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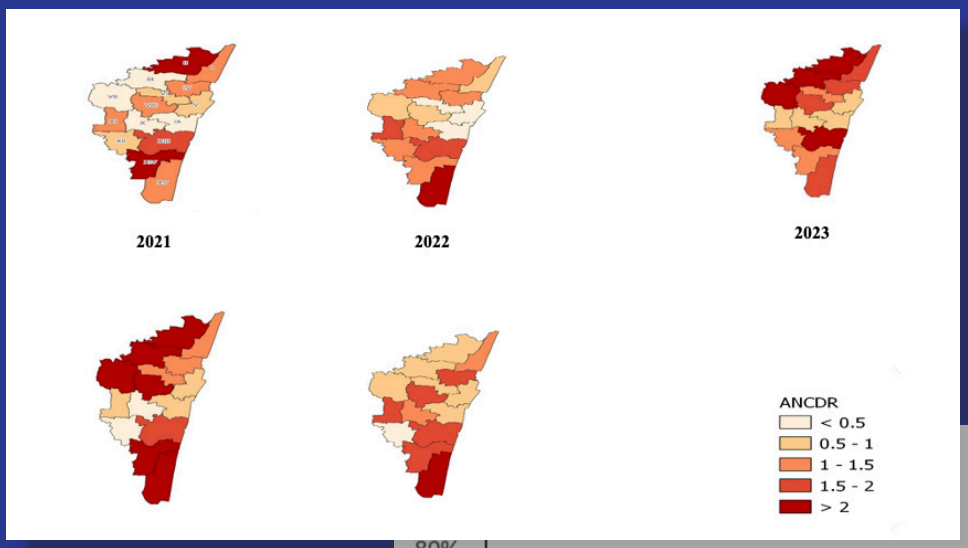

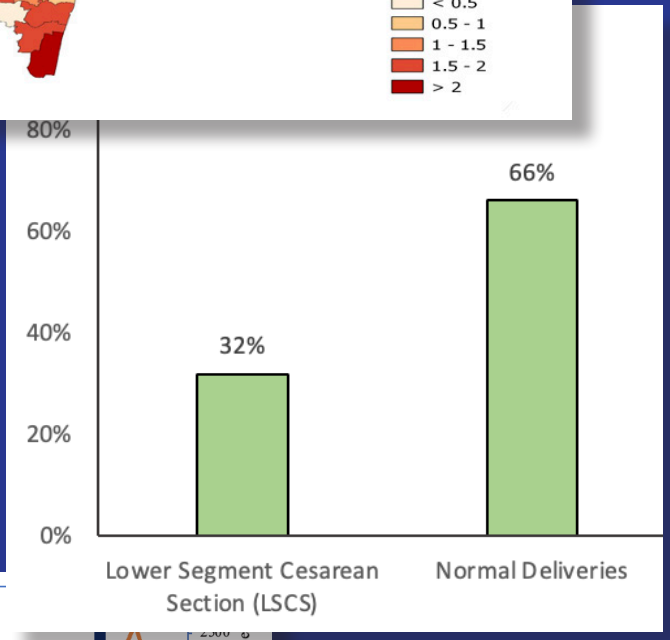

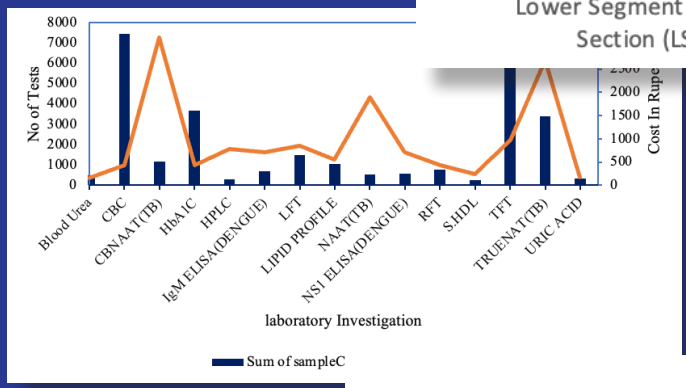

RESEARCH IS TO SEE WHAT EVERYBODY ELSE HAS SEEN, AND TO THINK WHAT NOBODY ELSE HAS

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ORIGINAL ARTICLE

FORMATIVE EVALUATION OF HMIS 3.0 PILOT, POONAMALLEE HUD, TAMIL NADU, 2025

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ABSTRACT

INTRODUCTION : Health Management Information System (HMIS) facilitates systematic recording, storage, and analysis of health data to support decision-making and strengthen service delivery. Tamil Nadu, an early adopter of digital health, launched HMIS in 2007 and is transitioning to HMIS 3.0, integrating services across care levels with improved analytics and real-time reporting. This study evaluates HMIS 3.0 implementation in public health facilities under Poonamallee HUD.
METHODS : A cross-sectional formative evaluation was conducted in all 13 public health facilities from February 2024 to March 2025 using input, process, and output indicators. Data sources included system logs, module usage reports, digital registers, and stakeholder interviews. Data were collected via Epicollect and analyzed in Epi Info.
RESULTS: Facilities were equipped with 52 desktops, 13 tablets, printers, and broadband. Nine of 16 modules were activated, and all staff received training. Compliance exceeded 98% for outpatient registration, prescriptions, laboratory tests, and inpatient documentation, while ABHA-ID creation remained low (23%). Outpatient consultations totaled 472,520, with 77% digital prescriptions and 59% linked to dispensed drugs; 83% of 134,856 lab reports were digitized.
CONCLUSION: HMIS 3.0 demonstrated infrastructure readiness and high module uptake. Gaps in ABHA-ID adoption, prescription–dispensation linkage, and module rollout highlight areas for targeted improvement before state-wide scale-up.
KEYWORDS : HMIS 3.0, Digital Health, Public Health Facilities, Infrastructure Readiness, Health Service Delivery.

INTRODUCTION

Health Management Information System (HMIS) is a process through which health data (inputs) are systematically recorded, stored, retrieved, and processed to support decision-making (outputs). This decision-making encompasses key managerial functions such as planning, organizing, and controlling healthcare services at the national, state, and institutional levels.[1] In the context of public health programs, HMIS primarily addresses healthcare delivery components such as antenatal care, immunization, and disease control as well as administrative aspects like reporting, inventory and financial management, and oversight of vehicles and personnel. Hence, an effective HMIS is fundamental to the efficient functioning of a health system. While such systems are still largely managed manually in most parts of India, they can also be implemented through computerized platforms.[1]

Tamil Nadu stands as one of the leading states in India when it comes to the implementation of the Health Management Information System (HMIS). The state embarked on its digital healthcare journey in 2007, introducing HMIS as a tool to streamline healthcare management and improve service delivery. Over the years, HMIS has been rolled out across various levels of the healthcare system, ensuring comprehensive coverage.[2]

Tamil Nadu is now transitioning to the latest version of the Health Management Information System (HMIS) – HMIS 3.0 – as part of its ongoing commitment to improving healthcare services through technology. Building on the success of earlier versions, HMIS 3.0 brings enhanced features designed to further streamline healthcare processes, improve data accuracy, and ensure seamless integration across all healthcare facilities, from Primary Health Centres (PHCs) to Government Medical College Hospitals (MCHs).

The upgraded system offers improved user interfaces, advanced analytics, and enhanced reporting capabilities, allowing healthcare professionals to access real-time patient data more efficiently. This transition marks a significant step forward in the state's digital healthcare journey, enabling better decision-making, faster service delivery, and improved patient care outcomes.

With HMIS 3.0, Tamil Nadu continues as a leader in healthcare innovation, ensuring that its health infrastructure is future-ready and capable of meeting the growing demands of its population.

The enhanced version, HMIS 3.0, integrates services across primary, secondary, and tertiary care facilities

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within a unified digital platform, allowing for seamless tracking of patient care and facility performance. Tamil Nadu is implementing HMIS 3.0 in a phased manner, with Poonamallee Health Unit District (HUD) identified as the one of the pilot study sites along with Poonamallee Government Hospital, Avadi Government Hospital, Tirunelveli Maternal and Child Health Centre (MCH), Kovilpatti MCH. This study aims to document the implementation process and assess the functionality of HMIS 3.0 in Poonamallee HUD to evaluate its readiness for broader rollout and to inform strategies for strengthening digital health service delivery.

OBJECTIVES

1. To describe the functioning of HMIS 3.0 in public health facilities in Poonamallee HUD, 2025
2. To evaluate the functioning of HMIS 3.0 based on infrastructure, system usage, and service delivery indicators in Poonamallee HUD, 2025.

METHODS

STUDY SETTING: Poonamallee is Health Unit district located in Thiruvallur District which comprises of 13 PHCs (8 urban PHCs, 2 Upgraded PHC and 5 Additional PHCs). HMIS was implemented in Poonamallee in all the 13 PHCs and is functional since February 2024.

STUDY DESIGN: A cross-sectional evaluation was conducted and the activities carried out implementation of HMIS 3.0 in Poonamallee HUD is described by abstracting information through Government Orders, operational guidelines and strategy documents and also by interviewing the stakeholders at State, District and Block level.

A logical framework approach was employed using input, process, and output indicators. Data sources included facility-level system logs, module usage reports, and digital registers. Analysis focused on system uptake, infrastructure readiness, and inter-facility variation in adoption.

SAMPLING AND SAMPLE SIZE: No sampling methods were used as all the thirteen public health facilities, including Urban PHCs, Urban CHCs, and Additional PHCs under Poonamallee HUD were included in the assessment.

Evaluation Period: Since Initiation (16.02.2024 to 31.03.2025).

DATA COLLECTION METHODS AND TOOLS: A record review of the facility-level system logs, module usage reports, and digital registers. Data abstraction forms were used to collect information from records. Data was collected by Epicollect software and data was managed using excel. Data analyzed by Epi info to derive proportions of input, process and output indicators.

Description of HMIS-3.0:

Figure 1 illustrates the functioning of HMIS 3.0.[2] The primary objectives of HMIS 3.0 are to streamline data collection and management, reduce manual errors, and digitize patient records and clinical workflows. By providing real-time access to comprehensive health data, HMIS empowers healthcare personnel and government officials to make timely and informed decisions. The integration of patient histories, diagnostics, prescriptions, and treatment plans into a unified digital system enhances continuity of care, minimizes redundancy, and improves overall treatment quality. Furthermore, HMIS supports optimal allocation of resources—including human resources, medical supplies, and infrastructure by providing accurate, up-to-date information to facility managers and district health administrators.

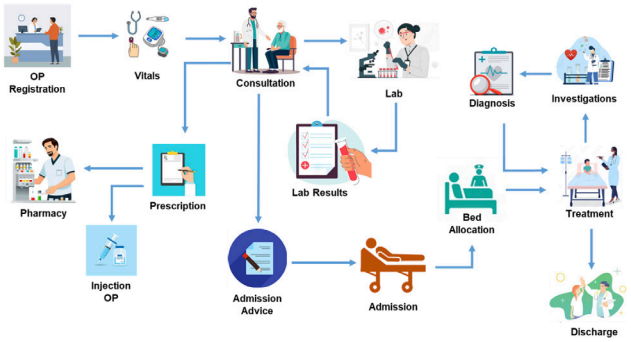

Figure:1 Structural frame work of HMIS-3.0 with key features

Key features of HMIS 3.0 include modules for patient registration, clinical information management, inventory tracking, human resource oversight, financial reporting, and advanced analytics. The platform's enhanced user interface is designed to simplify data entry and improve accessibility for frontline health workers. New functionalities such as mobile access and interoperability with national digital health systems (e.g., ABHA ID, electronic medical records) ensure wider usability and integration. Data security has also been significantly strengthened, with encrypted access and stricter user controls to protect patient privacy.

HMIS 3.0 introduces a range of advancements aimed at strengthening digital health delivery across all levels of care. The system features an improved, user-friendly interface that simplifies data entry and enhances user experience for healthcare workers. Enhanced security protocols, including stronger encryption and access controls, ensure the protection of sensitive patient data in line with privacy standards. HMIS 3.0 also offers seamless interoperability with other digital health platforms such as electronic medical records (EMRs) and national health databases, supporting comprehensive and integrated care. A key addition is mobile accessibility,

which allows healthcare providers to access the system remotely, facilitating improved service delivery in rural and underserved areas. Patients can also view their medical records through a dedicated mobile app, empowering them with access to their health information.

The implementation of HMIS 3.0 is aimed for benefits across the health system. Real-time access to patient data enables more accurate diagnoses and treatment decisions, leading to improved patient care and safety. By automating key administrative processes, HMIS 3.0 enhances operational efficiency, freeing up healthcare workers to focus more on clinical duties. The system also strengthens public health surveillance by offering insights into disease patterns and health trends, allowing for faster, data-driven responses to emerging health issues. Additionally, the digitization of records and automation of workflows contribute to cost-effectiveness by reducing the need for paper-based documentation, minimizing manual errors, and improving overall resource utilization.

Evaluation of HMIS 3.0 in Poonamallee HUD:

Inputs:

All 13 facilities were equipped with essential hardwares including 52 desktop computers, UPS units, 13 tablets, printers, and 11 biometric devices—all functional at the time of review. High-speed BSNL broadband connectivity was available at all facilities, with reported 100% uptime. Nine out of sixteen software modules were activated during the pilot, including patient registration, outpatient consultations, pharmacy (OP), laboratory (OP), admission-discharge-transfer (ADT), and dashboard modules. Seven modules—such as inpatient services, biomedical waste, and patient enquiry—were yet to be operational. All staff involved in data entry, clinical service, and pharmacy management were trained before rollout, ensuring foundational readiness for digital adoption. The pilot had been operational since February 2024.

Process:

All 13 facilities (100%) reported complete compliance in OP registration in HMIS, prescription generation, lab investigations, drug dispension, IPD admission entry, and IPD discharge entry. However, ABHA-ID generation was completed in only 3 out of 13 facilities (23%). Under maintenance and support, 100% of reported software issues (54 out of 56) and all hardware issues (2 out of 2) were resolved.

Input indicators	N	n	%
Infrastructure			
Desktops	52	52	100
UPS	52	52	100
Tablets	13	13	100
Printers	13	13	100
Internet	13	13	100
Connectivity			
BSNL 30,40&50 mbps	13	13	100
Modules			
Patient Registration module	13	13	100
Emergency Registration	13	13	100
Out Patient Department Management	13	13	100
Injection OP	13	13	100
Investigation for Lab (for OP)	13	13	100
Pharmacy Management (for OP)	13	13	100
Dash Board (OPD)	13	13	100
ADT (Admission Discharge Transfer)	13	13	100
Inventory- store Management	13	13	100
Mobile app for doctors	13	13	100
Mobile app for Citizens	13	13	100
Patient Enquiry	0	13	0
In Patient Department (IPD)	0	13	0
Investigation for Lab (for IP)	0	13	0
Pharmacy Management (for IP)	0	13	0
Bio Medical waste management	0	13	0
Trained Human resources			
Medical officers	13	13	100
Staff Nurses	13	13	100
DEOs	13	13	100
Pharmacists	13	13	100
Lab Assistants	13	13	100
HMIS Technical support	2	2	100

Outputs

A total of 4,72,520 outpatient consultations were recorded during the evaluation period, of which 3,63,026 prescriptions (Rx) were generated digitally through the HMIS platform, reflecting a 77% uptake of the prescription module. Of the 3,63,026 prescriptions (Rx) generated, 3,16,782 prescriptions were with drug advise entry. However, only 59% of the prescriptions (1,88,485 out of 3,16,782) had associated drug dispensation entries. Out of 1,34,856 investigations, 1,13,247 reports were digitally generated and recorded, resulting in 83% compliance. In terms of inpatient care, the number of inpatient admissions recorded (981) was slightly more than the number of discharges (963).

Output indicators	N	n	%
Rx Generated in HMIS	4,72,520	3,63,026	77%
Drug Dispensed in HMIS	3,16,782	1,88,485	59%
Lab report generated in HMIS	1,34,856	1,13,247	83%
Inpatient Admission in HMIS	981	981	100%
Inpatient discharge in HMIS	963	981	98%

DISCUSSION

This formative evaluation of the HMIS 3.0 pilot in Poonamallee HUD highlights both the opportunities and challenges of transitioning to a digital health management platform in Tamil Nadu. The pilot demonstrated strong infrastructural readiness, with universal availability of hardware, reliable internet connectivity, and complete training coverage across all facilities. These inputs ensured a favorable environment for digital adoption, in contrast to earlier experiences of fragmented or delayed rollouts of health information systems in other parts of India.

Process indicators suggest that outpatient workflows including registration, prescription generation, laboratory services, and pharmacy modules were successfully digitized across facilities, indicating rapid uptake of digital systems by healthcare staff. This aligns with international evidence that strong frontline engagement and adequate technical support are critical determinants of early success in health information system implementation. However, certain critical gaps persisted. For example, despite 77% digital prescription generation, only 59% had corresponding drug dispensation records, pointing to workflow discontinuities and possible duplication of manual processes. Similarly, although inpatient admissions and discharges were captured digitally, the full inpatient service modules were yet to be activated, limiting the scope of comprehensive patient tracking.

The relatively low coverage of ABHA-ID generation (23%) underscores the challenges of integrating HMIS 3.0 with national digital health initiatives. Ensuring interoperability with ABHA and other national platforms is essential for building a unified health record system. Addressing these integration challenges will be crucial before statewide expansion.

Outputs from the evaluation also emphasize that while digital recording has improved data completeness and accessibility, there is still a need to bridge the gap between recorded prescriptions, dispensed drugs, and laboratory services to ensure continuity and accuracy of digital records. These findings are consistent with lessons from digital health transitions in other states, where partial module usage and incomplete workflows reduced the effectiveness of new platforms.

An important advancement with HMIS 3.0 is the shift from paper-based records to a fully digital platform, enabling real-time monitoring of health services and patient care. Previously, data entry, reporting, and supervision relied on manual registers, leading to delays, errors, and increased administrative workload. With HMIS 3.0, facility and district managers can access up-to-date information on service delivery, resource utilization, and patient outcomes, which facilitates timely decision-making. This real-time monitoring also has financial implications, as improved efficiency and reduced duplication of manual processes can potentially lower operational costs and optimize budget allocation for the government. The system thus not only strengthens service delivery but may also contribute to cost savings in public health administration.

LIMITATIONS

This evaluation primarily focused on the Input–Process–Output (IPO) model of HMIS 3.0 implementation. Portal-based evaluations using frameworks such as the CDC Surveillance System Evaluation Framework or the PRISM Framework which assess technical, organizational, and behavioral determinants affecting data quality and use, including real-time monitoring of service delivery and public health indicators were not included in this study. Future evaluations should incorporate these dimensions to provide a more comprehensive understanding of system performance.

CONCLUSION

The evaluation of HMIS 3.0 in Poonamallee HUD demonstrates that while the digital infrastructure and

foundational systems are in place, consistent and holistic adoption of modules across facilities remains a challenge. Outpatient and laboratory modules demonstrated consistent usage and formed the core of digital data entry. However, gaps existed between prescriptions and drug dispensation, limited inpatient module activation. The current phase represents a critical opportunity to strengthen system usability, reinforce training, and improve module integration before state-wide scale-up.

To address existing gaps and support the effective scaling of HMIS 3.0, several areas merit qualitative investigation. These include assessing user experience and system usability through in-depth interviews with healthcare providers and data entry staff to identify practical challenges and workflow inefficiencies. Future evaluations should incorporate portal-based assessments using the CDC Surveillance System Evaluation Framework or the PRISM Framework to examine technical, organizational, and behavioural determinants. Integrating real-time monitoring will allow assessment of the system's impact on service delivery and public health indicators. Evaluating the effectiveness of training, particularly in low-performing facilities, can guide targeted capacity-building strategies. Finally, capturing patient experiences with digital registration and access to care will help align the HMIS platform more closely with service delivery needs.

CONFLICT OF INTEREST

None

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ORIGINAL ARTICLE

PATTERNS AND PRACTICES ON MENSTRUAL HYGIENE AMONG RURAL AND URBAN ADOLESCENT GIRLS IN TAMIL NADU: A CROSS-SECTIONAL STUDY

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INTRODUCTION

Adolescence is derived from Latin word 'Adolescere' which means 'to grow up'. Adolescents are individuals between 10 and 19 years of age1. They represent 16% of the world's population and 18% of Indian population. Adolescence period is categorized as early adolescence (10-14 years) and late adolescence (15-19 years). During early adolescence, physical changes begin with growth spurt and development of the sex organs and secondary sexual characteristics. In the late adolescence period, the major physical changes have occurred by now and the psychological changes develop.[2]

Adolescence in girls is a special period as it the period of psychological and physical preparation for safe motherhood and is characterized by onset of menstruation (menarche) in girls. Menstruation, and the menstrual cycle are characterized by variability in volume, pattern and regularity. The onset of menstruation is between 10 years and 16 years of age, though its timing may vary depending on nutritional, sanitary, and socioeconomic conditions. Throughout the childbearing years of the women, it remains as a normal physiological phenomenon indicating woman's reproductive health and the capability of procreation and cease at menopause approximately between the ages of 45-55 years. The menstrual cycle is often irregular during first two years after menarche due to anovulatory cycles because of immature hypothalamic–pituitary–ovarian axis, but regular menstrual cycle becomes established by the third year after menarche.[3,4,5]

Menstrual hygiene relates to the health care needs and requirements of women during menstrual cycle. UNICEF defined Menstrual hygiene Management (MHM) as 'women and adolescent girls using a clean menstrual management material to absorb or collect blood that can be changed in privacy as often as necessary for the duration of menstrual period, using soap and water for washing the body as required and having access to facilities to dispose of used menstrual management materials. Thus, use of sanitary pads and adequate washing of the genital area are the essential good hygienic practices during menstruation which can protect the health in the long run.[6] Gynecological and reproductive tract infections are more likely in poor hygienic practices and unsafe sanitary conditions. There is a substantial lacuna in menstrual hygiene practices among adolescent girls and differences in menstrual hygiene practices based on spatial differences exist. Hence this study is attempted to compare the menstrual hygiene patterns and practices among adolescent girls in rural and urban field practice area of tertiary care teaching hospital in Tamil Nadu.

METHODS

This is a community based analytical cross-sectional study conducted among adolescent girls aged 11-19 years age residing in the urban and rural field practice areas of Karpaga Vinayaga Institute of Medical Sciences & Research Centre, Tamil Nadu during August 2017 to October 2019.

SAMPLE SIZE AND SAMPLING: Based on a study by Barathalakshmi et al., where 37.7% of girls followed good menstrual hygiene practices, the required sample size was calculated with a 5% allowable error and 10% non-response rate, yielding 410 participants. Using probability proportional to size, the sample was distributed as 273 adolescent girls from rural areas and 137 from urban areas; ultimately, the study

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was carried out among 256 rural and 137 urban participants.

STUDY TOOL: Semi structured questionnaire containing the details on socio-demographic characteristics, age of menarche, patterns and problems, hygiene practices and restrictions during menstruation.

DATA COLLECTION: Adolescent girls were visited at their houses and questionnaire was administered by one-on-one direct interview method. Assent from adolescent girls and consent from their mothers was obtained.

OPERATIONAL DEFINITION: Adolescent girls who changed pads ≥ 3 pads/ day, used disposable sanitary pads or clean cloth, took bath daily, cleaned their external genitalia with soap and water daily during menstruation, were considered to have followed good menstrual hygiene practices.

DATA ANALYSIS: The data obtained were entered in Microsoft Excel sheet and analyzed using SPSS. Quantitative variables were summarized as mean and standard deviation or median and interquartile range. Qualitative variables were summarized as Percentages/proportions. Chi square test was used as the test of significance for categorical variables. Menstrual hygiene practices were assessed using four items. Those who practiced all the 4 were considered to have followed good menstrual hygiene practices and the remaining were considered to have inadequate practice on menstrual hygiene.

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

RESULTS

Table 1. Socio Demographic characteristics of study participants

Variables	Rural (N= 256) n (%)	Urban (N=137) n (%)	Total N=393 n (%)
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)
Toilet facility at home	198 (77.34)	137 (100)	335 (85.24)
Toilet facility at study place	256 (100)	137 (100)	393 (100)

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). Majority belonged to nuclear family in rural (63.67%) and urban (73%). Regarding the place of education, 80.1% of the adolescent girls in rural and 89.1% in urban were studying in private institutions. All the girls in urban had toilet facility at home, whereas 198 (77.34%) girls in rural had toilet facility at home. [Table 1]

Table 2: Patterns and practices during menstruation among study participants

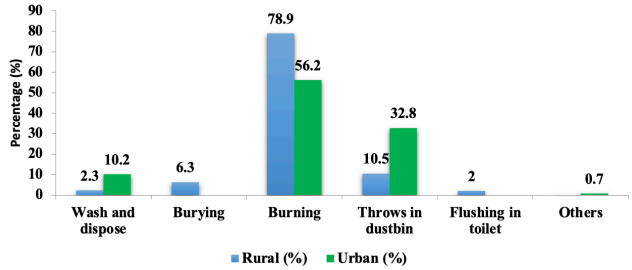
Variables	Rural (N= 256) Frequency (%)	Urban (N=137) Frequency (%)	Significance
Age at menarche in years [mean ±(SD)]	**12.53 (1.19)**	**11.98 (1.09)**	**4.91 (<0.001)***
Frequency			
Once a month	215 (83.98)	119 (86.9)	
Once in 2-3 weeks	10 (3.91)	4 (2.9)	1.06 (0.79)
Once in 4-5 weeks	6 (2.34)	4 (2.9)	
Others/ Irregular	25 (9.77)	10 (7.3)	
Days of bleeding in each cycle [median (IQR)]	5 (2)	5 (2)	
Amount of flow			
Scanty	15 (5.86)	6 (4.38)	
Normal	192 (75)	117 (85.4)	**11.031 (0.001)***
Excess	49 (19.14)	14 (10.22)	
Type of absorbent used			
Sanitary pads	256 (100)	137 (100)	
Bathing daily during menstruation			
Yes	256 (100)	137 (100)	
Washing genitalia during menstruation			
Water only	45 (17.58)	27 (19.71)	0.27 (0.6)
Water and soap	211 (82.42)	110 (80.29)	
Number of sanitary pads changed per day during menstruation			
≤2	63 (24.60)	40 (29.20)	0.97 (0.32)
≥3	193 (75.39)	97 (70.80)	
Overall practice			
Good practice	160 (62.5)	90 (65.69)	0.393 (0.53)
Inadequate practice	96 (37.5)	47 (34.31)	

Patterns and practices of menstruation:

The mean age at menarche in rural area was 12.53±1.19 years, whereas in urban, it was 11.98±1.09 years, the difference of which is statistically significant (p<0.001). The length of menstrual cycle was one month in 83.98% girls in rural and 86.9% girls in urban. Regarding the flow, 85.4%

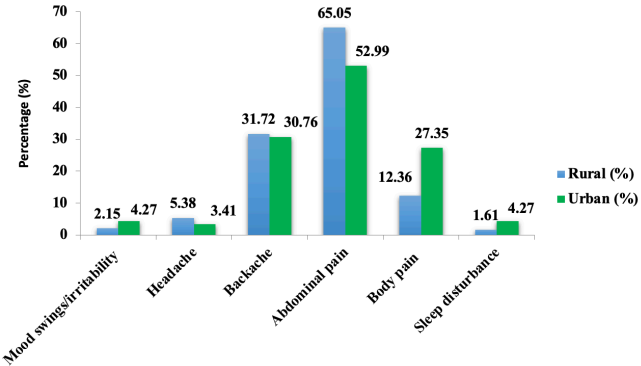
girls in urban area have normal flow of menstruation whereas in rural area, only 75% girls have normal flow, the difference is statistically significant (χ^2=11.031; p value <0.001). The median duration of menstrual flow in both the areas was 5 (2) days.

Figure 1: Methods of disposal of absorbent materials



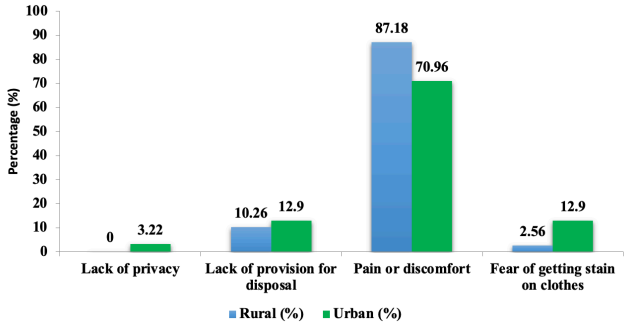
All the girls, both in rural and urban used sanitary pads. All the girls took bath daily during menstruation. Regarding the cleaning of genitalia, 82.42% girls in rural and 80.29% girls in urban area washed the genitalia with soap and water daily during menstruation. More than 70% girls in rural and urban changed 3 or more than 3 pads daily. No statistically significant difference was noted between girls in rural and urban area regarding washing the genitalia with soap and water and number of pads changed daily. Good hygienic practices (changing ≥ 3 absorbents/day, using disposable sanitary pads or clean cloth, took bath daily, cleaned their external genitalia with soap and water daily during menstruation) were followed by 62.5% girls in rural area and 65.69% girls in urban area. The difference was not statistically significant (χ^2 =0.393; p value =0.531). [Table 2] Burning was the most common method of disposal in both rural (78.9%) and urban areas (56.2%) [Fig 1].

Figure 2: Types of Premenstrual /menstrual problems experienced by study participants



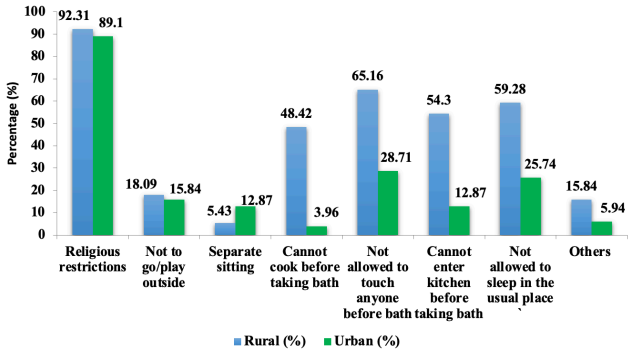
Premenstrual or menstrual symptoms and school absenteeism among adolescent girls: Premenstrual or menstrual problems are more among adolescent girls in urban area (85.4%) than rural area (72.66%) and this difference is found to be statistically significant (χ^2 =8.21; p value <0.001). The most common problem was abdominal pain (65.05% in rural and 52.99% in urban), followed by backache (31.72% in rural and 30.76% in urban) and body pain (12.76% in rural and 27.35% in urban) [Fig 2]. Absenteeism during menstruation was reported by 39 (15.23%) girls in rural and 31 (22.63%) girls in urban, which was not statistically significant (χ^2 3.33; p 0.07). Pain or discomfort (87.18% in rural and 70.96% in urban) was the most common reason [Fig 3].

Figure 3: Reasons for school absenteeism



Restrictions practiced during menstruation: Restrictions were practiced by 221 (86.3%) girls in rural and 101 (73.72%) girls in urban areas. This difference was significant statistically (χ^2=9.580, p value-0.002). Among the 221 (86.3%) adolescent girls who practiced restrictions in rural, 92.31% were not allowed to attend religious restrictions, 65.16% were not allowed to touch anyone before taking bath, 59.28% were not allowed to sleep in the usual place, 54.3% were restricted from entering kitchen before taking bath, 48.42% were not allowed to cannot cook before taking bath.

Figure 4: Types of restrictions practiced by adolescent girls



The other restrictions (15.84%) were: not allowed to touch plants or to feed animals. Among the 101 (73.72%) girls who practiced restrictions in urban, 89.1% were not allowed to participate in religious activities, 28.71% from touching anyone before taking bath and 25.74% were restricted from sleeping in the usual place [Fig 4].

DISCUSSION

In the present study, the mean age at menarche in rural area was 12.53±1.19 years, whereas in urban, it was 11.98±1.09 years, which is similar to a study done by Senapathi P[8] in Mangaluru Karnataka where it was 12.71 ± 0.67 Years in rural and 12.57 ± 0.73 Years in urban area.

In this study, normal menstrual flow was reported by 75% girls in rural and 85.4% girls in urban. Similarly, Ali TS[9] in urban Karachi, Pakistan reported that 70% girls had normal menstrual flow. The number of days of menstrual flow was 5 days in 31.25% girls in rural and 40.1% girls in urban in this study, while Jogdand K[10] in a slum in Guntur reported 15.96% girls had blood flow for more than 5 days. In another study, Devi RU[11] in a rural area in Kancheepuram, 20% girls reported having menstrual flow for more than 5 days.

In this study, menstrual or premenstrual symptoms were experienced by 72.66% girls in rural and 85.4% girls in urban. Abdominal pain was experienced by 65.05% girls in rural and 52.99% in urban. Similarly in Tamil Nadu, Jothy K[12] in rural areas of Cuddalore, Barathalakshmi J[7] in urban Chidambaram and Priya SS[13] in rural area of Salem reported that 78.8% and 75.6% and 94.6% girls respectively experienced abdominal pain. In Indian context, Agarwal N[14] reported that 59.7% girls in a rural area in Chhattisgarh had abdominal pain and Kumar K[15] in Bihar reported 79.5% girls in rural area had abdominal pain. Problems during menstruation were reported by adolescent girls in other countries. Alosaimi JA[16] in a city in Saudi Arabia reported that 57.6% experienced abdominal pain.

All the girls in this study (rural and urban) reported that they used sanitary pads only which was considered as one of the good hygienic practices. Similarly, Iswarya S[17] in an urban area in Coimbatore reported 100% sanitary pads usage among adolescent school girls. Barathalakshmi J[7] in urban Chidambaram and Seenivasan P[18] in urban Chennai, Tamil Nadu reported sanitary pads usage among 90.5% girls and 92.6% girls respectively. In other states, Kumar P[19] in Uttar Pradesh reported sanitary pads usage in 35.1% rural and 62.5% urban girls. Mohanty S[20] in urban slums of Odisha, Ramachandra K in urban Bangalore K[21], Kapoor G[22] in rural Jammu and Kumar K[15] in rural Bihar reported pad usage as 56.8%, 69%, 59% and 70% respectively. Whereas Chauhan P[23] in rural Telangana reported 97% sanitary pads usage among adolescent girls.

In the context of changing pads per day, 36.33% girls in rural changed 4 pads per day and 37.23% in urban changed 3 pads per day. Fehintola FO[24] in a city in Nigeria reported that 19% changed the materials three or more times. Mohanty S[20] in urban slums of Odisha reported that 20% girls changed the absorbent only once a day. In Telengana, Chauhan P[23] reported that 52% girls in rural changed twice and 43.6% changed more than twice a day. Parle J[25] in rural Maharastra reported that 49.2% girls changed the pads twice daily. Iswarya S[17] in study at urban Coimbatore reported that 61.5% girls changed 2-3 pads per day and 38.5% changed more than 4 pads per day.

In the present study good hygienic practices were followed by 62.5% girls in rural, 65.69% girls in urban and inadequate practice were found in 37.5% in rural, 34.31% urban while Barathalakshmi J[7] in urban Chidambaram, Tamil Nadu reported that only 37.7% girls were following good hygienic practices. Parle J[25] in rural Maharashtra reported that 47.1% followed good practice and 52.8% girls had poor practice and during menstruation. In a city in Iran, Siabani S[26] reported poor practice among 81% girls and in a study by Upashe SP[27], in a town in Western Ethiopia 39.9% girls followed good practices on menstrual hygiene.

In this study, the methods of disposal of used absorbent material were burning (78.6% in rural and 56.2% in urban), throwing in dustbin (urban 10.5%, urban 32.8%), washing and disposing (urban 10.2%, rural 2.3%), burying (rural 6.3%) and flushing in toilet (urban 2%). Similarly, Kumar P[19] in Uttar Pradesh reported that 47.8% girls in rural and 33.5% girls in rural disposed by burning. Thakre SB[28] in Nagpur reported that 52.2% girls disposed by burning (rural 60.96%, urban 46.89%), 39.79% disposed along with the routine waste and 6.72% used other methods of disposal. Deepa S[29] in a study at rural areas of Coimbatore, Erode and Tiruppur reported that 48.5% practiced burying as a method of disposal. Kapoor G[22] in rural Jammu reported that 70.45% were throwing with routine waste and 7.58% burnt the used material.

Absenteeism during menstruation was observed in 15.23% girls in rural and 22.63% girls in urban in the present study. In contrast, Kumar P[19] in Uttar Pradesh reported as 44.7% in rural and 40.9% in urban. Alosaimi JA[16] in Saudi Arabia reported 27.2% absenteeism and Chauhan P49 reported 32.7% absenteeism in rural Telangana. Varghese MM[30] in Porur, Chennai urban reported 5.4% absenteeism while Parameaswari PJ[31] reported 30.1% in urban Chennai, Tamil Nadu.

Restrictions during menstruation were practiced by 86.3% girls in rural and 73.72% girls in urban areas. Restriction regarding religious activities was the most commonly practice, rural (92.31%) and urban (89.1%). Similar results

were shown by Barathalakshmi J[7] in urban Chidambaram where 98.6% were not allowed to visit temple and Parle J[52] in rural Maharashtra where 88.9% girls were prevented from visiting holy places. On the contrary, Fehintola FO[28] in a city in Nigeria reported that 45.75% girls were restricted from attending celebration and festivities.

Regarding food restrictions, 47.27% girls in rural and 59.9% girls in urban areas avoided foods such as non-vegetarian foods, sweets, papaya, mango and curd, whereas Fehintola FO[24] in a city in reported that 17.92% restricted certain foods during menstruation. In a study at Chennai by Varghese MM30, food restriction was reported by 69.3% girls. Jothy K[12] in rural Cuddalore reported that 49.7% avoided certain foods such as sour foods, papaya, radish and non-vegetarian dishes during menstruation. There was a significant difference in restrictions practiced in rural and urban areas. Also, the restrictions practiced were higher among Hindus (rural 95.5%, urban 83.81%) than other religions. This shows that religion was significantly associated with restrictions both in rural and urban areas. Varghese MM30, Chennai also reported that religious restrictions were more common among Hindus. This may be because restrictions are believed to be part of religion in India.

CONCLUSION

This study highlights important differences in menstrual patterns and hygiene practices between rural and urban adolescent girls in Tamil Nadu. The mean age at menarche was earlier among urban girls, likely reflecting better nutritional and living conditions compared to their rural counterparts. Menstrual and premenstrual problems were more frequently reported by urban girls. Notably, all participants in both rural and urban areas reported the use of sanitary napkins, a key component of good menstrual hygiene. This reflects the significant role of the Menstrual Hygiene Programme in Tamil Nadu, implemented under the Rashtriya Kishor Swasthya Karyakram (RKSK), which aims to promote menstrual hygiene among adolescent girls aged 10–19 years in rural areas. However, overall adherence to good hygiene practices was suboptimal in both settings, indicating that the programme needs to be strengthened beyond the supply of sanitary napkins. Burning was the most common method of sanitary pad disposal, despite being an unsafe practice with environmental concerns. School absenteeism during menstruation was significant in both groups, underscoring the impact of menstruation on educational participation. Restrictive practices were more common in rural areas, although religious restrictions were widely observed across both rural and urban populations.

The findings emphasize the urgent need for targeted menstrual health education that dispels myths and taboos, promotes safe and hygienic practices, and encourages sustainable disposal methods. Schools, health workers, and community platforms can serve as effective channels for disseminating accurate information and fostering supportive environments.

At the policy level, ensuring access not only to affordable menstrual products but also to safe and sustainable disposal facilities is critical. Strengthening menstrual hygiene management is vital not only for improving reproductive health outcomes but also for empowering adolescent girls, reducing school absenteeism, and supporting their long-term educational and social development.

CONFLICT OF INTEREST

None

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ORIGINAL ARTICLE

COST SAVINGS FOR THE PUBLIC THROUGH INTEGRATED ESSENTIAL LABORATORY SERVICES (IELS): A CROSS-SECTIONAL STUDY, NAMAKKAL, INDIA, 2025

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INTRODUCTION

Globally, the World Health Organization (WHO) has emphasized the critical role of diagnostics in achieving Universal Health Coverage (UHC), highlighting that nearly 47% of the global population has little or no access to essential diagnostics.[1] The Lancet Commission on Diagnostics (2021) further underscored the "diagnostics gap" as a major barrier to equitable healthcare delivery, especially in low- and middle-income countries, where inadequate access leads to delayed diagnoses, poor treatment outcomes, and higher financial burden on patients. Bridging this gap through public sector diagnostic coverage is considered central to advancing global health equity.[2] In India, The 70:70 paradox limits access to healthcare in India: people incur 70% of their healthcare expenses out of their pockets, of which 70% of the amount goes only toward medications, leaving them in debt and impoverished. Some of India's main health obstacles are high out-of-pocket expenses (OOPE), inadequate or ambiguous quality of medical care, restricted access, and lack of proper medical care availability.[3] Recognizing this, the Government of India introduced the Free Diagnostic Services Initiative (FDSI) under the National Health Mission in 2015, aiming to provide an assured menu of essential tests at all levels of care. This aligns with the National Essential Diagnostics List (NEDL) 2019, which was the first of its kind globally, placing India at the forefront of institutionalizing essential diagnostics within UHC frameworks.[4] The Government of Tamil Nadu launched the Essential Diagnostics Services System (EDSS) in 2019 under the Free Diagnostic Services Initiative (FDSI) to enhance access to quality laboratory services. In 2022, this programme was redesignated as Integrated Essential Laboratory Services (IELS), focusing on strengthening laboratories by providing essential equipment, reagents, and a Laboratory Information Management System (LIMS) interlinking primary, secondary, and tertiary care facilities. Under this initiative, health facilities are mandated to provide an assured menu of tests either in-house or through a hub-and-spoke model.

Financial barriers to diagnostics contribute significantly to out-of-pocket expenditure (OOPE) in India, with poorer populations often disproportionately affected.[5] Broader health financing challenges also emphasize the need for sustainable public diagnostic coverage to mitigate inequities.[6]

Tamil Nadu has been one of the leading states in operationalizing free diagnostic services, with IELS serving as a model for integrating laboratory networks through digital platforms and cluster-based management. In Namakkal district, 64 PHCs, 8 GHs, 1 GMCH, and 1 DPHL are interconnected through 30 IELS clusters. This study estimated the Out of Pocket Expenditure(OOPE) saved by calculating the equivalent private-sector costs of diagnostic tests performed between January–June 2025, assuming zero direct cost to patients under IELS.

METHODS

A descriptive cross-sectional study was undertaken using data retrieved from the IELS software for the period January to June 2025. During this six-month interval, a total of 31,469 diagnostic samples were processed across 73 distinct tests performed at different levels of healthcare delivery, ranging from primary to tertiary care facilities. To maintain analytical rigor and restrict the scope to patient-related diagnostics, environmental samples including operation theatre (OT) swabs, OT sterility assessments, labour ward surveillance swabs, and water samples were excluded. Following this exclusion, the dataset comprised 29,478 patient-derived samples representing 69 clinical diagnostic tests, which served as the basis for further analysis. Descriptive statistics were employed to summarize

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the distribution of tests by type and level of healthcare facility. The number of samples included for each of the 69 clinical diagnostic tests was tabulated.

To estimate the potential out-of-pocket expenditure (OOPE) savings attributable to the IELS initiative, a comparative cost analysis was performed. Data on the prevailing cost of diagnostic tests in the private sector were collected from five laboratories within Namakkal district, of which two held accreditation from the National Accreditation Board for Testing and Calibration Laboratories (NABL), thereby ensuring quality and reliability of reported costs. The mean unit cost of each test was calculated by averaging values across these laboratories. The OOPE savings were subsequently derived by comparing the estimated private-sector expenditure for the same volume and type of diagnostic services with the zero-cost model under IELS, where patients incur no financial burden for accessing diagnostic services.

RESULTS

Between January and June 2025, 29,478 samples covering 69 diagnostic tests were processed under the Integrated Essential Laboratory Services (IELS) in Namakkal district. The estimated private sector equivalent cost was ₹285.3 lakhs, representing the out-of-pocket CBC Count (7,464 tests; ₹31.5 lakhs), Thyroid Hormone Analysis (5,768; ₹56.1 lakhs), and HbA1c (3,686; ₹15.7 lakhs). High-cost molecular diagnostics such as TRUENAT (3,377; ₹91.2 lakh) and CBNAAT (1,155; ₹36.7 lakh) accounted for a substantial share of savings. Additional notable tests included Liver Function Tests (₹12.5 lakh), Renal Function Tests (₹3.2 lakh), and Lipid Profile (₹6.0 lakh). These findings underscore the significant financial protection provided by IELS through free access to essential diagnostics.

Table 1: Top five lab investigations sent through IELS

S.No	Test name	Number of samples
1	Complete Blood Count(CBC)	7464
2	Thyroid Hormone Analysis (T3, T4, TSH)	5768
3	Glycosylated haemoglobin (HbA1C)	3686
4	TRUENAT	3377
5	LFT (Liver Function Test)	1475

Figure 1 shows the utilization pattern by type of investigation. The Complete Blood Count (CBC) was the most frequently performed test (7,464 samples), followed by Thyroid Function Tests (5,768) and HbA1c (3,686), reflecting the high demand for routine and chronic disease-related diagnostics. In contrast, the number of molecular diagnostics such as TRUENAT (3,377) and CBNAAT (1,155) was comparatively lower; however, these tests had the highest average unit cost (>₹2,500–₹3,000), contributing disproportionately to the estimated private sector equivalent expenditure. Together, TRUENAT and CBNAAT accounted for nearly half of the total financial savings. Moderately priced tests such as Liver Function Tests (1,442; ₹12.5 lakh), Renal Function Tests (1,654; ₹3.2 lakh), and Lipid Profiles (1,689; ₹6.0 lakh) showed consistent utilization, aligning with the rising burden of non-communicable diseases. Infectious disease diagnostics including IgM ELISA (dengue) and NS1 ELISA (dengue) were less frequently requested.

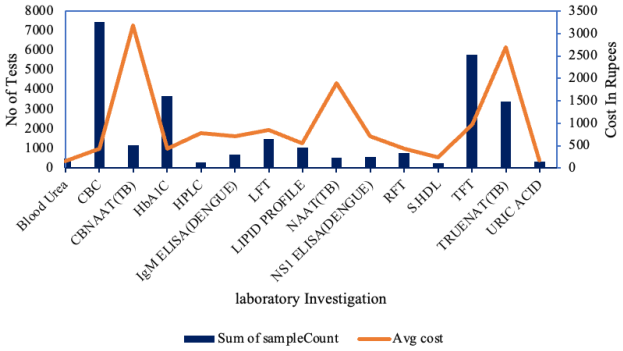

Figure 1: Test Utilization and Average Private-Sector Costs under IELS, Namakkal

DISCUSSION

This study demonstrates that the IELS programme in Namakkal significantly reduced out-of-pocket expenditure (OOPE), saving an estimated ₹285 lakhs over a six-month period. By providing an assured package of essential diagnostics free of cost, the programme directly addressed one of the major contributors to medical impoverishment in India. A key limitation of this analysis is the assumption that, in the absence of IELS, all patients would have sought private-sector diagnostic services. In reality, some patients may have accessed public secondary or tertiary facilities where selected tests are available, while others may have foregone necessary investigations altogether due to financial constraints. Consequently, the savings reported here may represent an upper-bound estimate. Nevertheless, the findings are consistent with previous evidence from India, which highlights the disproportionate diagnostic burden borne by vulnerable and low-income populations.[7,8] High OOPE on diagnostics not only delays care-seeking but also increases the risk of health expenditure, particularly for households managing chronic diseases such as diabetes, thyroid disorders, and tuberculosis.[9] Global studies similarly show that diagnostic access is a critical determinant of universal health coverage (UHC), with the Lancet Commission on Diagnostics estimating that nearly 50% of the world's population lacks access to basic tests.[10]

The results from Namakkal also illustrate the dual role of IELS in meeting both high-volume, low-cost needs (e.g., CBC, HbA1c, thyroid function tests) and high-cost, lower-frequency molecular diagnostics (e.g., TRUENAT and CBNAAT). The inclusion of advanced molecular tests under a free public diagnostic framework is particularly significant in the Indian context, where tuberculosis remains a major public health challenge and molecular testing is critical for early detection and drug-resistance monitoring.[11] By absorbing these costs, IELS not only provides financial protection but also strengthens disease control efforts.

Before the implementation of Integrated Essential Laboratory Services (IELS), biological specimens such as sputum and serum for infections including dengue, scrub typhus, leptospirosis and typhoid were routinely collected at peripheral facilities but often had to be transported to higher centres without any formal support for field staff. With the roll-out of IELS, a structured incentive system was introduced—₹6 per kilometre for transport of samples and ₹100 per day as a daily allowance. This financial support has encouraged health-care workers to undertake sample transportation work that was previously difficult to sustain due to lack of incentives. The improved motivation and logistical support may partly explain the higher number of samples reaching laboratories in the post-IELS period, contributing to the observed savings in out-of-pocket expenditure for patients.

Moreover, the integration of laboratory information through the Laboratory Information Management System (LIMS) enhances surveillance, ensures accountability, and supports rational utilization of resources across primary, secondary, and tertiary levels of care. This aligns with WHO's Essential Diagnostics List (EDL) and India's commitment under the National Health Policy 2017 to expand access to diagnostics as part of comprehensive primary healthcare.[12,13]

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ORIGINAL ARTICLE

TRENDS AND MATERNAL OUTCOMES OF TEENAGE PREGNANCY IN POONAMALLEE HUD, TAMIL NADU, 2022 – 2025

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ABSTRACT

INTRODUCTION : Adolescent pregnancy is a major global public health concern, associated with increased maternal and neonatal risks such as anemia, eclampsia, preterm birth, and low birth weight. Despite a global decline in adolescent birth rates, India continues to report substantial teenage childbearing. NFHS-5 (2019–21) shows that 6.8% of Indian women aged 15–19 years have begun childbearing, with Tamil Nadu reporting 6%. Teenage pregnancy is strongly linked to early marriage, lower education, and socioeconomic disadvantage. This study aimed to assess the trends, sociodemographic characteristics, and maternal outcomes of teenage pregnancy in Poonamallee HUD, Tamil Nadu, from 2022 to 2025.
METHODS : A descriptive cross-sectional study was conducted in Poonamallee HUD, Tamil Nadu, using PICME records of 281 teenage pregnancies (2022–2025). Sociodemographic details, pregnancy outcomes, and complications were analyzed.
RESULTS: The prevalence was 1.09%, rising to 2.0% in 2024–2025, coinciding with strengthened registration under PICME 3.0 (January 2024). Most cases were in the 18–19 year group. Normal deliveries accounted for 66%, cesarean sections 32%, and abortions 2%. High-risk conditions were reported in 23.3%, mainly anemia and hypothyroidism.
CONCLUSION: Teenage pregnancies, though relatively low, showed rising trends and significant complications, underscoring the need for targeted adolescent health interventions.
KEYWORDS : Teenage pregnancy, maternal outcomes, adolescent health, Tamil Nadu, Poonamallee, PICME.

INTRODUCTION

The World Health Organization defines adolescent pregnancy as "pregnancy in young women aged 10–19 years". Adolescent pregnancy remains a global public health concern. Every year, an estimated 21 million girls aged 15–19 years in developing regions become pregnant and approximately 12 million of them give birth.[1]

Globally, Adolescent Birth Rates has decreased from 64.5 births per 1000 women (15–19 years) in 2000 to 41.3 births per 1000 women in 2023. However, rates of change have been uneven in different regions of the world with the sharpest decline in Southern Asia (SA), and slower declines in the Latin American and Caribbean (LAC) and sub-Saharan Africa (SSA) regions. Although declines have occurred in all regions, SSA and LAC continue have the highest rates globally at 97.9 and 51.4 births per 1000 women, respectively, in 2023 particularly in low- and middle-income countries where the burden is disproportionately high.[2]

Adolescent mothers (aged 10–19 years) develop significantly higher risks of pregnancy-related complications, including eclampsia, puerperal endometritis, and systemic infections, compared to women aged 20–24 years. Their infants are also at greater risk of adverse outcomes such as low birth weight, preterm birth, and severe neonatal conditions. However, evidences on childbirth among girls aged 10–14 years are limited, global estimates in 2023 indicate an adolescent birth rate (ABR) of 1.5 per 1000 for this group, with higher rates observed in sub-Saharan Africa and Latin America and the Caribbean.[3]

In India, according to the National Family Health Survey (NFHS-5, 2019–21), 6.8% of women aged 15–19 years were either pregnant or given birth at the time of the survey. This proportion varies widely across states and districts, with higher prevalence in rural areas and among adolescent girls with lower educational status and poorer wealth status.[4] States such as West Bengal, Bihar, and Tripura continue to report higher adolescent fertility rates, while states like Kerala and Himachal Pradesh exhibit considerably lower rates.[2]

Key drivers of adolescent pregnancy in India include early marriage, limited access to quality education, and barriers to adolescent-friendly reproductive health services. Despite the enactment of the Prohibition of Child Marriage Act (2006), child marriage persists in several regions. NFHS-5 data show that 23.3% of women aged 20–24 years were

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married before the legal age of 18, with higher prevalence in states such as West Bengal (41.6%), Bihar (40.8%), and Jharkhand (39.7%) 2. Early marriage is closely associated with early childbearing, as married adolescent girls often lack the autonomy to delay pregnancy or access contraceptive services.

In Tamil Nadu according to NFHS 5 (2019–21) reports, about 6 % of girls aged 15–19 in Tamil Nadu were either pregnant or given birth at the time of the survey which remains unchanged from NFHS 4 (6 %). In discussion with stakeholders of the district, this study was planned to describe in teenage pregnancy in Poonamallee Health Unit District of Tamil Nadu from 2022 to 2025 and to assess the effect of teenage pregnancies and their maternal outcomes.

METHODS

A descriptive cross-sectional study was conducted using data from the Pregnancy and Infant Cohort Monitoring and Evaluation (PICME) system. Records of 281 teenage pregnancies between April 2022 and March 2025 were analyzed.

The data included information on key sociodemographic variables, such as: Age, Educational status, Marital status, Type of residence (urban/rural), history of any high risk during antenatal period and Pregnancy outcome. Descriptive analysis was carried out using Microsoft Excel and proportions were calculated.

RESULTS

The overall prevalence of teenage pregnancy during 2022–2025 was 1.09% with variation across years: 1.3% in 2022–2023, 1.1% in 2023–2024, and 2% in 2024–2025.

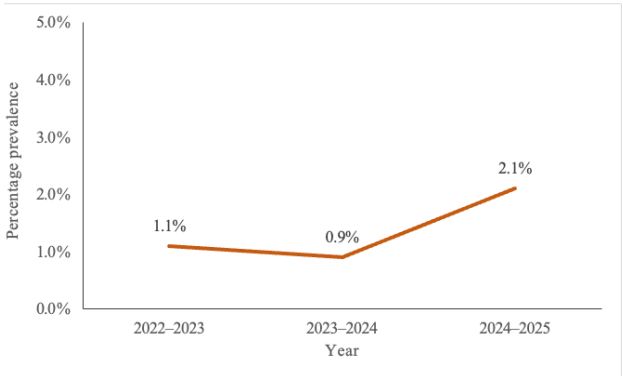

Fig 1: Trend of Teenage Pregnancy in Poonamallee (N=281), 2022-2025

Among the 281 teenage pregnancies reported, the majority were in the 18–19 year age group, accounting for 73.3% followed by 17–18 years 20.3% and 16–17 years 4.6% while 1.8% in 15–16 year group and no cases were reported among girls younger than 15 years.

Table1: Age distribution of teenage pregnancies in Poonamallee HUD (N=281), 2022–2025

Age group	n	%
Age < 15	0	0.0
Age 15 - 16	5	1.8
Age 16 - 17	13	4.6
Age 17 - 18	57	20.3
Age 18 - 19	206	73.3

The prevalence of teenage pregnancy was 64.4% in Poonamallee block and 35.6% in Avadi corporation. The highest proportion of teenage pregnancies was reported from Thirunindravur (17.8%), followed by Thirumazhisai (15.6%), and Poonamallee Urban (11.1%). Nemam and Thirumullaivoyal each accounted for 8.9%, while Poonamallee Rural, Cholambedu, and Mittnamallee each contributed 6.7%. Soranchery reported 4.4%, and Paruthipattu 6.7%. Periyar Nagar, Thandurai, and Vilinjiyambakkam each accounted for 2.2%.

Table 2: Place distribution of teenage pregnancies in Poonamallee HUD (N=281), 2022-2025

Location	n	%
Nemam	25	8.9
Poonamallee Rural	19	6.7
Poonamallee Urban	31	11.1
Soranchery	12	4.4
Thirumazhisai	44	15.6
Thirunindravur	50	17.8
Poonamallee	181	64.4
Cholambedu	19	6.7
Mittnamallee	19	6.7
Paruthipattu	19	6.7
Periyar Nagar	6	2.2
Thandurai	6	2.2
Thirumullaivoyal	25	8.9
Vilinjiyambakkam	6	2.2
Avadi Corporation	100	35.6

Among the teenage pregnancies reported, 66.0% resulted in normal deliveries, while 32.0% required Lower Segment Cesarean Section (LSCS). Abortions were reported in 2.0% of cases. Among the teenage pregnancies reported, 23.3% of teenage pregnancies had one or more high-risk conditions. Among the antenatal complications reported, Anemia was observed in 9.3% of teenage pregnancies. Hypothyroidism was present in 6.0% of the teenage pregnancies. Gestational diabetes mellitus (GDM) in 3.3%, while PIH/Preeclampsia and heart disease complicating pregnancy were each reported in 1.2,1.3% respectively, Short primi (height <145 cm) was documented 1.3% of teenage pregnancies and others accounted for 0.7%.

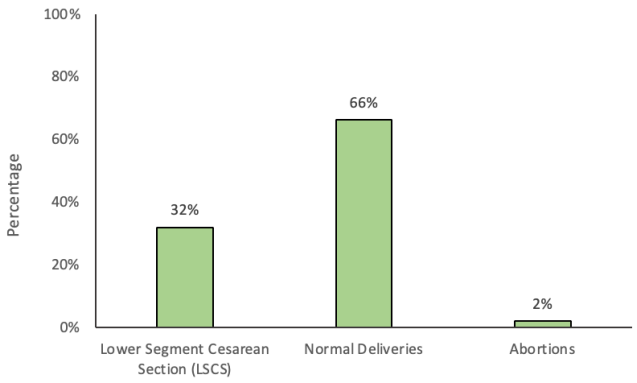

Fig. 2: Pregnancy outcome of teenage pregnancies, Poonamallee, 2022-2025

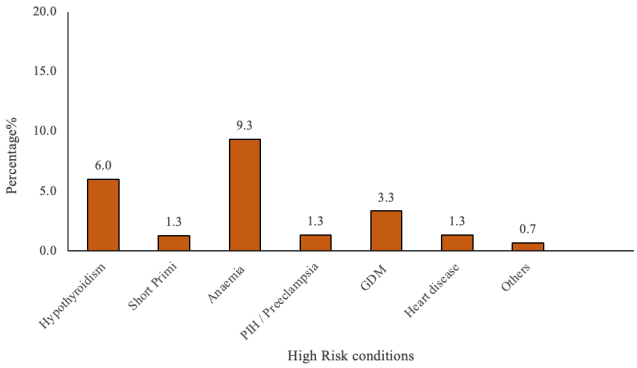

Fig 3: Prevalence of high risk complications among teenage pregnancy, 2022-2025, Poonamallee

DISCUSSION

This study reveals that teenage pregnancy in Poonamallee block, though relatively low, demonstrated a fluctuating trend, with a recent rise to 2.1% in 2024–2025. Nearly one-third of these pregnancies required cesarean delivery, while a small proportion ended in abortion, highlighting the heightened vulnerability of this age group to adverse maternal outcomes. Notably, the observed increase may be due to enhanced registration and tracking under PICME 3.0, launched in January 2024, wherein mandatory Aadhaar authentication has strengthened pregnancy identification and reporting.

High-risk conditions were present in 23.3% of teenage pregnancies, with anemia being the most common, followed by hypothyroidism, gestational diabetes mellitus, pregnancy-induced hypertension/preeclampsia, and heart disease. These findings are consistent with national and global evidence highlighting the nutritional, biological, and social vulnerabilities of adolescent mothers.

Despite a global decline in ABR from 64.5 births per 1000 women aged 15–19 years in 2000 to 41.3 in 2023, regional disparities persist. Southern Asia has witnessed the most significant declines, while sub-Saharan Africa (SSA) and Latin America and the Caribbean (LAC) continue to report the highest ABRs at 97.9 and 51.4 per 1000 women, respectively.[3] There are also large intra-country variations; for example, in Zambia, adolescent childbearing rates ranged from 14.9% in Lusaka to 42.5% in the Southern Province in 2018,[4] and in the Philippines, from 3.5% in the Cordillera Administrative Region to 17.9% in the Davao Peninsula Region in 2017.[5]

Key drivers of adolescent pregnancy in India include early marriage, limited access to quality education, and barriers to adolescent-friendly reproductive health services. Despite the enactment of the Prohibition of Child Marriage Act (2006), child marriage persists in several regions. NFHS-5 data show that 23.3% of women aged 20–24 years were married before the legal age of 18, with higher prevalence in states such as West Bengal (41.6%), Bihar (40.8%), and Jharkhand (39.7%).[2] Early marriage is closely associated with early childbearing, as married adolescent girls often lack the autonomy to delay pregnancy or access contraceptive services.

Sexual abuse is another major driver of adolescent pregnancy. A WHO report estimated that 120 million girls under 20 had experienced sexual violence from a non-partner, while one in eight children globally had been sexually abused before the age of 18.[7] Among girls aged 15–19, one in twenty reported having experienced forced sex (2020 estimate)8. Additionally, about 24% of girls aged 15–19 have experienced physical or sexual violence from an intimate partner at least once in their lifetime, with 16% reporting such experiences in the past 12 months (WHO, 2018).[10]

Preventing adolescent pregnancy, childbearing, and child marriage is essential for improving health outcomes across the life course and achieving the Sustainable Development Goals (SDGs), particularly indicators 3.7.2 and 5.3.1. While most interventions have focused on pregnancy prevention, there is increasing recognition of the need to improve access to and the quality of maternal care for adolescent mothers. Access and quality vary widely by geography and social status, with adolescents often receiving substandard clinical and interpersonal care compared to adults.

CONCLUSION

This study highlights the rising trend of teenage pregnancy from 2022 to 2025, particularly in 2024–2025. The majority of cases were concentrated in the 18–19 year age group, with significant variation across blocks and urban–rural settings. Although most teenage pregnancies resulted in

normal deliveries, nearly one-third required cesarean section, and a nearly one fourth of them were complicated by high-risk conditions, predominantly anemia and hypothyroidism. These findings underscore the need for strengthened adolescent health programs, school-based health education, early identification of high-risk pregnancies, and targeted interventions to reduce preventable complications and improve maternal and neonatal outcomes.

CONFLICT OF INTEREST

None

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ORIGINAL ARTICLE

URBAN HOTSPOTS OF LEPROSY: CHILD AND MIGRANT-LINKED TRANSMISSION IN CHENNAI, 2021–2025

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ABSTRACT

INTRODUCTION : Annual New Case Detection Rate (ANCDR) per 100,000 population remains a critical indicator for monitoring progress under India's National Leprosy Eradication Programme (NLEP). While Tamil Nadu as a state has maintained relatively low ANCDR, Chennai district, a metropolitan and purely urban setting, presents unique challenges due to large-scale migrant settlements, high mobility, and floating population. Notably, child ANCDR in the district has been consistently higher compared to the state average, suggesting active transmission. This study describes the epidemiological profile and spatial distribution of new leprosy cases across the 15 administrative zones of Chennai during 2021–2025, with reference to time, place, and person distribution.

METHODS : Secondary data were extracted from official programme registers for the fiscal years 2021–2025. Variables included age, gender, type of leprosy, presence of deformity, and mode of case detection. Population denominators were derived from 2011 Census projections, disaggregated by age and gender. ANCDR was calculated annually and stratified by zone, age group, gender, and type of leprosy. Special attention was given to industrial and border zones to understand spatial clustering.

RESULTS: A total of 515 new leprosy cases were reported during the five-year period. The overall ANCDR ranged from 1.0 per 100,000 in 2020–21 to 1.3 in 2024–25, with a transient peak above 2.0 during 2022–23. Spatial analysis showed six zones reporting ANCDR >2.0, three of which were industrial hubs and three located at district borders (range: 2.0–4.9). Child ANCDR was notably high, ranging from 3.5 to 11.5, especially in industrial, their adjoining residential zone and border zones. Multibacillary (MB) cases constituted more than 50% of all detections, with MB ANCDR remaining stable across zones (approximately 1.2). Paucibacillary (PB) cases were more common in the <15-year age group (1.5 per 100,000). No cases were reported among listed household or neighborhood contacts despite systematic screening.

CONCLUSION: Surveillance in Chennai shows static overall ANCDR but persistent hotspots in industrial and border zones with elevated child ANCDR, indicating ongoing transmission likely linked to migrants. Stable MB rates and absence of contact cases suggest transmission beyond households. Conventional case-finding may miss such foci, underscoring the need for innovative surveillance strategies targeting migrant populations to sustain elimination goals.

KEYWORDS : Leprosy, Annual New Case Detection Rate, Urban Health, Migrants, Child Leprosy, Industrial Zones, NLEP, Chennai

INTRODUCTION

Leprosy, caused by Mycobacterium leprae, remains a public health challenge in India despite achieving elimination status at the national level in 2005. India continues to contribute more than half of the world's annual new leprosy cases.[1] The Annual New Case Detection Rate (ANCDR) is a critical indicator used to monitor progress under the National Leprosy Eradication Programme (NLEP).[2]

Tamil Nadu state has sustained relatively low ANCDR in recent years; however, Chennai district, a purely urban metropolitan setting, presents unique epidemiological challenges. Migrant labour, floating population and high-density settlements increase risk of sustained transmission. Notably, child ANCDR in Chennai has remained higher than the state average, suggesting active transmission.[3]

While rural leprosy transmission dynamics have been well studied, there is limited evidence on urban hotspots, particularly in industrial and border zones where migrants congregate. This study examines five-year surveillance trends (2021–2025) in Chennai, focusing on spatial patterns and vulnerable sub-populations.

METHODS

STUDY DESIGN AND SETTINGS: A descriptive cross-sectional study was conducted using secondary programme data from 15 administrative zones of Chennai district, Tamil Nadu, India.

DATA SOURCES: Case data were extracted from official NLEP

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registers for 2021–2025. Variables included:Age, gender, type of leprosy and mode of detection (active vs. passive). Population denominators were derived from 2011 Census projections, disaggregated by age and gender.

DATA ANALYSIS: ANCDR was calculated as number of new cases per 100,000 population annually. Rates were stratified by zone, gender, and age group (<15 years vs. ≥15 years). Data were analyzed using descriptive statistics and presented as trends over time.

RESULTS

From 2021–2025, 515 new cases were detected in Chennai. The overall ANCDR ranged from 1.0 per 100,000 in 2021 to 1.3 in 2025, with a transient spike to >2.0 in 2022–23(Figure 1). Six zones reported ANCDR >2.0 (range: 2.0–4.9), of which three were major industrial hubs and three were located at district borders(Figure 2). Child ANCDR was disproportionately high (3.5–11.5 per 100,000)(Figure 4), concentrated in industrial and border zones. Paucibacillary leprosy were more common among children (Table 2). Multibacillary leprosy accounted for more than 50% of all detections, with stable MB ANCDR (~1.2). Paucibacillary leprosy was more frequent among children (Table 2). No household or neighbourhood contact cases were identified despite systematic screening. Self- reporting and case detection by active search were almost equal across years (Table 3).

Table 1: Distribution of ANCDR/100,000 populationby age group and gender, Chennai district, Tamil Nadu, India, 2021-2025

Age group	2020-21	2021-22	2022-23	2023-24	2024-25
<15	0.1	0.8	2	0.5	0.5
>15	1.2	1.3	1.9	1.6	1.5

Gender	2020-21	2021-22	2022-23	2023-24	2024-25
Male	1.4	1.7	3.3	1.8	1.7
Female	0.5	0.7	0.5	0.9	0.9

Table 2 : Distribution of ANCDR/100,000 population by type of leprosy, Chennai district, Tamil Nadu, India, 2021-2025

Type of leprosy	2020-21	2021-22	2022-23	2023-24	2024-25
PB	0.6	0.6	0.9	0.5	0.5
MB	0.5	0.7	1.2	1	0.8

Table 3: Distribution of ANCDR/100,000 population by mode of detection, Chennai district, Tamil Nadu, India 2022- 2025

Mode of detection	2022-23	2023-24	2024-25
Contact tracing	0	0	0
Active search	0.8	0.3	0.8
Self-reporting	1	1	0.4

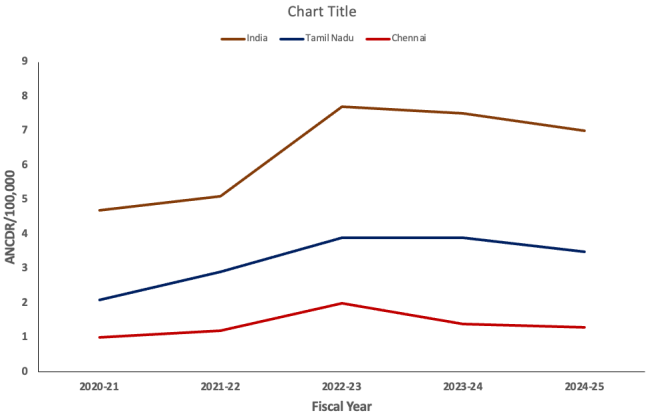
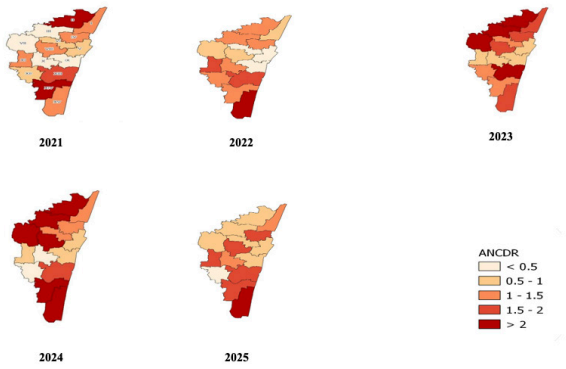
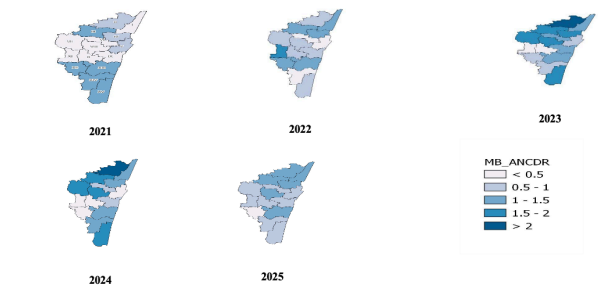


Figure 1: Distribution of Annual New Case Detection Rate by year, Chennai district, Tamil Nadu, India, 2021-2025



(Zone I – Tiruvotriyur, Zone II – Manali, Zone III – Madhavaram, Zone IV – Tondiarpet, Zone V – Royapuram, Zone VI – T.V.K.Nagar, Zone VII – Ambattur, Zone VIII – Anna Nagar, Zone IX – Teynampet, Zone X – Kodambakkam, Zone XI – Valsaravakkam, Zone XII – Alandur, Zone XIII – Adyar, Zone XIV – Perungudi, Zone V – Sholinganallur)

Figure 2: Distribution of Annual New Case Detection Rate (ANCDR) per 1,00,000 by Zones, Chennai District, Tamil Nadu, India, 2021- 2025



(Zone I – Tiruvotriyur, Zone II – Manali, Zone III – Madhavaram, Zone IV – Tondiarpet, Zone V – Royapuram, Zone VI – T.V.K.Nagar, Zone VII – Ambattur, Zone VIII – Anna Nagar, Zone IX – Teynampet, Zone X – Kodambakkam, Zone XI – Valsaravakkam, Zone XII – Alandur, Zone XIII – Adyar, Zone XIV – Perungudi, Zone V – Sholinganallur)

Figure 3: Distribution of Multibacillary leprosy Annual New Case Detection Rate (MB ANCDR) per 1,00.000 population by Zones, Chennai district, Tamil Nadu, India 2021-2025

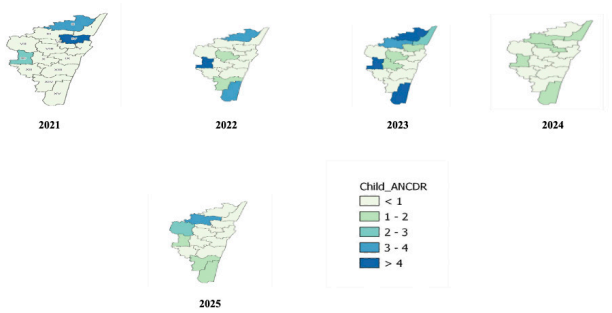


Figure 4: Distribution of Child Annual New Case Detection Rate (Child ANCDR) per 1,00,000 population by Zones, Chennai district, Tamil Nadu, 2021-2025

DISCUSSION

Our findings reveal that while the overall ANCDR in Chennai remained relatively static and lower than the National and State ANCDR (Figure 1) hotspots persist in industrial and border zones (Figure 2). The elevated child ANCDR in these zones signals ongoing community transmission (Figure 4). Similar findings have been reported in urban areas of India and Brazil, where migrant populations play a key role in sustaining transmission.[4,5]

The predominance of Multibacillary leprosy (>50%) (Table 2) and the absence of cases among household contacts suggest that new infections are more likely linked to transmission in community or workplace settings rather than traditional household foci. This aligns with evidence that migrants, who have the infection and residing among the local residents spread the disease.[6]

This study has certain limitations that should be considered when interpreting the findings. As it relied on secondary programme data, the accuracy and completeness of case records could not be independently verified. Population denominators were derived from 2011 Census projections, which may not fully reflect the dynamic urban population, particularly in the context of rapid growth and unrecorded migrant influx. The retrospective and descriptive design limited the ability to establish causal inferences regarding transmission pathways. Despite systematic screening, no new cases were identified among household contacts, which may indicate limitations in current surveillance approaches rather than a true absence of risk. Additionally, molecular or laboratory confirmation of Mycobacterium leprae transmission was not performed, which would have strengthened the epidemiological interpretation. Finally, advanced geospatial modelling was not employed, restricting the precision of hotspot identification. Nevertheless, the analysis provides valuable insights into leprosy epidemiology in a metropolitan context and highlights important gaps in surveillance.

CONCLUSION

Five-year surveillance of leprosy in Chennai revealed that, although the overall Annual New Case Detection Rate (ANCDR) remained relatively static from 2021 to 2025, persistent hotspots continue to exist in industrial and border zones. Elevated child ANCDR in these same areas is a significant concern, as it points to ongoing community-level transmission and recent infections. The findings strongly suggest that migrant populations, particularly those concentrated in industrial hubs and border settlements, play a central role in sustaining urban transmission. The predominance of multibacillary cases alongside the absence of new household contact cases indicates that transmission is occurring outside traditional household or neighborhood clusters. These observations highlight that conventional surveillance and case-finding strategies, which focus on household contacts, may be insufficient in metropolitan environments with high mobility and dense populations.

RECOMMENDATIONS

In light of these findings, several measures are recommended to strengthen leprosy control efforts in urban and migrant-dense settings:

1. Targeted surveillance should be prioritized in industrial hubs and border zones through regular, community-based screening to detect early cases and prevent ongoing

transmission.

2. Workplace-centered interventions for migrant workers, including health education campaigns, dermatological screening, and integration of leprosy awareness into occupational health services, are urgently needed.

3. Integration with urban health and welfare systems can enhance coverage, by embedding leprosy services within broader urban health missions, labor welfare schemes, and social protection programs.

4. Geospatial mapping and digital tools should be adopted to identify and monitor hidden transmission pockets in real time, enabling more precise targeting of resources.

5. Adaptation of NLEP strategies is necessary to address the unique challenges of metropolitan contexts, including migration, floating populations, and community-level transmission outside household networks.

6. Child leprosy detection should be maintained as a key sentinel indicator for monitoring ongoing transmission and guiding focused interventions.

7. Together, these recommendations call for a shift from conventional household-based surveillance toward more innovative, migrant-focused, and community-driven approaches to sustain leprosy elimination goals in urban settings.

CONFLICT OF INTEREST

None

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ORIGINAL ARTICLE

CHALLENGES IN DIAGNOSING PURE NEURITIC LEPROSY AMIDST DIAGNOSTIC ABUNDANCE IN AN URBAN SETTING – A CASE REPORT FROM CHENNAI DISTRICT, SEPTEMBER 2025

Sridevi Govindarajan [(1)], Vasanthi Thangasamy [(1)], Dharmalingam Vedanayagam [(1)]

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

ABSTRACT

INTRODUCTION : Leprosy, though declining globally, continues to present diagnostic challenges due to its varied clinical manifestations. Pure neuritic leprosy accounts for about 5–10% of cases in India and less than 5% globally. Neurological involvement may be the first or predominant symptom, yet lack of awareness among non-dermatology specialists often leads to misdiagnosis. Overreliance on negative slit-skin smears, incomplete clinical correlation, and diversion into alternate differential diagnoses may result in prolonged delays in initiating multidrug therapy (MDT), thereby worsening disability outcomes. Reporting such cases highlights existing gaps in clinical practice and reinforces the importance of maintaining a high index of suspicion for leprosy in endemic regions.

METHODS : We describe the clinical course of a 72-year-old male from Chennai evaluated over a three-year period across multiple healthcare facilities. Clinical history, diagnostic investigations, specialist referrals, and management strategies were systematically reviewed. The diagnostic pathway was mapped to identify missed opportunities and causes for delay in establishing the diagnosis of Hansen's disease.

RESULTS: The patient first presented in July 2022 with bilateral hand numbness, difficulty buttoning shirts, and spontaneous blisters. A private neurologist diagnosed carpal tunnel syndrome, and carpal tunnel release surgery was performed without improvement. At a government tertiary hospital, slit-skin smears tested negative for Mycobacterium leprae, leading to exclusion of leprosy and referral to neurology. Nerve conduction studies suggested median nerve neuropathy, and extensive work-up for autoimmune and vascular causes remained inconclusive. The patient was repeatedly managed with intermittent steroids for presumed neuropathy, yielding only temporary relief.

Over the next two years, symptoms progressed, with recurrent hand ulcers and extension of numbness to the lower limbs. In August 2025, the neurologist referred the patient to a central government neurology research institute, where a sural nerve biopsy confirmed Hansen's disease, with Fite-Faraco stain demonstrating clusters of lepra bacilli. The patient was subsequently referred back to the government tertiary hospital, where MDT was initiated in September 2025, more than three years after symptom onset.

CONCLUSION: This case illustrates the diagnostic challenges of leprosy in the absence of skin lesions and negative slit-skin smears, particularly for specialists outside dermatology in endemic regions. The prolonged delay in initiating MDT underscores systemic gaps in physician awareness beyond dermatology and public health. The lessons learned reinforce the importance of integrating leprosy training into continuing medical education for neurologists, rheumatologists, and general practitioners. Early recognition of neuropathy patterns, judicious use of confirmatory tools such as nerve biopsy when smears are negative, and timely referral are essential to prevent irreversible morbidity. Strengthening clinical vigilance and interdisciplinary collaboration remains a cornerstone in advancing toward the goal of true leprosy elimination.

KEYWORDS : Neural Leprosy, clinical diagnosis, multidrug therapy, neglected disease

INTRODUCTION

Leprosy remains a public health problem in several endemic regions, including India, which contributes nearly half of the world's new cases annually despite achieving elimination status at the national level.[1] The disease presents with a wide clinical spectrum, ranging from indeterminate macules to advanced multibacillary cases with deformities. Pure neuritic leprosy (PNL), in which peripheral nerve involvement occurs without obvious skin lesions, accounts for approximately 5–10% of leprosy cases in India[2] and less than 5% globally.[3] This form is diagnostically challenging and is often missed or mistaken for other neurological disorders. Over-reliance on slit-skin smear negativity, absence of dermatological findings, and specialty-specific diagnostic biases contribute to prolonged delays in initiating multidrug therapy (MDT).[4] We report a case from Chennai District where leprosy was overlooked for more than three years, underscoring the consequences of diagnostic neglect in an endemic urban setting.

RESULTS

A 72-year-old male from Chennai, presented in July

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2022 with bilateral hand numbness, difficulty in buttoning shirts, and spontaneous blisters over the fingers. He also complained of intermittent burning sensations.

At his first consultation with a private neurologist, he was diagnosed with carpal tunnel syndrome and underwent bilateral carpal tunnel release surgery. The intervention provided no relief.

Later in November 2022, he was referred by the neurologist to the dermatology department of Government Medical College hospital. A slit-skin smear was performed there turned out to be negative and leprosy diagnosis was ruled out and he was referred to the neurology department there for nerve conduction study.

Nerve conduction studies showed bilateral median nerve neuropathy, later progressing to ulnar involvement. He was also evaluated extensively for autoimmune and vascular neuropathies, including antinuclear antibody profile and vasculitis markers, all turned out to be inconclusive. He came back to the private neurologist and was treated intermittently with oral corticosteroids, which offered only temporary relief. During this period, his symptoms progressed. He developed recurrent blisters turned into ulcers on his hands. By early 2025, he reported numbness in the feet and difficulty in walking.

In August 2025, the same private neurologist referred him to a central government neurology research centre for advanced evaluation and nerve biopsy. A sural nerve biopsy done there revealed chronic inflammatory infiltrates with granuloma formation. Fite-Faraco staining demonstrated clusters of acid-fast bacilli consistent with Mycobacterium leprae.

The private neurologist referred him back to the Government Medical College Hospital for further treatment. He was diagnosed with pure neuritic leprosy and initiated on multibacillary MDT in September 2025, more than three years after onset of symptoms. Supportive physiotherapy and ulcer care were also introduced.

DISCUSSION

This case highlights multiple missed opportunities for early diagnosis of leprosy despite the patient residing in an endemic district. The diagnostic delay of over three years resulted in progression of neuropathy. While skin smears are valuable, they are frequently negative in PNL and should not be used to exclude the diagnosis.[2,5] Many clinicians, especially non-dermatologists, equate leprosy only with skin involvement, overlooking its neuritic presentations.[6] Neurologists and surgeons often focus on common neuropathies such as entrapment syndromes, vasculitis, or autoimmune causes, delaying recognition of leprosy.[7] Lack of nerve biopsy utilization: Nerve biopsy, though invasive, remains the gold standard for confirming PNL, especially when skin smears are negative.[8]

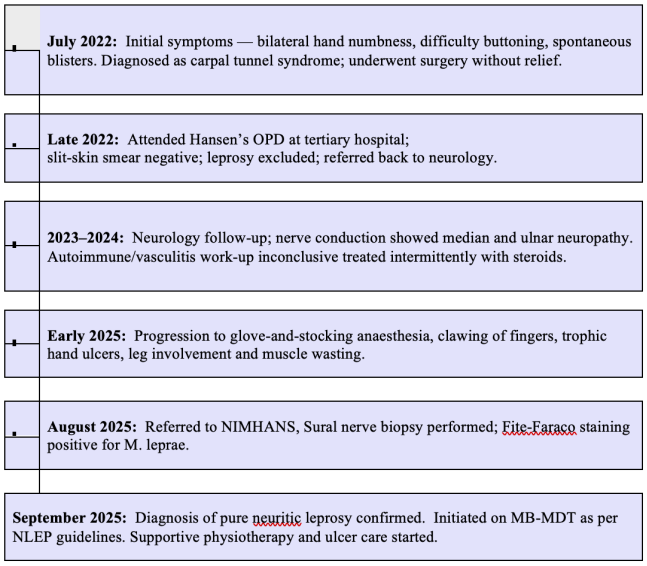

Figure 1: Timeline of symptoms, investigations, and diagnosis.

Previous studies from India report average diagnostic delays of 1–3 years in PNL, with many patients developing irreversible disability by the time MDT is initiated.[9,10] Our patient underwent unnecessary surgery and prolonged steroid therapy, reflecting both financial and health burdens.

This case presentation highlights the importance of: maintaining a high index of suspicion for leprosy in endemic areas, considering nerve biopsy early when neuropathy is unexplained, cross-disciplinary training for neurologists, rheumatologists, and general physicians, reinforcing leprosy awareness in continuing medical education programmes.

CONCLUSION

Pure neuritic leprosy should remain a key differential diagnosis in endemic regions when evaluating unexplained peripheral neuropathy. Negative skin smears should not be used to rule out leprosy. Early referral, judicious use of nerve biopsy, and timely initiation of MDT are essential to prevent disability and achieve true elimination.

CONFLICT OF INTEREST

None

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ORIGINAL ARTICLE

INSIGHT360TN: AN AI-POWERED WEB PLATFORM FOR NFHS DATA VISUALIZATION AND PUBLIC HEALTH INSIGHTS IN TAMIL NADU – A PROCESS DOCUMENTATION

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ABSTRACT

The National Family Health Survey (NFHS) is a cornerstone of India's public health system, yet its vast datasets are often locked in formats that are inaccessible for timely local-level decision-making. To address this critical gap, the Insight360TN platform was developed as a web-based tool to transform complex NFHS statistics for Tamil Nadu into interactive and actionable insights. Built entirely with client-side technologies, the platform integrates optimized NFHS-4 (2015–16) and NFHS-5 (2019–21) data to power a suite of analytical tools, including dynamic choropleth maps, district performance rankings, and correlation analyses. A key innovation is the integration of Google's Gemini 1.5 Pro AI, which generates natural language summaries to make statistical findings understandable to non-technical users. The result is a high-performance, cost-effective platform that successfully democratizes access to vital health data, demonstrating a powerful model for bridging the gap between data availability and evidence-based policymaking in Tamil Nadu.

The Challenge of Actionable Health Data in Public Health Governance

National health surveys like the National Family Health Survey (NFHS) are a cornerstone of India's public health system, providing invaluable data for planning and evaluation.[3] However, the strategic value of this data is entirely contingent on its accessibility and usability for the local-level decision-makers responsible for implementing policy. For years, a persistent challenge has been the disconnect between the availability of rich data and the capacity of administrators to apply it effectively.

The primary barrier lies in the traditional format of NFHS data. Findings are typically disseminated through lengthy technical reports, large and cumbersome spreadsheets, and complex datasets that are difficult for non-specialists to navigate.[1], [2] This format creates a significant hurdle for practical application by policymakers, district health officers, and program managers who need to make timely, evidence-based decisions. The problem is not a lack of information but a critical lack of tools that can convert abstract numbers into a clear, usable narrative of progress and disparity.

Without modern digital tools, simple yet critical analytical tasks become slow and difficult. For example, a district health officer attempting to compare immunization coverage trends between two neighboring districts or a state planner seeking to understand the relationship between rising female literacy and maternal health outcomes would face a time-consuming manual process. This inability to easily visualize trends, compare geographic performance, or explore relationships between different health indicators means that valuable insights remain buried within the data. Ultimately, the core challenge is the lack of tools to transform static data into dynamic, actionable knowledge. This disconnect impedes responsive public health management and prevents the full potential of national survey data from being realized, setting a clear stage for the need for a technological solution.

Introducing Insight360 TN: A Solution Engineered for Tamil Nadu

The Insight360TN platform was engineered as a direct and strategic response to the challenges of data inaccessibility. Its core mission is to bridge the gap between raw data and actionable intelligence by transforming complex national survey statistics into an optimized, user-friendly, and interactive tool tailored specifically for Tamil Nadu. The platform was designed to convert the static, tabular data of the NFHS into an engaging visual story of public health across the state.

To achieve this, Insight360TN was built to empower decision-makers at all levels by combining meticulously

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optimized datasets, powerful visualization tools, and AI-generated summaries. The platform's goal is to make intricate health data simple, engaging, and understandable, enabling users to explore indicators, compare district-level performance, and uncover the evidence needed to craft more effective public health policies.

The following sections detail the rigorous methodology and process undertaken to build this innovative platform, from data sourcing and optimization to the establishment of a robust statistical framework.

The Methodological Blueprint: Building an Optimized and Intelligent Platform

The development of Insight360TN was guided by a multi-faceted approach that prioritized performance, accuracy, and usability. This required a robust strategy for sourcing and validating data, a breakthrough technical optimization to ensure a responsive web experience, a novel method for handling administrative boundary changes, and a clear statistical framework to ensure that all analyses were meaningful and easy to interpret.

Data Sourcing and Architecture Strategy

The platform's foundation rests on a carefully selected set of high-quality data sources and a modern, lightweight technical architecture.

National Family Health Survey (NFHS): District-level indicators from NFHS-4 (2015–16) and NFHS-5 (2019–21) were obtained from the National Data and Analytics Platform (NDAP), a NITI Aayog initiative.[1,2]

Administrative Boundaries: Geographic boundary data for Tamil Nadu's districts was sourced from the Tamil Nadu Geographic Information System (TNGIS) to ensure spatial accuracy.[5]

Insight360TN was built entirely with client-side technologies—HTML5, CSS3, and JavaScript—which eliminates the need for external servers and reduces operational costs. Data visualization is powered by Chart.js for charts and Leaflet.js for interactive maps. This serverless architecture was a key strategic decision to ensure the platform's accessibility and sustainability.

The Data Optimization Pipeline: A Technical Breakthrough

A primary technical hurdle was the large size of the raw NFHS datasets and geographic files, which were unsuitable for efficient delivery in a web browser. To overcome this, a rigorous optimization pipeline was implemented, involving the pruning of redundant fields from the JSON data and the conversion of high-precision GeoJSON boundaries to the more compact TopoJSON format.

Table 1: Size Reduction Achieved Through Data Optimization Pipeline

Data Component	Original Size	Optimized Size	Size Reduction
NFHS JSON Data	15 MB	2.1 MB	86%
Geographic Boundaries	8 MB	1.8 MB	77.5%
Total Data Payload	**23 MB**	**3.9 MB**	**83%**

This aggressive 83% reduction in the total data payload was the critical breakthrough that made a high-performance, entirely client-side, and server-independent platform feasible.

A Novel Approach to District Reorganization

Between the NFHS-4 and NFHS-5 survey periods, Tamil Nadu underwent a significant administrative reorganization that resulted in the creation of six new districts. This posed a major challenge to data comparability, as direct trend analysis would be inconsistent.

To solve this, a novel "inheritance model" was developed. For the NFHS-4 period, new districts inherited the health indicator values from their parent districts to ensure historical continuity and enable trend analysis. For the NFHS-5 period, these new districts were represented by their own independently collected survey data, reflecting the new administrative reality.

This reorganization was not merely a cartographic exercise but a strategic public health initiative. Each new district was formed with a specific focus, such as enhancing rural healthcare coverage in Kallakurichi, improving tribal population health in Tenkasi, and managing industrial health in Ranipet. The inheritance model ensures these newly defined administrative units can be analyzed within a consistent historical context.

Establishing a Statistical Framework for Meaningful Interpretation

To ensure that data visualizations and rankings were statistically sound and easy to interpret, a clear analytical framework was established.

Indicator Classification: All NFHS indicators were classified into one of three categories: Positive (n=74, 57.8%), where

higher values are better (e.g., immunization coverage); Negative (n=47, 36.7%), where lower values are better (e.g., mortality rates); or Neutral (n=7, 5.5%), representing descriptive metrics like sex ratio. This system is essential for generating meaningful rankings and comparisons.

Normalization and Ranking: To allow for comparisons across different indicators, all values were normalized using min-max scaling. Districts were then grouped into tertiles (top, middle, and bottom performers) for clear visual classification on maps and charts.

Correlation Analysis: The platform uses Pearson correlation coefficients and plots regression lines to enable users to analyze and visualize the relationships between any two indicators, facilitating a deeper understanding of the social determinants of health.

This robust methodological blueprint culminated in a high-performance platform capable.

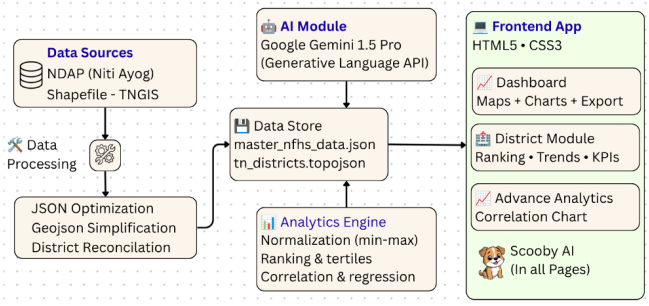

Figure 1: System Architecture of Insight360TN: Data Pipeline, Analytics Engine, and Frontend Integration

Platform Architecture and AI Integration

The strategic choice of a lightweight, client-side architecture was central to achieving the project's goals of high performance, universal accessibility, and cost-effectiveness. By design, the platform operates entirely within a user's web browser, eliminating the need for expensive server infrastructure and ensuring rapid, responsive performance.

The platform was built using a modern technical stack of HTML5, CSS3, and JavaScript, with specialized libraries for visualization. Chart.js powers the dynamic statistical charts, while Leaflet.js is used for the interactive geographic maps. This lean architecture ensures that the entire application can be delivered quickly, even on modest internet connections.

A key innovation of Insight360TN is the integration of Google's Gemini 1.5 Pro AI via a Firebase REST API. This allows the platform to translate complex statistical patterns and data visualizations into clear, concise, and understandable natural language summaries. This feature is designed to bridge the gap between data analysts and policymakers, making sophisticated findings accessible to non-technical users and directly supporting evidence-based decision-making.

This integrated architecture supports the platform's core features and analytical capabilities, transforming raw data into actionable intelligence for public health governance.

Results: Platform Performance and Analytical Capabilities

The rigorous methodology and optimized architecture resulted in a platform that successfully balances analytical depth with exceptional speed and accessibility. Insight360TN provides a suite of powerful features designed to equip users with immediate, data-driven insights.

Platform Performance and Accessibility

The platform's design choices resulted in outstanding technical performance and ease of access:

Total application size: The entire platform is only 4.5 MB, ensuring a minimal footprint.

Initial loading time: Loads in under three seconds on a standard internet connection.

Rendering speed: Interactive maps and dynamic charts render almost instantly, allowing for fluid data exploration.

Data Export: Users can export the underlying data for any visualization as a CSV file, enabling easy integration into external reports and presentations.

Core Features for Data-Driven Insights

Insight360TN provides four primary features designed to transform raw data into clear, actionable intelligence

Interactive Choropleth Maps: Users can visualize the geographic distribution of any health indicator across Tamil Nadu's districts. A simple toggle allows for a direct comparison between NFHS-4 and NFHS-5 data, making it easy to observe changes and trends over time.

District Performance Rankings: This feature automatically displays the best and worst-performing districts for any selected indicator, enabling health administrators to rapidly identify priority areas that may require targeted interventions or further investigation.

Correlation Scatter Plots: This powerful analytical tool allows users to explore the relationship between two different health indicators—for example, plotting female literacy rates against immunization coverage to visually assess their connection.

AI-Powered Summaries: Integrated directly into the user interface, this feature provides concise, narrative context for visualized data. It transforms complex statistical patterns into understandable summaries, making findings accessible to non-technical stakeholders.

Illustrative Analytical Findings

The platform's capabilities make it easy to uncover and communicate important public health relationships. Analyses conducted with the tool clearly show that districts with higher female literacy rates consistently perform better on key maternal and child health indicators. Similarly, the platform visualizes the strong correlation between high immunization coverage and lower infant mortality rates. It also highlights the link between positive nutrition outcomes and indicators of women's empowerment, underscoring the critical role of social determinants in overall public health.

These results demonstrate the platform's success in translating a complex methodological vision into a tangible, high-impact tool for public health policy and technical innovation.

Discussion: Contributions, Implications, and Limitations

Beyond its immediate utility as an analytical tool, the Insight360TN project offers significant contributions to the field of public health informatics. Its design and implementation provide a valuable blueprint for making complex national data more accessible, understandable, and actionable for a wide range of stakeholders.

Key Contributions and Public Health Implications

The platform's primary contributions lie in its technical approach and its potential to transform public health practice.

1. Technical Innovation: The project successfully demonstrates that large national datasets can be highly optimized for use in lightweight, client-side web applications. Furthermore, the "inheritance model" for handling administrative boundary changes represents a novel methodological contribution for ensuring longitudinal data integrity—a common challenge in public health informatics.

2. Data Democratization: The platform empowers a wide range of stakeholders by providing tailored benefits. For the State Health Department, it offers real-time monitoring and evidence-based planning support. District Health Officers can use it for performance analytics and priority area identification. Researchers and academics gain standardized, exportable data access, while policymakers receive visual insights and AI-powered recommendations to ground discussions in evidence.

3. Bridging the Analyst-Policymaker Gap: The integration of AI-generated summaries is a key innovation that translates statistical findings into clear, actionable language. This feature allows policy discussions to be grounded in data without requiring all participants to have advanced statistical training.

Direct Policy and Intervention Applications

Insight360TN is a practical tool designed to directly guide public health planning and interventions. By providing instant access to visualized data, the platform achieves an estimated 75% reduction in report generation time and eliminates the need for manual data compilation. This allows health officials to quickly pinpoint districts with persistently low immunization coverage and target them for special vaccination campaigns. Similarly, areas with a high prevalence of anemia can be identified for focused nutrition programs, and data from regions with weak maternal health indicators can provide clear evidence to support initiatives aimed at strengthening institutional delivery services.

Strengths and Limitations

A balanced assessment reveals the platform's significant strengths alongside areas for future development.

Table 2: Comparative Assessment of Platform Strengths and Limitations

Strengths	Limitations
High Accessibility: Runs in any standard browser with no additional infrastructure required.	Data Latency: Relies on NFHS data, which is only collected every five years.
Cost-Effective: Client-side architecture eliminates the need for external servers.	Geographic Scope: Currently covers only Tamil Nadu, though the design is scalable.
Open and Transparent: The entire source code is openly available under an MIT license.	AI Dependency: AI summaries are supportive tools and depend on the quality of underlying models.
	Functionality Gaps: The platform is not yet mobile-friendly and lacks flexibility to incorporate datasets beyond NFHS.

These strengths and limitations frame the platform's current utility and highlight a clear path for its future evolution.

Conclusion and Future Directions

Insight360TN successfully illustrates the immense potential of technology to transform dense, complex health data into actionable, user-friendly knowledge. By combining highly optimized datasets, intuitive geographic visualization, and AI-powered natural language interpretation, it effectively converts static NFHS tables into a dynamic tool for evidence-based policymaking. The platform demonstrates a replicable blueprint for data democratization efforts globally, particularly through its solutions for handling administrative reorganization and establishing a statistically robust framework for indicator classification.

In essence, the platform serves as a "system of nerves," transmitting critical signals from the data across the body of the public health system, making it more responsive and adaptive to the needs of the population. Looking ahead, future directions for the platform include expansion to other states, integration with the forthcoming NFHS-6 data, and the enhancement of its analytical capabilities with predictive analytics to forecast health trends and better inform proactive public health strategies.

Acknowledgments

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Acknowledgments

Live

Application: The application can be accessed at https://insight360tn.web.app/ and is best viewed on a laptop or desktop.

Source Code: The complete source code is available on GitHub under the MIT license at https://github.com/drsivambbs/Insight360TN.

CONFLICT OF INTEREST

None

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ORIGINAL ARTICLE

TOBACCO CESSATION OUTCOMES IN THOOTHUKUDI DISTRICT: A DESCRIPTIVE STUDY FROM 2024–2025

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ABSTRACT

INTRODUCTION : Tobacco use is a leading cause of preventable mortality, responsible for more than 1.35 million deaths annually in India. Tamil Nadu reports a prevalence of 10.2% among adults, with smokeless tobacco contributing significantly to oral cancers. This study assessed quit rates and cessation outcomes among tobacco users attending the Tobacco Cessation Centre (TCC) in Thoothukudi.

METHODS : A descriptive cross-sectional study was conducted between April 2024 and March 2025 using secondary data from TCC records. A total of 57 individuals were analyzed. Demographic factors, Fagerstrom dependence scores, treatment modalities, and quit status were assessed. Carbon monoxide (CO) levels were used to verify abstinence.

RESULTS: The overall quit rate was 43.8%. The mean age of participants was 46 years, with 95% males. Most participants (84%) used only behavioural interventions, while 16% received both behavioural therapy and nicotine replacement therapy. Mean Fagerstrom scores were 4.3, and mean CO levels decreased from 18.7 ppm at baseline to 2.5 ppm at follow-up. Family-reported abstinence confirmed 37.5% sustained quitting.

CONCLUSION: Tobacco cessation services at the district level demonstrated effectiveness, particularly through behavioural interventions. Sustained abstinence was feasible with continuous follow-up and CO monitoring. Strengthened counselling, NRT accessibility, and community engagement are critical to improving quit rates.

INTRODUCTION

Tobacco use remains one of the most significant public health challenges worldwide. It is associated with more than eight million deaths globally each year, including 1.35 million deaths annually in India.[1]

The country faces a dual burden of both smoked and smokeless tobacco products, which contribute to cancers, cardiovascular diseases, chronic respiratory illnesses, and metabolic disorders. Smokeless tobacco alone accounts for nearly 40% of India's oral cancer burden, while smoking leads to chronic obstructive pulmonary disease (COPD), ischemic heart disease, and stroke. Quitting tobacco is associated with immediate and long-term health benefits, reducing the risk of cardiovascular disease within one year and the risk of oral and lung cancers over time.[2]

In Tamil Nadu, 10.2% of adults use tobacco according to GATS-2 (2016–17).[3] Thoothukudi district, with its industrial and coastal population, presents unique challenges for cessation programs due to socio-economic vulnerabilities, patterns of smokeless tobacco use, and occupational stressors. District-level Tobacco Cessation Centres (TCCs) provide essential support through counselling, behavioural therapy, and nicotine replacement therapy (NRT). This study was designed to evaluate the effectiveness of the Thoothukudi TCC, describe the demographic characteristics of its clients, and assess the outcomes of cessation interventions from 2024 to 2025.

METHODS

A descriptive cross-sectional study was conducted at the Tobacco Cessation Centre (TCC) of Thoothukudi Medical College and Hospital from April 2024 to March 2025. Out of 4000 total registrations in TCC, 57 individuals who registered at the TCC and opted for quitting tobacco during the study period were included.

There were no exclusion criteria, and all registrants were considered. Data were extracted from the Quitters Line List maintained at the TCC. Variables included demographic details (age, sex, education, occupation), duration of tobacco use, nicotine dependence based on the Fagerstrom score and classifying as low moderate and high dependance, treatment modalities (behavioural counselling and/or NRT), quit status (self-reported and family-reported), and carbon monoxide (CO) levels at baseline, 3 months, and follow-up in July 2025.

Descriptive statistics were applied. Categorical variables were expressed as frequencies and percentages, and continuous variables as means. Tables and bar diagrams were constructed to summarize results.

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RESULTS

A total of 57 individuals were registered for tobacco cessation at the TCC during the study period. Out of 57 participants, 25 (43.8%) successfully quit tobacco use, while 32 (56.2%) did not. Quitters had a mean age of 48 years compared to 46 among non-quitters, with an average tobacco use duration of 24 and 26 years respectively.

Among the quitters, 56% belonged to the age group 20- 45 years, 32% belonged to age less than 20 years. 92 % of them were male and 2%were female. Educational status 40% were illiterate/primary educated as shown in Table 1.

Table 1: Sociodemographic profile of quitters attending TCC, 2024-2025

Variables	Category	n	%
Age Group	<20	8	32
	20–45	14	56
	46–60	2	8
	>60	1	4
Gender	Male	23	92
	Female	2	8
Qualification	Illiterate / Primary	10	40
	High school	8	32
	Secondary	3	12
	Graduate	4	16

Quit status reported by family indicated 37.5% abstinence, while quit status as reported by the individuals were 44.6%.

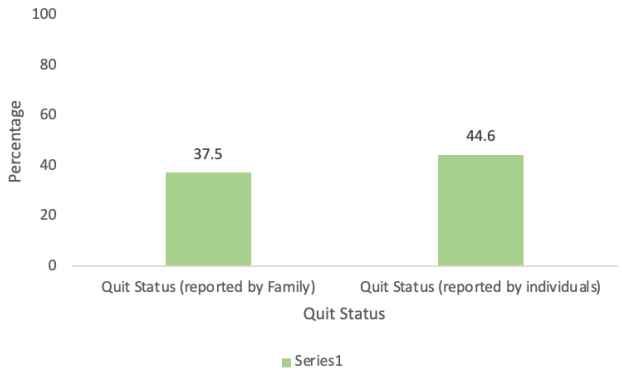


Figure1: Quit status as reported by quitters and their family in TCC, Thoothukudi, 2024-2025

Based on duration of tobacco use, the highest proportion of quitters had used tobacco for 15–25 years (26.8%), followed by 25–35 years (19.6%), and more than 35 years (10.7%) as mentioned in Table 2.

Based on Fagerstrom scores, 28% had low dependence (0–3), while 72% had moderate dependence (4–6) while no individual reported high dependence. The mean Fagerstrom score among quitters was 4.3.

Table 2: Duration of Usage of tobacco among quitter, TCC, Thoothukudi, 2024-2025

Duration of tobacco usage (years)	n	%
<5	2	3.6
5–15	1	1.8
15–25	15	26.8
25–35	11	19.6
>35	6	10.7

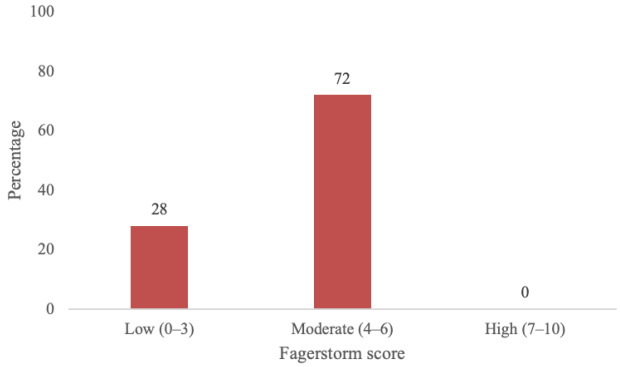
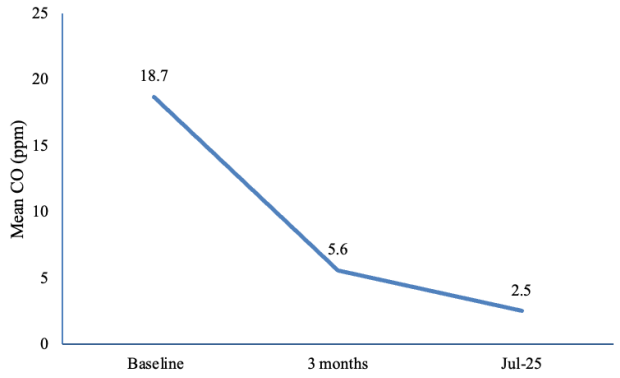


Figure2: Fagerstorm scores for nicotine dependence among quitters, TCC, 2024-2025

Of the 25 quitters, 84% relied solely on behavioural counselling, while 16% required both behavioural therapy and NRT.

Treatment Type	n	%
Behaviour Changes	21	84
Both NRT and Behaviour Changes	4	16

The mean CO level decreased from 18.7 ppm at baseline to 5.6 ppm at 3 months, and further to 2.5 ppm at follow-up in July 2025, providing objective evidence of quitting and improved lung health.



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DISCUSSION

This descriptive study highlights the effectiveness of tobacco cessation services provided at the district level. The quit rate of 43.8% compares favourably to international benchmarks where rates typically range between 25% and 40% in community-based cessation programmes. The findings reinforce the value of behavioural interventions, which were sufficient for the majority of participants, and suggest that expanding such services can yield significant public health gains.

Carbon monoxide monitoring provided a reliable biochemical validation of quitting, confirming sustained abstinence. The marked drop in CO levels from 18.7 ppm to 2.5 ppm underscores the physiological benefits of cessation. The discrepancy between self-reported and family-reported quit rates indicates possible biases in self-reporting, which is why objective monitoring is critical.

The underrepresentation of women is consistent with national data showing lower tobacco use among females, but may also point to cultural and accessibility barriers. Additionally, while some participants achieved complete abstinence, others reported reduced use rather than quitting, highlighting the need for stronger motivational and relapse-prevention support. Peer support groups, community outreach, and increased availability of pharmacological aids such as bupropion and varenicline could further improve outcomes.

Overall, this study adds to the evidence base supporting the integration of structured counselling, pharmacological support, and monitoring into tobacco cessation programs. It also demonstrates the feasibility of scaling up district-level models across Tamil Nadu and India at large.

CONCLUSION

Tobacco cessation is an urgent public health priority in India. The Thoothukudi TCC experience demonstrates that structured counselling, supported by CO monitoring, can achieve meaningful quit rates and sustained abstinence. Expanding these services to other districts, ensuring accessibility of NRT and pharmacological aids, and incorporating community engagement strategies are essential next steps. By strengthening cessation programs, India can reduce the immense burden of tobacco-related morbidity and mortality, contributing directly to national and global non-communicable disease control targets.

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ORIGINAL ARTICLE

ACUTE GASTROENTERITIS OUTBREAK AMONG SCHOOL STUDENTS ON EXCURSION TO KODAIKANAL, TAMIL NADU, INDIA, 2024 - AN EPIDEMIOLOGICAL INVESTIGATION

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ABSTRACT

INTRODUCTION : Contaminated food sickens one in ten people globally every year. In Kodaikanal, Tamil Nadu, India, On 12th November, 2024 an acute gastro-enteritis outbreak occurred among school students who came for excursion from Kerala. Food borne outbreaks commonly occur due to poor hygiene or handling practices. The objective is to analyse patterns, to pinpoint the source (food or environmental) and symptoms, thereby providing insight for prevention strategies.
METHODS : As modified the case definition as; Any case with one episode of diarrhoea with or without vomiting and fever and not Integrated disease surveillance programmes standard case definition. Interviews were conducted, line listed with demographic and clinical symptom (person). An epi-curve (time) and spot map (place) aided in understanding the outbreak's temporal and geographical distribution. Attack rates were calculated. Stool, blood & water samples were collected. A retrospective cohort study analysed food exposures, while risk ratios were computed using epi-info software.
RESULTS: Among the 187 (184 were students and 3 were teachers) consumed steamed biriyani, Chicken curry, Rice, Parotta, Gobi 65, Chapatti and Vegetable curry for dinner. There were 109 cases, with vomiting (47%) and diarrhoea (14%) with fever (11%). The median incubation period was 6 hours and 45 minutes. Microbiology results for stool and blood samples were inconclusive, as were the water samples; We found an association between symptoms and food consumption. A retrospective cohort study indicated a risk ratio of 1.36 (95% CI: 1.10 – 1.84) for chicken curry, attributing 80% of cases to it.
CONCLUSION: The acute gastroenteritis outbreak was a single-exposure, point-source event with rapid symptom onset following the consumption of chicken curry; despite inconclusive laboratory and water sample results.
KEY WORDS: Gastro-enteritis, Foodborne outbreak, Chicken, Risk ratio, India

INTRODUCTION

Food borne diseases remain a major public health problem. Globally and estimated one out of every ten people are affected globally each year as per World Health Organisation.[1] In India foodborne disease outbreaks also remain a major public health concern, especially during group gatherings and mass catering events.[2] According to the Integrated Disease Surveillance Programme (IDSP), acute diarrheal diseases constitute one of the leading causes of reported outbreaks nationwide (IDSP Annual Report, 2022.[3] Schools and excursion groups are particularly vulnerable due to bulk food preparation under suboptimal hygienic conditions.[4]

Kodaikanal, a popular hill station in Tamil Nadu, attracts large numbers of student excursion groups. The sudden occurrence of gastroenteritis among healthy adolescents poses risks of rapid spread, significant morbidity, and public panic. Investigating such outbreaks is crucial not only to mitigate immediate health risks but also to identify food safety lapses and strengthen preventive measures.

Outbreak Notification. On 12 November 2024 midnight, Kodaikanal Government Hospital reported a cluster of students presenting with vomiting, fever, and diarrhoea. The students were part of a class 10 of a school who came for excursion from central Kerala. The Chief Medical Officer confirmed the outbreak and alerted the block health team. The district IDSP unit was informed for immediate response after confirming the outbreak.

This outbreak offered an opportunity to conduct a systematic field investigation, combining descriptive and analytical epidemiology, to establish the likely source and recommend targeted interventions.

OBJECTIVES

1. To describe the outbreak of acute gastroenteritis among students by time, place, and person among school students who came from Kerala to Kodaikanal, Tamil Nadu, India, 2024

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2. To identify the potential source of exposure (whether it is environmental or food source) associated with this illness among school students who came from Kerala to Kodaikanal, Tamil Nadu, India, 2024.

METHODS

Case Definition used for active case finding

A probable case was defined as occurrence of one or more episodes of loose stools per day, with or without vomiting, with or without fever, among school students and teachers who came for excursion to Kodaikanal, Tamil Nadu, India between 12/11/2024 & 13/11/2024. This was modified from the standard case definition of IDSP to capture more cases.

Case Search and Data Collection

Active case search for new cases among all students, nearby hotel staff, and the local community to find any spillover infections was done. A Passive-case findings from all the hospitals in the town were also undertaken. A structured questionnaire to gather information on people's age, gender, symptoms, when their symptoms started, and what specific food they ate was created. Data was collected using Epi-collect software and data were collated in Microsoft excel 2019 software.

Clinical and Laboratory Investigation

To identify the cause of the illness, collected stool and blood samples from four sick students, as well as water samples from the food preparation area. These were all sent to the district microbiology laboratory for analysis. However, it was not possible to collect the food samples as the food were already discarded and not in place.

Descriptive Epidemiology

Based on the onset of symptoms, to understand the trends and pattern, an epidemic curve was created (Figu 1). A spot map was also used to show how the cases we clustered geographically. We calculated the incidence the illness by sex and age using attack rates (Table 1), a.... the different clinical symptoms (Table 2) were described as proportions.

Analytical Epidemiology

Study design: A Retrospective cohort study instead of a case control study was done based on two reasons. The first is we had a defined set of school students and it is a closed event; Secondly, it was able to list out all the food items that were prepared, served and consumed.

Population: All the 184 students and 3 teachers who came for excursion from Kerala to Kodaikanal.

Exposure: The specific food items consumed for dinner were listed with a structured questionnaire again using epi-collect software and collated using Microsoft excel -2019. The questionnaire had questions based on the time of food consumption, Time of Onset of symptoms, food that they ate. Analysis: For Analysis Attack rates were calculated, relative risks (RR), and 95% confidence intervals calculated using Epi Info 7.2 software.

RESULTS

Descriptive Findings

It was found that among the 184 students and 3 teachers who came for excursion; They consumed food in a hotel at around 7:00 PM; Students started to develop symptoms at around 8:30 PM (Index case) on 12/11/2025. No other people suffered similar symptoms as evidently seen from the hospital records and nearby private clinics. All were treated as outpatient and none were presented with severe dehydration requiring hospitalisation with in-patient care.

Table 1. Description of Acute Gastro enteritis among students who came for excursion to Kodaikanal, Tamil Nadu, India, 2024 categorised by Gender and those presented with symptoms explained in Proportions. (N=187) (n=109)

Symptoms by Gender	With symptoms		Without symptoms		Total
Male	56	(53.3%)	49	(46.7%)	105
Female	53	(64.6%)	29	(35.4%)	82
Total	109	(58.3%)	78	(41.7%)	187

Table 2. Description of Acute Gastro enteritis among students who came for excursion to Kodaikanal, Tamil Nadu, India, 2024 categorised by symptoms type explained in Proportions. (N=187) (n=109)

Symptom Profile	n	%
Vomiting	88	47.1
Diarrhoea	26	13.9
Fever	20	10.7

Out of 184 students and 3 teachers exposed, there were 109 cases, resulting in an attack rate of 58.3% (Table 1). The median incubation period for symptoms to appear was 6 hours and 45 minutes (Figure 1). As evidently seen in the epi-curve it is a point source outbreak. Among boys, there were 56 cases, accounting for 53.3%, while 53 girls were affected, accounting for 64.6% (Table 1). Girls were more affected than boys. The most common symptom was vomiting 47%, followed by diarrhoea at 14% and fever at 11% (Table 2).

Table 3. Risk of getting the disease and the type of food consumed among students who came for excursion to Kodaikanal, Tamil Nadu, India, 2024 (N=187) (n=109)

Food	Ate specific food			Not eaten specific food			Risk ratio
	Sick	Total	(%)*	Sick	Total	(%)*	
Biriyani	91	154	59.09	18	33	54.55	1.08(0.78-1.51)
Cabbage Curry	3	5	60.00	106	182	58.24	1.03(0.50-1.52)
Chapatti	33	55	60.00	76	132	57.58	1.04(0.80-1.35)
Chicken Curry	80	125	64.00	29	62	46.77	**1.36(1.10-1.84)**
Fish curry	9	20	45.00	100	167	59.88	0.75(0.46-1.23)
Gobi 65	10	26	38.46	99	161	61.49	0.63(0.38-1.43)
Mandhi Rice	55	103	53.40	54	84	64.29	0.83(0.65-1.06)
Parotta	65	114	57.02	44	73	60.27	0.95(0.74-1.21)
Vegetable Curry	20	50	40.00	58	137	42.34	1.06(0.71-1.56)

*Attack Rate calculated

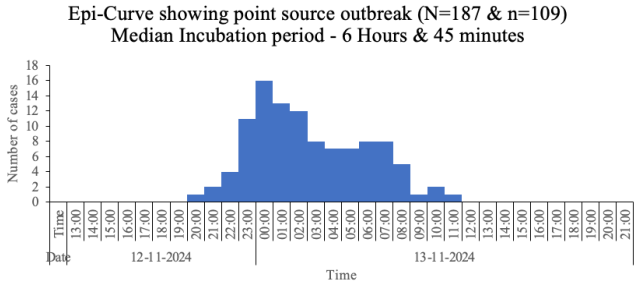

Figure 1. Distribution of cases by time of onset of symptoms among students and teachers who came for excursion to Kodaikanal, Tamil Nadu, India, 2024 (N=187) (n=109)

Laboratory Findings

Initial lab results from the samples were negative for enteric pathogens. Stool cultures did not show any enteric pathogens, and blood cultures had no bacterial growth. Additionally, the water samples tested negative for coliforms.

Analytical Findings

Analysis of the different food items revealed that only chicken curry was significantly associated with the illness. The attack rate for those who ate the chicken curry was 64%, compared to 47% among those who did not. This gave a relative risk of 1.36 (95% CI 1.10-1.84) (Table 3), indicating a strong link between consuming chicken curry and becoming sick. In contrast, other foods like biriyani, cabbage curry, chapati showed no significant association, with relative risks of 1.08, 1.03, and 1.04, respectively as it included the null value. The consumption of these other items was also not statistically significant.

DISCUSSION

This outbreak of acute gastroenteritis was characterized by abrupt onset of vomiting, short incubation period, and clustering among students who consumed a common meal. No other Person in the town other than these students suffered similar symptoms as evidently seen from the hospital records and nearby private clinics. The epidemiological evidence implicated chicken curry as the vehicle of infection.

Etiological Consideration

The median incubation period (6–7 hours) and predominant vomiting suggest Staphylococcus aureus enterotoxin[5] or Bacillus cereus emetic toxin[6] as possible agents. Both toxins are heat-stable, explaining the lack of culture positivity in stool or food samples[7,8] (Lindström et al., 2011; Bennett et al., 2013). The negative microbiological findings may also be due to delayed sample collection and prior antibiotic administration.[9]

Gender Differences

A higher attack rate was observed among females (64.6%) compared to males (53.3%). This could be due to variations in portion size, preference for chicken curry, or chance variation given the cohort size.

Public Health Importance

Foodborne outbreaks in excursion groups have significant consequences. They pose a clinical burden, as young people can experience rapid dehydration and may even require hospitalization. There is also a reputational risk associated with these outbreaks. For tourist destinations like Kodaikanal, such incidents could negatively impact tourism.[10] Ultimately, a single outbreak can harm both the health of individuals and the economic well-being of a community.

Comparison with Literature

Similar outbreaks due to chicken-based dishes have been reported in India, with common pathogens including S. aureus[11] and B. cereus.[12] The attack rate in our outbreak (58.3%) aligns with earlier documented foodborne incidents involving single contaminated dishes served to large groups.[13]

LIMITATIONS

There are three main limitations to this study. Firstly, there is a possibility of recall bias, as students may not have accurately remembered food consumption details; Secondly, laboratory limitations, since prior antibiotic use and the absence of leftover food limited the confirmation of the causative pathogen and the lack of an environmental investigation, which did not include screening food handlers for carrier states.

CONCLUSION

This was a single-exposure, foodborne outbreak among excursion students in Kodaikanal. The epidemiological investigation implicated chicken curry as the likely source, with a clinical presentation compatible with toxin-mediated gastroenteritis.

RECOMMENDATIONS

To prevent future foodborne outbreaks, several measures shall be implemented. First, there must be compliance with FSSAI guidelines at all tourist destinations. Additionally, cooks and hotel staff preparing large meals for groups should undergo mandatory food safety training. Routine inspections of catering units serving excursion groups are also necessary to ensure these standards are maintained at-least if not done. Schools organizing excursions should also be educated on the importance of selecting caterers with safe practices.

Action Taken

The restaurant and the hotel were closed for a week; All employees were given training to handle food hygienically. Awareness Programme was conducted to all food handlers in town about safe hygiene practices.

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ORIGINAL ARTICLE

PARACETAMOL OVERDOSE FOLLOWING IMMUNIZATION IN TAMIL NADU, 2024: FROM RELIEF TO RISK – LESSONS FROM A CASE SERIES AND PUBLIC HEALTH INTERVENTIONS

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ABSTRACT

INTRODUCTION : Adverse Events Following Immunization (AEFI) range from more frequent minor side effects, such as fever or pain at the injection site, to rare but serious adverse reactions such as anaphylaxis, death, etc. For the children between 6 weeks to 6 years under the AEFI Surveillance Programme, syrup paracetamol (125mg/5ml) is recommended for uniformity and preventing dosing errors. However, AEFI cases due to paracetamol overdoses do occur. This study describes a series of five paracetamol overdose following immunization reported in Tamil Nadu during 2024 and enlists the state level interventions to prevent the occurrence of paracetamol overdose following immunization.

METHODS : AEFI cases are reported through the SAFEVAC portal in accordance with the AEFI Surveillance and Response Operational Guidelines (2024) and undergo causality assessment by the State Causality Assessment Committee. In 2024, of 454 cases reported in Tamil Nadu, five were identified as paracetamol overdose and assessed for causality.

RESULTS: Among the five cases, four children recovered, while one child died from severe toxicity leading to acute liver failure. The reasons attributed are incorrect dosing by health workers, repeated administration by caregivers, misinterpretation of prescriptions, and the availability of non-uniform paracetamol formulations. State-level corrective measures included, supply of a uniform paracetamol formulation (125 mg/5 ml syrup with measuring cups) through TNMSC, communication with the National AEFI Secretariat regarding the risks posed by multiple formulations, training of Medical Officers and Health Workers on safe dispensing with supportive supervision, and sensitisation of professional bodies (IMA, IAP) on overdose risks.

CONCLUSION: This case series illustrate how errors in dosage, misinterpretation by caregivers, and the use of multiple formulations can have serious consequences, including death. State level interventions demonstrate that coordinated policy decisions, capacity building, and stakeholder engagement are essential to safeguard child health and prevent recurrence of such adverse events.

KEY WORDS: Paracetamol overdose, Adverse events Following Immunisation, Public Health Interventions.

INTRODUCTION

Immunization is one of the most cost-effective health investments and a success story for global health and development1. Under the Universal Immunization Programme in Tamil Nadu, 11 Vaccines are being provided to children and pregnant mothers against the 12 Vaccine Preventable Diseases (VPDs). Annually, around 9.5 lakhs pregnant women and 8.77 lakhs children / infants are being covered under this UIP programme.[2]

Immunization sessions are being conducted both as Institutional in all days a week and on every Wednesday as Outreach sessions. Around 6.5 lakhs immunisation sessions are conducted in Tamil Nadu annually. 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. These events can range from more frequent minor side effects, such as fever or pain at the injection site, to rare but serious adverse reactions such as anaphylaxis, death, etc.[3] The frequency of fever occurring within the first 24 hours following vaccination is highest following Pentavalent, DPT and IPV. For the children between 6 weeks to 6 years under the universal immunization programme, syrup paracetamol (acetaminophen) of strength 125mg/5ml is recommended for uniformity and preventing dosing errors.[3]Nevertheless, AEFI cases due to paracetamol overdoses do occur. This study describes a series of five paracetamol overdose following immunization reported in Tamil Nadu during 2024 and enlists the state level interventions to prevent the occurrence of paracetamol overdose following immunization.

METHODS

In accordance with AEFI Surveillance and Response Operational Guidelines 2024, AEFI cases occurring in districts

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are reported in SAFEVAC- Surveillance and Action For Events following Vaccination portal4. These cases are causally assessed by the State Causality Assessment Committee. Of the 454 cases reported in Tamil Nadu during 2024, five cases of paracetamol overdose are reported, and causally assessed by the State Causality Assessment Committee.

RESULTS

Among the five cases of paracetamol overdose reported, four cases recovered and one child died. Summary of the 5 cases are described in Table 1.

Contributing factors of paracetamol overdose	State level initiatives in preventing paracetamol overdose
▪ Dosage miscommunication between mother and health worker	▪ Trained Medical Officers and Health Workers on the Immunisation Manual, emphasizing supportive supervision and correct dispensing. ▪ Supplied paracetamol syrup (125 mg/5 ml) with calibrated measuring cups via TNMSC for immunisation sessions.
▪ Repeated oral administration by mother or caregiver ▪ Misinterpretation of prescribed doses	▪ Health workers and medical Officers sensitised to ensure parents and caregivers understand the right dosage.
Use of Paracetamol drops in field	▪ Addressed risks of multiple formulations with National AEFI Secretariat ▪ Requested supply of a single, uniform paracetamol syrup (125 mg/5 ml) for children
Additional doses of paracetamol administered by private practitioners without verifying prior doses given to the child	▪ Sensitised professional bodies (IMA, IAP) on overdose risks to strengthen awareness and safer prescribing practices, including verification of prior paracetamol intake before prescribing further doses.

Case 1 & 2:

1 month 13 days old twins who received bOPV 1, fIPV 1, PCV 1, Penta 1 and Rota 1 developed fever and seizures on the same day. Both were given excess doses of paracetamol (2.5 ml twice, 1 ml containing 150 mg of paracetamol, ~312 and 208 mg/kg respectively). Both children were hospitalized. Clinical examination was normal. Investigations revealed elevated CPP (59.4 mg/l), Serum Acetaminophen (134 mcg/ml). Diagnosed as simple febrile seizure and paracetamol overdose. Treated with antibiotics, antiepileptics, Vitamin K and N-acetyl cysteine (NAC). Both recovered.

Case 3:

3 months 10 days old male child vaccinated with bOPV 2, Penta 2 and Rota 2. On the same day baby developed fever with a background history of cold for 2 days and vomiting for 1 day (4 episodes). The mother administered 7.5 ml of paracetamol (150 mg/ml), instead of 0.4 ml advised by the health worker.

On the next day, baby developed fast breathing and was taken to a private clinic, where he was prescribed paracetamol 0.7 ml, oseltamivir, and nebulisation. Despite this, the symptoms persisted with poor feeding. The mother also gave 2 teaspoons of karpooravalli extract. The child was re-evaluated at the same clinic and referred to tertiary care hospital 2 days after vaccination.

On admission, the child had grunting respirations and was shifted to the PICU. He was intubated and started on NAC infusion, bicarbonate correction, and inotropes. During the course of management, child developed endotracheal bleeding, melena, and shock. Inotropes were escalated, and in view of fresh bleeding, packed red blood cells were transfused and steroids were initiated.

Despite all supportive measures, the child remained in refractory shock and suffered a cardiac arrest in the PICU. On day 3 of vaccination, the child had absent heart sounds, blood pressure, and palpable pulse. Pupils were 3 mm dilated and non-reactive, with no spontaneous respiration. Despite resuscitative efforts, the baby was declared dead.

Case 4:

3 months 15 days old female child vaccinated with bOPV 3, Penta 3, Rota 3, fIPV 2, PCV. Post vaccination, on the next day baby had fever, for which Paracetamol was given 4 times a day at a dose of 2.5 ml/dose (1ml~150 mg) ~1500mg/day ~ 348mg/kg. There was also a history of cough and cold for 1 day. The baby was referred from the PHC to Medical College Hospital and admitted. On examination, child was normal.

Initial investigations showed that liver enzymes were mildly elevated. However, from day 2 of admission, SGOT and SGPT levels became 370/166 U/L, which reduced on treatment with N-acetylcysteine, Vitamin K and intravenous fluids. The child recovered and later discharged.

Case 5:

4 months 11 days female child vaccinated with bOPV 3, Penta 3, Rota 3, fIPV 2, PCV 2. On the next day, baby had high grade fever, paracetamol was given 6th hourly for 2 days (cumulative dose: 360 mg/kg/day). On Day 2 of vaccination, child had seizure, taken to nearby hospital, loaded with antiepileptic drugs (AEDs) & paracetamol and referred to a private tertiary care hospital, where investigations revealed metabolic acidosis. NAC infusion started and child was referred to a Govt tertiary care hospital.

On admission, child had hematemesis and melena, treated with N acetyl cysteine, FFP and Vitamin K, levetiracetam. Serial CBC monitoring, liver enzyme monitoring done, which showed deranged coagulation profile. In view of prolonged derangement of coagulation profile, CT Brain done which showed mild diffuse hyperintensities in right cerebral hemisphere (suggestive of possible Encephalitis or Infarct). MRI Brain revealed Bilateral T2 globus pallidus hyperintensities, suggestive of secondary changes to liver failure. With treatment, child gradually improved and recovered.

Contributing factors for paracetamol overdose as identified in causality assessment and state level initiatives in preventing paracetamol overdose are outlined in Table 2.

DISCUSSION

Among the AEFIs, fever is the most common minor reaction attributed to most of the vaccines administered under UIP. The frequency of fever and local reaction (pain, swelling, redness) is highest following pentavalent, DPT and IPV. Paracetamol (acetaminophen) is commonly used as the first-line symptomatic medication for fever and pain management in the paediatric population, and it is the only drug recommended to treat fever in neonates5. When used in recommended doses and for a short duration (<72 hours), paracetamol has a good safety profile in infants. However, hepatotoxicity may occur after intake of a single high oral dose (> 150 mg/kg/ dose) or multiple excessive doses.[6,7]

Accidental paracetamol-induced hepatotoxicity owing to errors in dosage in infants has been reported globally. The reasons for overdosing include repeated oral administration by caregivers for persistent fever, and use of unsuitable formulations. Liver failure after repeated doses of paracetamol has been rarely reported, resulting from drug accumulation.[5]

This case series reports 5 cases of accidental paracetamol overdose, including one death due to paracetamol toxicity resulting in liver failure, disseminated intravascular coagulation and refractory shock. The reasons attributed are miscommunicated dosage by health worker, repeated oral administration by mother or caregiver, misinterpretation of prescribed doses and use of non-uniform formulations.

AEFI Surveillance and Response Operational Guidelines 2024 recommends that under UIP, syrup paracetamol of strength 125mg/5ml is preferable for uniformity and preventing dosing errors for the children aged between 6 weeks to 6 years. Despite this, field observations revealed that Paracetamol drops (supplied through National Health Programs as part of Kit A) are frequently used in practice. Drops pose challenges in dosing comprehension, particularly for mothers and caregivers who may already be distressed post-vaccination. This increases the likelihood of unintentional overdosing.

As observed in cases 3 and 5, additional doses of paracetamol were administered in private hospitals. This underscores the need to sensitise private practitioners to verify prior paracetamol intake before prescribing further doses. The State Causality Assessment Committee reviewing these cases emphasized the responsibility of health workers to ensure that caregivers understand dosing instructions clearly. Communication failures, especially in situations where the caregiver is anxious, can have catastrophic consequences, as illustrated by all the cases in this series. These findings underscore the importance of health workers not only prescribing the correct formulation but also verifying caregiver comprehension before dispensing.

State causality Assessment Committee insisted that it is the responsibility of health workers to ensure that mothers and caregivers clearly understand the correct dosage, particularly when they are anxious and distressed after their child's vaccination. The Committee also recommended that supportive supervision need to be strengthened.

From a programmatic perspective, five key actions are warranted. First, health workers should document the dosage of paracetamol advised for managing adverse events following immunisation in health records. Second, policy measures should enforce the supply of a single, uniform paracetamol formulation (125 mg/5 ml syrup) under UIP and National Health Programs to prevent confusion arising from multiple formulations across different supply kits. Third, supportive supervision needs to be strengthened at all levels of the health system to ensure adherence to guidelines. Fourth, continuous training and refresher training for health workers and supervisors should be institutionalized to build capacity for safe prescribing, dispensing, and caregiver education. Fifth, Sensitisation of private practitioners and paediatricians to verify prior paracetamol intake before prescribing further doses.

At the state level, several corrective measures were undertaken to address the issue of paracetamol overdose following immunisation. First, risks posed by multiple paracetamol formulations was addressed with the National AEFI Secretariat and requested to ensure the supply of a single, uniform formulation of paracetamol syrup (125 mg/5 ml) for the paediatric population, thereby preventing confusion arising from multiple formulations across different

supply kits. Second, to ensure accurate administration, paracetamol syrup (125 mg/5 ml) with calibrated measuring cups was supplied through the Tamil Nadu Medical Services Corporation (TNMSC) for use during immunisation sessions. Third, training of Medical Officers and Health Workers on the Immunisation Manual was completed, with emphasis on supportive supervision and appropriate dispensing of paracetamol for AEFI management. Fourth, Professional bodies, including the Indian Medical Association (IMA) and the Indian Academy of Paediatrics (IAP), were also sensitised on the risks associated with paracetamol overdose to strengthen awareness and promote safer prescribing practices.

CONCLUSION

This case series highlights the preventable risk of paracetamol overdose following immunisation. The reported cases illustrate how miscommunication in dosage, misinterpretation by caregivers, and the use of multiple formulations can have serious consequences, including death. In response, Tamil Nadu implemented a series of corrective measures, including ensuring uniform paracetamol formulations with calibrated measuring cups, training of health workers on safe dispensing and supportive supervision, and sensitisation of professional bodies on overdose risks. These interventions demonstrate that coordinated policy decisions, capacity building, and stakeholder engagement are essential to safeguard child health and prevent recurrence of such adverse events.

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