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ABSTRACT

It is important to identify and outline the role of governments, health and other sectors, communities, and households to achieve faster reductions in maternal mortality. While most states in India are grappling with the problem of high MMR, states such as Tamil Nadu have managed to reduce MMR levels to 79 deaths per 100,000 live births (SRS 2011–13). Against this backdrop, we review the policy experience of Tamil Nadu in achieving faster decline in maternal mortality. Tamil Nadu not only allows capturing the role of developmental factors but also presents an interesting case to explore the importance of governance in health systems. The public health system in Tamil Nadu has promoted skilled care by ensuring adequate supply of human resources for health and by improving access to a functioning referral system. This review also presents a framework for synergistic policy to cover determinants including health system, economic growth, developmental infrastructure, education, nutritional status and a focus on the marginalised sub-groups. In concluding, we identify that for sustained MMR reduction, Tamil Nadu has to eliminate intra-state inequities and focus on interventions to reduce all preventable causes of maternal deaths. It is expected that some of the lessons from the Tamil Nadu experience can be replicated by Empowered Action Group states to achieve faster reductions in maternal mortality.

Keywords: MMR, maternal mortality, maternal health, Tamil Nadu

1 INTRODUCTION

The high burden of maternal deaths among developing countries is recognised as a critical health policy concern. The global attention to maternal mortality is synonymous with the launch of the Safe Motherhood Initiative in 1987 by international agencies and governments to raise global awareness about the impact of maternal mortality and morbidity, and find solutions. Thereafter, important events in the 1990s, including the International Conference on Population and Development (ICPD 1994), incorporated human rights into the definition of safe motherhood and emphasised the need for broader political, social, and economic interventions to reduce maternal mortality. These events played an important role while deciding upon interventions for improving reproductive health and family welfare services, particularly among the marginalised sections of the population. The UN Declaration of the Millennium Development Goals (MDG) provided much necessary impetus for reducing maternal deaths by promoting inter-sectoral convergence across international, national, private, and civil society organisations (CSO). Despite important improvements in maternal health and reduction in maternal deaths, however, the MDG Report observes that progress has been rather slow (UN 2012).

India is committed to the MDGs in maternal and child health, but recent trends in the reduction in its maternal mortality suggest that India will likely miss its target (GoI 2011). The maternal mortality ratio (MMR) in India continues to be high, and is estimated at 178 deaths per 100,000 live births in 2010–12 (RGI 2013). Besides, this aggregate MMR figure hides stark socioeconomic and regional disparities—for example, the MMR varies from 328 in Assam to 66 in Kerala (RGI 2013). A few studies have highlighted the disproportionate burden of maternal deaths among socio-economically marginalised communities (Montgomery et al. 2014; Gupta et al. 2010; Kolandaswamy et al. 2010; Banerjee et al. 2013; Subha Sri and Khanna 2014). It was expected that the launch of the National Rural Health Mission (NRHM) would help all states reduce their MMR faster, but the improvements have not been commensurate with the underlying strategies and potential.

This implies that the current challenge is to identify and outline the role of governments, health and other sectors, communities, and households in population-wide strategies to improve health service access and affordability, care seeking behaviour, and healthy practices (World Bank 2012). While most states in India are grappling with the problem of high MMR, states such as Tamil Nadu, Kerala, and Maharashtra have managed to reduce MMR levels to below 100 deaths per 100,000 live births. Such stark contrast in performance between states in the country deserves greater attention. This note documents the various health care interventions in Tamil Nadu that have reduced maternal mortality, to provide other high MMR states and regions valuable policy lessons.

In fact, Kerala and Tamil Nadu are the only two South Indian states with MMR levels well below the much sought after level of 100. However, in this paper we focus on Tamil Nadu[1] for the following three reasons. First, it may be noted that skilled care requires adequate supplies and access to a functioning referral system. These aspects are relatively well developed through the public health system operations in Tamil Nadu whereas, in Kerala, these are increasingly associated with the private sector and with high income households (Kutty 2000). Second, Tamil Nadu has followed a trajectory whereby an assessment of MMR reduction could be attempted by accounting for the skill levels of attendants, with adequate controls specified to capture the access to health infrastructure and its quality. Such an analysis would help comprehend whether MMR reductions are affordable in relatively low-income settings, such as EAG states; and, if yes, how these should be implemented across weaker health systems (Pathmanathan et al 2003). Third, Tamil Nadu not only allows for capturing the role of developmental factors but also presents an interesting case to explore the importance of governance in health systems (Padmanaban et al 2009). Given the purpose, the rest of the paper is organised as follows: Section 2 provides a conceptual framework to understand the stage and factors associated with MMR reduction. Section 3 reviews the policy experience of Tamil Nadu with specific reference to maternal health. Section 4 outlines the preparations and readiness of various levels of health facilities to provide maternal health services and delivery care. Section 5 concludes with a brief discussion on the overall policy experience of Tamil Nadu.

2 CONCEPTUALISING MMR REDUCTION

The three-delay framework is largely applied in resource-poor settings to identify the obstacles in provision and utilisation of timely and high quality obstetric care for reducing maternal mortality (Thaddeus and Maine 1994). The first delay may occur due to late recognition of the life threatening condition, financial and opportunity costs, previous experience with the health care systems, or simply because of the lack of a decision-maker. The second delay is caused by factors like unavailability and/or high cost of transportation, geographical distribution of facilities and travel-time considerations. The third delay is associated with intra-facility issues, such as shortage of medical supplies, equipment, and trained human resources. While effective, the three-delay model is generic in construct, as it does not focus on more fundamental determinants underlying maternal deaths, whereas policies and programmes need further information for preventing and treating maternal morbidity that may or may not cause death (Pacagnella et al. 2012). Also, perceptions of the problems associated with institutional care, whether technical or interpersonal, may themselves delay the quest for treatment (Jeffery and Jeffery 2010). Hence, it is important to contextualise these delays alongside the structural environment and MMR levels.

[1] Padmanaban et al. (2009) as well as WHO (2009) also describe several health system interventions that have been instituted in Tamil Nadu to address maternal health care and maternal mortality.

From a policy perspective, the structural environment is summarily captured by the obstetric transition framework, which describes the gradual shift of countries or regions from higher to lower MMR (Souza et al. 2014). This construct describes the shifting pattern of causes of maternal death (from direct obstetric causes to indirect causes) and highlights the required changes in policy focus from the natural history of pregnancy and childbirth to institutionalisation and over-medicalisation of maternity care. Souza et al (2014) describe five stages of obstetric transition (Table 1).

Table 1 Stages of obstetric transition

Stage	MMR	Cause	TFR	Delay	Characteristics	Country
1	MMR > 1,000	Direct	High TFR	Phases 1 & 2	• Maternal deaths attributable to communicable diseases such as malaria • Little or so done to rectify the situation • Social, economic and cultural factors have predominant influence	Chad, Somalia
2	300 ≤ MMR < 1,000	Direct	High TFR	Phases 1 & 2	• Women seek health care services • Low levels of basic health care services and other infrastructure (transport, roads and human resources)	Kenya, Afghanistan
3	50 ≤ MMR < 300	Direct & Indirect	Variable TFR	Phases 1, 2 & 3	• Emphasis on secondary and tertiary prevention	India, Bangladesh
4	5 ≤ MMR < 50	Indirect	Low TFR	Phase 3	• Over-medicalization as a threat • Shift towards non-communicable diseases as a cause of death • Delays within health facilities	China, Sri Lanka
5	MMR < 5	Indirect	Very low TFR	Phase 3	• Sustainability of quality of care • Management of vulnerable population (migrants) • Consolidation of advances against structural factors (gender inequality and violence against women)	Sweden, Singapore

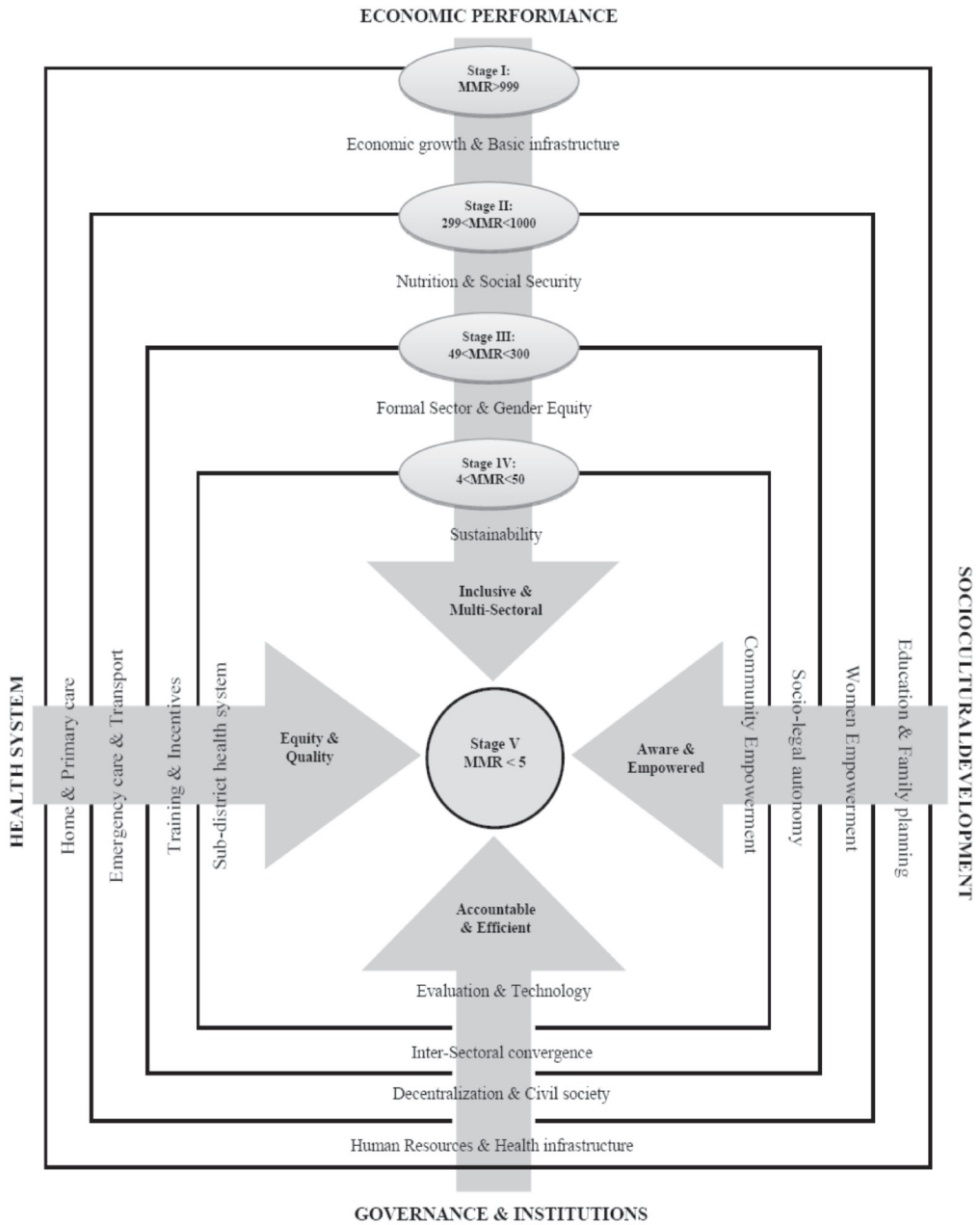
Source: Based on Souza et al (2014). Country classifications based on MMR estimates from WHO (2012)

Stage 1 (MMR > 1,000) and Stage 2 (300 ≤ MMR < 1,000) are identified with very high MMR, and share features such as poor health and developmental infrastructure. Here, the focus is on the first delay, and policies aim to motivate and encourage households and communities to utilise institutional care. In many ways, Stage 3 (50 ≤ MMR < 300) is a turning point in obstetric transition, and calls for action on all three delays, with greater emphasis on deploying human resources trained in the management of complications and disabilities. In Stage 4 (5 ≤ MMR < 50), deaths related to non-communicable diseases become a major concern alongside issues such as precautionary over-medicalisation. Stage 5 (MMR < 5) is the ideal stage, where sustaining health care investments, infrastructure quality, technological advancements, and universal coverage of health care services continue to drive the policy agenda.

While initial improvements in MMR may be correlated with economic development, progress to higher stages requires a synergistic policy approach, with focus on factors including health system, economic growth, developmental infrastructure, education, and nutritional status, and an exclusive focus on marginalised sub-groups. In fact, some existing frameworks for MMR causes and reduction (see McCarthy and Maine 1992; Campbell et al. 2006; World Bank 2012) that largely focus on health system strengthening also argue that sustained MMR reduction requires a combination of both direct and indirect strategies. Such an approach is spelt out in an alternative framework (Figure 1).

The framework emphasises all-round, simultaneous improvement in economic performance, sociocultural environment, health system inputs, and governance and institutions. However, it must also be accepted that, because of resource and developmental constraints, not all countries can achieve the comprehensive range of requisites under each dimension. In fact, countries in Stage 1 MMR levels are typically those where the development process is yet to be initiated. However, with improvements in economic outcomes, education, and basic health care infrastructure (including primary health care), MMR levels decline rapidly and countries progress to Stage 2. With economic growth, further improvements are warranted in all domains with specific focus on women empowerment, community participation (decentralisation and civil society partners), and basic interventions on nutritional health and development of emergency care. These measures help reach Stage 3, but faster MMR reduction requires strong commitment toward gender equity both in social and economic spheres. Besides, parallel investments for strengthening health system (infrastructure and management) are maintained. Finally, progress to Stage 4 requires the development of independent health system at block (sub-district) level. Also, it calls for universal coverage not only through systematic monitoring and evaluation but through community empowerment, to respect the right to health and quality of care. Sustained action across the four broad domains (as shown in Figure 1) will help achieve the objectives of equity, empowerment, inclusiveness, and accountability.

Figure 1 Conceptual framework for MMR reduction



Source: Authors

3 THE TAMIL NADU EXPERIENCE

This section describes how all-round developmental initiatives in Tamil Nadu helped it improve maternal health relatively quickly. Much of the description presented here is based on the policy note prepared by the Department of Health and Family Welfare, Government of Tamil Nadu (2014), and on other relevant research, such as Padmanaban et al. (2009) and WHO (2009).

3.1 Structural Environment

Tamil Nadu is a large state in southern India. It is the eleventh largest state in the country by area and the sixth largest by population. It is one of the most urbanised states in the country; 48 per cent of the population live in urban areas. (Census of India 2011). Tamil Nadu has traditionally boasted of good human development indicators and was ranked sixth by the Human Development Report 2011. It ranks second on economic indicators. Its per capita net state domestic product (NSDP) was estimated at Rs 112,664 in 2013–14 (2004–05 series, current prices). Tamil Nadu is among the higher income states of the country. Its agricultural sector is huge, but its economy is driven mainly by industry and the services sector. These sectors have helped generate employment and reduce poverty, given the high proportion of urban population. Opportunities for education and employment have also helped achieve greater gender equity than several other states in the country. The social reforms movement in the state, which focused on an egalitarian society, dates to the 1920s, during colonial rule. The socio-political class in the state have made society informed and aware about individual and societal well-being. The movement, which focused specifically on gender equity, has impacted maternal and child health, and helped improve female literacy, increase the age of women at marriage, and spread ideas of contraception and family planning. In the mid-1950s, school-based meal programmes were started to improve the nutritional status of school-going children, and strengthened during the 1980s. The state increased public health investment during the 1990s, and ensured a greater focus by spending almost half its budget on primary health care (WHO 2009). To meet the health sector's demand for additional resources, the state initiated public–private partnerships, and used funds from national government and international donor agencies to increase expenditure on maternal and child health.

Table 2 Comparison of key indicators, Tamil Nadu and India

Indicato	Source	Tamil Nadu	India
Crude Birth Rate	SRS 2011	15.9	21.8
Crude Death Rate	SRS 2011	7.4	7.1
Infant Mortality Rate	SRS 2011	22	44
Maternal Mortality Ratio	SRS 2010-12	90	178
Total Fertility Rate	SRS 2011	1.7	2.4
% who had 3 or more ANC visits	NFHS 3	95.9	50.7
% who delivered in a health facility	NFHS 3	87.8	40.8
% delivered by a skilled provider	NFHS 3	90.6	48.8
% who received a postnatal check up	NFHS 3	91.3	36.8

The Tamil Nadu Public Health Act, 1939 is an important legal and policy support that places health at the centre of development process in Tamil Nadu. The Act also facilitated the effective devolution of resources between state and local governments. Such an enabling environment has sustained the improving trends in health and health care. Table 2 shows some of the state's health indicators and compares these to the national figures. In fact, Tamil Nadu has been performing particularly well on maternal health care indicators. Tamil Nadu had a MMR[2] of about 372 in the mid-1980s and 195 in the early 1990s (Bhat et al. 1995; Bhat 2002). Clearly, unlike India, Tamil Nadu has experienced faster reductions to achieve the current MMR[3] of 90 per 100,000 live births (RGI 2013). The trends in MMR decline is depicted in Table 3, along with the absolute and relative change in MMR[3] during 2001 to 2014. The reduction in MMR is high in 2003, 2006, and 2009 in both absolute and relative terms. The rest of this section therefore presents certain broad descriptive features of the Tamil Nadu health system with a particular emphasis on aspects directly related to maternal and child health.

Table 3 Trends in MMR reduction in Tamil Nadu, 2010–2014

Year	MMR	Absolute Change	Relative Change (%)
2001-02	145	-	-
2001-03	123	22	-15
2001-04	114	9	-7
2001-05	109	5	-4
2001-06	94	15	-14
2001-07	95	-1	1
2001-08	93	2	-2
2001-09	79	14	-15
2001-10	85	-6	8
2001-11	79	6	-7
2001-12	73	6	-8
2001-13	73	0	0
2001-14	68	5	-7

Source: Government of Tamil Nadu (2014)

[2] Sheelarani (2007) cited in Padmanaban et al (2009) suggests that Tamil Nadu's MMR was 380 in 1993. However, this differs from the indirect estimates presented in Bhat et al (1995) and Bhat (2002). Using indirect methods, P N Mari Bhat estimates that Tamil Nadu had a MMR of about 372 in the mid-1980s and about 195 in the early 1990s. In fact, the SRS 2001-03 data suggests a MMR of 134 for the state which perhaps is more in line with the estimates of Bhat (2002).

[3] Interestingly, as per the state government estimates Tamil Nadu's MMR in 2010-12 is expected to be in the range of 73-79 whereas the current estimates (2013-14) suggests MMR of 68 per 100,000 live births (Govt. of Tamil Nadu 2014).

3.2 Streamlined Health Administration

Tamil Nadu is one of the most urbanised states (48 per cent urban, Census of India 2011), and has an eminent and a rich history of modern health care, both curative and preventive. The health administration in the state is well-staffed and well-structured. There is a clear division of roles and functions across the directorates of medical education, medical and rural health services, public health and preventive medicine, Indian medicine and homoeopathy, family welfare, food safety and drugs control administration, state health transport, medical services (ESI), and the medical services recruitment board. These directorates are further supported through key programmes and initiatives, including the National Health Mission (NHM), Tamil Nadu Health Systems Project (TNHSP), Tamil Nadu Medical Services Corporation (TNMSC), and Tamil Nadu State AIDS Control Society (TNSACS). The state has established councils through statutory orders to register and regulate the practice of medical, nursing, and paramedical professionals. The state also has used an alternative approach to demarcate districts as Health Unit Districts (HUDs). The health administration is being organised under 42 HUDs, which are usually, but not always, coterminous with Revenue Districts. (WHO 2009). This has greatly improved health administration and indicates conscious planning efforts by policymakers.

There is a clear demarcation of responsibilities as envisaged under primary, secondary, and tertiary level care. The Directorate of Public Health and Preventive Medicine is entrusted with all aspects of primary health care. The Directorate of Public Health and Preventive Medicine is entrusted with all aspects of primary health care. Its major focus is on the provision of community-based maternity and child health services, including family welfare, prevention and control of diseases, and positive behaviour change through universal primary health care.This directorate is responsible for the functioning of 1751 primary health centres (PHC), 134 urban PHCs, 8706 health sub-centres, and 388 hospitals-on-wheels. Given the population and geographical profile, these numbers easily fulfil the revised Indian Public Health Standards (IPHS) guidelines for health facilities. Further, it acts as a nodal centre for various primary health care programmes and is also responsible for civil registration. Similarly, all the secondary level care is provided by the Directorate of Medical and Rural Health Services, which effectively links the primary and tertiary levels. At this level, there is a total 105 hospitals (including 30 district headquarters hospital) that provides comprehensive emergency obstetrics and newborn care (CEmONC). The directorate of medical education is accountable for both tertiary level health care services and the regular training of the staff and functionaries.

Several administrative initiatives have contributed to the improvement in maternal health care. Prominent is Tamil Nadu's unique model of providing free drugs within the public sector facilities, through the Tamil Nadu Medical Supplies Corporation (TNMSC). The TNMSC facilitates centralised procurement of drugs directly from manufacturers through a

tender process. Manufacturers supply the drugs directly to district warehouses. The drugs are delivered to different facilities, based on requirement. The delivery is based on a passbook system: each facility is entitled to a certain quantity of drugs, based on the patient loads and usage patterns of the previous year. In addition to providing a regular supply of drugs and ensuring rational use, the TNMSC has instituted check mechanisms, including employing external independent agencies, to ensure the quality of drugs.

Another important administrative decision has been in the field of human resources for health. Until recently, the recruitment into the state medical and public health services was direct (either by the Tamil Nadu Public Commission or through the employment exchange). Due to large staff size, and massive job responsibility, recruitments through these departments were difficult and a cumbersome process. Realising the problem, in 2012 Tamil Nadu set up a separate Directorate of Human Resource and Medical Services Recruitment, to improve the availability and deployment of human resources for health. This medical service board is the first of its kind in India.

The Tamil Nadu Health System Project (TNHSP) is another pre-eminent project of the state government. Funded by the World Bank, it has been implemented effectively to improve health care services. The TNHSP is supporting the government in developing a partnership with several NGOs, on the public–private partnership model, to support the state health system by providing equipment, buildings, and manpower for providing essential and emergency obstetric care.

3.3 Efficient Surveillance System

Tamil Nadu estimates maternal mortality using data from its own surveillance system. The system mandates that the Village Health Nurse (VHN) must report every maternal death to the medical officers at the concerned PHC and block medical officer, who must in turn report it to the Deputy Director of Health Services (DDHS) at the district level, who must in turn report it to the Director of Public Health and to the District Collector. Thus, information of each death reaches the highest level at both district and state level. All reporting takes place within 24 hours of receiving the news of death, wherever the death took place, including private facilities.

Reported cases of maternal death are reviewed at different levels. First, a community-based verbal autopsy is carried out within a few days of reporting by a team comprising of the Block Medical Officer, the concerned PHC medical officer, community health nurse and VHN. This exercise tries to identify causes and contributors to the death. This report is then submitted to the DDHS. Thereafter, a facility-based audit is carried out at the facility where the death occurred, to factors related to the care that the woman received that may have led to her death. This includes a review of the deceased woman's medical records. Finally, a special

audit is conducted by two independent obstetricians—this includes a home visit, facility review, and review of medical records. A district-level maternal death review committee audits the reports every month and institutes corrective action. The district collector reviews the minutes of the committee's meeting every month—the family of the deceased woman is invited to attend this review to present their side of the story. Additionally, all maternal deaths are audited quarterly at the state level, along with the concerned districts, through video conferencing.

Table 4 Maternal death surveillance methods

Method	Description	Human Resource
Community-based maternal reviews (verbal autopsy)	Information obtained through email/fax/telegram Follow-up investigation in 15 days Motive: Document specific circumstances leading to maternal death Delay: First and second	Medical officers
Facility-based review of maternal deaths	Review of maternal death in the facility where women was treated and/or had died	Facility doctors
	Findings reviewed by MDAC, then by District RCH Committee	Medical Death Audit Committee (monthly)
	Motive: investigation of causes, treatment given and circumstances of death to see whether death could have be avoided	District Reproductive and Child Health (RCH)
	Delay: Third	
Near-miss case audit	Defining 'near-miss' events: either as acute obstetric complications that immediately threatens the survival of a women but do not result in death by chance or because hospital care she received during pregnancy, Labour, or within 6 weeks after the termination of pregnancy or delivery	Medical officers trained since 2008 to carry audits
	Motive: Whether provider was able to handle the complication properly or not	

Source: Based on Padmanaban et al. (2009)

Setting up such a system has presented several lessons. It requires consistent support for instituting the system, and much effort to sensitise peripheral health workers to motivate them to report maternal deaths and persuade them that this is a learning process and not a fault finding exercise. With such sustained commitment, it is now claimed that the system is able to document and review almost all maternal deaths in the state. In fact, the system is so robust that the concerned authorities (including VHNs) would be pulled up if they did not report a

maternal death, since the system would detect it through surveillance. The maternal death review system has thus become a mechanism by which the system learns from every woman's death and institutes corrective action. Some issues identified through this process and addressed include provision of emergency transport, accompanied transfers during referrals, and referral protocols. This is in stark contrast to the situation in other states of India, where perhaps about one-fifth of expected maternal deaths are reported and reviewed.

3.4 Incentives and Services

In 1987, Tamil Nadu instituted the Dr Muthulakshmi Reddy Maternity Benefit Scheme (MRMBS), to assist poor pregnant women and lactating mothers financially during pregnancy and after childbirth (Balasubramanian and Ravindran 2012). The scheme provides a conditional cash benefit, and is disbursed in three instalments, conditional to the woman having different components of antenatal care, an institutional delivery, and complete immunisation of the baby (Govt. of Tamil Nadu 2014). The benefit has increased to Rs.12,000 per beneficiary in recent years. The scheme appears effective, although there are no formal evaluations. Tamil Nadu also has an innovative birth companion scheme, which allows for the presence of a close friend or family member with the woman during the process of labour and birth to provide emotional support and improve maternal and neonatal outcomes (Shanta et al. 2014).

Since the early 1990s, the state of Tamil Nadu has been making concerted efforts to promote institutional deliveries. In the state, over 90 per cent of women deliver in health facilities. This proportion is much larger than in most other states. All PHCs have three staff nurses (trained in skilled birth attendance) posted round the clock, and VHNs are incentivised to encourage institutional deliveries. The services provided by facilities include a sheltered waiting area, bathrooms, running water, drinking water, clean linen, and solar water heaters. Funds have been used to improve the ambience by building good approach roads, signage, fencing, gardens, etc. To help women become familiar with the PHC, innovative schemes like maternity picnics and *valaikappu* (traditional bangle ceremony) have been held. These have resulted in an increase in the proportion of deliveries in PHCs and block PHCs, thus freeing up higher-level facilities to focus on women with complications. Importantly, this has also resulted in a shift of deliveries from the private sector to the public sector, and probably reduced out-of-pocket expenditure on delivery. Some hospitals have the facility for the expectant mother to go to the hospital 10 days before her delivery, and stay with a relative. These hospitals also provide a kitchen. This initiative reduces expenses on food to a minimum. These facilities are provided to pre-empt any serious complication, and to reduce the delay in transit if an obstetric emergency occurs just before the delivery.

Tamil Nadu also provides good antenatal care. Presently, VHNs in the community register pregnancies 12 weeks before gestation. The Maternal Child Tracking System (MCTS),

which monitors every pregnancy in the entire state through a unique identification number (ID), facilitates such registration. The registration of a pregnancy 12 weeks before gestation, and entry into the MCTS, is also a pre-condition for eligibility for the Dr. Muthulakshmi Reddy Scheme. Once the woman is registered, she receives further antenatal care at the PHC. This includes at least five antenatal visits, during which several examinations are carried out: weight monitoring, blood pressure examination, basic investigations including haemoglobin, blood group, and HIV screening, screening for gestational diabetes, tetanus toxoid immunisation, and provision of iron folic acid (IFA) tablets. The state has also ensured adequate infrastructure and human resource for these activities. Primary health centres have auto-analysers, for conducting laboratory tests, and ultrasound machines, to scan pregnant women. Medical officers at PHCs have been trained to use the ultrasound machines.

Recently, districts with high maternal mortality have started a programme to identify high-risk mothers. The VHN screens pregnant women for a list of high-risk conditions; once a week, an obstetrician deputed to a lower-level facility validates the results. The obstetrician plans their care during pregnancy and delivery, and refers them to a higher-level facility for delivery. The prevalence of anaemia during pregnancy is very high in India, and anaemia is a major contributor to maternal deaths and morbidity. In Tamil Nadu, antenatal care has made special efforts to address anaemia—a protocol has been drawn up at PHCs for treating anaemia in late pregnancy with iron sucrose injections, in addition to haemoglobin estimation and provision of IFA tablets. The state ensures supply of drugs, and trains medical officers at PHCs.

There have been certain district-specific innovations as well. The maternal death review process found that while women received antenatal care during early pregnancy, they are left out during late pregnancy—a crucial period when complications like pre-eclampsia develop—because of the cultural practice of migrating to their maternal homes for childbirth. In Kancheepuram district, a cross-notification system has been instituted to ensure that such women continue to receive care from the PHC that serves the area they were moving into. Another innovation in the same district has been to provide antenatal care to migrants working in construction sites close to Chennai through a mobile antenatal service at their work site. If they received antenatal care from the VHN for at least six months, they were also eligible for the Dr. Muthulakshmi Reddy Scheme.

The state of Tamil Nadu acknowledges that incentivising staff enhances their efficiency and motivates them to function more responsibly, and recognises health professionals to improve the quality of community services. In 1996, it introduced incentive packages for enhancing ANC services and promoting institutional deliveries. The VHN/ANM receives Rs. 50 per case if she provides five ANCs and conducts institutional deliveries. But if ANC is being provided, and she refers the case for institutional delivery, she receives an incentive of Rs. 25 for each case. Specialists attending emergency deliveries (when they are not on duty) are paid

an honorarium, and travel assistance, so that no woman is deprived of services. Similar initiatives have also been launched in other Indian states such as Gujarat (Bhat et al. 2009).

3.5 Addressing Proximate Determinants

High fertility, abortion, transport, and emergency care are among the key determinants of maternal mortality. Improvements are critical to achieve faster reductions in MMR (McCarthy and Maine 1992). In the 1980s and 1990s, Tamil Nadu was able to reduce its total fertility rate through family welfare services (it is currently 1.7). Nevertheless, two challenges are unmet: achieve a balance between various contraceptive methods; and increase male participation for sterilisation (only 1 per cent). Unsafe abortion is one of the important causes of maternal deaths in the state. Various initiatives have been taken to reduce the risk of maternal death by providing training to medical officers and enforcing certain rules and regulations. In fact, hospital staff other than specialists and medical officers are not allowed to conduct medical termination of pregnancy (MTP).

Emergency Obstetric Care (EmOC) is an essential intervention in the prevention of maternal deaths. EmOC has been divided into Basic EmOC (BEmOC) and Comprehensive EmOC (CEmoC). While BEmOC covers services such as antibiotics and removal of placenta, performing of caesarean section and blood transfusion is included in CEmOC services (Table 5). Tamil Nadu has provided for BEmOC in almost all PHCs in the state by ensuring the presence of staff nurses who are trained. Their induction training includes training in skilled birth attendance that equips them with skills to provide BEmOC. In addition, they receive periodic training to upgrade their skills – for example, some nurses we met recounted being trained in active management of third stage of labour to prevent post partum haemorrhage. Similarly, nurses are trained in the use of non-pneumatic anti-shock garment for initial stabilisation in cases of haemorrhage.

Table 5 Signal functions used to identify BEmOC and CEmOC services

	Basic EmOC services	Comprehensive EmOC Services
1.	Antibiotics (Injection)	(1-6) All of those included in Basic EmOC
2.	Oxytocics (Injectables)	7. Perform C-sections
3.	Anticonvulsants (Injectables)	8. Perform blood transfusion
4.	Manual removal of placenta	
5.	Removal of retained products	
6.	Assisted vaginal delivery	

Source: Field visit, Kancheepuram, Tamil Nadu

In order to provide wide access to CEmOC, Tamil Nadu took on an innovative strategy – it identified two facilities per district through geographical mapping to be upgraded to a

CEmOC facility – the criterion was that no woman should need to travel more than 2 hours to reach a CEmOC facility. The identified facilities were upgraded on a priority basis both with human resource and infrastructure and equipment to CEmOC facilities. Specialists' positions were rationalised by withdrawing all specialists from general services and posting them in CEmOC centres. The present allocation is four gynaecologists, four paediatricians, and two anaesthetists in every CEmOC centre. These centres are also equipped with blood transfusion facilities. Presently, there are 125 CEmOC centres in the state. Thus, by systematic mapping, and planning of human resource and other resources, Tamil Nadu has ensured adequate availability of both Basic and Comprehensive EmOC across geographical areas.

Blood transfusion is a critical intervention that can save a mother's life when faced with obstetric complications such as haemorrhage and severe anaemia. Availability and access to blood transfusion is a key gap in many states that has been identified to contribute to maternal mortality. Tamil Nadu has done exceedingly well in ensuring availability and access to blood through several health system interventions. Tamil Nadu has established blood banks in the public sector at all district hospitals and medical colleges and at all CEmOC centres. In addition, blood storage units have been established at all upgraded PHCs. This ensures access to blood at even lower level facilities. One of the key bottlenecks identified for blood transfusions especially at lower level facilities was a shortage of blood bank technicians. To overcome this, Tamil Nadu resorted to multi tasking. All doctors, staff nurses, and lab technicians at CEmOC centres and upgraded PHCs were trained in blood cross matching and transfusion. This helped overcome the obstacle caused by human resource shortage. These health system interventions were combined with a public awareness campaign to increase voluntary donation of blood. This has resulted in a situation where varied groups such as colleges, youth associations, cinema/film fans' associations and political party cadres organise blood donation campaigns as part of their regular activities. This has ensured that there is adequate supply of blood all the time.

Delay in transport contributed to maternal deaths was a key learning from the maternal death review process in Tamil Nadu. Thus, a decision was taken to address this and presently the state operates ambulance services in public-private partnership mode with a toll free number 108. Transport is free for pregnant women under this programme. Besides, Tamil Nadu has introduced a special vehicle for providing emergency transport in hilly areas and difficult terrain to address transport issues in these areas. Tamil Nadu has also ensured a seamless referral system that provides care for women when they develop complications. In the Tamil Nadu referral system, women, when in need of a referral, are provided "accompanied transfer"- that is, a health care provider accompanies the woman to the higher level facility, providing continuing care during the time of transfer and handing over the woman to a responsible provider at the higher centre. In addition to this, communication is established through phone calls made to the higher facility to ensure that care will indeed be provided there. If there is a situation where this may not be so, for example, when a specialist

is on leave, then the woman is transferred to the next nearest facility, thus avoiding delay in travelling back and forth. Also, referral letters are provided with the woman detailing all care provided at the lower facility and details of the woman's clinical condition.

4 PREPAREDNESS OF HEALTH FACILITIES

The preparedness of health facilities was reviewed by field visits to selected health facilities in Tamil Nadu. The visits were undertaken by the study team during August 2014. The key findings from the facility visits are reported as follows:

CEmOC centre, Kancheepuram

The CEmOC centre in Kancheepuram is located in the centre of Kancheepuram town close to the main bus stand and next door to the district hospital.

Human resources The centre is staffed with six obstetricians apart from a head of the obstetric department, 6 paediatricians in addition to a head of department and three anaesthetists. It is noteworthy that these specialists also look after the regular gynaecology work in the district hospital. The anaesthetists also help with general surgery and trauma related work. There is a shortage of staff nurses with only three posted in the labour room and working one per shift. There are 4 ANMs in the labour room. The senior authorities shared that they faced a staff shortage at all levels and the existing staff structure was inadequate to meet the load of patients.

Physical infrastructure The centre was centrally located and all services were displayed with good signage at the entrance. The centre has a 6 bedded labour room. When we visited, there were curtains around all beds; 4-5 of them were occupied, but no birth companions could be seen. The staff shared that the facility conducts 300-350 deliveries every month, many of which are women with complications referred in from lower level facilities. Almost 50 per cent of the deliveries were by caesarean section. There was an emergency operation theatre close to the labour room; since a surgery was going on, we did not visit it. Close to this was the Sick Newborn Care Unit (SNCU), this had one newborn ventilator.

Blood availability The district hospital was equipped with a blood bank. The staff shared that due to several public awareness campaigns conducted, there was a lot of voluntary blood donation and there was no shortage of blood. In fact, they sometimes had more than they needed and had to postpone planned camps.

Referral systems There were 70 women who were referred in from other facilities in the previous month. There were streamlined referral systems where whenever a woman was to be referred from a lower level facility, this was communicated a priori to the facility through a dedicated mobile phone. This helped in being well prepared for emergencies. Some of the

staff shared that this centre was overloaded because some of the neighbouring CEmOC centres were not functioning to full capacity. Very few patients were referred out from this centre, and only for intensive care.

Challenges Staff shortage was cited as a major challenge by almost everyone we met and this was affecting some services at least. For example, they had been provided with an adult ventilator to improve intensive care, but did not have an anaesthetist to manage it.

Upgraded PHC, Thiruppukkuzhi, Kancheepuram district

The upgraded PHC in Thiruppukkuzhi is a 30 bedded health facility. On an average, 90-100 deliveries take place every month in the facility.

The upgraded PHC has been developed as a referral facility intermediary to the CEmOC centres. There are two such upgraded PHCs in the Health Unit District. These also offer caesarean section facilities by hiring in obstetricians and anaesthetists. Most of these are planned caesarean sections, for example in the case of a previous caesarean or with a malpresentation, and by offering these at this level of an upgraded PHC, the load on higher facilities like CEmOC centre is reduced.

Thiruppukkuzhi PHC performs about 50 caesareans every month, most of them referred from lower facilities. The next referral centre is the CEmOC centre in Kancheepuram, about 12 km away, where women with complications that need higher level care are referred to.

Human resource The centre is staffed by three medical officers and a Block Medical Officer. A PHC medical officer trained in obstetrics is deputed here a few days of the week based on need to perform elective caesareans and tubectomies. The centre also hires in specialists from the private sector as required.

Physical infrastructure The centre is located on the main road and is connected by a good road. The campus is spacious with a lot of greenery that makes it very pleasant. There is goo signage.

The centre is 30 bedded with a labour room and with a separate toilet and bathroom that were reasonably clean. The operation theatre was situated close by – we did not visit this since a surgery was going on. There was a blood storage unit that was functional. The BMO informed us that adequate blood was available at all times.

The BMO informed us that they provided food from the centre for high-risk pregnant women admitted prior to delivery and also to all postnatal women.

Challenges Shortage of human resource was seen as a major challenge. With the centre conducting a significant number of deliveries including caesareans regularly, it was felt that the existing human resource was inadequate.

In addition, the funds allocated to the centre were also found to be insufficient to cope with the increased load. Maintenance activities could not be postponed as they would then affect functioning of the centre. The BMO mentioned how she had spent her own money to repair the AC stabiliser in the theatre and also the water pump motor and was waiting to be reimbursed. Similarly though a washing machine had been provided, operation theatre linen with blood stains needed to be sent to a dhobi to get rid of the stains. Again, funds had not come in for this. Special funds had been sanctioned the previous year for the centre to address this funds shortage. However, this was a one time grant and had not been sanctioned this year again.

Avaloor additional PHC

Avaloor additional PHC is located about 20 km from Kancheepuram in Kancheepuram district. The facility conducts about 10-15 deliveries every month.

Human resources The PHC is staffed by one lady medical officer. In addition, three staff nurses appointed under the RCH programme are posted in shifts round the clock to manage deliveries. The PHC has five Health Sub-centres under it with Village Health Nurses and a Sector Health Nurse who is their supervisor. In addition, a contractual posting of a staff nurse had been made under the Non-Communicable Diseases screening programme.

The staff nurses under the RCH programme had undergone training in skilled birth attendance, Active Management of Third Stage of Labour and in IMNCI. On interacting with them, we found them very confident of handling obstetric complications.

The medical officer and staff nurses also showed us case sheets of women delivering in the facility – these were found to be systematically maintained. Partograms were also found to be systematically maintained for all women delivering in the PHC, something that is usually not seen even in medical colleges.

Physical infrastructure The PHC is located within a small building. The campus was seen to be green. Shelters had been put up for patient waiting areas. The postnatal ward was attached to the labour room and had a toilet and bathroom attached. Solar water heaters provided hot water facility to the women for bathing. The PHC was also equipped with a laboratory that performed all basic tests.

Challenges It was shared that running a PHC with a single medical officer was difficult, since she had to go away on deputation to health camps and school health programmes.

Community-based services—interaction with VHNs

The team interacted with the VHNs posted in the different sub-centres of the PHC. They shared the community-based services provided to pregnant women.

The VHNs visited the villages under them in turn on Mondays to provide community based services. They were provided with pregnancy testing kits that helped them confirm pregnancy in the community itself. Following this, the woman was registered for antenatal care.

Pregnancy Infant Cohort Monitoring and Evaluation System Tamil Nadu has put in place a MCTS that helped maintain a database of all pregnant women. The Pregnancy Infant Cohort Monitoring and Evaluation System (PICME) software was used for this purpose. Village Health Nurses were now provided with laptops to facilitate this process.

Antenatal care Once the woman was registered for antenatal care, she was referred to the PHC to get laboratory investigations and antenatal check ups from the medical officer. The lab investigations included screening for anaemia and gestational diabetes mellitus.

Support to pregnant women VHNs established contact and rapport with pregnant women in their communities – they ensured that they received antenatal care, got requisite blood tests done and also regular ultra-sonograms. Women were also provided VHN's mobile numbers which they could use to contact them in an emergency. VHNs also helped pregnant women apply for and receive benefits under the Muthulakshmi Reddy Scheme.

Government Kasturba Gandhi Hospital for Women and Children

The Government Kasturba Gandhi Hospital, popularly known as the Gosha Hospital, is a tertiary level institution specially providing care to women and children. The hospital also houses the EmOC training centre for the state.

EmoC training centre

The EmOC training centre located in KGH is the nodal training centre for health care providers in the state to receive training in Emergency Obstetric Care and skilled birth attendance. So far, 16 batches of doctors (8 in each batch) and 20 batches of nurses (10 in each batch) have been trained here. The centre houses a skill laboratory that is equipped with mannequins and other training aids necessary for building knowledge and skills in EmOC. These include

- mannequins to practice skills of antenatal examination;
- models to develop skills in examining progress of labour through pelvic examination;
- models to learn skills of caesarean section including suturing the uterus;
- mannequins to learn skills of resuscitation both in adults and newborns; and
- model of pneumatic anti-shock garment to provide obstetric first aid for haemorrhage.

In addition, the training also covers infection prevention and bio medical waste disposal.

The centre provides training in EmOC for medical officers to address the issue of specialists and increase the pool of providers able to provide specialised services by multi-tasking. The medical officers are picked from different PHCs. They undergo a training for six months that includes three levels of examination and are subsequently posted in facilities where caesarean sections are performed.

There are also mechanisms for continuous support and supervision following this – they are invited to follow up meetings, are given regular feedback, and can also call up the nodal officer for ongoing support.

Tertiary care at Kasturba Gandhi Hospital

KGH is one of the specialised centres for women and children in Chennai. Close to 8,000 deliveries take place in this facility every year. Since this is a premier referral facility, close to 60 per cent of the deliveries are by caesarean.

Emergency care The hospital is well organised to handle women presenting or referred with emergencies and complications. Firstly, the hospital has an obstetric casualty that is staffed 24 hours by a doctor and is well stocked with drugs and emergency equipment. This service is located close to the entrance so that there is no delay in initiating treatment.

The emergency services include a labour room, emergency operation theatre, a room for women with eclampsia, a post-operative care room. These are well equipped with drugs, oxygen, equipment. We also found them remarkably clean during our visit. A separate septic labour room provides care for women with infections who need to be isolated.

In addition to this, the hospital has a high dependency unit with five beds that provides intensive care. This unit is equipped with critical equipment like ventilators. The hospital also has a Neonatal Intensive Care Unit providing up to Level 3 care.

Regular care The hospital has a well-designed outpatient block for providing antenatal care. This block contains all services under one roof including counselling services, laboratory, pharmacy, ultrasound.

Challenges It was shared that the hospital did not face shortage in terms of human resource or equipment and supplies. The doctors shared that they found the incidence of pre-eclampsia/eclampsia going up and suggested that community based services be strengthened to address this.

5 DISCUSSION AND CONCLUSION

While conceptualising MMR reduction, it is abundantly clear that faster reductions are possible only in a synergistic environment that involves rapid progress in all the four domains: *health system*, *economic performance*, *sociocultural outlook*, and *governance and institutions*. The review[4] of policies and programmes in Tamil Nadu clearly indicates that the state has not only provided adequate resources for public health but has also utilised them efficiently. This also qualifies the state as delivering good health at low cost (Balabanova et al. 2011). The health system in Tamil Nadu has a rich history and has received considerable attention from governments and policymakers. Besides, social reforms have helped to maintain focus on egalitarian goals of equity and universal care. The fiscal management of the state has made a conscious effort to invest in the social sector, and has invested in successful programmes in the field of nutritional health and women empowerment.

The political environment also has shown singular commitment towards maintaining higher socioeconomic welfare of the citizens thus allowing greater space to pursue egalitarian goals of health and welfare. With such past cumulative achievements Tamil Nadu is now on the verge of entering stage IV ($5 \leq MMR < 50$) of the obstetric transition. The developmental experience of Tamil Nadu provides valuable lessons for states that are facing severe resource constraints for social sector spending. An important issue here is to emphasise on the cumulative nature of investments for public health strengthening. In contrast, India's planning and development has not been able to adequately cater to the established health care norms and also failed to allocate much needed resources for the public health sector. In fact, India has one of the lowest public health spending figures of about 1.2 per cent of GDP. Lack of funding also implied that several state health systems lack its own agenda and that programmes and interventions often expect greater devolution of central government funds for the health sector.

Apart from investments, Tamil Nadu also offers valuable lessons in terms of health governance and health care institutions. The public health management system and supportive structures have always been a priority and since independence, Tamil Nadu has been focusing to build their primary health care services to be more affordable and providing quality of care to their population. In fact, it is widely acknowledged that governance and strong political support to health system are the triumphant reasons behind a good public health system in Tamil Nadu (Muraleedharan et al 2011, Das Gupta et al 2010, Mehrotra 2006, Padmanaban et al 2009, Vora et al 2009, WHO 2009, Kalaiyarasan 2014). Tamil Nadu has been able to develop appropriate policy frameworks and monitoring systems to support programme implementation in the health sector. Unlike several other states, Tamil Nadu has

[4] See Vora et al (2009), Padmanaban et al (2009), WHO (2009), and Muraleedharan et al (2005). Also see Das Gupta et al (2010).

not only developed a well-structured (sub-centre, primary health centre, community health centre, district hospitals and medical colleges) public health system but also successfully managed its human resources for health. This was largely possible because of a renewed emphasis on medical education and dynamic policy environment that allowed education, training, and recruitment in accordance with the local requirements. In this context, creation of a separate public health cadre is a key aspect of the Tamil Nadu health system whose importance only increases with shifting demographic and epidemiological profile of the country. Clearly, Tamil Nadu shares a number of lessons that can be applied to high MMR regions of India to improve policy implementation and increase availability of human resources for health. Nevertheless, the state also faces shortage of specialists but the magnitude of the problem is much smaller than compared to other states in India.

Tamil Nadu has managed and controlled some of the proximate determinants of maternal mortality. For instance, reduction in fertility levels in the early 1980s has provided the momentum for improving quality of care at both institutional and household level and also reduced the risk of maternal deaths. Also in recent years, the state has developed a good network of emergency care hospitals and referral transport system. This has benefited by unique initiatives such as identification of health districts. Availability and access to blood transfusion is well developed through an emphasis on public awareness campaigns. Besides, several of the skilled birth attendants are regularly trained to provide basic emergency care. But nevertheless, some parts of the state continue to face shortage of specialists at EmOC facilities. Furthermore, the maternal death review system has become a mechanism by which the system learns from every woman's death and institutes corrective action. There is significant emphasis to obtain timely and complete information on maternal deaths. This is possible because of well developed surveillance mechanism for maternal and child health in the state. In the last few years, surveillance has received further attention and new initiatives have been rolled out across the state. The performance is notably better and it is possible that it can be considered as an alternative for vital registration to provide comprehensive information for beneficiary care as well as for policymaking.

The health system in Tamil Nadu aims to develop mutual respect and trust among beneficiaries and health system. In fact, avenues for greater engagement and discussions are identified to overcome basic fear or embarrassment among beneficiaries and help them understand aspects of maternal health care. Such important role of grass-root workers is a benchmark of successful health care systems. Besides, the financial incentives for delivery care provided to pregnant women and lactating mothers is substantially higher than what is provided in other states or under the national rural health mission. Given such initiatives, it is no surprise that these would lead to a favourable impact on maternal health. However, Tamil Nadu now has to focus on two key issues for further reduction in MMR. First, it has to overcome intra-state inequities in distribution of maternal deaths. Part of this inequity is driven by the poor socioeconomic status of tribal and other backward communities who not

only have poorer access but also lack awareness of health care facilities. Second, the state has to increasingly focus on interventions to reduce all preventable causes of maternal deaths. For instance, the concept of obstetric transition suggests that Tamil Nadu has to now increasingly on indirect as well as NCD-related causes of maternal deaths. This would also imply sustainability of ongoing initiatives taken by the state and is likely to affect the pace of reduction in maternal deaths in India. Given the developmental narrative of Tamil Nadu, it is only reasonable to expect greater socio-political commitment towards maternal and child health which would continue to place Tamil Nadu ahead of other states in India.

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