give birth before age 18.²

One in four Indian women 26.8% is married before 18 years, and 7.8% of women aged 15 to 19 years are pregnant or mothers, according to the latest available 2015-16 National Family Health Survey (NFHS)-4 data.⁴

The National Family Health Survey (NFHS-3) (2005-06)³ for Tamil Nadu recorded a teenage pregnancy rate of 8% in the state, which decreased to 5% in NFHS-4 (2015-

16)⁴ and slightly increased to 6.3% in NFHS-5 (2019-20).⁵ In comparison, national teenage pregnancy rates declined from 16% in NFHS-3 to 7.9% in NFHS-4 and further to 6.8% in NFHS-5.

The most common causes of teenage pregnancy in India are early marriage, community and social pressure to marry, sexual abuse, violence, lack of information about sexual and reproductive health and rights, lack of education or school drop-out, and low Socioeconomic status.⁶

Early childbearing, or pregnancy and delivery during adolescence, can derail girls’ otherwise healthy development into adulthood and have negative impacts on their education, livelihoods, and health.⁷

Many girls who are pregnant are pressured or forced to drop out of school, which impacts their educational and employment prospects and opportunities. Early pregnancy



Please Scan this QR Code to

View this Article Online

Article ID: 2024:04:04:13

Corresponding Author: Vijaykumar R

e-mail : vijay.rajendran6@gmail.com

and childbearing can also have social consequences for girls, including reduced status in the home and community, stigmatization, rejection, and violence by family members, peers, and partners, and early and forced marriage.

Teenage pregnancy has numerous health consequences for adolescents and their newborns. Complications during pregnancy and childbirth represent the leading cause of death among girls aged 15–19 years worldwide due to greater risks of abortion, eclampsia, puerperal endometritis, systemic infections, and prematurity. Furthermore, social and economic consequences, such as rejection, violence, and interruption of studies, compromise their future.⁸

Stillbirths and newborn deaths are 50% higher among infants born to adolescent mothers than among those born to mothers aged 20–29 years. Infants of Teenage mothers are also more likely to have low birth weight, which can have a long-term impact on their health and development.⁹ Hence, this study aims to identify the trends in teenage pregnancy in Tamil Nadu from 2019 to 2024 and the distribution of teenage pregnancies across districts in Tamil Nadu.

METHODS

A descriptive cross-sectional study was conducted to examine the trends in teenage pregnancy in Tamil Nadu. The study utilized data from the Health Management Information System (HMIS) portal, a reliable and comprehensive source of information.

A total of 49,93,093 records of antenatal mothers in the HMIS portal were retrieved for analysis from April 2019 to March 2024, allowing for a comprehensive examination of trends over the past five years. The collected data were entered into Microsoft Excel. Descriptive analysis was performed to determine the proportion of teenage pregnancies and, the distribution of teenage pregnancies across different districts in Tamil Nadu.

RESULTS

The study analyzed data from the HMIS portal, covering a large cohort of 49,93,093 antenatal mothers between April 2019 and March 2024, and identified 62,870 teenagers with the Cumulative teenage pregnancy rate of 1.3%. The rate of teenage pregnancy over the years are 2019-20 at 1.1%, 2020-21 at 1.3%, 2021-22 at 1.3%, 1.1% in 2022-23 and 2023-24 at 1.5% (Table 1, Figure 1).

Table 1. Distribution of frequency in Teenage pregnancy as per HMIS in Tamil Nadu during 2019-2024

	2019-20	2020-21	2021-22	2022-23	2023-24
Total No. Of Pregnant Mothers	1025851	1000683	1009521	1002096	954942
No. of Teenage Pregnancies	11772	12606	13447	10685	14360
%	1.1	1.3	1.3	1.1	1.5

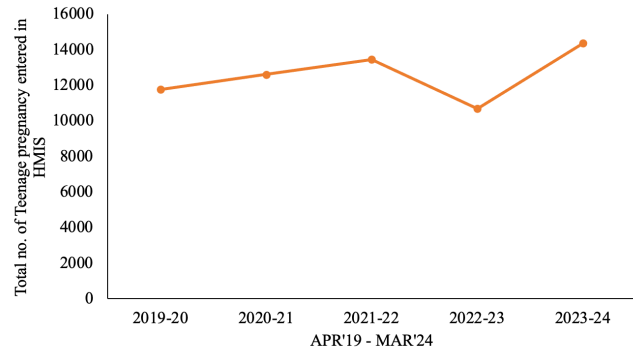


Figure 1. Trend in teenage pregnancy in Tamil Nadu during 2019-2024

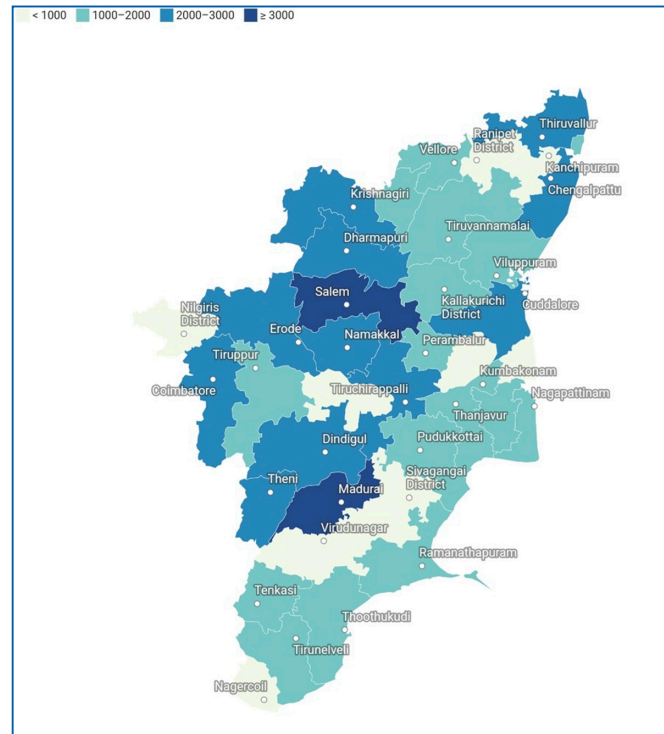


Figure 2: Distribution of frequency of Teenage pregnancy across districts in Tamil Nadu during 2019-2024

Figure 2 presents the analysis of teenage pregnancy rates across various districts in Tamil Nadu. Salem and Madurai have a teenage pregnancy prevalence of over

3,000, while districts such as Kancheepuram, Sivagangai, Virudhunagar, Nagercoil, and Chennai report a prevalence of less than 1,000.

DISCUSSION

The study analyzed the trends of teenage pregnancy and distribution across districts in Tamil Nadu over the last five years (2019-2024), using data from the HMIS portal. The total number of AN mother entries in HMIS during this period in Tamil Nadu was 49,93,093, out of which 62,870 were classified as teenagers, resulting in a Cumulative teenage pregnancy rate of 1.3%. There was a decline in teenage pregnancies in 2022, with 10,200 reported cases. However, the overall number of AN (Antenatal) mother entries in the HMIS during the same period was also lower, at 1,002,096 pregnancies. Among the districts, Nagapattinam has the highest prevalence of teenage pregnancy, followed by Theni and Perambalur. Kancheepuram, Virudhunagar, Nagercoil, and Chennai have the lowest teenage pregnancy rates in the study period.

The increase in the teenage pregnancy rate from 1.1% to 1.5% in the most recent period of 2023-24 in Tamil Nadu raises concerns and underscores the need for continued monitoring and evidence-based policies and interventions to address it. It is crucial to understand the factors contributing to this upward trend and the need to develop effective strategies to manage and reduce teenage pregnancies in Tamil Nadu.

To address this issue comprehensively, a multi-pronged approach is required. Firstly, targeted interventions should be implemented to educate teenagers about sexual and reproductive health, contraception, and the potential consequences of early pregnancy in school/out-of-school settings. These interventions can be delivered through schools, community centers, other village youth groups and healthcare facilities. Additionally, it is necessary to provide access to affordable and reliable contraceptive methods to ensure that teenagers have the means to make informed choices and prevent unintended pregnancies.

Furthermore, comprehensive sex education programs can play a vital role in empowering teenagers with knowledge about their sexual and reproductive health rights, promoting healthy relationships, and encouraging responsible decision-making. These programs should be age-appropriate, culturally sensitive, and implemented in collaboration with parents, educators, healthcare providers, and other interlinked departments.

Support systems should also be established to

provide emotional, social, and medical support to teenage mothers. This includes ensuring parental guidance and support, access to prenatal care, safe delivery services, and postnatal support. Additionally, efforts should be made to address the underlying social and economic determinants of teenage pregnancy, such as poverty, lack of education, and gender inequality. By addressing these factors, the overall well-being and prospects of teenage mothers can be improved.

LIMITATIONS

The study relied solely on data from the HMIS, which only provides aggregate numbers of cases, and does not include individual line-list data. Additionally, since the HMIS lacks a mechanism for authenticating the details entered, there are limitations in verifying the accuracy and completeness of the information. It included antenatal mothers in the HMIS portal excluding the cases of teenage pregnancy that were not reported or did not seek antenatal care, from public health facilities leading to an underestimation of the actual prevalence. It analysed data from April 2019 to March 2024, which provides five years for assessing trends in teenage pregnancy. However, a longer timeframe could have provided a more comprehensive understanding of long-term trends and patterns. The study relied solely on quantitative data for analysis. Qualitative data could have provided additional insights into the underlying factors contributing to teenage pregnancy and potential strategies for prevention. Further studies, may explore an in-depth understanding of facilitators of teenage pregnancy would also be beneficial to strengthening adolescent health in Tamil Nadu.

CONCLUSION

The findings reveal that teenage pregnancy remains a significant concern within the region, with a teenage pregnancy rate of 1.3% among the antenatal mothers as per HMIS during the study period. The outcome of 62,870 teenage pregnancies, presents an opportunity for further study and analysis. It is important to recognize that the challenge of teenage pregnancy requires a holistic approach. While the existing interventions such as Adolescent Reproductive and Sexual Health (ARSH) Program, Kishori Shakti Yojana (KSY), Adolescent Friendly Health Clinics (AFHC) and numerous awareness campaigns have made significant strides, there is a need for greater emphasis on behavioural change communication, school-based sex education and community participation. Encouraging active involvement from communities, parents, and other stakeholders will

foster a more comprehensive and sustainable approach.

CONFLICT OF INTEREST

None

REFERENCES

1. Data accessed from <https://data.unicef.org/topic/child-health/adolescent-health/> dated 11.06.2024.
2. Blum RW, Gates WH (Department of Population, Family and Reproductive Health, United Nations Population Fund). *Girlhood, not motherhood: Preventing Adolescent Pregnancy*. New York: UNFPA; 2015. 62.
3. Data accessed from <https://rchiips.org/nfhs/NFHS-3Reports/India.pdf> dated 11.06.2024.
4. Data accessed from <https://rchiips.org/nfhs/NFHS-4Reports/India.pdf> dated 11.06.2024.
5. Data accessed from <https://rchiips.org/nfhs/NFHS-5Reports/India.pdf> dated 11.06.2024.
6. Data accessed from <https://plan-international.org/srhr/teenage-pregnancy/> dated 11.06.2024
7. Grønvik T, Fossgard Sandøy I. Complications associated with adolescent childbearing in Sub-Saharan Africa: A systematic literature review and metaanalysis. *PLoS ONE*. 2018;13(9):e0204
8. de Vienne CM, Creveuil C, Dreyfus M. Does young maternal age increase the risk of adverse obstetric, fetal and neonatal outcomes: a cohort study. *Eur J Obstet Gynecol Reproductive Biology*. 2009;147(2):151–6.
9. Liang M, Simelane S, Fillo GF, Chalasani S, Weny K, Canelos PS, et al. The state of adolescent sexual and reproductive health. *J Adolesc Health*. 2019;65(6):3–15.

ORIGINAL ARTICLE - PUBLIC HEALTH

KNOWLEDGE AND ATTITUDE ON MENSTRUATION- A COMPARATIVE STUDY AMONG RURAL AND URBAN ADOLESCENT GIRLS IN CHENGALPATTU, TAMIL NADU

*Kanagabala Balasubramanian⁽¹⁾, Roseline F. William⁽²⁾, Thirunaaukarasu D⁽²⁾,
Geetha Mani⁽³⁾, Vidya D C⁽³⁾, Gladius Jennifer H⁽⁴⁾*

(1) Directorate of Public Health and Preventive Medicine

(2) Department of Community Medicine, Karpaga Vinayaga Institute of Medical Sciences and Research Center

(3) Department of Community Medicine, Bhaarith Medical College & Hospital,

(4) School of Public Health, SRM Institute of Science and Technology

ABSTRACT

INTRODUCTION : Adolescence in girls is marked by menstruation, which is surrounded by various psychological and religious barriers due to lack of knowledge about the process. The Menstrual Hygiene Programme in Tamil Nadu, implemented under the Rashtriya Kishor Swasthya Karyakram (RKSK), aims to promote menstrual hygiene among adolescent girls aged 10–19 years in rural areas. Without accurate understanding, menstruation can be distressing for a girl. Discussing this with a girl is important because the inaccurate and inadequate knowledge she acquires from peers and family members leads to a vicious cycle of misinformation. However, most adolescent girls in India have little knowledge on menstruation, reproduction and sexuality. Hence this study is attempted to compare the knowledge and attitude on menstruation among adolescent girls in rural and urban field practice areas of a tertiary care teaching hospital in Tamil Nadu.

METHODS : A community based analytical cross-sectional study was conducted during April 2018 to Oct 2018 among adolescent girls aged 10 to 19 years, residing at the rural and urban field practice areas of Karpaga Vinayaga Institute of Medical Sciences & Research Centre, Chengalpattu, Tamil Nadu. About 256 adolescent girls in rural and 137 girls in urban area were interviewed using a semi structured questionnaire. The knowledge section consisted of 5 questions. Those who scored ≤ 2 were considered to have poor knowledge, those who scored 3 were considered to have fair knowledge and who scored ≥ 4 were considered to have fair knowledge about menstruation. The attitude section consisted of 3 questions. The score ≤ 1 was considered unfavorable attitude and score ≥ 2 was considered as favorable attitude towards menstruation.

RESULTS : Overall, 38.28% and 54.74% girls in rural and urban respectively had good knowledge about menstruation. The attitude towards menstruation was favorable among 78.52% girls in rural and 64.23% girls in urban.

CONCLUSION : Overall, adolescent girls in urban had good knowledge compared to rural area. Overall attitude was better in girls in rural area than in urban area.

KEYWORDS : Menstrual hygiene, Knowledge, Attitude, Rural, Urban

INTRODUCTION

India has the largest adolescent population with 243 million adolescents. Adolescence is a phase of transition from childhood to adulthood, where an adolescent undergoes physiological, psychological and social changes. It is the time they become independent, establish new relationships, develop social skills and learn new behavior that will last for the rest of their lives.¹ This is a fascinating, yet, crucial, stressful period in an individual's life which requires special attention. However, they are often a neglected group because of the relatively low morbidity and mortality rates of this age group.²

Adolescence in girls is marked by menstruation, which is the periodic vaginal bleeding that occurs from menarche

till menopause. Menstruation is surrounded by various psychological and religious barriers due to lack of knowledge about the process. Although menstruation is a natural process, it is still regarded as unclean in Indian society.³ It is believed that menstruation contaminates the body and makes it unholy. This is linked with several perceptions and practices which might result in adverse health outcomes. Poor personal hygiene and unsafe sanitary conditions during menstruation



Please Scan this QR Code to

View this Article Online

Article ID: 2024:04:04:14

Corresponding Author: Kanagabala Balasubramanian

e-mail : kanagabala2693@gmail.com

increases the susceptibility for reproductive tract infections (RTI) and gynecological problems.³ These infections when left untreated, can lead to several consequences like infertility, ectopic pregnancy, fetal wastage, prenatal infection, low birth weight babies and toxic shock syndrome.⁴

The Menstrual Hygiene Programme in Tamil Nadu, implemented under the Rashtriya Kishor Swasthya Karyakram (RKSK), aims to promote menstrual hygiene among adolescent girls aged 10–19 years in rural areas. As part of the program, each adolescent girl who has attained puberty receives three packs of sanitary napkins (each pack containing six pads) in six distribution rounds conducted every two months.

School-going adolescents receive the napkins from their school nodal teachers, while non-school-going adolescents receive them through ASHAs, VHNs, or AWWs. Health education is an integral part of the Menstrual Hygiene Programme in Tamil Nadu. Under this program, adolescent girls are educated about menstrual hygiene management, which includes raising awareness about the importance of maintaining proper hygiene during menstruation, dispelling myths and misconceptions, and providing information on how to use and dispose of sanitary napkins safely. These educational sessions are often conducted by school nodal teachers, ASHAs, VHNs, or Anganwadi workers, ensuring that both school-going and non-school-going adolescents benefit from the initiative.

Most adolescent girls in India have little knowledge on menstruation, reproduction and sexuality. Without accurate understanding, menstruation can be distressing for a girl. Discussing this with a girl is important because the inaccurate and inadequate knowledge she acquires from peers and family members leads to a vicious cycle of misinformation.

A vast information gap exists among adolescent girls living in rural and urban areas regarding awareness about menstruation and menstrual hygiene. Hence this study is attempted to compare the knowledge and attitude on menstruation among adolescent girls in rural and urban field practice areas of a tertiary care teaching hospital in Tamil Nadu.

METHODS

A community based analytical cross-sectional study was conducted during April 2018 to Oct 2018 among adolescent girls aged 10 to 19 years, residing at Pulipakkam and Anna Nagar, the rural and urban field practice areas respectively of Karpaga Vinayaga Institute of Medical

Sciences & Research Centre, Chengalpattu, Tamil Nadu.

Sample size and sampling: Iswarya S et al⁵ in a study conducted at Coimbatore reported that 63% of the adolescent girls thought menstruation was a good process. Using this prevalence, 5% difference and 10% non-response, the sample size was estimated to be 410. Using Probability proportional to size, the sample size was calculated to be 273 adolescent girls in rural area and 137 adolescent girls in urban area. Eventually, the study was conducted among 256 adolescent girls in rural and 137 girls in urban area.

Study tool: A pre-tested and semi-structured questionnaire containing the details on demography, age at menarche, information about knowledge and attitude of menstruation.

Data collection: House-to house visits were made. After getting written informed consent from the mother and assent from the adolescent girl, the questionnaire was administered by in-person interview method.

Data analysis: The data obtained was entered in Microsoft Excel sheet and analyzed using SPSS. Knowledge and attitude related to menstruation was analyzed. The knowledge section consisted of 5 questions. Those who scored ≤ 2 were considered to have poor knowledge, those who scored 3 were considered to have fair knowledge and who scored ≥ 4 were considered to have good knowledge about menstruation. The attitude section consisted of 3 questions. The score ≤ 1 was considered unfavorable attitude and score ≥ 2 was considered as favorable attitude towards menstruation.

Ethical issues: Ethical clearance was obtained from the Institutional Ethical Committee (IEC) of Karpaga Vinayaga Institute of Medical Sciences and Research Centre, Chengalpattu, Tamil Nadu.

RESULTS

In the present study, the age of the participants ranged from 11-19 years, with the mean age of 15.58 ± 2.22 years (15.83 ± 2.30 years in rural area and 15.13 ± 1.99 years in urban area). Most of the girls interviewed were unmarried in rural 255 (99.6%) and urban area 136 (99.3%).

Table 1 represents the demographic profile of participants. Majority of the participants, 327 (83.21%) were Hindus. In urban areas most of the girls belonged to upper 51 (37.2%) and upper middle class 49 (35.8%), while in rural areas, majority belonged to lower middle 96 (37.5%) and upper lower 69 (27%) socioeconomic class.

Awareness about menstruation before menarche was observed more among adolescent girls in rural areas 130 (50.78%) than in urban areas 59 (43.1%). However, this difference was not statistically significant ($\chi^2 = 2.12$; $p = 0.14$).

Table 1. Demographic characteristics of study participants:

Variables	Rural	Urban	Total
	(N= 256) n (%)	(N=137) n (%)	N=393 n (%)
Education of the participants			
Middle school	32 (12.5)	21 (15.3)	53 (13.49)
High school	75 (29.3)	48 (35)	123 (31.3)
Intermediate or post high school diploma	149 (58.2)	68 (49.6)	217 (55.22)
Religion			
Hindu	222 (86.7)	105 (76.6)	327 (83.21)
Muslim	7 (2.7)	7 (5.1)	14 (3.56)
Christian	27 (10.5)	25 (18.2)	52 (13.23)
Socioeconomic status [Modified BG Prasad classification]			
Upper	27 (10.5)	51 (37.2)	78 (19.85)
Upper middle	53 (20.7)	49 (35.8)	102 (25.95)
Lower middle	96 (37.5)	32 (23.4)	128 (32.57)
Upper lower	69 (27)	4 (2.9)	73 (18.58)
Lower	11 (4.3)	1 (0.7)	12 (3.05)
Family type			
Nuclear	163 (63.67)	100 (73)	263 (66.92)
Joint family	55 (21.48)	35 (25.5)	90 (22.9)
Three generation family	38 (14.84)	2 (1.5)	40 (10.18)
Study place			
Government	51 (19.9)	15 (10.9)	66 (16.79)
Private	205 (80.1)	122 (89.1)	327 (83.21)

The major source of information about menstruation was from school teachers (49.23% rural, 53.22% urban), followed by mothers (25.84% in rural) and friends (20.97% in urban) (Fig 1).

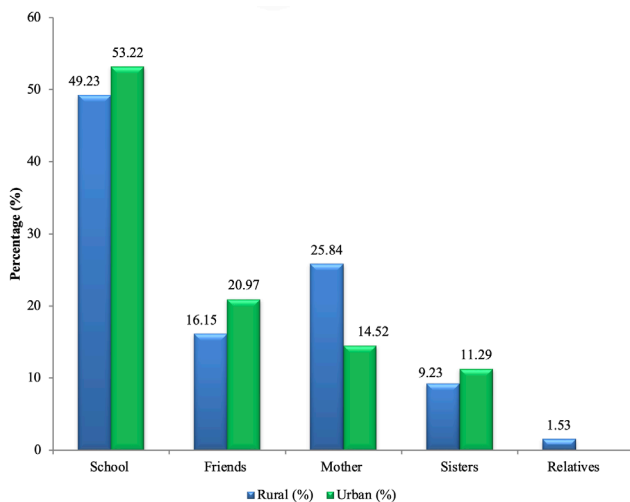


Figure 1: Source of information about menarche among the study participants

Majority of the girls (82.43% in rural and 80.3% in urban) reported that ideal age at menarche was 12-14 years. Only 28.12% girls in rural and 39.42% girls in urban were aware of menstruation as a physiological process. Also 16.8% and 10.95% girls in rural and urban respectively were not

aware of the cause of menstruation and this was found to be statistically significant (p 0.022). Only 41.8% and 52.5% girls in rural and urban respectively were aware that uterus was the source of menstrual bleeding and 31.6% girls in rural and 19.7% girls in urban were not aware of any source of bleeding. This difference was found to be statistically significant (p <0.05). Overall, 38.28% and 54.74% girls in rural and urban respectively had good knowledge about menstruation, which is statistically significant (p <0.01) [Table 2].

Table 2: Knowledge on menstruation among study participants

Variables	Rural	Urban	Chi square (P value)
	(N= 256) n (%)	(N=137) n (%)	
Ideal age at menarche (years)			
9 to 11	33 (12.89)	23 (16.8)	1.686 (0.430)
12 to 14	211 (82.43)	110 (80.3)	
15 to 16	12 (4.68)	4 (2.9)	
Cause of menstruation			
Physiological process	72 (28.12)	54 (39.42)	9.60 (0.022) *
To clean the body or remove dirty fluids	137 (53.52)	62 (45.25)	
For reasons of inner heat	4 (1.56)	6 (4.38)	
Don't know	43 (16.8)	15 (10.95)	
Source of menstrual bleeding			
Uterus	107 (41.8)	72 (52.5)	9.412 (0.024) *
Abdomen	20 (7.8)	6 (4.4)	
Urethra	48 (18.8)	32 (23.4)	
Don't know	81 (31.6)	27 (19.7)	
Frequency of menstrual cycles			
Once a month	228 (89.1)	125 (91.2)	4.188 (0.242)
2-3 weeks	14 (5.5)	2 (1.5)	
4-5 weeks	8 (3.1)	5 (3.65)	
Don't know	6 (2.3)	5 (3.65)	
Occurrence of menstruation during pregnancy			
Yes	16 (6.3)	11 (8)	0.464 (0.793)
No	222(86.7)	116 (84.7)	
Don't know	18 (7)	10 (7.3)	
Overall knowledge			
Poor	48 (18.75)	29 (21.17)	14.504 (0.001) *
Fair	110 (42.97)	33 (24.09)	
Good	98 (38.28)	75 (54.74)	

Table 3 reveals that 24.6% girls in rural and 26.28% girls in urban area were of the opinion that menstruation is debilitating. Regarding the restrictions during menstruation, 73% girls in rural and 71% girls in urban believed that a girl need not follow restrictions during menstruation. Also 44.53% girls in rural and 61.3% girls in urban believed that

one should avoid eating certain foods during menstruation and this was difference was found to be statistically significant ($\chi^2 = 10.054$, $p < 0.01$). The attitude towards menstruation was favorable among 78.52% girls in rural and 64.23% girls in urban. This was statistically significant ($p < 0.05$).

Table 3: Attitude of adolescent girls towards menarche

Variables	Rural	Urban	Chi square (P value)
	(N= 256) Frequency (%)	(N=137) Frequency (%)	
What do you feel about menstruation?			
As debilitating/bothersome	63 (24.6)	36 (26.28)	0.131 (0.71)
As natural process	193 (75.4)	101 (73.72)	
Do you believe that one should follow restrictions during menstruation?			
Yes	69 (27)	39 (28.5)	0.102 (0.74)
No	187 (73)	98 (71.5)	
Do you believe that one should avoid certain foods during menstrual cycles?			
Yes	114 (44.53)	84 (61.3)	10.054 (0.001)*
No	142 (55.47)	53 (38.7)	
Overall attitude towards menstruation			
Unfavorable	55 (21.48)	49 (35.77)	9.354 (0.002)*
Favorable	201 (78.52)	88 (64.23)	

DISCUSSION

Awareness about menstruation before menarche:

Awareness about menstruation before menarche was 50.78% in rural and 43.1% in urban area in this study. Paria B6 in a study in West Bengal reported that 44.72% girls in urban area and 30.07% girls in rural area had awareness about menstruation prior to attainment of menarche, which is contrary to our study.

Source of information about menstruation:

In this study, school teachers were the main source of information in rural (49.23%) and urban area (53.22%) followed by mothers (25.84% in rural) and then followed by friends (20.97% in urban). On the contrary, Paria B6 reported that mother was the main source of information about menstruation in 73.98% urban girls and 81.25% of rural girls. Other studies by Barathalakshmi J7 in urban area of Chidambaram and Devi RU8 in rural area in Kancheepuram also report mothers as the first source of information.

Knowledge about menstruation:

About the physiological nature of pregnancy, in the present study 28.12% and 39.42% of the girls in rural and urban areas respectively were aware of menstruation as a physiological process, while Kumar P9 in Uttar Pradesh found that 66.2% girls in rural and 74.3% girls in urban were

aware which was higher than the present study.

In an urban area at Coimbatore, Iswarya S5 reported that 88% girls were aware that menstruation was a physiological process, while in a rural area at Telengana, Chauhan P10 revealed that only 18.6% were aware, which was lesser than this study.

In context of source of menstrual bleeding, 41.8% girls in rural and 52.5% in urban were aware that it was uterus. Kumar P9 in Uttar Pradesh reported that, 24.3% and 41.9% of the girls in rural and urban respectively were aware that uterus was the source which was lower than the present study. On the contrary, Iswarya S5 found that 92.5% girls studying in a school in urban area, Coimbatore were aware of uterus as the organ from where bleeding occurs, which is higher than the current study.

Overall, 38.28% girls in rural area, 54.74% girls in urban had good knowledge about menstruation, while 42.97% girls in rural, 24.09% girls in urban had fair knowledge and 18.75% in rural, 21.17% in urban had poor knowledge on menstruation. Dillu R11, Haryana reported that 11% girls in urban had poor knowledge, 81% had fair knowledge and 8% had good knowledge about menstruation which was lower than the present study

Attitude towards menstruation:

In this study, menstruation was believed to be inconvenient by 24.6% girls in rural and 26.28% girls in urban, while Kumar P9, Uttar Pradesh reported that 48.1% girls in rural and 40.5% girls in urban considered it inconvenient. Regarding the restrictions during menstruation, 73% and 71% girls in rural and urban respectively in the present study felt that a girl need not follow restrictions, whereas in Andhra Pradesh Savanthe AM12 reported that 84.1% girls in urban believed that one should follow religious restrictions. In the present study, 44.53% in rural and 61.3% in urban believed that certain foods should be avoided during menstruation. Similarly, in Andhra Pradesh, Savanthe AM12 reported that adolescent girls in urban believed in avoiding curd (52.8%) and non-vegetarian foods (34.7%).

CONCLUSION

Although adolescent girls in rural area showed similar patterns to urban girls in most knowledge-related indicators, girls in urban areas exhibited better overall knowledge about menstruation. Awareness about menstruation before menarche and attitude towards the physiological nature of menstruation and imposed restrictions were more favorable among girls in rural areas than in urban areas. This suggests that, due to urbanization and greater

access to information, rural girls are gradually catching up with their urban counterparts. This study has identified gaps in knowledge and attitudes regarding menstrual hygiene, providing a valuable foundation for implementing corrective measures. Strengthening health education through Menstrual Hygiene Program with culturally sensitive communication strategies, particularly focusing on menstrual physiology, is essential in both urban and rural areas to bridge knowledge gaps. Addressing gaps in attitude requires multifaceted approach, including peer education, parental awareness programs, and broader societal initiatives. Efforts such as leveraging mass media, fostering political discourse, and promoting community dialogues are critical to normalizing menstruation and reducing associated stigma.

CONFLICT OF INTEREST

None

REFERENCES

1. World Health Organization. Coming of age- Adolescent health. Available at <https://www.who.int/health-topics/adolescents/coming-of-age-adolescent-health>. Accessed on 18th July 2019.
2. Planning commission. Report of the working group on adolescents for the tenth five year plan. Accessed on 18th July, 2019. Available at www.planningcommission.nic.in/aboutus/committee/workgroup/wg_adolcnts.pdf
3. Dasgupta A, Sarkar M. Menstrual hygiene: How hygienic is the adolescent girl? *Indian J Community Med.* 2008 April; 33(2):77-80.
4. Ram R, Bhattacharya SK, Bhattacharya K et al. Reproductive tract infection among female adolescents. *Indian journal of Community Medicine.* 2006;31(1):32-33.
5. Iswarya S, Varshini A. Impact of health education on menstrual hygiene: An intervention study among adolescent school girls. *Int J Med Sci Public Health* 2018;7(6):468-473.
6. Paria B, Bhattacharyya A, Das S. A comparative study on menstrual hygiene among urban and rural adolescent girls of West Bengal. *J Fam Med Primary Care* 2014;3:413-7
7. Barathalakshmi J, Govindarajan PK, Ethirajan N, Felix AJW. Knowledge and Practice of Menstrual Hygiene among School Going Adolescent Girls. *National Journal of Research in Community Medicine.* 2014 Apr-Jun; 3(2): 138-142.
8. Devi RU, Sivagurunathan C, Kumar PM. Awareness about menstrual hygiene among adolescent girls in rural area of Kancheepuram district-Tamil Nadu. *Int J Pharm Bio Sci.* 2016 Jan; 7(1): (B) 267 – 269.
9. Kumar P, Gupta SB, Danish I, Nipun A. A Comparative Study of Menstrual Practices among Urban and Rural Adolescent School Girls in Bareilly District, India. *Int.J.Curr. Microbiol.App.Sci.* 2016; 5(3): 42-46.
10. Chauhan P, Shaik RA, Anusha DVB, Sotala M. A study to assess knowledge, attitude, and practices related to menstrual cycle and management of menstrual hygiene among school-going adolescent girls in a rural area of South India. *Int J Med Sci Public Health* 2019;8(2):114-119.
11. Dillu R. Study to assess the knowledge regarding menstrual hygiene among adolescent girls of a selected school in Sonapat. *International Research Journal of Natural and Applied Sciences.* 2017 April; 4(4):71-78.
12. Savanthe AM, Nanjundappa VH. Menstruation: a cross-sectional study on knowledge, belief, and practices among adolescent girls of junior colleges, Kuppam, Andhra Pradesh. *Int J Med Sci Public Health* 2016;5:22-27.



PUBLISHER

**THE DIRECTORATE OF PUBLIC HEALTH AND PREVENTIVE MEDICINE
NO.359, ANNA SALAI, TEYNAMPET, CHENNAI - 600 006.**