“Impact of COVID-19 pandemic on utilisation of maternal and child health services in three priority districts of Tamil Nadu: An explanatory mixed methods study”

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List of Abbreviations

ANC	Antenatal Care
ASHA	Accredited Social Health Activists
AWW	Anganwadi worker
CHN	Community Health Nurse
CHW	Community Health Workers
FGD	Focus Group Discussions
GDM	Gestational Diabetes Mellitus
HTN	Hypertension
HUD	Health Unit District
IDI	In-Depth Interviews
IFA	Iron and Folic Acid
JIPMER	Jawaharlal Institute of Postgraduate Medical Education and Research
JSY	Janani Suraksha Yojana
LMIC	Low-and-Middle-Income Countries
MCH	Maternal and Child Health
MNCH	Maternity, Neonatal, And Child Health
MO	Medical officer
MRMBS	Muthulakshmi Reddy Maternity Benefit Scheme
NFHS	National Family Health Survey
NGO	Non-Governmental Organization
NQAS	National Quality Assurance Standards
PNC	Postnatal Care
RMNCH+A	Reproductive, Maternal, Newborn, Child, and Adolescent Health
SHN	Sector Health Nurse
VHSNC	Village Health Sanitation and Nutrition Committee
VHSND	Village Health Sanitation and Nutrition Day
VHN	Village Health Nurse

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Summary

Introduction: COVID-19 pandemic challenged health systems worldwide in delivering essential health services to pregnant women and children. Psychological stress and adverse pregnancy outcomes are reportedly higher among this group. In this study, we aimed to compare the coverage of MCH services, maternal/neonatal outcomes and the contraceptive uptake during the covid pandemic and pre-covid period. We also aimed to explore the challenges faced by the healthcare providers and the mothers in delivering and availing these services respectively in selected districts of the state of Tamil Nadu.

Methodology: The study was conducted in three districts of Tamil Nadu covering a total of five Health unit Districts (HUDs) namely Tiruvannamalai, Cheyyar, Theni, Thoothukudi and Kovilpatti. A total of 5000 records of mothers registered for AN care during January to March 2019 (Pre-covid period) & January to December 2020 (covid period) were randomly extracted from 10 PHCs of each HUD. Variables on socio-demography like age, education, occupation, and socio-economic status; clinical characteristics like gravida, parity, number of ANC checkups in each trimester, date of vaccinations for mother and the child, details pertaining to the screening of GDM, ultrasound scan, maternal outcome and child outcomes, type and mode of delivery and PNC visit within two weeks of delivery were extracted from the records maintained at health facilities. In addition to this, details on Muthulakshmi Reddy Maternity Benefit Scheme (MRMBS) and Janani Suraksha Yojana (JSY) scheme were also extracted. In-depth interviews and focus group discussions regarding the challenges faced, strategies adopted to overcome the challenges and suggestions for improving the existing service delivery were conducted among various cadres of health workers (Doctors, anganwadi workers, ASHA, SHN); mothers and their first-degree relatives (mother/ mother-in-law/ husband).

Results: A total of 4955 mothers were included for analysis after excluding the mothers with completely missing data. Of total 4955 mothers, 87.8% of them had visited PHCs during their

second trimester for check-up during covid compared to 86.4% in the pre-covid period. During the third trimester, there was drop in the AN visits (33.9% vs 32.6% during pre-covid and covid period). There was no significant difference between the two groups (26.1% Vs 29.5%) in terms of delay in TT immunization where the delay was more common in the pre-covid period. The proportion of abortion rates (7% vs 9%) and stillbirths (0.7% vs 1.5%) was higher during the covid period and there was a significant difference in abortion rates ($p=0.020$) and stillbirths ($p=0.002$) between the two groups. However, there was no difference in maternal death between the groups. Coverage of postnatal visits were reportedly higher during the covid time (84% Vs 96.0%) as compared to the pre-covid period and there was a statistical difference ($p<0.001$) between the groups.

Qualitative interviews provided challenges faced by the healthcare workers (resistance from the community, abuses from the community, work overload, etc.,), mothers and their families (financial constraints, lack of transportation to access health care, fear of the spread of covid, stigma, etc.,) and the issues at the healthcare system level (lack of bed, less number of the ambulance, less manpower, etc.,). Several strategies were adopted by the healthcare workers to overcome these challenges by using the existing resources for an alternate use (task shifting), doorstep delivery of vaccination and drug provision, having intersectoral coordination, prioritizing the high risk, use of advanced technologies and telecommunication to deliver the services more efficiently. Their suggestions for improvement were to improve infrastructure to enhance service provision and improve awareness among the public.

Conclusion: Health systems were able to deliver ANC services and immunization services during the pandemic. However, stillbirth and abortion rates were higher during the covid-19 pandemic. The COVID-19 pandemic has had a significant impact on maternal and child health services with a higher number of abortion rates and stillbirths in Tamil Nadu and has

emphasized the need for better preparedness and resilience in healthcare systems to respond to pandemics and other health crises.

Introduction

The COVID-19 pandemic posed severe challenges to public health systems worldwide and opened a phase of uncertainty, bringing several economies to a standstill. The pandemic was non-discriminatory in its impact, affecting all sections of human society. The mark of COVID-19 in India was on January 30, 2020, with the first case being reported in Kerala. (1) The cases crossed the 500 mark by March 2020, which imposed a one-day curfew followed by a complete lockdown throughout the country to limit the spread of the virus. Initially, the number of covid cases and death due to covid was relatively low compared to many developed nations, despite being the 2nd most populous country in the world. This can be attributed to the stern lockdown during the initial phase of covid. (2) The nascent public health systems of low-and-middle-income countries (LMICs) struggled to maintain non-COVID essential services for vulnerable groups during the pandemic as the healthcare personnel and resources were largely diverted for COVID response. (3) Thus, the epidemic challenged the health system to deliver essential health services.

The onset of the COVID pandemic slowed the pace of operationalisation of AB-HWCs, posing several challenges such as posting of Community Health Officers for COVID care, re-routing of funds for COVID management, infrastructural strengthening etc. During the pandemic, community health workers (CHWs) viz., ASHA, ANM and Community Health Officers undertook a series of new tasks in addition to their routine services, including maternal and child health (MCH) services. These new tasks include conducting household surveys for COVID-19 case detection, creating awareness about COVID-19, COVID testing, door-to-door visits, contact tracing and vaccination drives. Along with these additional tasks, they have also contributed to their routine job responsibilities in the community. (4,5) Researchers have identified the shortfalls in the provision and utilisation of routine MCH services during the current pandemic. A drop in utilisation of antenatal care (ANC) and post-natal care (PNC) (6)

institutional delivery (7),routine immunisation services (8,9) and family planning services signifies the lapses in MCH care due to the COVID-19 pandemic. Also, owing to the deficient health workforce in the public health systems, the available human resources for health were deputed to the Covid Care Centres, Dedicated COVID Health Centres and Dedicated COVID Hospitals, mainly at the secondary care facilities.

This led to minimal or no functional clinical services at the primary care level, leading to a larger extent of compromised routine services.

Pregnant women and children are vulnerable groups who require special attention during the COVID-19 pandemic. Pregnant women are vulnerable not merely because of their higher risk of having a severe form of COVID disease leading to adverse maternal and neonatal outcomes, but also due to suboptimal antenatal and postnatal care provision during the COVID period. (10) The aberration in essential healthcare services was reported to have contributed to psychological stress and adverse pregnancy outcomes, including preterm birth. (11) This could be attributed to the reduction in utilisation of the health care services, number of household visits by the community healthcare workers etc.

The utilisation of community platforms such as VHNDs, and VHSNCs, which are important for awareness, health education and, parallelly, for immunisation of infants, antenatal follow-ups were also compromised. Myths and misinformation about COVID-19 due to lack of awareness resulted in stigma and led to low community support and reluctance to accept healthcare services during COVID. (12)

From the community perspective, challenges such as lack of family support, stress, and fear of contracting the infection; facility-level challenges, like logistic problems relating to transportation and inadequate personal protective equipment during the initial phase; and community-level challenges, like stigma, resistance and lack of community support were important hindrances to the provision of MCH services during the COVID-19 pandemic.

India COVID-19 Emergency Response and Health Systems Preparedness Package funds were allocated to support the states' preparedness and prevention-related functions for managing the COVID-19 Pandemic. There had been an upsurge in the second wave, and the rural and peri-urban areas, which were so far not affected by COVID-19, also had a large number of cases.

To address the challenge, National Medical Council and NITI Aayog, to avert the impact of the COVID pandemic on maternal and child healthcare services, developed guidelines on utilising telemedicine and other context-specific solutions to ensure non-COVID essential healthcare services. (13) Despite such efforts, the studies showed suboptimal maternal care provision during a pandemic. The 14th Common Review Mission undertaken by MoHFW also reports that the community awareness of outreach ANC services was limited and was found to be further disrupted due to COVID-19. It was also observed that there was a delayed registration of pregnancies, low coverage and poor identification and tracking of High-risk pregnancies. A study from Puducherry, a Union Territory of India having a well-performing health system with the best maternal and child health care indicators, reported that only 60% of antenatal women completed the recommended antenatal visits. (14) The qualitative component of the study provided the reasons for not availing the optimal antenatal care during the COVID period and also gave insights into the negative impact of COVID on the general well-being of pregnant women. However, the study conducted in the well-performing district may not reflect the situation in districts with poor maternal and child healthcare indicators.

There has been a dramatic reduction in immunisation services during the pandemic, whereby more than a 20% decrease was observed for all vaccines except for BCG. For BCG, the reduction observed was 12.24%, which might be attributed to the fact that it is administered at birth in case of institutional deliveries in a public health facility as well as at VHND sessions. Similar results were reported by Rukmini who evaluated reports of the National Health Mission (NHM) to estimate the disruption of healthcare services in rural India. (15,16)

The impact of COVID on maternal and child health services would have been severe in high-priority districts of Tamil Nadu. The pregnant women and children in Thiruvannamali, Theni and Thoothukudi of Tamil Nadu, with a high proportion of the population residing in hard-to-reach areas, could have had a greater challenge in accessing healthcare services. Even prior to COVID pandemic, the above districts had poor maternal and child healthcare indicators. Full antenatal care service utilisation in Thiruvannamalai, Theni and Thoothukudi was 35%, 19% and 29%, respectively. (17,18) However, there has been no systematic assessment of the impact of COVID on the maternal and child healthcare indicators in these districts and the challenges in delivering the services.

Hence, we aimed to assess the antenatal care services, maternal and neonatal outcomes, postnatal care services and coverage and timeliness of childhood vaccination among pregnant women and infants during the first and second wave of COVID in Thiruvannamalai, Theni and Thoothukudi districts of Tamil Nadu and compare the indicators with pre-COVID time. Also, we aim to explore the challenges and experiences of women and health providers in accessing and providing antenatal, intra-natal, and postnatal services and childhood immunisation. The study would provide information on the current situation and challenges in maternal and neonatal care provision during the pandemic in high-priority districts. This information would be useful for making a necessary mid-course correction to improve maternal and child healthcare services and also prepare the health system to negate the impact of a future pandemic on essential healthcare services.

Objectives

1. In two cohorts (pre-COVID cohort: January 2019 to March 2019 and during COVID: January 2020 to December 2020) of pregnant women who had registered for antenatal care in primary health centres in three priority districts of Tamil Nadu (Tiruvannamalai, Theni and Thoothukudi), to compare
    a. coverage of obstetric care services (antenatal, intranatal and postnatal), and childhood immunisation services
    b. maternal and neonatal outcomes
    c. contraceptive uptake

2. To understand the challenges and experiences of women and healthcare providers in accessing and providing the obstetric care, contraceptive services, and childhood immunisation services in the public health sector during the COVID pandemic

Review of Literature

A. Coverage of obstetric care services (antenatal, intra-natal, and postnatal) and childhood immunisation services:

To understand the experience of vulnerable communities, such as urban slum dwellers, regarding maternal and child health services during COVID-19, **Sahoo KC et al**. conducted a multi-city qualitative study. Forty-eight in-depth interviews were conducted in four Indian states, including Odisha, Uttarakhand, Chhattisgarh, and Assam, among women living in urban slums in the antenatal, intranatal, and postnatal phases. The data were analyzed using the framework analysis method. Despite the mandatory stay-at-home, many women acknowledged that routine immunizations and antenatal check-ups continued uninterrupted, mainly at the community level. The family members and relatives had restricted visits to the health facility during labor or post-delivery to prevent transmission. Fear of covid infection led women to choose shorter hospital stays and fewer postnatal check-ups after delivery. (19)

AK Singh et al., in their study, attempted to assess the indirect effect of the pandemic on maternal and child health services in nine community development blocks of Sant Kabir Nagar district, Uttar Pradesh. Data on maternal health services were obtained from the selected programs – Janani Suraksha Yojana, Janani Shishu Suraksha Karyakram (JSSK), and Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA). Data from the Janani Shishu Suraksha Karyakram (JSSK) and universal immunization program (UIP) were obtained for evaluating child health services. The impact of the pandemic on services was determined by comparing data from the pandemic phase with data from 2019. In the study, there was decreased coverage of all interventions for mother and child health. The number of institutional deliveries overall was reduced by 2.26%. There was a 22.91% decline in antenatal services. Immunization services were reduced by more than 20%. (20)

Rabbani U et al. conducted a facility-based cross-sectional survey in the Qassim region of Saudi Arabia during the COVID-19 pandemic to assess the proportion of missed antenatal care appointments among pregnant women. The survey was conducted among the 400 pregnant women admitted for delivery at Maternity and Children Hospital (MCH), Buraidah. Socio-demographic information, obstetric history, missed appointments, and reasons for missed appointments were all recorded. Analysis was carried out in Statistical Package for the Social Sciences (SPSS), version 21.0 (IBM Corp., Armonk, NY). Medians with interquartile range (IQR) were reported for continuous variables, and for categorical variables, frequency and proportions were reported. Regression models were used to assess the factors associated with missed antenatal appointments. About one-third (30%) of the women had missed at least one ANC appointment in their current pregnancy. Among primary care patients and hospital patients, the most common reasons for missing appointments were fear of infection (52% and 47%), the facility not functioning as usual (25% and 7.5%), and fear of infection to children (19% and 17%). The study also found that family size and gravidity were significantly associated with missed appointments. (21)

In 2021, **Kassie A et al**. published a study evaluating the indirect impacts of COVID-19 on the utilization of reproductive, maternal, and newborn health services in South West Ethiopia. It was a comparative cross-sectional study. As a baseline comparator, information from March to June 2019 (before COVID-19) was utilized to evaluate the usage and effectiveness of reproductive, maternal, and new born healthcare services. This information was compared with an equivalent period of March–June 2020 (during COVID-19) to evaluate any significant change in utilization and outcome of services. Microsoft Excel 2010 was used to enter the data, which was exported to SPSS 25 and R3.5.0 for analysis. The data were computed using an independent sample t-test and a two-sample test of proportion, and the findings were displayed in the text, tables, and graphs. P-values lower than 0.05 were regarded as statistically

significant. The study concluded that there was a significant decrease in the mean use of antenatal care (943.25 visits vs. 694.75 visits), births in medical facilities (808.75 births vs. 619 births), family planning (4744.5 visits vs. 3991.25 visits), and newborn immunization (739.5 doses vs. 528.5 doses) between March-June 2019 and March-June 2020. (22)

A cross-sectional data review was conducted between April and May 2021 by **Gebreegziabher SB et al.** to assess trends in MCH health services performance during the COVID-19 pandemic in Addis Ababa, Ethiopia. The Addis Ababa Health Bureau's routine health management information system database was examined from July 2019 to March 2021 across all quarters. The proportion and mean with standard deviation were computed. To evaluate statistically significant variations in service performance, the T-test was used. During the first eight months of the COVID-19 pandemic, compared to the previous eight months' average performance, postnatal care visits, new contraceptives accepters, safe abortion care, and the number of under-five-year-old children treated for pneumonia all significantly decreased by 9.3% (p-value 0.04), 20.3% (p-value 0.004), 23.7% (p-value 0.01), and 77.2% (p-value<0.001, respectively). From January to March 2020, a quarter after the COVID-19 pandemic started, the trends in the first visit for antenatal care, new contraceptive users, pentavalent-3 vaccination, and under-five children treated for pneumonia started to decline. These declines accelerated from April to June 2020 after the national lockdown. (23)

A mixed-method study was conducted by **Bekele C et al**. to compare the use of maternity, neonatal, and child health (MNCH) services before and during the first six months of the COVID-19 pandemic. Eight health facilities that are a component of the Birhan field site in Amhara, Ethiopia, were used for the study, which compared the pattern of service utilization in the first half of COVID-19 with the equivalent time and data points in the prior year. Data on facilities services were gathered retrospectively over 18 months, from March 2019 to August 2020. There was a decline in the new family planning visits (43.2 to 28.5/month,

p=0.014) and sick under-5 child visits (225.0 to 139.8/ month, p=0.007) over the first six months of the pandemic compared with the same period in the preceding year. Although not statistically significant, there was a decline in the antenatal care visits (208.9 to 181.7/month, p=0.433), postnatal care visits (26.6 to 19.8/month, p=0.155), facility-level deliveries (90.7 to 84.2/month, p=0.776), and family planning visits (313.3 to 273.4/month, p=0.415). There was not much difference in the routine immunization visits for children (37.0 to 36.8/month, p=0.982). (24)

Burt JF et al. conducted an observational study in Kampala, Uganda, to assess the indirect effects of COVID-19 on maternal, neonatal, child, sexual, and reproductive services. Routinely collected data from Electronic Medical Records from July 2019 to December 2020 were obtained. The descriptive statistics summarised the primary outcomes before (July 2019–March 2020), during (April 2020–June 2020), and after the national lockdown (July 2020–December 2020). The number of antenatal attendances decreased significantly during the 3-month lockdown (370 lesser per month) and remained below pre-COVID levels. Attendance at programs to prevent HIV transmission from mother to child decreased. Women treated for high blood pressure, eclampsia, preeclampsia, adverse pregnancy outcomes (stillbirths, low birth weight, and premature infant births), neonatal unit admissions, deaths, and abortions all increased during the lockdown and immediately following the lockdown. The maternal mortality remained constant while the infant death rate increased from 39/1000 births to 49/1000 live births. (25)

Das Neves Martins Pires PH et al. undertook a mixed-method study to evaluate the effect of government limitations related to the Covid-19 epidemic on access to maternity and child healthcare services in Nampula, Mozambique. Maternal and child healthcare unit statistical indicators were compared from March-May 2019 to the same period in 2020. The Marrere health center and Marrere General Hospital were the two study sites. Interviews among health

professionals, traditional birth attendants, and patients in two areas were compared. There was a decline in maternal health services between 2019 and 2020 based on the following indicators: family planning visits and elective C-sections decreased by 28%; first antenatal visits during the first trimester decreased by 26%; hospital deliveries dropped by 4% ($p = 0.046$), while home deliveries increased by 74%; vaccinations for children dropped by 20%. (26)

A. ***Maternal and neonatal outcomes:***

Goyal M et al. conducted a prospective observational single-center study in the Department of Obstetrics and Gynaecology at AIIMS, Jodhpur from April to August 2020 to assess the effects of the COVID-19 pandemic on obstetric care and outcomes. All antenatal and parturient women admitted between April to August 2020 were included in the study. A comparison was made between data from the pre-COVID period of October 2019 to February 2020 regarding admissions, deliveries, antenatal visits, and reasons for inaccessibility of health care. As a result of the pandemic, institutional deliveries decreased by 45.1% ($P<0.001$), high-risk pregnancy increased by 7.2 %, and pregnant women were admitted to the intensive care unit 2.5 times more than before. One-third of women had inadequate antenatal visits. Lockdown and fear of acquiring infection were the main reasons for delayed health-seeking which resulted in 44.7% of pregnancies with complications. At the center, thirty-two symptomatic women who tested positive for COVID-19 were managed with good maternal and foetal outcomes. The study concluded that COVID-19 disease indirectly affects maternal and child health. (27)

Dorjey Y et al. conducted a descriptive retrospective study to assess the impact of the Covid-19 pandemic on maternal and child healthcare services in Phuentsholing General Hospital, Bhutan, from January 1 to June 30, 2022. Medical records of the patient for the pre-pandemic years 2018 and 2019 and the pandemic years 2020 and 2021 were reviewed. A review of all female patients and newborns admitted to the Maternal and Child Health Unit (MCH) was done. The data were analyzed using SPSS version 23. The admission rate decreased to 14.4%

during the COVID-19 pandemic. The total births and cesarean section rates fell by 10.1% and 16.1%, respectively. Antenatal and postnatal follow-up visits decreased significantly by 31.5% and 24.51%, while the total immunization rate reduced drastically during the pandemic. The impacts of the COVID-19 pandemic included missed antenatal and postnatal follow-up visits among pregnant mothers and newborn babies and missed immunization. (28)

B. Challenges and experiences of women and healthcare providers in accessing and providing maternal and child health services during the COVID pandemic

A qualitative study by **Mishra BK et al**. was conducted in Odisha between February and April 2021 to assess the challenges faced and mitigation strategies for providing maternal and child health (MCH) services during the covid-19 pandemic. In six districts of Odisha, in-depth interviews (IDI) and focus group discussions (FGD) were conducted among the CHWs (ASHA, ANM, LHV) as part of the qualitative study, and the data were analyzed using MAXQDA software. Routine MCH services were hindered by personal, facility, and community-level challenges. Misconceptions and myths caused stigma and opposition to COVID-19. A few effective strategies in addressing these challenges included sharing experiences with family, practicing yoga and pranayama, engaging ambulance bikes, providing financial assistance to mothers, counseling people, and involving community leaders. The study concluded that frontline workers would perform better at work and maintain MCH services during pandemics if proper strategy guidelines were developed and implemented. (12)

Wanyana D et al., in their cross-sectional quantitative study, assessed the utilization of maternal and child health (MCH) services during the covid – 19 pandemic. The study was conducted among all the public health facilities in Rwanda, East Africa. MCH data from March and April 2019 (before the COVID-19 outbreak) were compared with those from March and April 2020 to assess the utilization of 15 MCH services in the four categories, namely antenatal care (ANC), deliveries, postnatal care (PNC), and vaccinations. The MCH services under all

four categories were significantly decreased. The Northern and Western provinces were the worst affected, with a significant decrease in nine and twelve services, respectively. No significant changes were noted in the utilization of services in the Eastern Province. Only Kigali showed a significant increase in the fourth PNC visit for babies and mothers. At the same time, there was a significant increase in the use of MR vaccination in the Southern Province. According to the study's findings, the COVID-19 outbreak in Rwanda significantly impacted people's access to and use of vital MCH services. (29)

A cross-sectional survey was conducted between 16th September 2020 and 12th October 2020 by **Balogun M et al**. in Lagos, Southwest Nigeria, to assess the challenges faced by women who used RMNCH services in Nigeria's epicenter, their satisfaction with care received during the COVID-19 pandemic and the factors associated with their satisfaction. One thousand two hundred forty-one women of reproductive age were included who had received RMNCH services at one of twenty-two health facilities across the primary, secondary and tertiary tiers of health care during the COVID-19 pandemic. The respondents were selected via multi-stage sampling, and trained interviewers conducted face-to-face exit interviews. The four subscales: health care delivery, health facility, interpersonal elements of care, and access to services, were used to evaluate customer satisfaction. The association between individual characteristics and client satisfaction was evaluated using bivariate and multivariate analysis. Since the COVID-19 outbreak, 43.51% of responders have experienced at least one difficulty getting RMNCH services. One-third (30.91%) were unable to access service due to a lockdown, and 17.13 % were unable to travel. Respondents recorded a mean (standard deviation) score of 43.25 (6.28) out of 57 as satisfaction with the service. (30)

During the first wave of the COVID-19 pandemic in Nigeria, **Akaba GO et al.** conducted a qualitative study to determine the facilitators and barriers to access to MNCH services. Between May 2020 and July 2020, the study was carried out in 18 public health facilities in

Nigeria among various stakeholder groups. Fifty-four study participants across the three tiers of Nigeria's public health service delivery system (primary health centers, secondary health centers, and tertiary health centers) were included in the study. In-depth interviews were conducted among 54 study participants, including service users, service providers, and policymakers. The qualitative data were coded, themes were extracted from the transcripts, and a thematic approach was used for data analysis. In Nigeria, MNCH services were hindered by a fear of contracting COVID-19 infection at health facilities, transportation problems, stigmatization of sick people, a lack of personal protective equipment (PPE)/medical commodities, long waiting times in hospitals, a lack of human resources, and a lack of preparedness by health workers. (31)

Paudel M et al. conducted a qualitative study to understand the changes in reproductive, maternal, neonatal, and child health (RMNCH) services during the pandemic in Pakistan. The study was conducted among married women of reproductive age, community stakeholders, and healthcare professionals between November and December 2020. The interviews were conducted through semistructured in-depth interview guides and analysed in a thematic iterative approach. To reduce the crowding and maintain standard operating procedures (SOPs) like social distancing, all health institutions adjusted their routine operations, including service delivery times and staff hours. Stockouts and a shortage of supplies were frequently mentioned as major obstacles to getting care by women. Care-seeking patterns shifted from public to private facilities due to shortages and overcrowding. The utilization of RMNCH services decreased, initially due to limitations during the lockdown and later to concern over contracting COVID-19 at healthcare institutions. (32)

The utilization of maternal, neonatal, and child health (MNCH) services before and during the first six months of the COVID-19 pandemic was compared in a mixed-method study by **Bekele C et al**. The study examined the service usage pattern in the first half of COVID-19 with the

corresponding period and data points in the previous year in eight health facilities that are a part of the Birhan field site in Amhara, Ethiopia. Retrospective data collection on facilities services took place over 18 months, from March 2019 to August 2020. To evaluate barriers and facilitators to service provision/utilization, in-depth interviews were conducted. During COVID-19, healthcare providers and mothers reported several barriers to service utilization, including fear of disease transmission, economic hardship, and transportation disruptions. (24) A study was conducted between July and December 2020 in Ethiopia by **Tilahun B et al.** to investigate the epidemic's impact and identify effective maternal and child health services strategies. Both quantitative and qualitative approaches were applied. For the qualitative approach, 74 study participants under various categories, such as decision-makers, health workers, NGO delegates, and clients, were included through purposeful selection. Data collection involved 50 key informants and 24 in-depth interviews using an interview guide. Audio records have been transcribed verbatim, coded, and thematically analyzed. Based on the qualitative findings, the pandemic had negatively affected the quality and accessibility of MNCH services. MNCH services were also disrupted by COVID-19, especially in the first two months. During the pandemic, health professionals also struggled with a lack of personal protective equipment, work stress, and funding. A COVID-19 task force has been established by the health system at all levels, supported by a working guideline, as a coping mechanism. (33)

The delivery of essential health services was threatened by danger due to the coronavirus-19 pandemic and its side effects, which could impair population health and cause a protracted public health catastrophe. To assess the impact of the COVID-19 pandemic on the utilization of essential health services, **Shapira G et al**. conducted a study using a generalized interrupted time series study design in eight sub-Saharan African countries. Based on longitudinal panel data on monthly health facility service volumes from January 2018 to February 2020,

hypothetical service utilization levels were predicted from March to July 2020 without a pandemic. The most frequently impacted services were outpatient consultations, with a severe decline of 16% in Nigeria between March and July 2020. Among other services, child vaccination had the largest decline in several countries, with severe disruptions between April and May 2020. There has been a decrease in the utilization of maternal health services. However, some countries have noted significant declines in institutional deliveries, antenatal care, and postnatal care. (34)

To better understand the effects of COVID-19 on women refugees' access to and utilization of prenatal care, birth, and postnatal care in Eastleigh, Kenya, **Lusambili AM et al**. conducted a qualitative study. Qualitative in-depth interviews were conducted among the facility health care workers and community health volunteers (n = 10) and ANC and PNC refugee clients (n = 15) in Eastleigh, a semi-urban centre in the Kamukunji sub-county of Nairobi County, Kenya. NVIVO 12 software was used to analyse the data. During the first eight months of COVID-19, refugee women reported a preference for home deliveries and a reduction in utilization of healthcare services and delays in treatment. Several factors contributed to home deliveries and the delayed and low uptake of facility-based care, including fear, economic challenges, and the lack of policies for migrant inclusion in the healthcare system. (35)

Methodology

Study design:

Objective (Explanatory mixed-methods design):

1a, 1b, 1c: Record based cross-sectional analytical study was performed to compare the coverage of obstetric care services, maternal and neonatal outcomes and contraceptive uptake among pregnant mothers registered for ANC care during the pre-covid (January to March 2019) and covid period (January to December 2020) in the selected PHCs of three priority districts (5 HUDs in three districts) of Tamil Nadu.

2: Qualitative descriptive study: In-depth interviews (IDI) and focus group discussions (FGD) were conducted among the healthcare workers (medical officers, ASHAs, AWWs, VHNs, SHNs, CHNs) and the mothers who were pregnant during the aforementioned period. Relatives of the mothers, particularly the husband, mother or mother-in-law were also included.

Study setting:

General setting:

Tamil Nadu is a South Indian state comprising 38 geographically scattered districts with 87 revenue divisions and 42 HUDs spread over a total area of 1,30,058 sq.kms, As per the Census 2011, the population of Tamil Nadu is 72147030 with a literacy rate of 80.1%, a sex ratio of 996 and about half (48%) of the population are residing in urban areas. The Tamil Nadu model of public health is renowned for its success in providing quality health services at an affordable cost, especially to rural people. Tamil Nadu is the pioneering state with a distinctive public health cadre at the district level and also the first state to have legislated a Public Health Act in 1939.

The health and family welfare department of Tamil Nadu has several directorates designated for monitoring various healthcare services. There are Directorates for Public Health, Family

Welfare, Medical Education, Medical and Rural Health Services, Medical service corporations etc.

Under the Directorate of Public Health and Preventive Medicine, there are HDUs comprising both urban and rural areas. In the rural areas, there are block PHCs under which there are additional PHCs and upgraded PHCs and Health subcenters/ HSCs. In urban areas, there are municipalities/ corporation PHCs; also known as the urban PHCs. Every PHC is headed by a medical officer. The block PHC has a block medical officer who will be in charge of all the additional and upgraded PHCs in that block. Community Health Nurses (CHNs) will also be available at the block level to whom the sector health nurse (SHN) and the Village Health Nurse (VHN) would be reporting, SHN will be available at every PHC. VHNs are those who are in charge of the subcenters and go to the field and do field-level activities. Every PHC will have an SHN and 4-5 VHNs. In addition to this, there are ASHAs employed in some of the tribal blocks where there are hard-to-reach areas. In every district, there are one to two district hospitals/ Medical colleges.

Tamil Nadu has got one of the best health indicator profiles some of which are at the same level as that is seen in developed countries. The awareness about health and its parameters is quite strong. In spite of urbanization and increasing income thereby affordability; the community still has faith in the public health system which had been noticed while reviewing the services and community perception as reported by the 13th Common review mission. It is reported that most of the health facilities in Tamil Nadu have high availability of certain key services like AN care, routine deliveries, General medicine and pharmacies across all facilities. Basic medical equipment such as scales, stethoscopes and blood pressure apparatus are widely available at all health facility levels, but laboratory equipment such as glucometers, blood chemistry analyzers, and incubators was less readily available. For example, only 69% of district hospitals had glucometers, dropping to 45% at the sub-health centre level. This shows

a limited capacity for testing throughout the health system. While ECGs and ultrasounds are widely available, gaps are identified with regard to imaging equipment, particularly at lower-level health facilities. While 92% of district hospitals had X-rays, this figure was just 38% for community health centres. CT scans were available in just 38% of district hospitals and 4% of sub-district hospitals.

Specific setting:

The total fertility rate, maternal mortality ratio, neonatal mortality rate, infant mortality rate and U5 mortality rate of Tamil Nadu are 1.6, 63 per one lakh live births, 11 per 1000 live births, 16 per 1000 live births and 19 per 1000 live births respectively as per the SRS and NFHS reports. All the above indicators were much below the national average.

Tamil Nadu Health System Reform Program (TNHSRP) is a World Bank supported project implemented by Department of Health and Family Welfare (DoH&FW) of Tamil Nadu Government on Program for Results (PforR) basis. A special focus is maintained in nine priority districts of Tamil Nadu, which constitute the bottom quintile of the RCH indicators in the state and have a relatively large proportion of tribal populations. The six priority districts based on poor performance on RCH indicators are Ariyalur, Ramanathapuram, Theni, Thoothukudi, Tirunelveli, and Virudhunagar. Three indicators have been chosen to assess progress in this domain: full immunization, full ANC, and modern contraceptive prevalence rate. The three additional districts with relatively large ST populations are Dharmapuri, The Nilgris, and Tiruvannamalai. One of the result areas of TNHSRP is reducing the equity gaps in reproductive and child health in the above priority districts.

Interventions in the Program to reduce inequities between districts focus on a combination of supply- and demand-side interventions to support increased utilization of RCH services. The state provides mobile outreach services for tribal populations through 20 mobile medical units operated by nongovernmental organizations (NGOs) in tribal blocks. The mobile outreach team

offers minor ailment treatment, antenatal screening, NCD screening, and laboratory tests. Drugs are also provided free of charge. Additional supply-side interventions that will be introduced through the Program include better provision of quality RCH services as indicated by NQAS certification of primary and secondary care facilities. Furthermore, maternity stay wards will be established in remote areas to facilitate continuum of care before, during and after delivery which will positively impact both immunizations and contraceptive uptake.

For the conduct of this study, we have chosen the three high-priority districts (Tiruvannamalai. Theni and Thoothukudi) of Tamil Nadu with five HUDs i.e., Tiruvannamalai & Cheyyar, Theni and Thoothukudi & Kovilpatti. As per the national family health survey, 4 (NFHS-4) the key maternal and child health indicators like full antenatal care service utilization in Tiruvannamalai, Theni and Thoothukudi were 35%, 19% and 29%, respectively. However, there seems to be a marked improvement in the indicators as per NFHS-5. The routine MCH services are provided at the PHC or subcentre levels through the antenatal clinics on every Monday i.e., the VHN visits the antenatal mothers who have to visit the PHCs next day either at their houses or at the subcentre and remind them about the visit. On every Tuesdays, they have the ANC clinic at the PHCs. Wednesdays are designated for Vaccination of under 5 children at the subcentre, Thursdays are meant for post-natal visits, Fridays for Village health nutrition and sanitation day where health education is provided to the mothers and the family members and on Saturdays, the adolescent clinic is conducted in the PHCs.

Study participants:

Inclusion and exclusion criteria:

Primary Objective 1 (Quantitative):

Inclusion criteria: All mothers registered for antenatal care in selected ten PHCs in each of the five HUDs during January to March 2019 and during January to December 2020

Exclusion criteria: None

Primary Objective 2 (Qualitative):

Inclusion criteria:

Group 1 (HCWs): District Maternal and Child Health Officer (DMCHO), Medical officers (MO), Accredited Social Health Activists (ASHA), Village Health Nurse (VHN), SHN (Sector Health Nurse), Anganwadi workers (AWW) who were working in PHCs since 2019.

Group 2 (Beneficiaries): Mothers registered for AN care during the aforementioned period and the care takers of the pregnant mothers (Husband, mother, mother-in-law)

Exclusion criteria: None

Sample size estimation:

For Primary objective 1:

The sample size was calculated using OpenEpi version 3.0 with an absolute precision of 5% and 95% confidence level and design effect of 1.3. A study conducted by Revathi et al., in 2020 among the antenatal women who were registered for AN care in primary health centres of Puducherry reported that 40% of women did not complete their scheduled antenatal visits during the covid period. Anticipating the same proportion, the sample size calculated was 480. Adding a 5% non-response rate, data from 500 women were extracted for the study. Hence, the data were extracted for a total of 2500 women from five HUDs.

For comparing the indicators with the pre-COVID time (the levels of indicators- completed scheduled visits, full antenatal visit taken as 50% during pre-COVID time), assuming a 10% decrease in indicators during the COVID pandemic, 417 participants were needed for the comparison between two time periods. Since some of the maternal and newborn outcomes could be relatively low and to account for missing data we decided to include 500 from each HUD (a total of 2500 for each time period).

For Primary objective 2:

In-depth interviews were conducted among **5-6** purposively selected health care workers i.e., MO/ASHA/VHN/CHN/SHN and **5-6** high-risk pregnant mothers registered for antenatal care registered during the covid period. One to two FGDs were conducted among ASHAs, VHNs and AWWs. One FGD among the pregnant mothers during covid period and their caretakers i.e., husband, mother or mother-in-law of the pregnant mothers. One IDI was also conducted with the DMCHOs of all the five HUDs.

Sampling technique:

From each HUD, the list of PHCs were obtained for each block. We chose 10 PHCs at random proportionately to the urban and rural area distribution for each district. It was made sure that at least one PHC from each block was chosen to obtain maximum representation of the district. In Tiruvannamalai HUD, the chosen PHCs were Chennasamuthiram, Somasipadi, Kalambur, Pudupalayam, Reddiyarpalayam, Northampoondi, Meyyur, Anna Nagar, Jamnamaruthur, Nammiyampattu. In Cheyyar HUD, the chosen PHCs were Thiruvathipuram, Veerampakkam, Paniyur, S.V.Nagaram, Osur, Nedumpirai, Nallur, Mamandur, Madam, Malayampattu . Of which, one was urban, and the remaining nine were rural. In Theni HUD, the chosen PHCs were Kutchanur, M subbalapuram, Rayappanpatti, Theni bommayagoundanpatti, Cumbum,

Vadapudupatti, Gudalur, Jangalpatti, Gandamanur, Dombucherry. In Thoothukudi HUD, the chosen PHCs were Vallanadu, Thenthiruperai, Tharuvai Road- Hp, Salaipudur, Pudukottai, Padukkapathu, Mudalur, Kulasekarapattinam, Eral, Arumuganeri. In Kovilpatti district HUD, the chosen PHC were Boothalapuram, Kadalaiyur, Kadambur, Keelaeral, Nagalapuram, Vellalankottai, Pasuvanthalai, Perilovanpatti, Puthiyamputhur, Oorani street. In all the HUDs at least one PHC was urban, and one was tribal if there was any.

About 50 mothers registered during the covid and pre-covid were randomly chosen from each PHC. In total, about 100 mothers were chosen from each PHC at random.

Study procedure:

Quantitative: Data collection was started after scientific and ethics committee approval. Data collection was done over a period of eight months (March 2022 - December 2022). Principal investigator (PI) and the team made visits to all the ten randomly selected PHCs in the five chosen HUDs of Tamil Nadu. The permission had been obtained from the deputy director of the HUDs for conducting interviews among the health care workers and the pregnant mothers registered under the selected PHC and retrieval of data from the records.

The research staff extracted the following details using the structured proforma. We retrieved the data regarding the registration at first trimester, completion of scheduled ANC visits, date of TT vaccination, type of delivery, place of delivery, postnatal visits by a health worker within 2 weeks of delivery, timeliness of childhood vaccination (including BCG, OPV at birth, 3 doses of pentavalent, 2 doses of IPV and one dose of MR). Details of contraceptive uptake was extracted from the eligible couple register.

Data on transfer of MRMBS to the mothers were extracted for one urban, one rural and one tribal (wherever available) PHC during the covid and precovid period from all 5 HUDs.

Qualitative: In-depth interviews (IDI) and focus group discussions (FGDs) were conducted among the purposively selected women at their place of convenience to explore the challenges faced by them in accessing obstetric care and immunization services during COVID-19. IDI and FGD among the healthcare providers were also conducted at the PHCs in a pre-fixed time. Interviews were conducted by a person who is fluent in the local language (Tamil) and trained in qualitative research. The interviews were audio recorded after obtaining necessary informed consent. The audio recording and the field notes were used to prepare the transcripts. The interview transcripts were prepared within a day of the interview at the earliest possible. Iterative approach was used and the interviews were conducted till the point of information saturation.

Operational definitions:

Full antenatal care (ANC): Pregnant women receiving at least three ANC visits.

Timeliness for vaccine: For our study purpose, vaccination within two weeks of scheduled time period was considered 'vaccination as recommended'. Beyond two weeks of scheduled timing was considered as delay.

Study variables:

After reviewing the literature on this topic, the following variables related to antenatal care, intrapartum care, postnatal care, childhood vaccination were extracted from the records.

Independent variables:

1. **Socio-demographic characteristics of the mother:**
    a. Age
    b. Education

c. Occupation

d. Residence (urban/rural)

e. Socio-economic status (APL/BPL)

2. Antenatal history:

a. Date of last menstrual period

b. Date of AN registration

c. Parity (primi/multi)

d. Date of TT vaccination

e. Hemoglobin levels in each trimester (in mg/dl)

f. Tests to rule out diseases like HIV, syphilis (done/not done)

g. Glucose tolerance test (done/not done)

h. Co-morbid conditions developed during the time of pregnancy (yes/no)

i. History of abortion (yes/no)

j. Consumption of IFA (yes/no)

3. Intrapartum history:

a. Gestation at delivery (term/ pre-term)

b. Date of delivery

c. Type of delivery (normal/ assisted/ c-section)

d. Place of delivery (government/private)

e. Outcome of the baby (alive/death)

f. Birth weight of the baby (in kgs)

4. Child vaccination history:

a. BCG/ OPV given at birth (Yes/ No)

b. Date of BCG vaccination

c. Date of OPV vaccination

d. Date of Hep B vaccination

e. Date of IPV-1 vaccination

f. Date of IPV-2 vaccination

g. Date of pentavalent-1 vaccination

h. Date of pentavalent-2 vaccination

i. Date of pentavalent-3 vaccination

j. Date of MR-1 vaccination

5. **Benefits received:**

    a. JSY (Received/ not received)

    b. MRMBS (Received/ not received)

Dependent variables:

1. ANC visits in the first trimester (Yes/ No)
2. At least 3 ANC visits (Yes/ No)
3. IFA received (Yes/ No)
4. Timeliness of TT vaccines (Yes/ No)
5. Post-natal visit by medical staff within 2 weeks of delivery (Yes/ No)
6. Timeliness of BCG & OPV at birth, Pentavalent (1,2,3), IPV (1,2) and MR (1) vaccines (Yes/ No)
7. Maternal outcome (alive/dead)
8. Neonatal outcome (alive/dead)
9. Contraceptive uptake (Yes/No)

Statistical analysis:

Data was collected and entered in excel and analysis was done in STATA version14.

All the categorical variables i.e., demographic variables such as education, occupation, residence of the mother; pregnancy related characteristic like parity, comorbidities during

pregnancy, tests done to rule out diseases like HIV, syphilis, diabetes, type of delivery, place of delivery, gestational age at delivery, received JSY/MRMBS benefits, received postnatal visits were summarized as frequency with percentages. Continuous variables like age of the mother, hemoglobin levels in each trimester and birth weight of the baby were summarized as mean (SD) or median (IQR) based on the distribution of the data.

Objective 1a, 1b, 1c:

Coverage of obstetric care services such as full antenatal care (4 ANC visit + one TT + 100 IFA), vaccination delay, postnatal visit by the health care worker, maternal and neonatal outcome and contraceptive uptake were summarized as proportions with 95% confidence interval. Median days of vaccination delay was also reported.

Chi squared test of proportion was done to test the association between the above-mentioned obstetric care services, maternal and neonatal outcomes and the contraceptive uptake with the time of pregnancy i.e., the covid or the pre-covid period. For the comparison of continuous variables like birth weight of the baby and the hemoglobin levels in three trimesters between the two cohorts, independent t test is done. Log binomial regression was done determine the association and are reported as prevalence ratio (PR) with 95% Confidence Interval (CI). We included variables with a p value of <0.2 in univariate analysis into the multi variable regression model. P value <0.05 was considered for statistical gnificance.

Objective 2:

For qualitative component, in-depth interviews were transcribed within a day or at the earliest possible while listening to the audio recording and then translated to English. Manual descriptive content analysis was done to analyse the transcripts. Transcripts were reviewed by another person to decrease the bias and increase the interpretive credibility. Decisions on coding rules and theme generation were done using standard procedure and consensus. Any difference between the two was resolved by discussion. Codes were obtained using hybrid

approach (inductive and deductive coding). Finally, the findings were reported using COnsolidated criteria for REporting Qualitative research (COREQ).

Ethics approval:

The proposal was presented to the Institutional Ethics Committee to obtain ethics approval before commencing the project and the project was approved (JIP/IEC/2021/367). All standards of ethical guidelines were followed at each level of study. The participants were made aware that their participation in this study is voluntary. They may choose to leave the study anytime with no effect on their existing healthcare services. They were assured that their identity will not be disclosed anywhere and kept confidential, and the data generated would be used for research purposes only. The purpose of the study was explained to the participants, and written informed written consent was obtained by the investigator before the interview (qualitative). Informed consent forms and forms containing identifying information were secured in a locked file cabinet. It was ensured that all study-related documents besides the consent forms are devoid of identifying information. All data extracted were coded by a participant identification number (PID).

Data confidentiality: Only the Principal Investigators, co-Investigators of the study and the Institutional Ethics Committee members have access to the data. Unique study identifier was used to trace patients from one register to the next, but confidentiality was strictly maintained by keeping all the information securely in a locked cabinet and the electronic data file is kept in a password protected computer accessible only to the investigators. Data sets will be maintained securely for five years from completion of study.

Risk: Risk involved in the study will be categorized as low risk as the participants would have had some kind of psychological discomfort when asked about the challenges or difficulties faced during the covid period.

RESULTS

Table 1: Distribution of socio-demographic characteristics among the pregnant mothers during pre-covid (January 2019 to March 2019) and covid period (January 2020 to December 2020) in five HUDs in Tamil Nadu.

Category	Total N (%)	Pre-covid January 2019 to March 2019	Covid January 2020 to December 2020	p-value
Age groups (years)	**4955 (100)**	**2469 (100)**	**2486 (100)**	0.436
15-19	604 (12.2)	296 (12.0)	308 (12.4)	
20-34	2481 (86.4)	2133 (86.4)	2148 (86.4)	
35-45	70 (1.4)	40 (1.6)	30 (1.2)	
Education*	**3294 (100)**	**1665 (100)**	**1629 (100)**	0.677
No formal education	41 (1.2)	23 (1.4)	18 (1.1)	
1^{st} std to 5^{th} Std	491 (14.9)	258 (15.5)	233 (14.3)	
6^{th} std to 10^{th} std	938 (28.5)	480 (28.8)	458 (28.1)	
11^{th} std to 12^{th} std	816 (24.8)	400 (24.0)	416 (25.5)	
Degree and above	1008 (30.6)	504 (30.3)	504 (30.9)	
Occupation*	**3314 (100)**	**1658 (100)**	**1656 (100)**	0.365
Unemployed	1443 (43.5)	709 (42.7)	734 (44.3)	
Employed	1871 (56.5)	949 (57.2%)	922 (55.6)	

*data missing for 1661 on education, 1641 on occupation.

Around 86% of the mothers belonged to the age group of 20-34 years during both the pre and post COVID periods, and about 12% of the pregnancies represented the teenagers i.e., between 15 & 19 years. Out of 3294 mothers, 1008 (30%) had completed education up to degree level or above. But no formal education was received by 41 (1.24%) mothers. About 56% of the mothers were employed during both pre and post COVID periods. (Table 1)

Table 2: Distribution of provision of routine investigations among ANC mothers during pre-covid (January 2019 to March 2019) and covid period (January 2020 to December 2020) in five HUDs in Tamil Nadu.

Characteristics	Total N (%)	Pre-covid January 2019 to March 2019	Covid January 2020 to December 2020	p-value
Ultrasound in 1st trimester	**4955 (100)**	**2469 (100)**	**2486 (100)**	**<0.001**
Yes	3530 (71.2)	1655 (67.0)	1875 (75.4)	
No	1425 (28.8)	814 (33.0)	611 (24.6)	
Ultrasound in 2nd trimester	**4955 (100)**	**2469 (100)**	**2486 (100)**	**0.047**
Yes	3488 (70.4)	1770 (71.7)	1718 (69.1)	
No	1467 (29.6)	699 (28.3)	768 (30.9)	
Ultrasound in 3rd trimester	**4955 (100)**	**2469 (100)**	**2486 (100)**	0.198
Yes	1276 (25.8)	616 (24.9)	660 (26.6)	
No	3679 (74.3)	1853 (75.1)	1826 (73.4)	
Blood pressure in 1st trimester	**4955 (100)**	**2469 (100)**	**2486(100)**	**<0.001**
Yes	4575 (92.3)	2203 (89.2)	2372 (95.4)	
No	380 (7.7)	266 (10.8)	114 (4.6)	
Blood pressure in 2nd trimester	**4955 (100)**	**2469 (100)**	**2486 (100)**	0.203
Yes	4305 (86.9)	2130 (86.3)	2175 (87.5)	
No	650 (13.1)	339 (13.7)	311 (12.5)	
Blood pressure in 3rd trimester	**4955 (100)**	**2469 (100)**	**2486 (100)**	0.328
Yes	1640 (33.1)	801 (32.4)	839 (33.8)	
No	3315 (66.9)	1668 (67.6)	1647 (66.3)	
Other Investigations				
HIV testing	**4951 (100)**	**2467 (100)**	**2484 (100)**	**0.795**
Yes	4846 (97.9)	2416 (97.9)	2430 (97.8)	
No	105 (2.1)	51 (2.1)	54 (2.2)	
Syphilis testing	**4951 (100)**	**2467 (100)**	**2484 (100)**	0.580
Yes	4845 (97.9)	2417 (97.9)	2428 (97.7)	
No	106 (2.1)	50 (2.1)	56 (2.3)	
Blood grouping	**4951 (100)**	**2467 (100)**	**2484 (100)**	0.877
Yes	4918 (99.3)	2451 (99.3)	2467 (99.3)	
No	33 (0.7)	16 (0.7)	17 (0.7)	
Mothers received IFA	**4955 (100)**	**2469 (100)**	**2486 (100)**	**0.004**
Yes	4314 (87.1)	2116 (85.7)	2198 (88.4)	
No	641 (12.9)	353 (14.3)	288 (11.6)	

Out of 4955 mothers, first and second ultrasounds in respective trimesters were done by 70% of the mothers, but only 26% of them proceeded to take the third ultrasound. In a similar

manner, 95% of the mothers checked their first blood pressure values during COVID period and this result was statistically significant. Second blood pressure readings were checked for 97%, and only 33.7% of them had their BP checked the third readings. Almost all (97%) mothers were tested for HIV & syphilis and 99% of them underwent blood grouping and typing. Around 88% of the mothers received IFA during COVID time. (Table 2)

Table 3: Distribution of morbidities and high-risk conditions among ANC mothers during pre-covid (January 2019 to March 2019) and covid period (January 2020 to December 2020) in five HUDs in Tamil Nadu. (N=884*)

Category	Total N (%) 884 (100)	Pre-covid January 2019 to March 2019 n (%) 406 (100)	Covid January 2020 to December 2020 n (%) 478 (100)	p-value
Severe anaemia (Hb<7gm %)				
Yes	28 (3.2)	15 (3.7)	13 (2.7)	0.409
No	856 (96.8)	391 (96.3)	465 (97.3)	
Previous LSCS				
Yes	318 (35.8)	147 (36.2)	171 (35.8)	0.894
No	566 (64.2)	259 (63.8)	307 (64.2)	
High order birth				
Yes	127 (14.4)	59 (14.5)	68 (14.2)	0.897
No	757 (85.6)	347 (85.5)	410 (85.8)	
Teenage pregnancy				
Yes	31 (3.5)	15 (3.7)	16 (3.4)	0.780
No	853 (96.5)	391 (96.3)	462 (96.6)	
Rh -ve				
Yes	23 (2.6)	7 (1.7)	16 (3.4)	0.131
No	861 (97.4)	399 (98.3)	462 (96.6)	
Short Stature				
Yes	16 (1.8)	6 (1.5)	10 (2.1)	0.495
No	868 (98.2)	400 (98.5)	468 (97.9)	
Pregnancy induced HTN				
Yes	26 (3.0)	11 (2.7)	15 (3.1)	0.707
No	858 (97.0)	395 (97.3)	463 (96.9)	
Bad obstetric history				
Yes	27 (3.1)	9 (2.2)	18 (3.8)	0.182
No	857 (96.9)	397 (97.8)	460 (96.2)	
Elderly gravida				
Yes	21 (2.4)	13 (3.2)	8 (1.7)	0.137
No	863 (97.6)	393 (96.8)	470 (98.3)	
Others †				
Yes	96 (10.9)	44 (10.8)	52 (10.9)	0.984
No	788 (89.1)	362 (89.2)	426 (89.1)	

**Multiple categories are possible for one person*

†Conditions include DM, RHD, Epilepsy, tuberculosis, bronchial asthma, etc.

A minority (3%) of mothers had severe anaemia. Previous LSCS was observed in 318 out of 884 mothers. Around 14% of mothers had a high order birth and 31 out of 884 mothers had a teenage pregnancy. About 3% of the mothers were Rh -ve and 16 had short stature. Pregnancy induced hypertension was reported in 3% of the mothers. Out of 884, 27 mothers in total had bad obstetric history. Other conditions such as DM, RHD, Epilepsy, tuberculosis bronchial asthma were reported in 96 (10.8%) mothers. (Table 3)

Table 4: Distribution of antenatal services provided among ANC mothers during pre-covid (January 2019 to March 2019) and covid period (January 2020 to December 2020) in five HUDs in Tamil Nadu.

Category	TOTAL N (%)	Pre-covid January 2019 to March 2019	Covid January 2020 to December 2020	p-value
Delay in receiving TT 1st dose	**4153 (100)**	**2062 (100)**	**2091 (100)**	**<0.001**
No delay	3689 (88.8)	1774 (86.0)	1915 (91.6)	
Delay	464 (11.2)	288 (14.0)	176 (8.4)	
Delay in receiving TT 2nd dose	**3466 (100)**	**1725 (100)**	**1741(100)**	0.143
No delay	2881 (83.1)	1450 (84.1)	1431 (82.2)	
Delay	585 (16.9)	275 (15.9)	310 (17.8)	
Referral to a higher center during pregnancy	**2890 (100)**	**1489 (100)**	**1401 (100)**	**0.012**
Yes	750 (25.9)	357 (24.0)	393 (28.1)	
No	2140 (75.0)	1132 (76.0)	1008 (71.9)	
ANC visits				
1st trimester	**4955 (100)**	**2469 (100)**	**2486 (100)**	**<0.001**
Yes	4626 (93.4)	2225 (90.1)	2401 (96.6)	
No	329 (6.6)	244 (9.9)	85 (3.4)	
2nd trimester	**4955 (100)**	**2469 (100)**	**2486 (100)**	0.125
Yes	4315 (87.1)	2132 (86.3)	2183 (87.8)	
No	640 (12.9)	337 (13.7)	303 (12.2)	
3rd trimester	**4955 (100)**	**2469 (100)**	**2486 (100)**	0.345
Yes	1649 (33.3)	806 (32.6)	843 (33.9)	
No	3306 (66.7)	1663 (67.4)	1643 (66.1)	

First TT dose was delayed for 8.4% and 14.0% of the mothers during COVID and pre-COVID period respectively. The delay in second dose of TT was observed in 15.9% and 17.8% during pre-covid and covid period respectively. A total of 750 mothers were referred to higher centres since January 2019 and 28% of the mothers were referred during COVID time. ANC visits during COVID period for 1st, 2nd and 3rd trimester were given for 96.5%, 87.8% and 33.9% of the mothers respectively. (Table 4)

Table 5: Distribution of natal services provided among ANC mothers during pre-covid (January 2019 to March 2019) and covid period (January 2020 to December 2020) in five HUDs in Tamil Nadu.

Category	Total N (%)	Pre-covid January 2019 to March 2019	Covid January 2020 to December 2020	p-value
Gestational week	**4529 (100)**	**2274 (100)**	**2255 (100)**	
Term	3656 (80.7)	1830 (80.5)	1826 (81.0)	0.669
Pre-term	873 (19.3)	444 (19.5)	429 (19.0)	
Abortion	**4915 (100)**	**2442 (100)**	**2473 (100)**	
Yes	385 (7.8)	168 (6.9)	217 (8.8)	**0.013**
No	4530 (92.2)	2274 (93.1)	2256 (91.2)	
Type of delivery	**2730 (100)**	**1387 (100)**	**1343 (100)**	
Normal	1720 (63.0)	876 (63.2)	844 (62.8)	0.066
LSCS	963 (35.3)	495 (35.7)	468 (34.8)	
Assisted vaginal delivery	47 (1.7)	16 (1.2)	31 (2.3)	
Place of delivery	**4519 (100)**	**2267 (100)**	**2252 (100)**	
GH/ Govt medical college / District Hospital	3464 (76.7)	1745 (77.0)	1719 (76.3)	0.847
PNH	1044 (23.1)	517 (22.8)	527 (23.4)	
Home TD trained	11 (0.2)	5 (0.2)	6 (0.3)	
Outcome of baby	**4530 (100)**	**2274 (100)**	**2256 (100)**	
Alive	4496(99.2)	2263 (99.6)	2233 (99.0)	**0.022**
Still birth	34 (0.8)	11 (0.4)	23 (1.0)	
Outcome of mother	**4955 (100)**	**2486 (100)**	**2469 (100)**	
Alive	4954 (99.9)	2485 (99.9)	2469 (100)	0.319
Maternal Death	1 (0.01)	1 (0.04)	0 (0)	

Pre-term mothers constituted 19% of the sampled population. There were 217 (8.7%) mothers who underwent an abortion during the COVID period and 168 (6.8%) mothers had an abortion prior to COVID time. Overall, 63% mothers had a normal delivery and stillbirths accounted for about 1% of the total deliveries. Out of 4519 mothers, 76.6% delivered the baby at GH, Govt medical college, or District Hospital. Only 11 mothers in total had home delivery. In 99% of deliveries, the baby and mother were alive. (Table 5)

Table 6: Distribution of postnatal services provided among ANC mothers during pre-covid (January 2019 to March 2019) and covid period (January 2020 to December 2020) in five HUDs in Tamil Nadu.

Category	TOTAL N (%)	Pre-covid January 2019 to March 2019	Covid January 2020 to December 2020	p-value
Received post-natal care within 2 weeks of delivery	**4497 (100)**	**2264 (100)**	**2233(100)**	**<0.001**
Yes	4044 (89.9)	1900 (83.9)	2144 (96.0)	
No	453 (10.1)	364 (16.1)	89 (4.0)	
Received JSY benefits	**3397 (100)**	**1691 (100)**	**1706 (100)**	0.776
Yes	2671 (78.6)	1333 (78.8)	1338 (78.4)	
No	726 (21.4)	358 (21.2)	368 (21.6)	
Eligible MRMBS beneficiaries	**4955 (100)**	**2469 (100)**	**2486 (100)**	<0.001
Yes	4340 (87.6)	2115 (85.7)	2225 (89.5)	
No	615 (12.4)	354 (14.3)	261 (10.5)	

A statistically significant proportion of the mothers received post-natal care within 2 weeks of delivery. This proportion was 83% in pre-COVID period and increased to 96% during COVID period. JSY scheme benefits were received by 78% of the mothers during pre-COVID and COVID periods. About 85.7% of the beneficiaries in the pre-covid period and 89.5% of the beneficiaries in the covid period were eligible for the MRMBS scheme. There was a statistically significant difference between the beneficiaries during the pre-covid and covid in receiving the various installments of the MRMBS scheme. All the five installments were received by 46.2% of the people during the precovid period and 38.2% of the mothers during covid period. (Table 6)

Table 6a: Distribution of MRMBS to ANC mothers during pre-covid (January 2019 to March 2019) and covid period (January 2020 to December 2020) in five HUDs in Tamil Nadu. (N=1090)

Category	TOTAL N (%)	Pre-covid January 2019 to March 2019	Covid January 2020 to December 2020	p-value
Eligible MRMBS beneficiaries	**1090 (100)**	**544 (100)**	**546 (100)**	
Yes	944 (86.6)	462 (84.9)	482 (88.3)	0.104
No	146 (13.4)	82 (15.1)	64 (11.7)	
One installment received	**944 (100)**	**462 (100)**	**482 (100)**	
Yes	892 (94.5)	418 (90.5)	474 (98.3)	**<0.001**
No	52 (5.5)	8 (1.6)	44 (9.5)	
Two installments received	**944 (100)**	**462 (100)**	**482 (100)**	
Yes	810 (85.8)	400 (86.6)	410 (85.1)	0.504
No	134 (14.2)	62 (13.4)	72 (14.9)	
Three installments received	**944 (100)**	**462 (100)**	**482 (100)**	
Yes	656 (69.5)	335 (72.5)	321 (66.6)	**0.049**
No	288 (30.5)	127 (27.5)	161 (33.4)	
Four installments received	**944 (100)**	**462 (100)**	**482 (100)**	
Yes	628 (66.5)	325 (70.3)	303 (62.9)	**0.015**
No	316 (33.5)	137 (29.7)	179 (37.1)	
Five installments received	**944 (100)**	**462 (100)**	**482 (100)**	
Yes	580 (61.4)	307 (66.5)	273 (56.6)	**0.006**
No	364 (38.5)	155 (33.5)	209 (43.4)	
Nutrition kit 1	**944 (100)**	**462 (100)**	**482 (100)**	
Yes	92 (9.8)	40 (8.7)	52 (10.8)	0.270
No	852 (90.2)	422 (91.3)	430 (89.2)	
Nutrition kit 2	**944 (100)**	**462 (100)**	**482 (100)**	
Yes	5 (0.5)	4 (0.9)	1 (0.2)	0.164
No	939 (99.5)	458 (99.5)	481 (99.5)	

Although the first installment was received by a higher proportion of mothers during covid time, it is declining from the second instalment. A statistically significant difference was observed between the time periods in third, fourth and fifth installments. Nutrition kits were received by less than 10% of the mothers in total (table 6a)

Table 7: Distribution of immunization services provided among children during pre-covid (January 2019 to March 2019) and covid period (January 2020 to December 2020) in five HUDs in Tamil Nadu.

Category	TOTAL N (%)	Pre-covid January 2019 to March 2019	Covid January 2020 to December 2020	p-value
BCG vaccine	**2728 (100)**	**1351 (100)**	**1377 (100)**	**<0.001**
No delay	2426 (88.9)	1125 (83.3)	1301 (94.5)	
Delay (2 weeks)	302 (11.1)	226 (16.7)	76 (5.5)	
Hepatitis B zero dose	**4341 (100)**	**2148 (100)**	**2193 (100)**	0.351
No delay	4115 (94.8)	2043 (95.1)	2072 (94.5)	
Delay (24 hours)	226 (5.2)	105 (4.9)	121 (5.5)	
OPV birth dose	**4323 (100)**	**2137 (100)**	**2186 (100)**	0.861
No delay	3950 (91.4)	1951 (91.3)	1999 (91.5)	
Delay (2 weeks)	373 (8.6)	186 (8.7)	187 (8.5)	
Pentavalent vaccine 1st dose	**4435 (100)**	**2233 (100)**	**2202 (100)**	**0.039**
No delay	4207 (94.9)	2103 (94.2)	2104 (95.5)	
Delay (2 weeks)	228 (5.1)	130 (5.8)	98 (4.5)	
Pentavalent vaccine 2nd dose	**4375 (100)**	**2201 (100)**	**2174 (100)**	0.120
No delay	4262 (97.4)	2136 (97.1)	2126 (97.8)	
Delay (2 weeks)	113 (2.6)	65 (3.0)	48 (2.2)	
Pentavalent vaccine 3rd dose	**4159 (100)**	**2105 (100)**	**2054 (100)**	**0.013**
No delay	3978 (95.7)	1997 (94.9)	1981 (96.5)	
Delay (2 weeks)	181 (4.4)	108 (5.1)	73 (3.5)	
IPV 1st dose	**4435 (100)**	**2233 (100)**	**2202 (100)**	**0.039**
No delay	4207 (94.9)	2103 (94.2)	2104 (95.5)	
Delay (2 weeks)	228 (5.1)	130 (5.8)	98 (4.5)	
IPV 2nd dose	**4124 (100)**	**2084 (100)**	**2040 (100)**	**0.002**
No delay	3632 (88.1)	1803 (86.5)	1829 (89.7)	
Delay (2 weeks)	492 (11.9)	281 (13.5)	211 (10.3)	
MR – 1 vaccine	**3050 (100)**	**1612 (100)**	**1438 (100)**	0.868
No delay	2225 (72.9)	1178 (73.1)	1047 (72.8)	
Delay (2 weeks)	825 (27.1)	434 (26.9)	391 (27.2)	

During COVID period 94.4% children received BCG vaccine compared to 83.2% during pre-COVID period without any delay. Almost equal proportion (95%) of children received Hepatitis B zero dose during both periods without any delay. OPV birth dose was received by

91% of the children without any delay. Pentavalent 1st, 2nd and 3rd dose were received by 94.8%, 97.4% and 95.6% of the children respectively without any delay. IPV 1st dose was given to 94.8% of children and 2nd dose to 88% of the children without any delay. During COVID period this proportion was 95.5% for 1st dose and 89.6% for 2nd dose without any delay. This result was found to be statistically significant. MR-1 vaccine was received by 72.9% of the children without any delay. (Table 7)

Table 8: Distribution of contraceptive uptake among the mothers during pre-covid (January 2019 to March 2019) and covid period (January 2020 to December 2020) in five HUDs in Tamil Nadu.

Category	TOTAL N (%)	Pre-covid January 2019 to March 2019	Covid January 2020 to December 2020	p-value
Contraceptive uptake	**4530 (100)**	**2274 (100)**	**2256 (100)**	0.493
Yes	3963 (87.5)	1997 (87.8)	1966 (87.2)	
No	567 (12.5)	277 (12.2)	290 (12.9)	
Method	**3963 (100)**	**1997 (100)**	**1966 (100)**	0.057
Permanent method	1309 (33.0)	658 (33.0)	651 (33.1)	
IUCD	2638 (66.6)	1336 (66.9)	1302 (66.2)	
Pills/Condoms	5 (0.1)	0 (0)	5(0.3)	
Antara	11 (0.3)	3 (0.2)	8 (0.4)	

Among 4530 mothers, 87% reported contraceptive use and more than half of them (66.5%) used IUCD. Permanent method for contraception was followed by 1309 (33%) mothers. (Table 8)

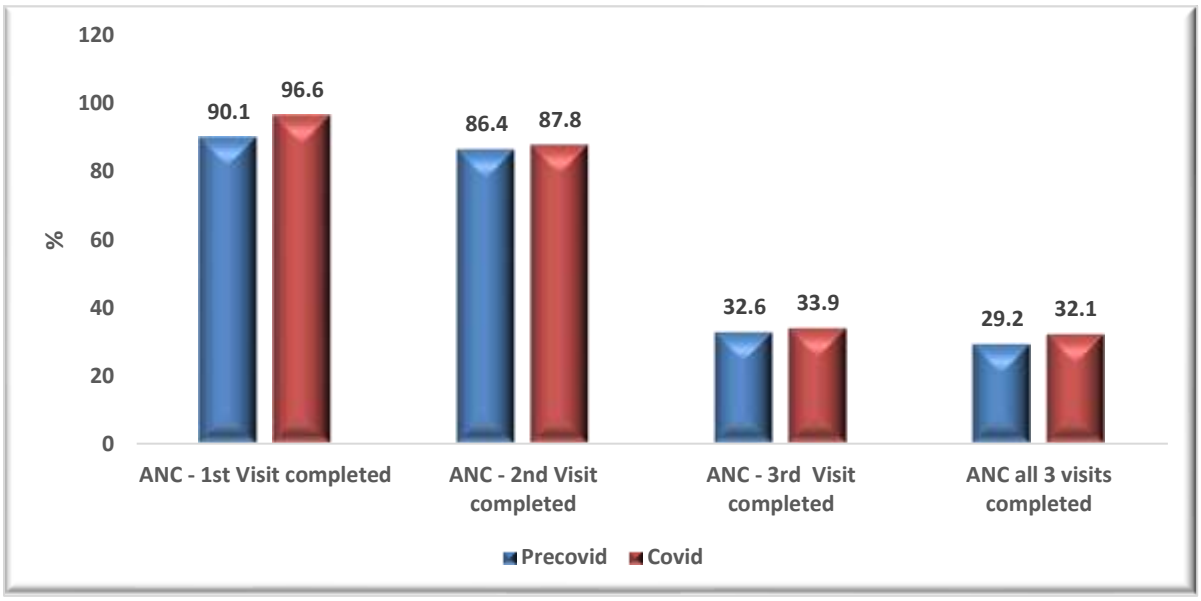
Table 9: Difference in mean haemoglobin levels in mothers and birthweight during pre-covid (January 2019 to March 2019) and covid period (January 2020 to December 2020) in five HUDs in Tamil Nadu.

Category	Pre-covid (Jan 2019 to Mar 2019) Mean (SD)	Covid (Jan 2020 to Dec 2020) Mean (SD)	Mean difference (95%CI)	P-Value*
Age of the mother (in years) (N=4955)	23.66 ± 3.99	23.48 ± 3.82	0.18 (-0.03 – 0.40)	0.097
ANC Registration week (in weeks) (N=4955)	10.70 ± 28.87	10.51 ± 30.28	0.19 (-1.45 – 1.85)	0.813
Hb1* (g/dL) (N=4538)	10.45 ± 1.00	10.68 ± 1.02	0.23 (0.17 – 0.29)	**<0.001**
Hb2* (g/dL) (N=4252)	10.40 ± 0.88	10.59 ± 0.92	0.19 (0.13-0.24)	**<0.001**
Hb3* (g/dL) (N=1575)	10.45 ± 0.88	10.57 ± 0.91	0.11 (0.03-0.20)	**0.010**
Baby birth wt. (In Kgs) (N=4486)	2.86 ± 0.44	2.87 ± 0.43	0.01(-0.03 – 0.01)	0.355

**Hb1- Hemoglobin in first trimester, Hb 2 - Hemoglobin in second trimester, Hb 3 -Hemoglobin in third trimester*

Average age difference of the mother during the pre-covid and covid period was 0.18 (-0.03 – 0.40) years. On an average, the mean difference in the ANC registration was 0.19 (-1.45 – 1.85) weeks. The mean difference in hemoglobin levels during first trimester (Hb1) , second trimester (Hb2) and third trimester (Hb3) values of mothers during pre-COVID and COVID periods was 0.23 (0.17 – 0.29), 0.19 (0.13-0.24) and 0.11 (0.03-0.20) and the difference was statistically significant. The mean difference in the birth weight of the baby was -0.01 (-0.03 – 0.001) kg. (Table - 9)

Fig 1: Proportion of ANC mothers who had completed visits in all the trimester from the selected 3 HUD districts during pre-covid & covid period



The proportion of ANC mothers not completed all the three visits had an increase of about 6% during the Covid period when compared with the pre-covid period in Thiruvannamalai district. However there had not been much difference among the ANC mothers who had not completed all the three visits in the Theni and Thoothukudi districts. (Figure 1)

Fig 2: Proportion of ANC mothers who had completed the scheduled visits in all the trimester from Thiruvannamalai during pre-covid & covid period

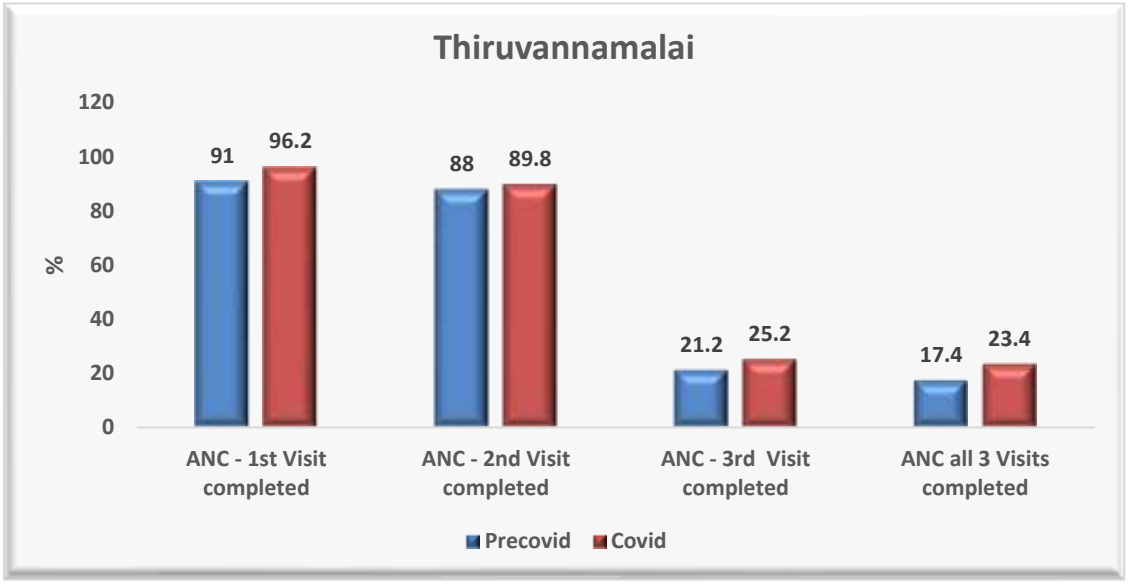


Fig 3: Proportion of ANC mothers who had completed the scheduled visits in all the trimester from Theni during pre-covid & covid period

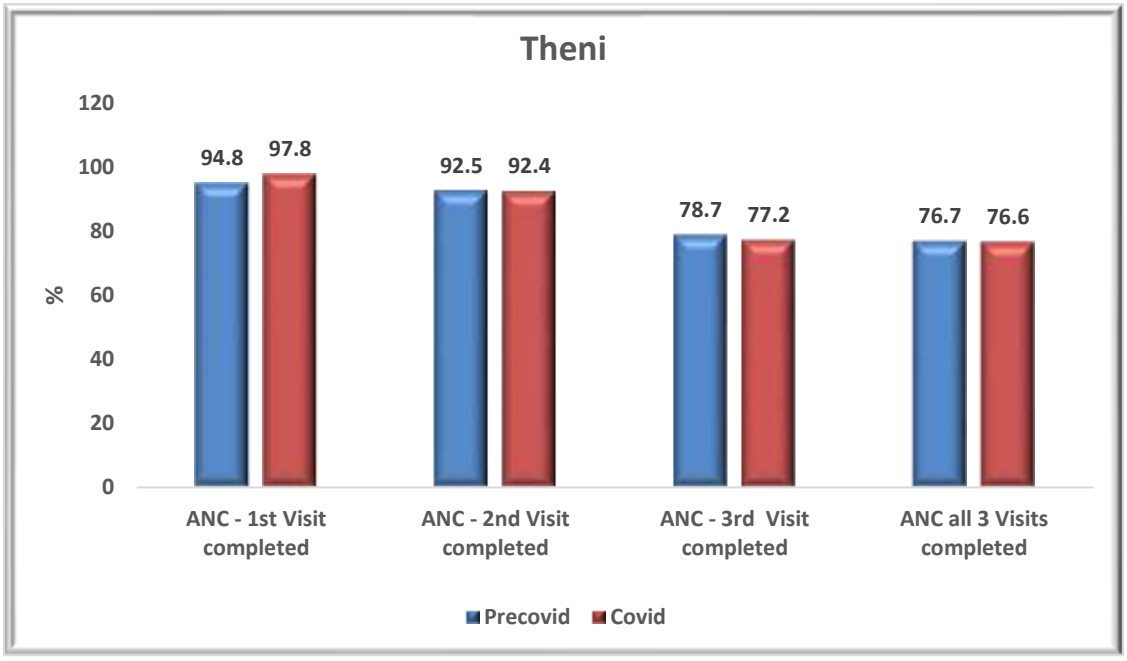


Fig 4: Proportion of ANC mothers who had completed the scheduled visits in all the trimester from Thoothukudi during pre-covid & covid period

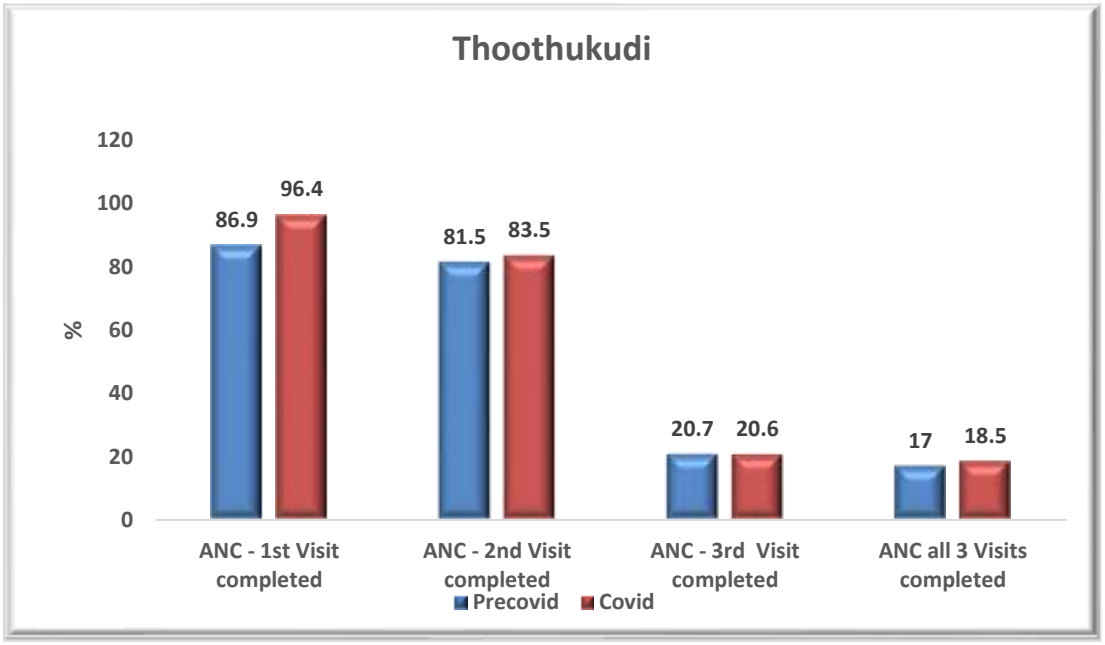
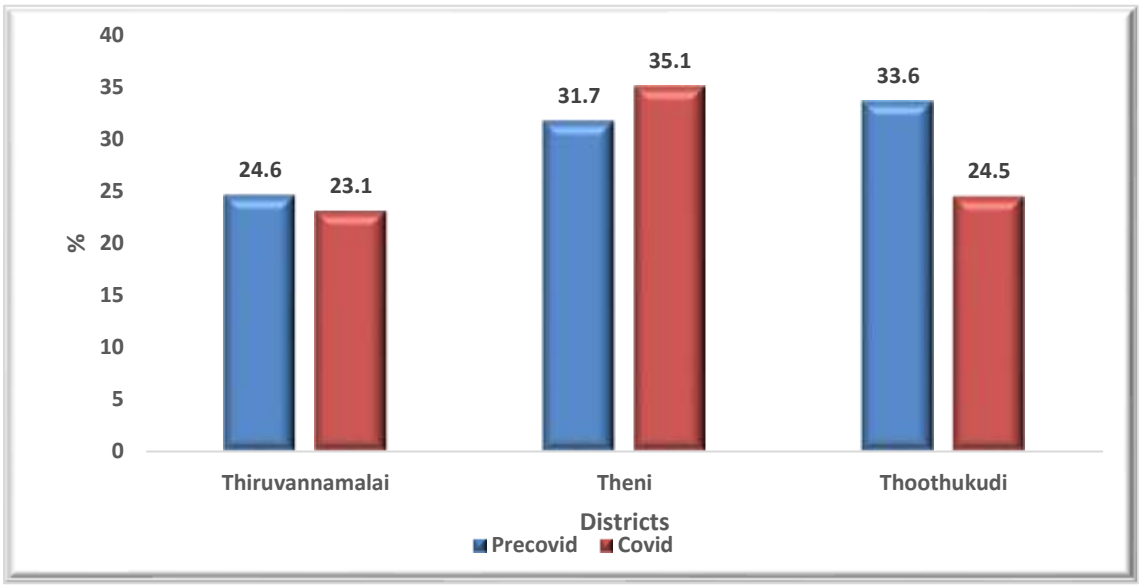
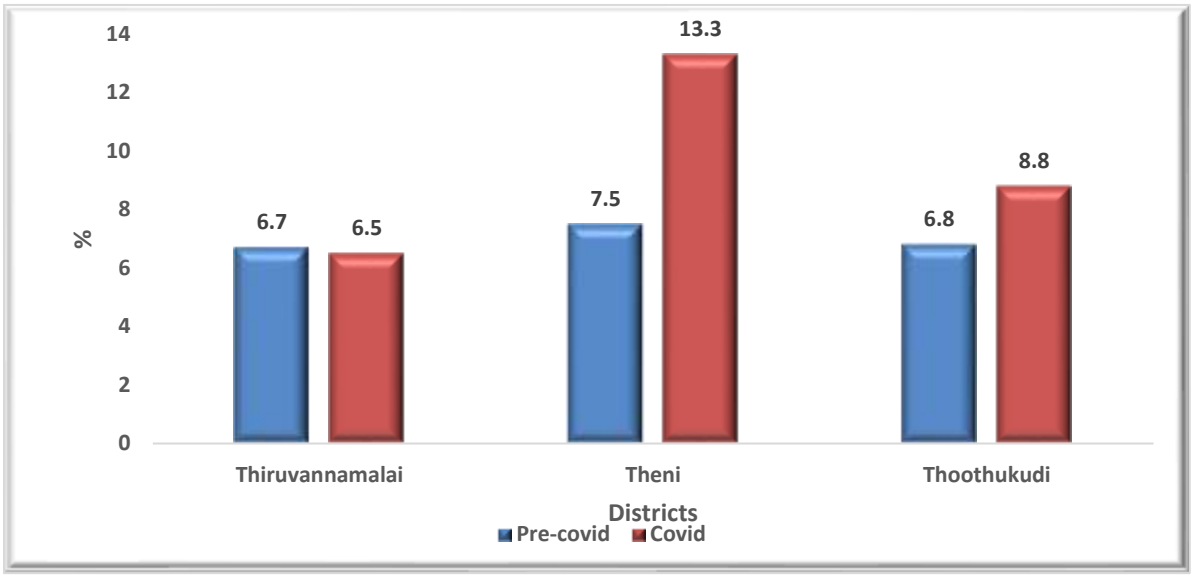


Fig 5: Delay in TT vaccination (first or second dose) in pregnant women in selected districts of TN during covid and pre-covid period



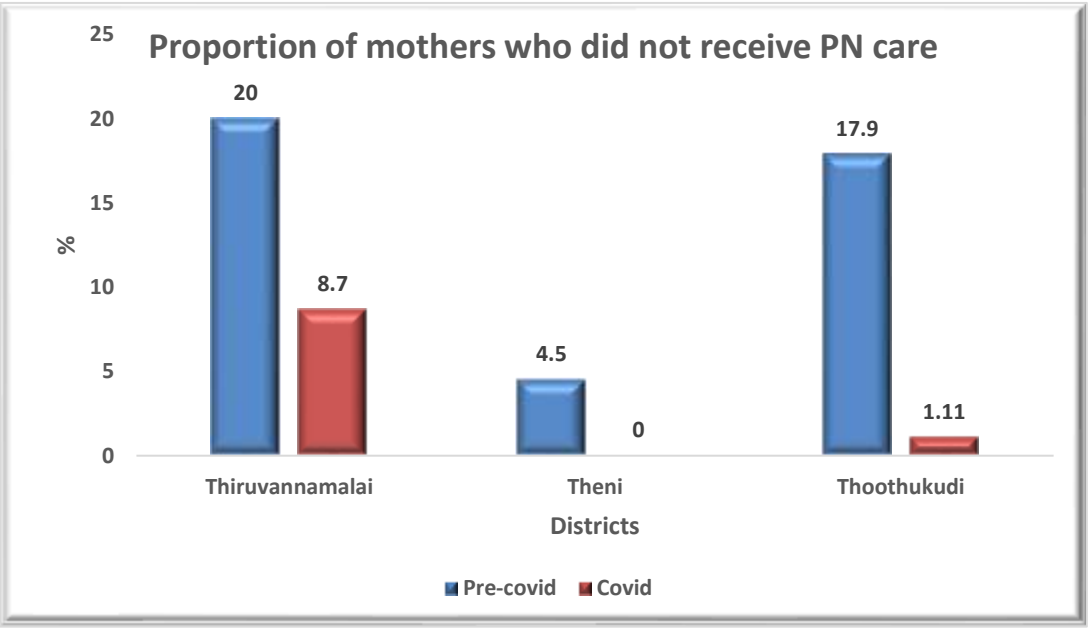
The proportion of TT vaccination delay had decreased by 1.5% and 9.1% in Tiruvannamalai and Thoothukudi districts during the Covid period when compared with the pre-covid period . However, there had been an increase of about 3.4% in TT vaccination delay in Theni district. (Figure 5.)

Fig 6: Proportion of abortion among the mothers registered for AN care in 3 districts during pre-covid & covid period



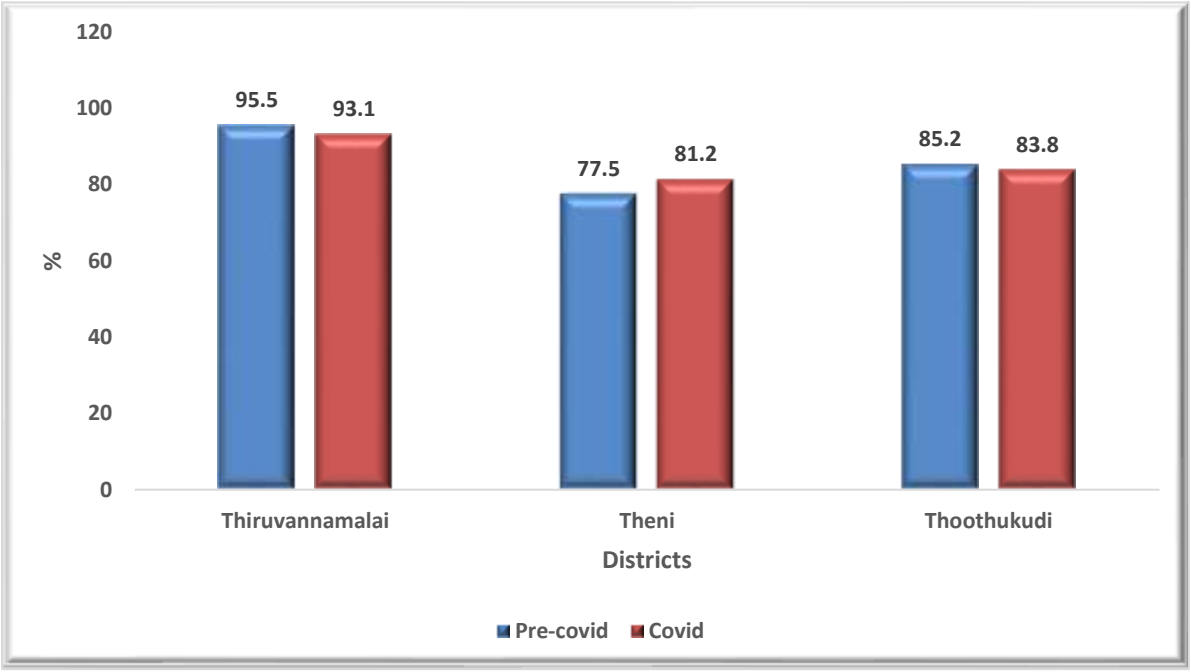
The proportion of abortion rates had increased to around 6% during the Covid period when compared with the pre-covid period in Theni district. Similarly, there had been an increase in the abortion rates of about 2% in Thoothukudi district whereas there was a reduction in the abortion rates by 0.2% in Thiruvannamalai district. (Figure 6)

Fig 7: Proportion who did not receive postnatal care among the 3 HUD districts during the pre-covid & covid period



The postnatal care has decreased during the covid period when compared to the pre-covid period. The postnatal care had increased by 11.3%, 4.5% and 16.8% in the districts of Thiruvannamalai, Theni and Thoothukudi. (Figure 7.)

Fig 8: Uptake of any contraception methods among the 3 districts during pre-covid & covid time



The contraceptive uptake has reduced by about 2% in Thiruvannamalai and Thoothukudi during covid as compared to pre-covid period. However, in Theni it has improved by 3% during covid as compared to pre-covid period. (Figure 8.)

Table 10: Completed ANC visits during pre-covid (January 2019 to March 2019) and covid period (January 2020 to December 2020) in five HUDs in Tamil Nadu.

Time period	Total N=4955 (100%)	ANC visit #		Unadjusted PR (95% CI)	Adjusted PR (95% CI)	P-Value*
		Not completed n (%)	completed n (%)			
Covid January 2020 to December 2020	2486	1687 (67.9)	799 (32.1)	1.07 (1.01 – 1.13)	1.10 (1.02 – 1.19)	**0.010**
Pre-covid January 2019 to March 2019	2469	1748 (70.8)	721 (29.2)	Ref	Ref	

†Adjusted for age, parity, district, and socio-economic status. The number of participants included for the adjusted analysis was N=4947.
#- ANC visit completed refers to minimum of 3 completed ANC visits

In the pre-covid period (January 2019 to March 2019), 29.2% of the ANC mothers had completed their ANC visits, whereas in the covid period (January 2020 to December 2020), only 32.1% had completed their ANC visits. In terms of ANC completion, after adjusting for age of the mother, parity, district and socioeconomic status, there was a statistically significant difference (aPR 1.10, 95% CI: 1.02-1.19; p=0.010) between pre-covid and covid periods.

Table 11: Delay in TT vaccination (>90 days for dose-1 OR > 6 weeks from Dose-1) in mothers during pre-covid (January 2019 to March 2019) and covid period (January 2020 to December 2020) in five HUDs in Tamil Nadu.

Characteristics	TOTAL N= 3565 (100%)	TT delay		Unadjusted PR (95% CI)	Adjusted PR (95% CI)	P-Value*
		Yes n (%)	No n (%)			
Covid January 2020 to December 2020	1781	464 (26.1)	1317 (73.9)	0.92 (0.85 – 0.99)	0.96 (0.86-1.06)	0.414
Pre-covid January 2019 to March 2019	1784	526 (29.5)	1258 (70.5)	Ref	Ref	

†Adjusted for age, ANC registration, parity, district, and socio-economic status. The number of participants included for the adjusted analysis was N=3562.

In the pre-covid period (January 2019 to March 2019), approximately 29.5% of ANC mothers experienced delay in TT vaccination during their ANC, while nearly 26.1% experienced TT delay in the covid period (January 2020 to December 2020). The median (IQR) number of days for first dose of TT vaccination during the precovid and covid period was 73 (61-84 days) and 73 (60.5-82 days). The median (IQR) number of days for second dose of TT vaccination from the first dose during the precovid and covid period was 33 (28-37 days) and 34 (28-37 days). Among the ANC mothers, during pre-covid and covid periods, there was no statistically significant difference (aPR 0.96, 95% CI: 0.86-1.06; p=0.414) in TT delay after adjusting for age, ANC registration, parity, district, and socioeconomic status.

Table 12: Abortion as pregnancy outcome during pre-covid (January 2019 to March 2019) and covid period (January 2020 to December 2020) in five HUDs in Tamil Nadu.

Time period	TOTAL N=4915 (100%)	Abortion		Unadjusted PR (95% CI)	Adjusted PR (95% CI)	P-value*
		Yes n (%)	No n (%)			
Covid January 2020 to December 2020	2473	217 (8.8)	2256 (91.2)	1.13 (1.03-1.24)	1.25 (1.04 – 1.51)	0.020
Pre-covid January 2019 to March 2019	2442	168 (6.9)	2274 (93.1)	Ref	Ref	

†Adjusted for age, ANC completed, ANC registration, parity, district, and socio-economic status. The number of participants included for the adjusted analysis was N=4907

ANC mothers had an abortion rate of 6.88% during the pre-covid period (January 2019 to March 2019), but increased to 8.77% during the covid period (January 2020 to December 2020). Among the ANC mothers, after adjusting for age, ANC registration, ANC completion, parity, district, and socioeconomic status there was a statistically significant difference (aPR 1.25, 95% CI: 1.04-1.51; p=0.020) in abortion during the pre-covid and covid periods.

Table 13: Post-natal visit by health centre staff within 2 weeks of delivery during pre-covid (January 2019 to March 2019) and covid period (January 2020 to December 2020) in five HUDs in Tamil Nadu.

Characteristics	TOTAL N=4497 (100%)	Postnatal visit within 2 weeks		Unadjusted PR (95% CI)	Adjusted PR (95% CI)	P-Value*
		Not completed n (%)	Completed n (%)			
Covid January 2020 to December 2020	2233	89 (4.0)	2144 (96.0)	0.37 (0.31-0.45)	0.24 (0.18-0.33)	**<0.001**
Pre-covid January 2019 to March 2019	2264	364 (16.1)	1900 (83.9)	Ref	Ref	

†Adjusted for age, parity, district, high risk during current pregnancy, mode of delivery, delivery place and socio-economic status. The number of participants included for the adjusted analysis was N=4497.

Nearly 85% of ANC mothers had completed PNC care within 2 weeks during pre-covid (January 2019 to March 2019), while 96% had completed it during covid (January 2020 to December 2020). There was a statistically significant difference (aPR 0.24, 95% CI: 0.18-0.33; p<0.001) in the PNC care within 2 weeks between the pre-covid and covid periods after controlling for age, parity, district, high risk during current pregnancy, mode of birth, delivery place, and socioeconomic status

Table 14: Contraceptive uptake during pre-covid (January 2019 to March 2019) and covid period (January 2020 to December 2020) in five HUDs in Tamil Nadu.

Characteristics	TOTAL N=4530 (100%)	Contraceptive uptake		Unadjusted PR (95% CI)	Adjusted PR (95% CI)	P-Value*
		Yes n (%)	No n (%)			
Covid January 2020 to December 2020	2256	1966 (87.1)	290 (12.9)	0.97 (0.88-1.05)	0.99 (0.97- 1.01)	0.613
Pre-covid January 2019 to March 2019	2274	1997 (87.8)	277 (12.2)	Ref	Ref	

†Adjusted for age, ANC completed, parity, district, high risk during current pregnancy, mode of delivery, delivery place, birth weight and socio-economic status. The number of participants included for the adjusted analysis was N=4530.

Contraceptive uptake was nearly 87% among the mothers during both pre-covid (January 2019 to March 2019) and covid (January 2020 to December 2020). After adjusting for age, ANC completion, parity, district, high risk during current pregnancy, mode of birth, delivery place, birth weight of the baby and socioeconomic status there was no statistically significant difference (aPR 0.99, 95% CI: 0.97-1.01; p=0.613) in the contraception uptake among the mothers during pre-covid and covid periods.

Qualitative component:

The qualitative interview revealed various healthcare workers' challenges such as resistance from the community, abuse from the community, overload of work). At the level of healthcare system there were issues various issues including lack of beds, fewer ambulances, less manpower, etc. Also, there were issues faced by the mother and her family levels such as financial constraints, lack of transportation, fear of spreading covid, stigma, etc. Several strategies like task shifting, door step delivery of vaccination and drug provision, having an intersectoral coordination, prioritizing the high risk, use of advanced technologies and telecommunication were adopted by the healthcare workers to overcome the challenges to deliver the services more efficiently. In addition to improving infrastructure, they suggested improving public awareness and service provision.

Table 15: Number of qualitative interviews conducted across the 5 HUD districts of Tamil Nadu among various participants**.**

	Theni	Thoothukudi		Thiruvannamalai	
		Thoothukudi	Kovilpatti	Cheyyar	Thiruvannamalai
Total no of interviews conducted = 91	20	20	14	19	18
IDI	12	16	14	10	13
FGD	8	4	0	9	5
HEALTH CARE WORKERS					
Medical Officer	5	2	3	4	5
SHN	1	0	3	0	0
VHN / CHN					
IDI	1	3	1	0	2
FGD	2	2	1	3	2
ASHA					
IDI	0	0	0	1	0
FGD	0	0	0	2	2
AWW					
IDI	0	1	0	1	0
FGD	2	1	0	2	0
PREGNANT MOTHERS					
IDI	4	5	7	4	6
FGD	3	1	0	1	1
RELATIVE					
IDI	1	5	0	0	0
FGD	1	0	0	1	0

Figure 9: Challenges faced, strategies adopted, suggestions provided by the pregnant mothers during the Covid-19 period

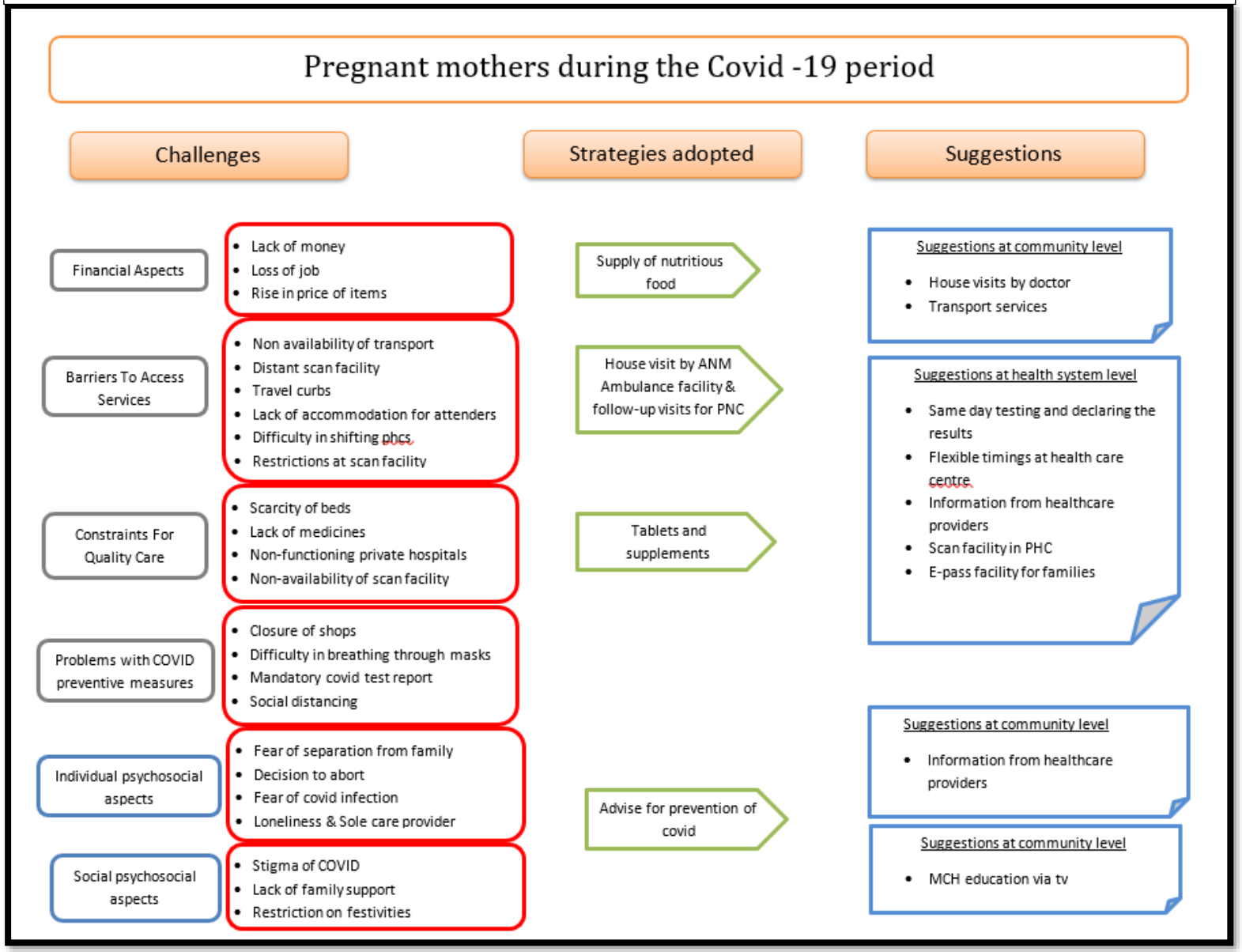


Figure 10: Challenges faced, strategies adopted, recommendations provided by the healthcare providers during the Covid-19 period

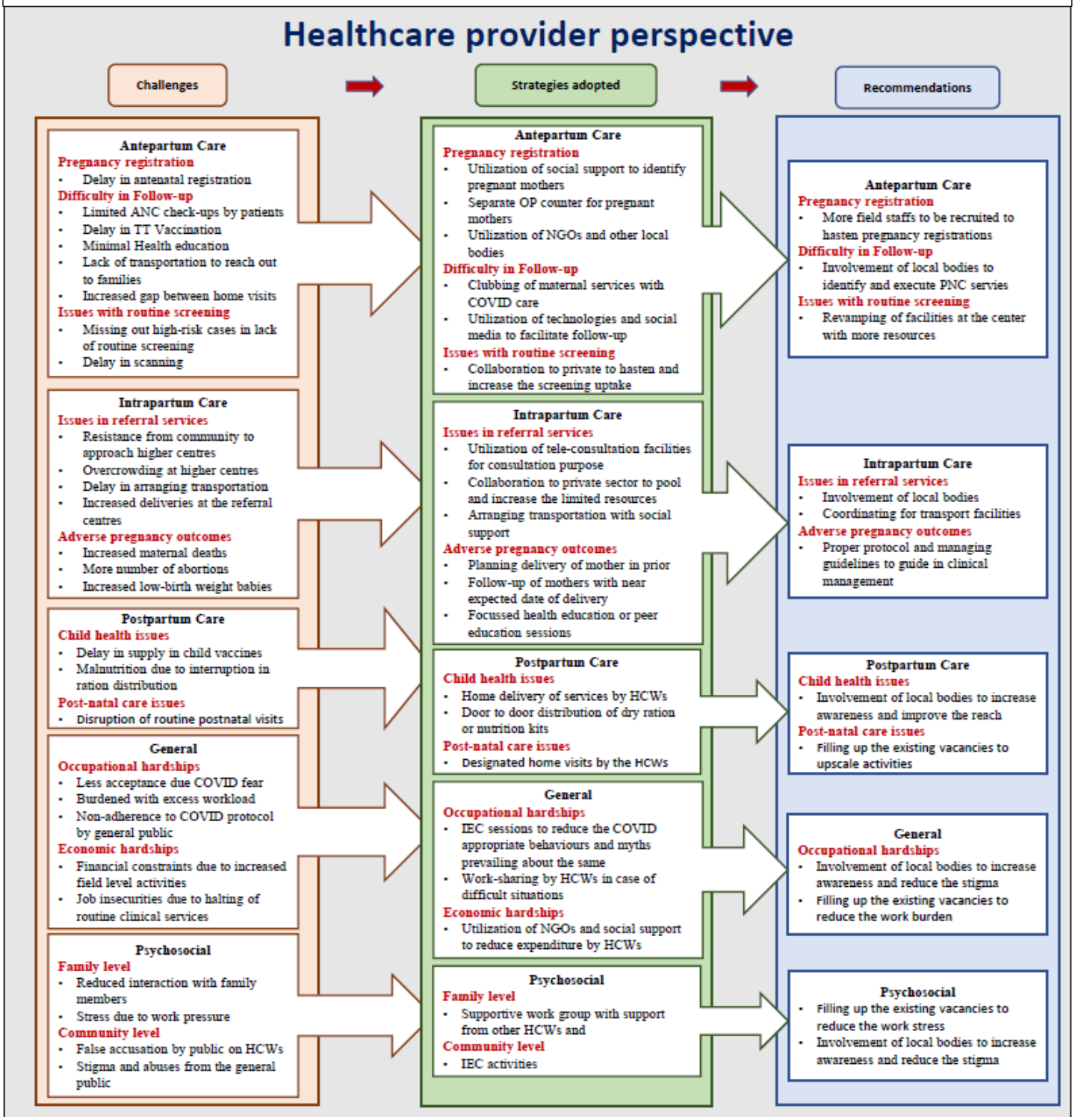


Figure 11. Healthcare workers perspective on challenges faced by the health system and pregnant mothers and their families and suggestions for improvement in providing care during pandemic

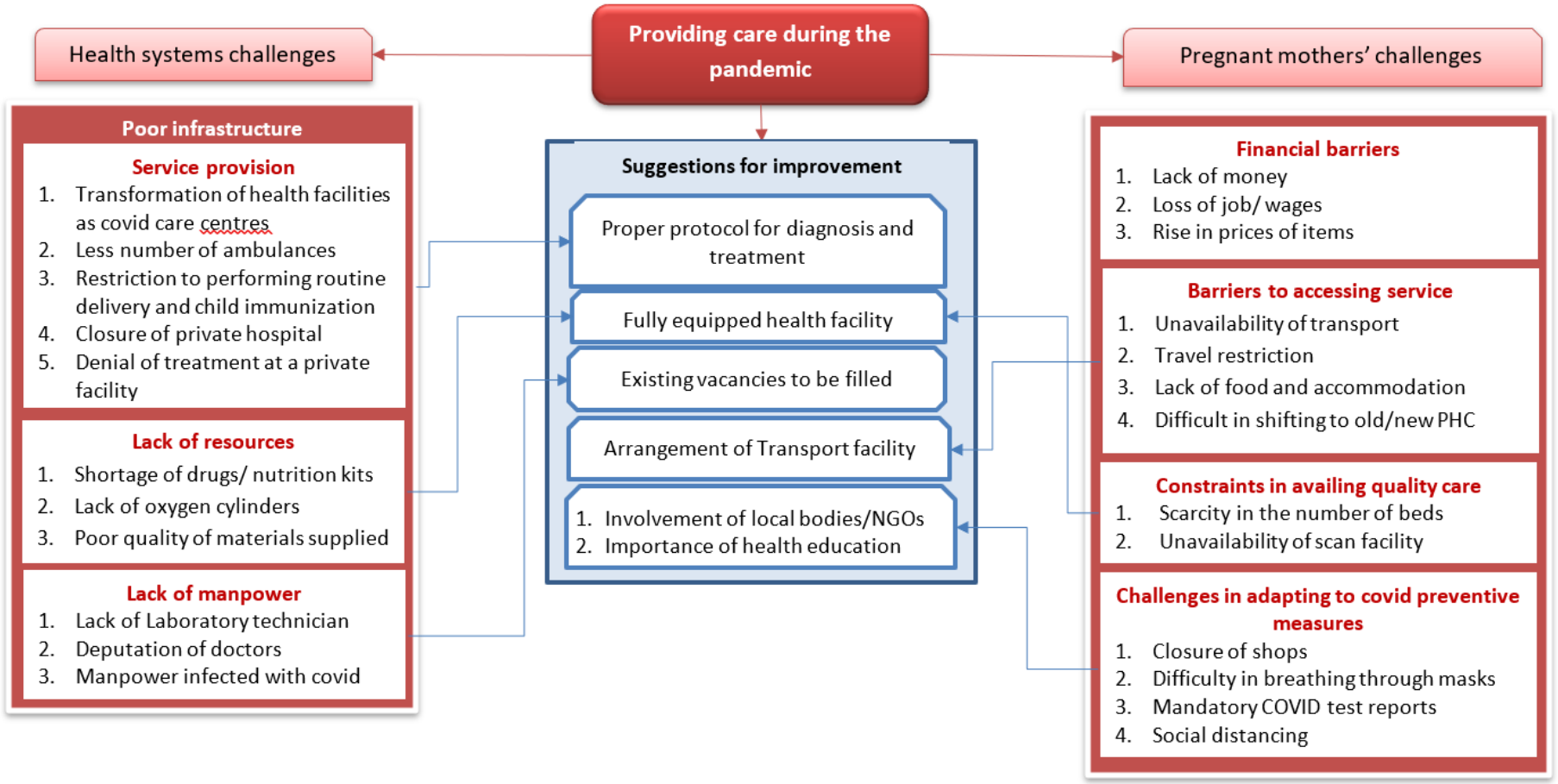


Table 16: Challenges faced by the Pregnant mothers during the Covid -19 period

Themes	Categories	Codes	Quotes
Challenges during COVID period	Financial aspects	lack of money	Since there wasn't a stable income, financially it was difficult. It was even difficult to put food in the table. We do 'ironing clothes' as our occupation so we faced problems with that *-29-year-old mother from Theni* I couldn't go for proper scans (USG), but others insisted to scan on right time. I delayed every scan because we couldn't manage to collect money for each of it. *- 24-year-old mother from Tiruvannamalai*
		loss of job	As we did not have a job it was difficult to provide food for the family *-29 year old mother from Theni* I was working as a teacher in private school and since they announced lockdown I had to resign from the job

			-22 year old mother from Tiruvannamalai There were very less job opportunities for me to provide for the family. It was a difficult situation. *-35 year old husband of 32 year old participant*
		rise in price of items	most of the essential items like food, Horlicks etc had increased price. So mostly we could only buy minimal things which were very essential *-26 year old mother from Theni*
		loss of wages	whenever my husband has to take me here, he has to leave his work for a day or half. They will reduce salary for that *- 24 year old mother from Tiruvannamalai* We were not able to go for work. There was no money and I was also not able to withdraw from bank. Employers had told only if we go to work, we will be paid. Otherwise, there will be loss of pay. When we go for work police did not allow us to go to work. So for three months we suffered a lot financially

			-35 year old husband of participant
	barriers to access services	non availability of transport	During lockdown it was very tough to come here as my house was little far. Bus facility was not available. Even if we come in two-wheeler, we couldn't afford petrol charges *- 24 year old mother from Tiruvannamalai* We had to travel from cheyyar to Tiruvannamalai. There was no transport facilities due to COVID. So we had to travel 3 hours in bike. *-35 year old husband of participant*
		distant scan facility	When we have to scan for the 7th month, I went out but police did not allow us to pass. Then through some relatives we asked permission and went to hospital but on that day, they did not take scan so we took up a room nearby and stayed till next day to take scan. But the room was not good and I struggled a lot *-27 year old mother who contracted COVID from Thiruvannanamali*

		travel curbs	Travelling was also very difficult during the pandemic. In case of emergencies, even going to the medical shop to get medicines was very tough *- 23 year old mother from Tiruvannamalai* We were not able to go for scan and come back. The government had closed the roads in some parts and the public themselves had closed the roads in some other parts. Then we had complained to the police and they removed the barriers. The scan centre and my house is only 10 minutes apart, but due to blocked roads it took more than 30 mins for me to reach my home. *-Husband of a 23 year old mother*
		lack of accommodation for attenders	there were no hotels around and attenders were not allowed to stay with me, my family had faced much difficulty. They mostly slept outside the hospital at night also *-26 year old mother from Tiruvannamalai*

		difficulty in shifting PHCs	During the pandemic all our registrations and reports were here and we were in kerala so we couldn't do check-ups easily. We had to do everything from the first including registrations and scan procedures and blood tests. *-29 year old mother from Theni*
		restrictions at scan facility	Sometimes it would be very crowded even if we took appointments. Before COVID they would take scans for more than 30 people. Because of COVID they would take scans for only 10 people so we had to return and come back the next day sometimes. *-25 year old mother from Theni* Only a limited number of scans were done per day at the facility. So we had to for 2 or 3 days to get the scan done *-54 year old mother-in-law of participant*
	constraints for quality care	scarcity of beds	There many patients in GH and bed facilities are less. We have to wait in the corridor and floors due to lack of space. Only after one

			bed was free, I was allowed to sleep on it along with my baby and till then I was waiting on floor *-24 year old mother from Tiruvannamalai*
		lack of medicines	Some medicines like the ones for diabetes and pressure were not available near our area. They were not available in PHC also at that time and so it was difficult for us *-24 year old mother from Tuticorin*
		Non-functioning private hospitals	We wanted to consult a good private hospital nearby. But they stopped most of their services. So we had to come to Govt facility for care *-25 year old other from Theni* At times we were not able to consult the doctors at the facility, so we had visited a private doctor for check-ups. But we were not able to contact the private doctor also during this time *-Husband of 23 year old mother*

		non availability of scan facility	No one here told me that scan here is free of cost and also, they said scan cannot be done here and told us to take scan in private centre. *-24 year old mother from Tiruvannamalai* For scans we were referred to private facility. During COVID time with all the restrictions it was very difficult for us to go to private facility for scans *-52 year old mother-in-law of participant*
	problems with COVID preventive measures	closure of shops	Getting necessary items to cook was also very challenging since shops were all closed *- 22 year old mother from Tiruvannamalai*
		difficulty in breathing through masks	Wearing masks by itself was a difficult task. Since there was a need to wear masks whenever we go out it was suffocating. *-22 year old mother from Tiruvannamalai*

		mandatory COVID test report	sometimes they would ask us to produce a COVID negative test report when we go for checkups. But it is not possible to always get tested everytime we travel *- 23 year old mother from Tuticorin*
		social distancing	Doctors used to maintain distance. But that way it was not very comfortable to maintain good relationship with our care takers *-27 year old mother from Tiruvannamalai who contracted COVID*

Table 17: Psychological distress of pregnant mothers during Covid-19 period

Themes	Categories	Codes	Quotes
Psychological distress during COVID period	Individual aspects	fear of separation from family	if I test positive, they may take me to hospital and isolate me. I have a small kid in my home. If I am isolated no one can take care of her. She is little and she would be with me only most times. So I was afraid about the results because my kid will struggle without me. *-25 year old mother from Tuticorin*
		decision to abort	Me and my husband initially thought that this pregnancy is not needed for us in this corona situation. Then the nurses in the health centre counselled us and told that they would come for house visits and take care of me by providing medicines, vaccines, and all. That's why we continued the pregnancy.
		fear of COVID infection	Everyone felt really worried that I got COVID during pregnancy. The pregnant woman next to me got affected by COVID and her child got aborted. This increased my fear

			-27 year old mother from Tiruvannamalai who contracted COVID I had fear about the virus spreading rapidly. Only during important check-ups we visited the hospital. We reduced the number of visits. *-29 year old mother from Theni* There was great fear about getting infected by COVID. Nobody was even allowed to talk inside the hospital. Nobody was allowed inside without masks *-55 year old mother-in-law of a mother from Theni*
		loneliness	Attenders weren't allowed anywhere near, so it felt like I was left alone there. It was very difficult for me *-25 year old mother from Theni*
		sole care provider	My husband was my only support. He had to look after me, our children and the household work. I had a caesarean section delivery and I did not have anyone else to look after me. *- 29 year old mother from Theni*

			They had allowed only one member to stay with the mother. I was the only person to go to the medical shop, hotels and again had to take care of the baby. It was very tough for me to do everything by myself *-46 year old mother of participant*
	Social aspects	stigma of COVID	Because of 2 deaths during COVID time, the neighbours in our place avoided us. They won't talk or come with us in that time. Even in shops, if we go for getting any essentials for baby also, all others will avoid us. So it was very hard for us during that time. If we go to shops for getting things, people used to come out from the shops and avoided us. We even thought of moving out from this village but because of corona lockdown, we were not able to do so during that time. *-24 year old mother from Tuticorin* There was stigmatization once people came to know that we have visited hospitals. Neighbours were worried and in fear. Patients

			were kept isolated without anyone to accompany them. So it increased the stress for the patient. These were some of the difficulties. *-30 year old husband of participant*
		lack of family support	I wanted to go and stay with my mother. But due to COVID. I was staying with my mother-in-law only and it was difficult to manage *-22 year old mother from Theni* No one from my family was able to come and see me or help me with anything. I had to manage everything by myself *-25 year old mother from Tuticorin*
		restriction on festivities	Like everyone else, I also had the desire to have a baby shower function. Since there were restrictions on gatherings it couldn't be done and it was very disappointing. *-23 year old mother from Tiruvannamalai*
Facilitators for maternal care from health system	ANC	nutritious food	Nutrition kits, supplements, tonics and protein powders were given in the kit. Health mixes were provided from the anganwadi. After

			delivery, a green box called Nalapettagam was given which had necessary things for the child. *-25 year old mother from Theni* We have received the kits in spite of covid and the staff nurse had reminded me through phone to get the kits *-Husband of a 23 year old mother*
		tablets and supplements	We got iron, calcium and vitamin tablets. Neighbours used to say tablets from government hospital will smell bad, but I got tablets of good quality. *-26 year old mother from Tiruvannamalai*
		house visits	The PHC staff came and gave the vaccination. For both the children, the staff came to the house. That was very helpful *-25 year old mother from Theni*
		Advise for prevention of COVID	the nurses would always tell us to wear masks and use hand sanitisers. They would also call and provide COVID information and sometimes come for COVID tests

			-22 year old mother from Tiruvannamalai
	PNC	Ambulance facility	after delivery they arranged an ambulance for me from hospital itself and dropped us off at home *- 25 year old mother from Theni* I am very happy that they provided ambulance services and other incentives for the mother *-36 year old husband of participant*
		follow up visits	Even after child birth, the nurse followed up on vaccinations to be given to the child and also helped me with the birth certificate *-29 year old mother from Theni* She (MO) called and informed to take injection; she also reminds me to take up vaccinations on date. *- 27 year old mother from Tiruvannamalai*

Table 18: Pregnant mothers' suggestions for improving maternal services during the Covid-19 period.

Themes	Categories	Codes	Quotes
Suggestions for improvement of care	Community level	house visits by doctor	I felt that it would be better if the doctor could visit us at homes when we are not able to go to PHC. It would be reassuring and would help us not to be fearful *-22 year old mother from Tuticorin*
		transport services	some arrangements should be done for travelling to PHCs and back to homes. This would have been very useful during emergencies like COVID lockdown *- 23 year old mother from Tiruvannamalai* For rural areas some arrangement for transport of expecting mothers should be arranged at least during such emergency situations like COVID *-36 year old husband of participant*
		MCH education via TV	We don't have touch phone, so it will be good if they can give the maternal care education in TV channels at specific times

			- 24 year old mother from Tiruvannamalai
	Health system level	same day testing and declaring the results	the tests will be taken in the morning and mostly we will have to go back the next day to get the results. It would be very helpful if we got test results during the same day -26 year old mother from Theni
		flexible timings at health care centre	sometimes if we reach a bit late we won't be able to see the doctor. So I think the timings should be more flexible at least during emergency situations *-24 year old mother from Theni*
		Information from healthcare providers	I want the doctors to inform about the treatment and procedures done. If they can provide us services and treatment like that in a private hospital with individual care it would be better. Also, message the medicines given to the patient so that it would be helpful for us *-34 year old husband of participant*

		scan facility in PHC	I always had trouble in reaching the scan centre as it was far. This facility is essential during pregnancy and so I think it should be made mandatory in PHCs *-25 year old mother from Tuticorin*
		e-pass facility for mothers	Government has provided e-pass for travelling to other places. In the same way if they had given any pass for the pregnant mothers, it would have been really helpful for us in reaching the hospital. *-36 year old husband of participant*
		delivery facility at PHC	I wish the health centre itself would try to do the delivery rather than sending us to GH. That would have been much easier for us *-24 year old mother from Tiruvannamalai*

Table 19: Challenges faced by the Healthcare workers during the Covid-19 period

Categories	Sub-categories	Codes	Quotes
Antenatal	Antenatal registration	Delay in Antenatal registration	"During COVID, many of the AN mothers would be out of town and they would call us from there for late registration. During that, they would not be able to visit us for 4-5 months. In the place where they are present, they wouldn't know whom to contact. Those places will not register the ANC mothers there and ask us to do the registration". - a *VHN working in PHC for 3 ½ years*.
	Follow-up	Decreased ANC check-ups	"During the pandemic many of the ANC patients did not turn up for check-up, that too people with early pregnancy since they had the fear of coming to the hospital. But people with late pregnancy were aware of the situation and they came for check-ups" - *A statement told by the MO in an urban PHC in Bommigoundanpatti, Theni* "We were asked to go for COVID related surveys in Theni urban and many other areas so we couldn't concentrate on the ANC mothers in our PHC"

			- stated by a SHN working for 2 years in a PHC
		Delay in TT vaccination	"Vaccines were out of stock and the ANC mothers had to wait and receive the vaccines." *- told by an Anganwadi worker working for the past 4 years in urban area.*
		Reduced VHND/ health education	"We did not conduct VHN days as we were not supposed to gather people." *- informed by a VHN in rural area.* "it was conducted but in a minimal way with the available resources. We had to handle with minimal manpower. Persons infected with covid will take leave for 7 days so it was difficult to work with the limited manpower" *- told by a medical officer working for past 2 years.*

		Lack of transport for hcws to visit household	“If they had provided us with some vehicle facility it would have been useful. We come to work along with our family members and after they drop us and go, on the way police will block them. Then we had to call the police and inform over phone” *- was shared by a VHN working for past 12 years* "We did not get the required transport for us to come to the work. If they had arranged a vehicle, it would have been useful for us" *- said by an anganwadi worker who had been working past 5 years*
		Increased gap between the follow-ups	“Before covid the ANC follow up was done every month. During covid it was once in 2 months" *- informed by a medical officer with an experience of 8 years*
		Increased waiting time	“The people were made to wait until a minimum of 30 persons were there. Because of this there was delay in taking swabs" *- as informed by a medical officer working for past 20 years*

	Screening	Missing out on high-risk cases	“At some point we missed out few cases, we used to do BP monitoring for high-risk mothers weekly twice or thrice, but during COVID we couldn’t follow that." *- informed by medical officer*
		Difficulty in transportation of samples	“But we had problem for transportation of swabs. That time I had spent my personal money" *- an experience shared by a medical officer working for past 20 years*
		Delay in scanning	"The number of beneficiaries for scan was limited during covid. So, the mothers were not able to take their scan at the exact week of their pregnancy" *- as said by a VHN working for past 5 years* "Yes, they had come to the tertiary care centre. But anomaly scan was not done for adequate number of mothers. This reflected in our infant mortality rate. There was lots of congenital anomaly" *- was said by a DMCHO*

Intranatal	Referral	Resistance to go to higher centres by the community	“But if we refer to GH, they don’t go fearing crowd and exposure to COVID” *- as informed by a medical officer.*
		Lack of food availability for the attenders	“During delivery and admission in the hospital, food is provided only to the mother" *- shared by an ASHA working for 2 years*
		Overcrowding at higher centres	"Because of crowd they don’t prefer to come to health centre also sometimes" *- a medical officer working in rural area said so.*
		Delay in arranging vehicle	"We faced transportation difficulties. The 108 ambulance services were always busy. We had to wait at least 45min" *- was informed by a 7-year experienced medical officer.*
		Increase in number of deliveries at referral centres	“In delivery cases, since they were all not able to go anywhere many cases had delivered here only and the delivery counts was increased in the pandemic time” *– said a SHN with 33 years of experience*

	Adverse pregnancy outcome	Maternal death/ preventable death	"There were 14 deaths at that time. And 9 of them died due to covid remaining 5 died of risks during pregnancy. If we had provided them with proper care, house visit and other ANC services then there could have been less maternal deaths comparatively" *- was shared by a DMCHO*
		Abortion	"There was an increase in abortion rates. About 80% of mothers who were covid positive in the first trimester got abortion. There was also premature labour for covid positive mothers" - as shared by a DMCHO "There was an increase in the abortion rate. Some of the pregnant mothers who were given vaccinations or those who were affected by the COVID 19 virus faced abortion. If there was an average of 10 abortions before the pandemic, it was increased to 15 during the pandemic" *- informed by a SHN* "Some of the ANC mothers got COVID positive. We immediately admitted them in the medical college hospital. They would get treatment and discharge after testing negative. During such instances, two of my patients

			had abortion after one month and one patient after 6months. It would have been because of the treatment and the antibiotics given when they were COVID positive" *- told by a SHN with 10 years of experience*
		Low birth weight	"For the past 2 years there is increase in the low-birth-weight babies and but there was increase in the infant mortality rate and neonatal mortality rate" *- informed by DMCHO*
Post-natal	PNC	Disruption of routine postnatal visits	" During covid PNC visit was not done properly. The VHN were not able to follow them up during the covid it was difficult as they were engaged in other works also." *- told by a medical officer working past 2 years*
		Delay in PN visits and immunization	“Due to fear of covid some of them postponed the immunization” *– replied an Anganwadi worker*

	Child health	Delay in immunization/ reason for delay in immunization	“Vaccines for the children were delayed and we had stopped the vaccines for a month. Supply of vaccines was there but they had concentrated more on covid vaccination." *- shared by an anganwadi worker of urban area*
		Mal-nutrition	"When we provide dry ration and eggs, the family members will cook all the eggs in a single day and eat. So, the child nutrition was compromised" *- shared by an anganwadi worker of urban area*
General	Occupational hardship	Less acceptance for hcws	“We used to go to check vitals for the quarantine patients that time we saw that the public was afraid of us. Even VHN was asked not to come. Some people did not allow to enter the streets. Patients or public used to say **“Since they work in hospital there is a high chance of being infected with covid. So, we must not talk with them.”** *- was informed by a 7-year experienced medical officer.* “One head master got affected. We went to her home to ask her to admit in hospital. Myself, SHN – we all went there. But she was talking very rude. She asked “do you know who I am? Why are you people so much interested

			about my health? Do not stand in front of my house. Go away." We asked all their family members to get tested for covid. They said "we know what is to be done. You can go." None of them came to hospital for testing or admission." - *shared by a nursing officer*
		Work overload	"We were affected on a larger scale. Work load was very high for our age. During the pandemic we were asked to go for all the house visits when someone becomes COVID positive and to conduct a survey. Additionally, we had to visit the ANC and PNC mothers and give them proper counselling regarding the pandemic. When vaccination was introduced, convincing the ANC mothers was a major issue." *- as informed by the VHN working for past 7 years*
		Non-adherence to covid protocols	"The crowd was more and it was very hard in those times to follow the protocols. Still making them to wear masks was difficult, about 50 percent of the population visiting will not wear masks even now" *- specified by a medical officer in service for past 4 years*

	Economic hardship	Financial constraints of the hcws	After finishing the survey works, we had to do field visits to check the ANC mothers which was not possible. Daily till 2pm we had to carry out COVID surveys in 100-150 houses. NCD programs should be carried out and follow up for three months should be done in our own vehicle or autos paying a fare of Rs.200-Rs.300. - *shared by a VHN with 31 years of experience*
		Job insecurity	"Due to lockdown restrictions many had lost their jobs and became unemployed at that time. Before the pandemic, people used to travel the other nearby districts for their jobs but in crisis situ most lost their jobs and struggled. Even this jobless situation impacted on all like the financial status, mental status got affected. The financial burden on accessing the basic needs also had increased" *- shared by a VHN with 20 years of experience*
Psychosocial	Family	Lack of family support	*it was difficult for us to go to the field as We had to go back and meet our family members so it was all difficult*

		Reduced family time	“We increased our OPD timing by starting early. The investigations were speeded up and the patient was sent home without waiting for the results. But the night duty staff did not have breaks for more than 3months” *- informed by the medical officer*
		Stress due to work pressure	“We forgot our family itself; I have to start from home by 7 am and return home by 7 or 8 pm only. So, in those times my husband took care of all family related works.” - *replied a SHN with 33 years of service*
	Community	False acquisition/ judgment on hcws	"For covid we tested the mothers and if found positive they blamed us. They told “you had made the test to be positive” *- replied by a VHN with experience of 4 years.* While vaccinating, we advise them to come for swab test. But they refuse to come for the test and tell that “You may get remuneration from

			government, so only you are asking to come for test and admit us as positives for your work" *- replied by SHN with experience of 33 years*
		Abuses from the community	When we survey public and send to Covid care centre, they used to scold us very harsh without listening to what we say. They do not come for testing if we go, they scold us. *- said 27 years old VHN*
		Stigma	During the pandemic, my son was affected by the COVID 19 virus. When the people from hospital came to verify, all the people from our village did not talk to us even after one year. He was asymptomatic only. But even now some of our neighbours do not talk to us properly" *- reply from an ASHA working for 10 years*
		Lack of basic facilities	"We ourselves were exposed to the virus. During the initial stages, the PPE kit, masks, and gloves were also not sufficient" *- replied by a medical officer working for 7 years*

Table 20: Health system challenges faced by the healthcare workers during the Covid-19 period

Categories	Sub-categories	Codes	Quotes
Poor infrastructure	services	Health facilities as covid care centers	"Initially we conducted deliveries in the block PHCs instead of the local PHCs. After that they were sent to the medical college hospital when many block PHCs were changed into COVID care centers." *- as stated by a DMCHO working for past three years.*
		Less number of ambulances	"During covid 108 ambulance was involved in covid works. So, there was a delay in transportation" - replied a VHN with three years of experience. "It was quite challenging. 108 ambulance services would not even be sufficient to transport COVID positive patients" *- was said by a medical officer*

		restriction to perform delivery and child immunization	"Vaccines for the children were delayed and we had stopped the vaccines for a month. Supply of vaccines was there but they had concentrated more on covid vaccination" - replied an Anganwadi worker in an urban area. "Delivery was conducted here before covid. During covid, the mothers were referred to GH" *- an Anganwadi worker with 26 years of experience*
		Closure of private hospital	"The ANC mothers suffered during delivery. Many of them had plans to go for check-up and delivery in private hospitals. During registration itself we would ask their preference. They would say they will not check in the government hospital as they and their family members preferred private hospitals. But because of the pandemic it was not possible to go to the private hospital for them since there were so many restrictions so they ended up coming here. The government doctors checked everyone and followed them up properly. The patients also had so much understanding towards us." *- was said by a VHN with 25 years of experience*

		Denial of treatment at private hospital	"Private hospitals were not willing to take cases if they had doubt that the mother was infected with covid" *- said by a DMCHO with 7 years of experience.*
	resources	Shortage of drugs/ nutrition kits	"We were able to give only one nutrition kit to each ANC where we would give two kits usually. When COVID was at the peak, we did not receive any kits so it was not given" - said a VHN with 20 years of experience "Some of the drugs were of shortage. Vitamin D3, Ivermectin, Zincovit were not available in sufficient quantities" *- said a medical officer with 2 years' experience*
		Lack of oxygen cylinders	"If we put admission for such patients in the PHC and if there is any emergency like drop in SpO2 levels, it becomes a problem since oxygen cylinders weren't sufficient in PHC. We had only one oxygen cylinder for emergency labour" *- an urban medical officer.*
		poor quality of the materials supplied	"We ourselves were exposed to the virus. During the initial stages, the PPE kit, masks, and gloves were also not sufficient"

			- replied by a medical officer working for 7 years
	manpower	Lack of Lab Technicians	"The lab technician comes only once in a week on Wednesday. In that one day they cover both NCD and ANC. So it would be very difficult for the ANC mothers to wait for a longer period of time. Initially the lab technician would be available all days but now only once a week" *- replied a VHN with 30 years of experience.*
		Deputation	"From here the staff nurses were deputed to the covid care centres for two weeks, in such times it was difficult. We were at the situations to work for even 12 hours a day sometimes" *- said a medical officer with 4 years of experience*
		infected with covid	"The workload in tertiary care centre was increased. The healthcare workers were also infected with covid. And there was work overload for the remaining persons" *- replied a DMCHO working for past 7 years*

Table 21: Healthcare workers perspective on challenges faced by the pregnant mothers during the Covid-19 period

Category	Codes	Quotes
Personal	lack of nutritious food	"The ANC mothers couldn't take proper nutritious food as they were financially affected" *- said a medical officer.*
	lack of transportation	"There were transport issues as there was minimum bus facility available at that time. I am telling from the public perspective. So, if they want to go to hospital, it was not possible because there was no bus facility at that time" *- replied a DMCHO working at a facility for 2 years.* "they were not able to come since there was no transport facility available at that time. And the pregnant mothers had to show their registration notebook to the police. So my area mothers found it difficult." *- replied a nursing officer with 6 years of experience*
	Difficulty to manage the elder child	"They would have two or three children at home and taking care of them will also be a difficulty. So, we were mainly concerned about preventing them from contracting the virus rather than finding a solution after becoming COVID positive."

		– said a medical officer with 7 years of experience
	Attenders not allowed	"Attenders were not allowed to come, if needed only one attender was allowed*"* *- replied a DMCHO with 7 years of experience*
	financial constraints	"in some of the houses the husband were daily labourers. So only if they go out, they can find a job and earn money and they will be able to purchase the groceries that is required. So, during corona they suffered to get groceries" *- replied an Anganwadi worker working for past 10 years.*
psychosocial issues	Fear of isolation if tested positive	"While coming onto reporting the symptoms to us, the public were afraid about the hospitalisation and isolation procedures so most individuals took over the counter drugs and stayed. Even in some cases they have asked for the medicines and informed us as for other reasons" *- said a VHN with an experience of 20 years*
	Fear of hospital admission among mothers	"Among the covid infected ANC mothers there was refusal to get admitted" *- replied a DMCHO with 6 years of experience*

	stigma due to covid	" One of the ANC mothers was positive and no one in that street helped them. They all felt were stigmatized in the society" *- replied a SHN*
	Restriction towards family functions & gathering	"The mothers were sent to their place after the baby shower in previous times. But at that time, it was not possible so few mothers worried as that they would have been cared much better than now at their mothers' place" *- replied a VHN with 20 years of experience*
	loss of family member due to covid	There was a family with two female children. Their father died due to COVID 19. Those were difficult situations. Many people were affected like this. *- replied a SHN working for 2 years*
Health system related	Poor accessibility to reach PHCs	"The next PHC was far away from this. But the accessibility is better than this PHC. So many of them will go to that PHC since transport facility was better at that facility. We would just send the information about the AN mother to the VHN there and they will be following the patient" *- a medical officer with 2 years of experience*

	Multiple visits for scan	"Sometimes there was problem in taking scans and they asked to come the next day" *- replied a VHN with 11 years' experience*

Table 22: Suggestions specified to improve maternal, child and other routine services

Categories	Codes	Quotes
Service Provision	Existing vacancies to be filled	"Our main problem was HR. special HR was given to us at later stage. If they had provided a little earlier there would not have been this much mortality" *- a request by a DMCHO who had worked for seven years.* "During the pandemic we had to adjust with the man power in hand. Only one doctor would be in duty and it was difficult to manage during such times. Additional man power if available will be of great use" *- a similar request was given by another DMCHO.*
	Equipped health facility	"Lab facility like RT-PCR at district hospital level or if possible, at block level and transportation facility" - was suggested by a medical officer of PHC. "We need the basic things like PPE kits, hand sanitizers, gloves and mask in good quality and in large quantity at the beginning of the pandemic itself so that we can work in an efficient way" *- requested by an urban medical officer.*

	Transport facility	"There were no bus services to certain areas like orathi. if there had been any vehicle / ambulance it would have been better for us to transport the patients for delivery" *- replied a nursing officer working for past 10 years* "for health care services specifically for the ANC and emergency cases separate ambulance / transport facility may be arranged" *- insisted by a medical officer with 4 years' work experience.*
	Involvement of local bodies	"We need help from Panchayat board for IEC" *- requested an urban medical officer.*
Awareness	Proper protocol for diagnosis and treatment	"Proper protocol on the nature of the disease and its progression and how to handle them should be given" *- said an urban medical officer.*

Table 23: Strategies adopted during Covid-19 pandemic to provide adequate antenatal care

Categories	Codes	Quotes
ANC care	**Rescheduling of ANC visits**	"Each HSC beneficiaries were asked to come in a particular week. Each day the beneficiaries were given appointment to come for the tests. we called 10 AN mother from 2 HSC per day and we conducted the ANC check-ups." - said 56 years old VHN. "So, there was around 70-80 ANC mothers at that time. So, it was like a crowd. So, we split up the ANC mothers into 5-6 members during the afternoon sessions daily" *- said a DMCHO working in Cheyyar district.*
	Involvement of NGO and other local bodies	"Sometimes the ANC mother would say that she is alright with anything but her family members wouldn't accept. So we asked them to bring the family members and gave counselling for everyone. In very problematic cases we used to bring in the law and order. Because we had a collectorate order that it is an offense if anyone stands as a hurdle for the accepting the decisions made by the ANC mother" *- a medical officer with 7 years of experience had shared her views.*

		"There was lot of support from NGOs also. IFA tablets and calcium tablets were circulated with self-help groups and volunteers." *- replied a DMCHO with 7 years of experience*
	Clubbing of maternal services with covid care	"The PNC services also managed by us only madam. While planning corona related works at field, we also included the other services within our plan. So, while visiting the area we simultaneously visit the PN mothers also and ensure the status madam. In very few cases we were not able to reach the mothers" *- shared by a VHN about her experience in working during covid.*
	Door delivery of services	"We would visit the mothers at their homes, check their reports. If they are normal, we provide them with iron folic acid tablets, calcium tablets and other vitamin D tablets at their home" *- said a VHN who had worked for 5 years* "For the school children we had measured the dry rations and delivered them to the children" *- said a 33-year-old SHN.*

	Use of Technologies	"we started realizing only after there was maternal deaths. We made the data entry operators to call and enquire on the symptoms of covid. We ensured that we were calling each mother weekly once. We involved the non-health workers and asked them about the flu like symptoms" *- informed a DMCHO* "During initial days of covid there was many restrictions. they had used the e-sanjeevani app for obtaining medical consultation. The pregnant mother had complained about pain below the hip region. The doctor had advised her to take the tablets. The mother was then fine" *- informed by a VHN* "We had started a ANC, PNC group, 6mo to 3 years group, preschool education group we had shared all the information in the respective group and also got their feedbacks also" *- a anganwadi worker in an urban PHC shared her experiences.*

	Additional care for high-risk mothers & referral	"The private hospitals weren't functioning. We would not know when they would have labour pain. We did not want them to struggle at that time. So, for the high-risk mothers, we would take a list and call them with our SHNs and ask them to get admitted on a specific day. For example, if it's a previous LSCS mother, we would admit them before 7days in the government hospital or medical college. So, we would contact them before 10days and ask them to get admitted on the day. Simultaneously we would contact the VHN and ask them to co-ordinate with the mother" *- replied a DMCHO*
	Home visit by HCW	"For mothers who were not able to come we visited them at their home. We checked their height, weight and enquired whether they have taken blood test and check their report" *- replied a VHN who had worked for four years*
	Separate OP counters for mothers	"AN mothers and NCD services were separately provided. The timing for the services was different." *- said a medical officer.*

		"We shifted the swab collection to the end of the ward. We arranged the ANC check-ups at different location to reduce the chance of contact with other patients. Separate entrance and area for the ANC mothers" *- said a medical officer with 2 years of experiences*
	Follow up of EDD mothers	"On the concerned day, the SHN would call and ensure if the patient is admitted. Daily EDD follow up will also be updated. The follow up is about taking a list of patients having delivery date on a particular day and checking if they have delivered the child. We did this with the help of three SHNs through instructions and suggestions from the DDH" *- an experience shared by the DMCHO*
	Plan for delivery	" We were in pandemic situation, and all the staff were busy with other COVID related works. So, we made plans for the ANC mothers as to when they should get admitted and where" *- replied a DMCHO with 6 years of experience*

	Collaboration with private sector	"Infrastructure was provided by the private medical colleges and the manpower was provided by the government. It was run 24*7 duties" *- replied a DMCHO with a six and half years of experience*

Table 24: Strategies adopted during Covid-19 pandemic to utilize the possible resources to provide antenatal care

Categories	Codes	Quotes
Resources	**Use of alternate resources**	"We had used MMU vehicle and RBSK vehicle. A separate ATP was put and using the vehicles we had visited the mothers at their place" - *shared a medical officer with 20 years of experience*
	Social support	"Many had utilised the AMMA unavagam (community canteen) also. Few rich families and politicians also gave some groceries in that time" - *replied a SHN with 33 years of experience* "We had five autos near the PHC itself and they were willing to provide service in case of emergency. We had a good rapport with them since all the hospital staff are staying nearby and near their services. A police constable is also available nearby to carry out things in an orderly manner" - *shared by an urban medical officer*
	Modification of existing infrastructure / use of alternate resources	"so in our facility for referral we will inform the block PHC and they will be providing us with ambulance. Also we have 3 mobile vans and if required even village leaders will give their vehicles"

		- *replied a healthcare worker with 26 years experience*
	door to door dry ration / nutrition kit	"Before covid we used to provide them with ration / nutrition rich cooked food. After covid we were asked to give the rations as door-to-door delivery" *- shared by anganwadi worker.* "For the school children we had measured the dry rations and delivered them to the children" *- shared another anganwadi worker.*
	Work sharing	"When one of us is infected with COVID the VHN from the nearby PHC would take care of it. If they do their field work on Tuesdays and Wednesdays, they would do my work on Thursdays and Fridays. They take help from the anganwadi workers in identifying any new ANC in the area" *- replied a VHN working for past 5 years*
	Fund mobilization	"We tried helping them by mobilizing funds. We have mostly migration population and since many workplaces were shut down many of them were jobless. There were not many charity houses like it was in big cities" *- replied a medical officer working in an urban area.*

	Intersectoral coordination	"There is always department co ordinations. Not only for the health departments, our collector conducted a daily meeting from 5pm to 8pm for co-ordination between all the departments. Meetings on how the medical colleges should function, what are all the preparations should be ready from the government hospital side, from the DPH side about swab collection. Likewise, each department would receive instructions on things to be done. In those meetings, the 108-ambulance service coordinator would also be present. The collector coordinated everything. So we did not have any issues regarding the 108 ambulance services" *- shared by one of the DMCHO interviewed.*
	Capacity building of existing staff	"We trained our staff for Hb, cell count, and other routine blood investigations for the ANC mothers" *- replied a DMCHO.*

Table 25: Strategies adopted to provide uninterrupted routine services during Covid-19 pandemic

Categories	Codes	Quotes
Management of other conditions	**Home delivery of NCD drugs**	"We tried to pack and deliver it at their homes. When the field staff go for visit, we planned to give the NCD drugs along with it" *- one of the DMCHO replied.*
	Provision of drugs for longer duration	"We would give the medicine at a stretch for two months so that they don't have to strain themselves buy visiting again and again." *- replied a VHN with 10 years of experience*
	Health education / peer education	"While visiting here, we made the mothers to sit with social distances and give health education instructions and also ask them to share those taught points to the neighbours too over a phone or to the nearby families" *- experiences shared by an SHN with 33years of experience.*
	Restriction of number of people for vaccination	"Before this corona period, we divide areas into 4 units and provide vaccines. But now due to the restrictions on gathering people in a place; we asked the beneficiaries individually to

		come at specific time to the CNC or we visit to the area or in some cases we ask them to come near the common places like bus stand and provide the vaccines to them" *- replied a VHN with 20 years of service.*
	Organising camps for provision of NCD services	"They also had arranged camps at the field so the NCD medicines were supplied directly at the field" *- shared by a VHN who had a service period of 5 years.*
	Covid vaccine for beneficiaries in containment zone	"We would call them and ask them to come to the neighbouring site for vaccination. If the beneficiary and the covid positive person are from the same family we cannot do anything" *- replied a DMCHO working for past 2 years.*

DISCUSSION

Summary of findings:

The study was conducted in three districts of Tamil Nadu covering a total of five HUDs namely Tiruvannamalai, Cheyyar, Theni, Thoothukudi and Kovilpatti. A total of 5000 records of mothers registered for AN care during January to March 2019 (Pre-covid period) & January to December 2020 (covid period) were randomly extracted from 10 PHCs of each HUD. A total of 4955 mothers were included for analysis after excluding the mothers with completely missing data. Of total 4955 mothers, 32.1% of them had visited PHCs for check-up in all the three trimesters during covid while it was 29.2% in the pre-covid period. There was no significant difference between the two groups (26.1% vs 29.5%) in terms of TT delay where the delay was more common in the pre-covid period. Abortion rates was higher (9%) during the covid and was 7% before covid which shows a 13% increased risk of abortion during the covid period. Similarly, there was increase in the proportion of still births (0.7% vs 1.5%) during the covid period. However, there was no difference in the maternal death between the groups. Post-natal visits were reportedly higher during the covid time (84% Vs 96.0%) as compared to the pre-covid period.

Upon exploration of the challenges in providing maternal and child health services during covid, three sub-themes emerged based on various aspects. They were the challenges faced by the health care workers, the challenges faced by the patients, and the ones faced by the health systems. These challenges were further narrowed down to understand the difficulties in ANC, PNC and intrapartum care provision and the psychosocial and general issues faced by an healthcare worker during covid. Similarly, the challenge faced by the health system is the poor infrastructure. The system had limited resources of manpower and were not able to provide all the services required for a pregnant woman. In a perspective of the HCW, patients had personal issues mainly loss of job which led to financial constraints and has also affected the intake of

nutritious food. They also had certain psychosocial issues where they feared being isolated in case of being tested positive for covid and there would be a need to get admitted in tertiary care centers.

Several strategies were adopted by the healthcare workers to overcome these challenges by using the existing resource for an alternate use like doing AN related works when they do COVID related survey and use of RBSK vehicles and MMU units to bring AN mothers to the PHC for AN care, door step delivery of vaccination and drug provision, having an intersectoral coordination, prioritizing the high risk, use of advanced technologies and telecommunication to deliver the services more efficiently. Their suggestions for improvement were to improve infrastructure to enhance service provision and improve the awareness among the public.

Patients had economic constraints, difficulty in accessing the health care services and adopting to the new protocols to prevent covid transmission in major. Said that one important aspect the mothers and the family members mentioned was the psychosocial challenges where they fear of acquiring covid infection and had to face stigma if tested positive for covid in the society. They suggested that the challenges can be overcome if the house visits are made by the doctor and the basic facilities are made available at the PHC level. However, they added that nutritious food, supplements and the house visits by the community health workers and proper on time referral and the PNC visits and telephonic calls facilitated them to get better antenatal care in a situation like the COVID pandemic.

Coverage of obstetric care services (antenatal, intranatal and post-natal), and childhood immunization services:

a. **Coverage of antenatal services:**

Our study considered completing ANC visits in all three trimesters as a proxy for coverage of antenatal services. Our study findings indicate a reduction in the completion of ANC visits by 3% in the covid period. The incompletion of ANC visits could pose a huge impact on maternal and neonatal outcomes as routine, timely screening would have been missed. The findings in our study were in line with the findings of **AK Singh et al**., in which there was a 22.91% decline in antenatal services. (20) The similarity could be attributed to the situation, as the pandemic has impacted all parts of the world. The stringent lockdown enforced to control the pandemic could have made it difficult for people to access the healthcare facility, especially in developing countries like India, with a huge number of hard-to-reach areas even in the pre-pandemic era.

Although the completion of ANC visits was less during the covid period, it is seen that the supply of IFA has increased during the covid period, and severe anemia was found to be less during that time. Anemia is the most common cause of any adverse maternal outcome. At times of situations like covid pandemic, during which many economic crises were evidenced, it would have been difficult for the families of pregnant mothers to have a nutritious or an iron-rich diet. Hence, mothers would have made sure to consume IFA for the better health of the baby and the mother. Also, there existed a fear among the healthcare workers themselves as the disease was completely new, and they could have prioritized the supply of IFA to have a better maternal and neonatal outcome.

Ultrasound scans which had to be done during the second trimester, have been reduced as it could be because of the closure of private facilities for scanning at large and the increased load in the number of mothers to be screened at the tertiary care centers available in the locality. The qualitative findings from our study support this as the mothers had to make multiple visits to get a scan done, and the fear of contracting covid refrained them from going to the hospital more frequently. This finding was supported by the findings of **Rabbani U et al.,** where the ANC mothers had missed the appointments due to fear of infections and the facility not functioning as usual. (21)

Although the prevalence of high-risk pregnancy remained more or less similar during the covid and the pre-covid period, the number of referrals to higher centres increased during the covid time. The probable reasons for referral could be that most of the PHCs did not conduct deliveries even in case of slight risk and were primarily focussing on COVID related activities Certain PHCs at the block level were converted as covid care centres and hence, could not conduct deliveries.

b. Coverage of intranatal services:

Our study did not find a significant difference in the gestational period at delivery between the two periods; however, the number of preterm deliveries was higher during the pre-covid period. As reported in other studies, the proportion of pre-term labors could have been reduced due to the stringent lockdown which restricted the mothers' physical activity/ motility/ mobility to a greater extent, which may have influenced induction and onset of labor. (36)

The proportion of normal deliveries and the LSCS had reduced during the covid period, and the number of assisted vaginal deliveries was found to be higher in our study. The results of our study aligned with **Das Neves Martins Pires PH et al.,** in which there was a 4% decrease in overall hospital deliveries, and elective C-sections decreased by

26%. (26) Similarly, institutional delivery was decreased in other studies by **Goyal M et al., Shapira G et al.,** and **AK Singh et al**.(20,27,34). The reason may be because the healthcare workers initiated LSCS after attempting assisted vaginal deliveries for selective cases to avoid the caseload during the pandemic. An LSCS would require procedures involving other specialists, and the procedure may produce aerosols that have the potential to spread covid. Also, the human resources were less, and the required hospital stay would be longer in the case of an LSCS. Hence, the number of assisted vaginal deliveries would have increased during this period, and the number of LSCS would have been reduced.

c. Coverage of post-natal services:

The coverage of post-natal visits within two weeks of delivery is about 15% higher during covid than pre-covid. This finding was, however, contrary to the findings of other studies. In a study by **Wanyana D et al.,** the MCH services such as antenatal care (ANC), deliveries, post-natal care (PNC), and vaccinations were decreased. (29) **Gebreegziabher SB et al**. and **Bekele C et al**. also found a similar decrease in post-natal care by 9.3% and a reduction in post-natal care visits from 26.6 to 19.8/month. (23,24) This difference observed could be due to two possible reasons. First reason could be that health care workers could have completed the PNC visits during their visit for covid related activities, and the second probable reason could be the increased telecommunication usage during the covid period.

In our study, there was a reduction in the proportion of mothers that received social benefit schemes from JSY and MRMBS. However, our study could not establish a statistically significant difference between the two time points. The small reduction in the proportion of beneficiaries is understandable as many of the non-essential services were not prioritized as the health system was geared towards managing the pandemic.

It is possible that some of the beneficiaries would not have submitted the essential documents required for availing the benefits of the above-mentioned schemes.

d. Immunization services:

Although the proportion of beneficiaries receiving the vaccination is similar in both periods, there seems to be a delay in receiving them. This finding was true in both the cases of TT vaccination in pregnant women and child immunization services. This finding was in concurrence with the study done by **AK Singh et al.,** in which the immunization services reduced by more than 20%. (20) Due to the delay, there can be an increased risk for incidence of vaccine-preventable diseases in the children. Though there was delay during the covid pandemic, the immunization coverage was close to 100% which is excellent in terms of coverage. From our study, we observed that there was a provision of doorstep vaccination at most places where the healthcare workers reached the beneficiaries' homes to provide vaccination during the pandemic. However, due to the enforcement of certain laws like not entering the area in case of being a containment zone and complete restriction in the movement for the people in the containment zone, there could have been a probability of not receiving timely vaccination.

Maternal and neonatal outcomes:

a. Maternal outcomes: Though the abortion rates were higher during the covid time compared to the pre-covid period, the difference was not statistically significant after adjusting for age, parity, and other variables that could impact the same. There were studies with findings similar to our study. At the same time, there are studies contradictory to our findings. **Fulcher IR et al**. reported that there were 1725 fewer abortions than expected, which is a 20% drop. (37) Such contrasting findings were due to the difference in the type of the COVID variant, which had affected the mothers, and the pandemic's effects, where the mothers could not have nutritious food, leading to increased abortions. Also, reporting bias cannot be ruled out as the functioning of the reporting systems were not expected to be the same during covid and pre-covid period.

b. Neonatal outcomes: The proportion of stillbirth was higher in the covid period (1% Vs. 0.4%), which is similar to the findings of **Khalil A et al.** (38), which could be attributed to delay in health seeking and difficulties in reaching the hospital when needed due to fear of contracting infection. In addition, accessibility to the health facility (especially the delay in referring the patient to a higher facility in case of an emergency) and poor infrastructure (lack of workforce, lack of beds, delay in scans), and reduced antenatal visits could have played an important role in the adverse outcome of the child. However, these findings are based on the unadjusted analysis, and the numbers were inadequate for performing an adjusted analysis. Qualitative inquiries also supported the above issues as interviews with some of the stake holders especially health care providers revealed similar findings.

Contraceptive uptake:

In our study, we observed there was a reduction in the contraceptive uptake during the covid period. However, the reduction in uptake of the contraceptive services was neither statistically significant nor significant in terms of public health importance. These findings were aligned with the findings of the study conducted in Addis Ababa, Ethiopia by **Gebreegziabher SB et al.,** where the new contraceptive acceptors significantly decreased by 20.3%. (23) The reduction in contraceptive uptake can be due to decreased access to family planning services. However, the qualitative analysis results contradict the findings where the healthcare workers reported that family health and welfare services were interrupted largely during the covid times. There are several studies in support of a reduction in contraception use in India during the covid period. **Singh S et al** had reported that there was a 43% drop in injectable contraceptives, 50% drop in intra-uterine devices (IUDs), and 21% drop in oral contraceptives. (39)

Challenges faced, new strategies adopted, and the suggestions for improvement in providing services in the public health sector during COVID:

Our study found a delay in providing all ANC services, from AN registration to the child's vaccination. The challenges faced by the health care workers were categorized based on the period of care provision as antepartum, intranatal, and post-partum. In addition to that, they also faced some general and psychosocial issues during this pandemic. These issues in ANC services were subcategorized as part of the service provision under challenges during the AN period. The sub-categories were AN registration, ANC follow-up, and screening of various infections and scans. Similarly, there were issues with referral and adverse pregnancy outcomes in the intranatal period, and post-partum was further classified as PNC and child health.

The major challenges faced by the healthcare workers were in providing maternal health services delay in AN registration, reduction in the AN checkups, increased waiting time for mothers, missing high-risk cases, difficulty in referral, increase in adverse maternal outcomes,

and most importantly, the resistance from the community to get tested or admitted for covid. These findings were in line with **Shapira G et al.** findings in which there was a severe decline in the utilization of maternal health services. (34) In addition to this, the other challenges that emerged from our study were that the HCWs had financial constraints and difficulty in visiting the AN mother / PN mother/ children for vaccination as no arrangements were made for visiting them, and they had to use their vehicles as public transport was restricted and hospital vehicles were diverted for covid related work. When there were no transport facilities for referral, they spent money from their pockets if the pregnant women's families faced financial hardship. The health care workers had faced issues within the family since they had to work longer without a break, and they had mentioned that they could not spend time with their families. The health care workers were worried and feared about covid as they had children and elders at home, and they may spread it to them after visiting COVID patients. In urban areas, separate accommodation for health care workers were provided, it was not the case in rural areas where finding separate accommodation for HCWs working in covid is difficult. Hence HCWs had to stay with their family and they feared that they could transmit the covid infection to their family members..

Yet another challenge faced by the HCW that emerged in our study was the lack of basic facilities for the healthcare worker when they go for the covid activities or MCH services. They did not have a place to drink water or eat something and lacked basic facilities like toilets. The general public stigmatized them for being healthcare workers and did not allow them to enter the houses due to fear of covid especially during the early phases of pandemic. The healthcare workers perceived this was because of a lack of awareness and misconceptions regarding the disease. Hence, they suggested that health education must be given importance, and community capacity building is necessary. Also, a doctor suggested that a standard protocol or guideline for diagnosis and treatment should be made available to the healthcare team to deliver the

service better. Also, the involvement or collaboration with the local bodies will help gain confidence among the general public, and the situation can be tackled better. Standard treatment guidelines were made available by the Directorate of Public Health and Preventive Medicine and were updated time to time. Also, local bodies were instructed to support the health departments in all possible ways in controlling the pandemic and also in delivering the routine essential services.

The challenges at the healthcare level were regarding the poor infrastructure at healthcare facilities where there was a lack of workforce, resources, and other services. Some examples are fewer ambulances, non-availability of USG facilities, deputation of the workforce, and lack of laboratory technicians. These all contributed to delays in reaching the hospital and seeking care. These findings were similar to the existing literature by **Sengupta et al.**, which identified various workplace challenges, including resource availability, adequacy, and allocation, perceived managerial ineffectiveness, inconsistent guidelines, and perceived occupational stress. Also, societal/community challenges included dreaded disease, social adaptiveness, and challenges related to essential services. (40) Participants (HCWs) in our study suggested fulfilling the existing vacancies to have an adequate workforce and other resources (equipment, ambulance) at least as per the IPHS standards, which would have helped them manage and handle situations better.

The challenges the mothers and their families faced were the economic crises where the families had lost their job/ wages, difficulty in buying food, and doing the basic scan procedures due to lack of money. Secondly, the issue was regarding access to care as there were transport restrictions and the compromised infrastructure with a lack of beds/ medicines to handle the situation. The mother from the middle or upper socio-economic class had issues with the closure of the private hospital and the lack of food and accommodation for the accompanying person. They also had difficulties following and adapting to the covid preventive measures like

closing shops and wearing masks and mandatory covid test reports at all places. Similar findings were reported by **Tyagi A et al**. in a study conducted in Maharashtra in which there was an increase in maternal malnutrition due to the rapid steps of mitigation taken to tackle the pandemic, leading to decreased food security, healthcare, and education. (41)

Given these challenges, they also mentioned facilitating factors like the supply of nutrition kits and medicines/ vaccines at their doorstep for improved nutrition, house visits, and health education by the healthcare team to ensure appropriate care. They also mentioned that the hospitals had arranged vehicles for their transport back home following delivery. They also suggested that services could be improved if the Government arranged a vehicle to visit the hospital and if the education was given on television or radio as a few of them didn't have a mobile phone. They added that the availability of a scan facility at the PHC level and the test result on the same day would be of more help in case of situations like covid. Though provision of services closer to home is the ultimate goal of universal health coverage and governments are working towards providing maternal health services closer to home, making USG available at PHCs or health wellness centres with required trained manpower will be an uphill task.

Strengths of the study:

1. The study employed a mixed method design which allowed to allowed to explore the perspectives of different stake holders including the health care providers and mothers and their relatives.
2. The study had comparison group (pre-covid period) to make comparison of maternal and child health service delivery indicators valid.
3. Comprehensive assessment of maternal and child indicators including post-partum contraceptive uptake is a strength
4. Within the districts selected, the study employed a sampling design which included the PHCs from rural and urban in a proportionate manner. Also, PHCs where tribal population is more were included in the sample to have a better representation.

Limitations of the study:

1. Quantitative component of the study relied on the secondary data maintained at different health facilities. There could be errors in capturing the data during pandemic and also data entry errors cannot be ruled out. Data was not complete for variables like details on high-risk pregnancy and type of delivery in selected health facilities. Routine program can strengthen the data capture mechanisms.
2. The study included only high priority districts under TNHSRP and the findings cannot be representative of other districts of Tamil Nadu. However, the other districts of Tamil Nadu were better performing in terms of MCH indicators and we expect the impact of COVID on MCH services would be less compared to high priority districts.
3. Since the sampling of study participants (mothers) was over a period of one year (Jan 2020- Dec 2020), impact of specific strategies like lock down on MCH service utilisation indictors could not be assessed.

Conclusion and recommendations

The COVID-19 pandemic has impacted maternal and child health services in Tamil Nadu like elsewhere. There was no major difference in the indicators related to maternal and child care services during pre-covid and covid periods except a slight increase in abortion and still births during the covid period. Qualitative findings revealed the following as the impact of COVID-19 on maternal and child health services.

1. Disruptions in healthcare delivery: The pandemic has led to widespread disruptions in healthcare delivery, including in maternal and child health services. This is due to the need for healthcare providers to prioritize COVID-19 patients and the closure of non-essential services. Improving the participation of private practitioners and non-governmental organizations/civil societies in providing essential health care services is recommended during the future pandemics or disaster situations.

2. Reduced access to healthcare: With the fear of contracting the virus, many expectant mothers and families with young children have been avoiding healthcare facilities, reducing access to maternal and child health services. Mobile health services can be strengthened to improve the access and the state health department has already increased the range of services that has been offered including NCD care, physiotherapy and palliative care.

3. Shortage of healthcare workers: The pandemic has resulted in shortage of healthcare workers, as many have fallen ill or have been quarantined. This has made it difficult for maternal and child health services to be delivered effectively. Human resources for health is one of the pillars of the health care system and improving the quality and quantity of human resources is important for any health system.

4. Financial stress: The pandemic has also caused financial stress for many families, making it difficult for them to afford maternal and child health services especially costs associated with travel. Government of Tamil Nadu has already implemented MRMBS scheme which will be supporting the financial needs in addition to the monetary incentives provided under JSY scheme.

In conclusion, the COVID-19 pandemic has impacted maternal and child health services in Tamil Nadu. Health system of Tamil Nadu in the high priority districts had responded well to the needs of mothers and children during the pandemic.

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Annexure 1: DPH Approval letter

Directorate of Public Health and Preventive Medicine
Scientific Advisory Committee
359, Anna Salai, DMS Campus, Teynampet, Chennai – 06.

S.No. DPHPM/SAC/2022/027 R.No.011575/HEB/A2/2022
Date : 07-05-2022

Sub:	Scientific Advisory Committee - Health Education Bureau (HEB) – Study Permission – Dr. C. Palanivel – "Impact of COVID-19 pandemic on utilisation of maternal and child health services in three priority districts of Tamil Nadu: and explanatory mixed methods study" – Regarding.
Ref:	Individual's Application Dated : 21-04-2022

With reference to above, Dr. Palanivel, Additional Professor, Department of Preventive and Social Medicine, JIPMER, is permitted to conduct a study on "Impact of COVID-19 pandemic on utilisation of maternal and child health services in three priority districts of Tamil Nadu: and explanatory mixed methods study" for academic year2022 under his own capacity.

Ethics Committee Approval Date	10.01.2022
Institution	Institutional Ethics Committee (Human Studies), JIPMER, Puducherry

Subject to the following conditions:

- Data Collected should not be published in the newspaper or in any media without the prior permission of Government of Tamil Nadu / DPH&PM, Chennai – 06.
- The data on the survey should not be shared with any other 3rd party and inference arising on analysis of the data should not be disseminated without the written permission of Director of Public Health and Preventive Medicine / Government of Tamil Nadu.
- The analytical findings are to be shared to this office for useful inputs.
- The outcomes of the proposed study, policy and its implications in the Public Health may be shared with this department.

Dr. T.S. Selvavinayagam,
Director of Public Health and
Preventive Medicine,
Chennai – 06.

To:
Dr. Palanivel,
Additional Professor,
Department of Preventive and Social Medicine,
JIPMER.

Copy To:
1. The Deputy Director of Health Services, Thiruvannamalai, Theni and Thoothukudi.
2. TNHSRP, Chennai – 06.
3. Indian Institute of Technology, Madras.

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Annexure 2: Institutional Ethics Committee Approval - JIPMER

जवाहरलाल स्नातकोत्तर आयुर्विज्ञान शिक्षा एवं अनुसंधान संस्थान
JAWAHARLAL INSTITUTE OF POSTGRADUATE MEDICAL EDUCATION & RESEARCH
(स्वास्थ्य एवं परिवार कल्याण मंत्रालय, भारत सरकार के अधीन राष्ट्रीय महत्व का संस्थान)
भारत सरकार / GOVERNMENT OF INDIA
(An institution of National Importance under Ministry of Health & Family Welfare)
धनवंतरी नगर, पुडुचेरी / Dhanvantari Nagar, Puducherry – 605006
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INSTITUTIONAL ETHICS COMMITTEE FOR OBSERVATIOLNAL STUDIES
DHR REG. NO. EC/NEW/INST/2020/331

JIP/IEC/2021/367 Date: 10.01.2022

CERTIFICATE

This is to certify that the project **No. JIP/IEC/2021/367,** entitled **"Impact of COVID-19 pandemic on utilization of maternal and child health services in three priority districts of Tamil Nadu: An explanatory mixed methods study."**, submitted by **Dr. Palanivel C, Additional Professor, Department of Preventive and Social Medicine, JIPMER** to the IEC has been granted exemption from review in the First Observational committee meeting held on **05-12-2022.**

Dr. Subitha L.,
Member Secretary
Institutional Ethics Committee
(Observational Studies), JIPMER

Member Secretary
Institutional Ethics Committee
(Human Studies),
JIPMER, Puducherry

Copy to:
Principal Investigator: Dr. Palanivel C, Additional Professor, Department of Preventive and Social Medicine
Co- Investigators: Dr. Ganesh Kumar, Additional Professor, Department of Preventive and Social Medicine
Dr. A M Veerakumar, Assistant Professor, Department of Community Medicine, Government Theni Medical College Hospital
Dr. Praveena Daya A, Senior Assistant Professor, Department of Community Medicine, Government Tirunelveli Medical College Hospital

Annexure 3: Data Collection Proforma

DATA COLLECTION PROFORMA

Demographic details

1. Mother's name :
2. Age (in years) :
3. Education (in years) :
4. Occupation :
5. Type of PHC : Urban / Rural

Obstetric care, immunization and contraception services

6. Parity : Primi para / Multi
7. Co-morbidities developed at the time of pregnancy : Yes/ No

If yes, specify : _____

8. Date of first TT vaccination :
9. Date of second Dose of TT :
10. Haemoglobin levels in each trimester :
11. Date of delivery :
12. Type of delivery : Normal/LSCS/Assisted vaginal delivery
13. Place of delivery : Govt / Private
14. Gestation at delivery : Term/ Preterm/ Abortion
15. Birth weight of the baby (in kg) :
16. Received JSY benefits : Yes/ No
17. BCG / OPV given at birth : Yes/ No
18. Date of BCG vaccination :
19. Date of pentavalent-1 vaccination :

20. Date of pentavalent-2 vaccination :

21. Date of pentavalent-3 vaccination :

22. Date of MR-1 vaccination :

23. ANC visits in the first trimester : Yes/ No

24. Completed at least 4 ANC visits : Yes/ No

25. Completed all the scheduled ANC visits : Yes/ No

26. Timeliness of TT vaccines : Yes/ No

27. Received post-natal care within 2 weeks of delivery : Yes/ No

28. Timeliness of BCG & OPV at birth, Pentavalent (1,2,3), IPV (1,2) and MR (1) vaccines: Yes/ No

29. Contraceptive use within one year of delivery : Yes/ No

30. If yes, method of contraception :

Annexure 4: Interview guide for beneficiaries

Interview Guide for beneficiaries

Name of the participant: ***DOI:***

Name of the interviewer: ***Start/end time:***

Introduce yourself to the participant and explain them the purpose of the interview. Inform them about the approximate duration of interview and obtain their consent to participate in the study. Obtain their consent for recording the conversation.

1. Warm up questions (introduction, place of residence, etc.,)
2. According to your opinion, how has this COVID-19 pandemic have affected your routine at home? (Probes: lockdown, job loss, non-availability of groceries, restricted mobility for walking and exercise).
3. Did you face any difficulty in availing health services before, during and after delivery during the pandemic? Kindly elaborate your experiences?
4. Why were you not able to avail the antenatal services? (Probe: non-availability of transportation facilities, fear of visiting the hospital, anxiety to go out of house, family support, getting medicines, fear of getting COVID, spread of COVID to child, delivery, income)
5. Did you face any difficulty in availing vaccination services for your child? If yes, please explain.
6. How did you cope up with these difficulties? (Probe: contacted healthcare provider through phone, consulted anyone for further clarification, information gathering through internet and watching tv etc.…)
7. In your opinion, how do you think the services could have been delivered to you in a better way during this kind of situation due to pandemic?

Annexure 5: Interview Guide for healthcare workers

Interview Guide for healthcare workers

Name of the participant: ***DOI:***

Name of the interviewer: ***Start/end time:***

Introduce yourself to the participant and explain them the purpose of the interview. Inform them about the approximate duration of interview and obtain their consent to participate in the study. Obtain their consent for recording the conversation.

1. Warm up questions (introduction, place of residence, etc.,)
2. According to your opinion, how has this COVID-19 pandemic have affected your routine at the health centre? (Probes: lockdown, home visits and referral services, non-availability of medicines and lab supplies, restricted mobility).
3. Did you face any difficulty in providing health services during the pandemic for antenatal women and new-borns? Kindly elaborate your experiences?
4. In your perspective what are the difficulties or challenges faced by the women in availing antenatal and immunization services? (Probe: non-availability of transportation facilities, fear of visiting the hospital, reduction in number of healthcare workers, anxiety to go out of house, getting medicines, fear of getting COVID, spread of COVID to child, fear related to delivery)
5. What are the good practices followed at your centre to improve the service delivery during this pandemic?
6. In your opinion, how do you think the antenatal and immunization services could be delivered in a better way during this kind of future pandemics?

Annexure 6: Photographs from the vists to PHC's