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Infant neonatal and post neonatal mortality in Madurai district, Tamil Nadu, India: A Geomedical study

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Abstract
The Infant Mortality Rate is a public health indicator of a complex societal problem. Various frameworks have been used to help the multiple determinants of infant mortality and to identify interventions to reduce infant mortality. The social causes of infant mortality persistent poverty, pervasive and subtle racism. The chronic stresses associated with them may not be easy to address, it is still possible to understand the risks of infant death by examining the biological pathways through which these societal forces act. The present study observes the impact of infant neonatal and post neonatal. The study area of Madurai District is located in the Southern part of Tamil Nadu, India. This study analyzed the infant mortality for the year 2017-2018 in Madurai District. This study is to identify the infant neonatal and post neonatal mortality rate in the study area and associate with ''Z'' Score variation based on GIS techniques. Identification and interpretation of infant mortality rate result in framing suitable policies and decisions for effective health care planning. Geographical Information System and statistical analyses are important in guiding health care agencies, public health officers and relevant authorities in progressing efficient control measures and contingency programs in identifying and prioritizing their efforts in effective infant mortality rate control activities. Findings suggest that some progress has been made in reducing infant mortality rates in Madurai particularly in most of the areas with very high infant mortality rates.

Keywords: GIS, neonatal, post neonatal, infant mortality rate

Introduction

A neonatal death (also called a newborn death) is when a baby dies during the first 28 days of life. Most neonatal deaths happen in the first week after birth. Neonatal death is different from a stillbirth. A stillbirth is when the baby dies at any time between 20 weeks of pregnancy and the due date of birth. Pregnant women have proven beneficial to both mother and infant by decreasing morbidity and mortality. Health is an important aspect for the development of human resources and their quality of life, necessary for the overall development of a country as a whole. The state of positive health implies the notion of 'perfect functioning' of the body and the mind. Psychologically, as a state in which the individual feels a sense of perfect well-being and of mastery over his environment and socially, as a state in which the individual's capacities for participation in the social system are optional (Twaddle, 1977) [26].

Scholarly evidence has shown that both under and over- nutrition lead to poor pregnancy and birth outcomes. During labour and delivery, maternal obesity was found to be associated with maternal death, hemorrhage, caesarean delivery, or infection (Ahmed *et al*. 2011; Normal and Reynolds 2011) [1, 17]. The study also derived a conceptual framework towards strengthening, control and sustainable development of the urban landscape. (Saravanabavan. *et al*. 2020; Balasubramani *et al*. 2015) [4, 5]. Various factors like malnutrition, immunization, disease, a poor source of drinking water are the factors affecting the general health of the people. Aggregate influence of these factors can be perceived through their effect on adult longevity, child mortality, general health of pregnant women, new born infants etc. The barriers to immunization coverage are adverse geographical location, absent or inadequately trained health workers and low perceived need for immunization, shortage of health care providers, poor intra partum and new born, diarrheal disease and acute respiratory infections also contribute to the high infant mortality rate. Health care and locational analysis of health care frontiers were also studied (Saravanabavan *et al*. 2006; Nisha, *et al*. 2020) [18, 4].

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The way infants are positioned in the hospital strongly influences parental practices at home (Colson & Joslin 2002; Gelfer, Cameron, Masters, & Kennedy, 2013; Vernacchio *et al*., 2003) [7, 13, 28].

Motherhood is the supreme fulfilment in women's life. Many women die in the process of childbirth especially in developing countries (Gangadharan & Rajula Helan 2010) [12]. Complications of pregnancy and childbirth are often the major causes of morbidity and mortality among women in child bearing ages. Ganesh Chandra Mallick (2010) [10]. Empirical work has also shown that education can serve as a means of adopting new health beliefs, gaining general knowledge, and applying specific knowledge about health and nutritional practices that promote child health (Ganesan and Saravanabavan 2018; Sudharsan and Saravanabavan 2019) [11, 4]. Another factor through which the socio-economic determinants such as income and household's wealth affect child health and nutritional status through some intermediary mechanisms that encompass household composition, dietary intake, medical treatment, and environmental contaminants (Saravanabavan *et al*. 2006, 2014, 2019) [18, 3-4].

Women who are less educated generally have more children on average and are younger at the time they first give birth. Specifically, greater the number of children in a household the greater is the competition for scarce resources, which could badly affect children's dietary intake, reduce their access to medical treatment, and increase their chances of getting exposed to infectious diseases Arup Maharatna (2005) [2]. Mahadevan, (2001) [15] is strongly influenced by many biological and socioeconomic factors. The biological determinants of child mortality have been studied extensively (Sheheersha *et al*. 2015; Vimala Vinnarasi and Saravanabavan 2017; Balaji and Saravanabavan 2019, 2020) [23, 3-4]. The important social determinants of child mortality which have been studied are education, occupation, income and wealth. Claeson (2004) [6] studied child mortality trends and determinants - policy implications for child survival in India. In 2003, about 2.2 million children under age 5 died in India which is the highest total of any country and about 20 percent of all child Deaths globally.

Kasturi Mondal Chander Sekhar (2011) [14] explained that Health is a vital component of Human capital and Human resources. Hence development strategies and policies must focus on the physical and mental wellbeing of women along with their male counterparts. Status and wellbeing of women are indicated by maternal mortality (MMR) and morbidity rates, infant mortality rates (IMRs) life expectancy, fertility rates, work participation rates age at marriage malnutrition etc. Among every one in five children (21.4%) was born with underweight (below 2.5 kg), and only half of all children were exclusively breastfed (53.3%). Yet, only 50.6% of children with diarrhoea received Oral Rehydration Solution, a simple method of managing diarrhoea, and 20.3% received zinc supplementation, which helps fight diarrhoea.

Study Area
Madurai District is one of the 38 districts of Tamil Nadu, in the southeastern part of India. It is the ninth-largest populated district in Tamil Nadu. The district lies between 9° 30′ north to 10° 30′ north latitudes and 77° 30′ east to 78° 30′ east longitudes. The areal extent of the study area is 3741.73 sq.km. (Figure No.1). In the year 1984, Madurai District was bifurcated into two administrative division Madurai and Dindigul. Again, in the year 1997, it was bifurcated as Madurai and Theni Districts. Madurai is also known as Temple City. The city of Madurai has been constructed in the form of a lotus and is built around the temple. The Madurai district is bounded on the north by Dindigul district and Tiruchirappalli district, east by Sivagangai district, west by Theni district and south by Virudhunagar district. The ground rises away from the city on all sides except in the south, bounded by the gently sloping terrain. Madurai is known for its hot climate. The average annual rainfall for 2018 was 85.76 cm.
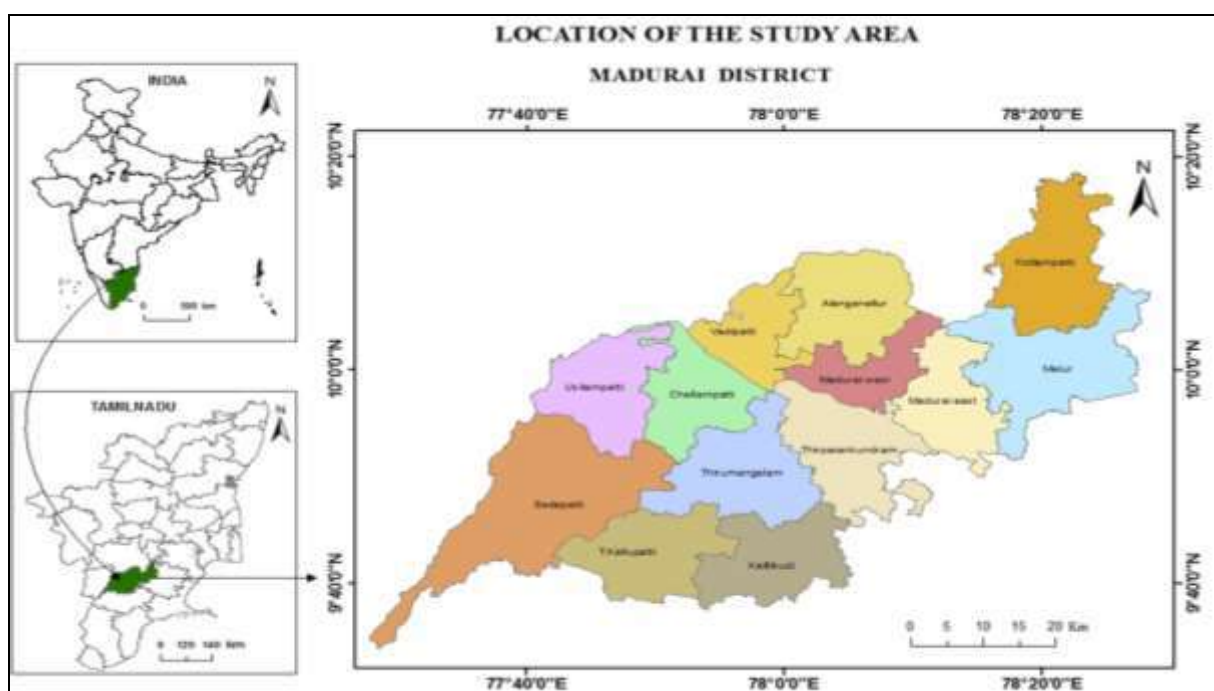

Fig 1: Location Map of the Study Area

Data and Methodology

To fulfil the above objectives, information has been collected from both primary and secondary sources. The Primary data collection for the study was done in the form of a sample questionnaire survey in selected areas of the study area. Stratified Random Sampling method is used for selecting samples for the survey. 300 samples were drawn for the present study. A predesigned questionnaire was used to collect primary data for the present investigation. Samples were taken by stratified sampling method. The analysis is confined to the married women of the reproductive age group 15 – 45 years. The primary data collection was collected directly from the respondents comprising both inpatients and outpatients who reported at the government hospitals during the period of data collection. On this representative sample, a survey was carried out to find out the reproductive health problems faced by women in Madurai District.

Data on socio-economic demographic factors, environmental factors, menstrual history, marital history, obstetric history, family planning practices, gynecological morbidities & health-seeking behaviour were collected from the women. The secondary data was collected for the period during 2017-2018. Madurai Corporation provides the major data required for the present study for the year 2018. The data collection is attempted at various levels to identify the infant neonatal and post neonatal mortality. The GIS Technique had been used in the present study to map the infant neonatal and post neonatal mortality. The maps were drawn with the help of mapping software ArcGIS. Pre-designed questionnaire was used to gather primary information. Graphical and suitable statistical techniques were used to analyze the data collected from the questionnaire survey. The statistical techniques had been done using statistical package for social sciences (SPSS). The infant neonatal and post neonatal mortality were explained with the help of cartographic tool by way of application of Z Scores values made by using SPSS.A descriptive analysis has been carried out initially.

Results and Discussions

a) Neo-Natal and Post Natal Mortality at Home – (2017-2018)

The place of delivery plays in neonatal survival as delivery outside a health facility is a risk factor of neonatal mortality. This finding concurs with the 2005 World Health Report which states that, giving birth in a health facility (not necessary a hospital) with professional staff is safer by far compared to doing so at home. From the analysis, we can find that the Neo natal death age group of 0 –28 days and post-natal death age group of 29-365 days. Total recorded Infant Death at home is (7.57). More number of deaths in the infant occur in post-natal period that is (4) compared to neo natal period which is recorded as (3.57) in Madurai District. The Table No.1 shows that very highly Infant mortality at home is recorded in the blocks of Thiruparankundram and Thirumangalam which indicate positive "Z" score value is Thiruparankundram (0.25) and Thirumangalam (0.03).The Highly registered cases are in the blocks of Kottampatti (-0.11), Madurai West (-0.19), and Usilampatti (-0.19).The moderate Infant Mortality at home recorded in the blocks of Melur (-0.26), Madurai East (-0.26), and Vadipatti (-0.34). The low level of cases recorded among the blocks Alanganallur (-0.41), Chellampatti (-0.49), Kallikudi (-0.41), T. Kallupatti (-0.56), and Sedapatti (-0.41) is shown in FigNo.2.
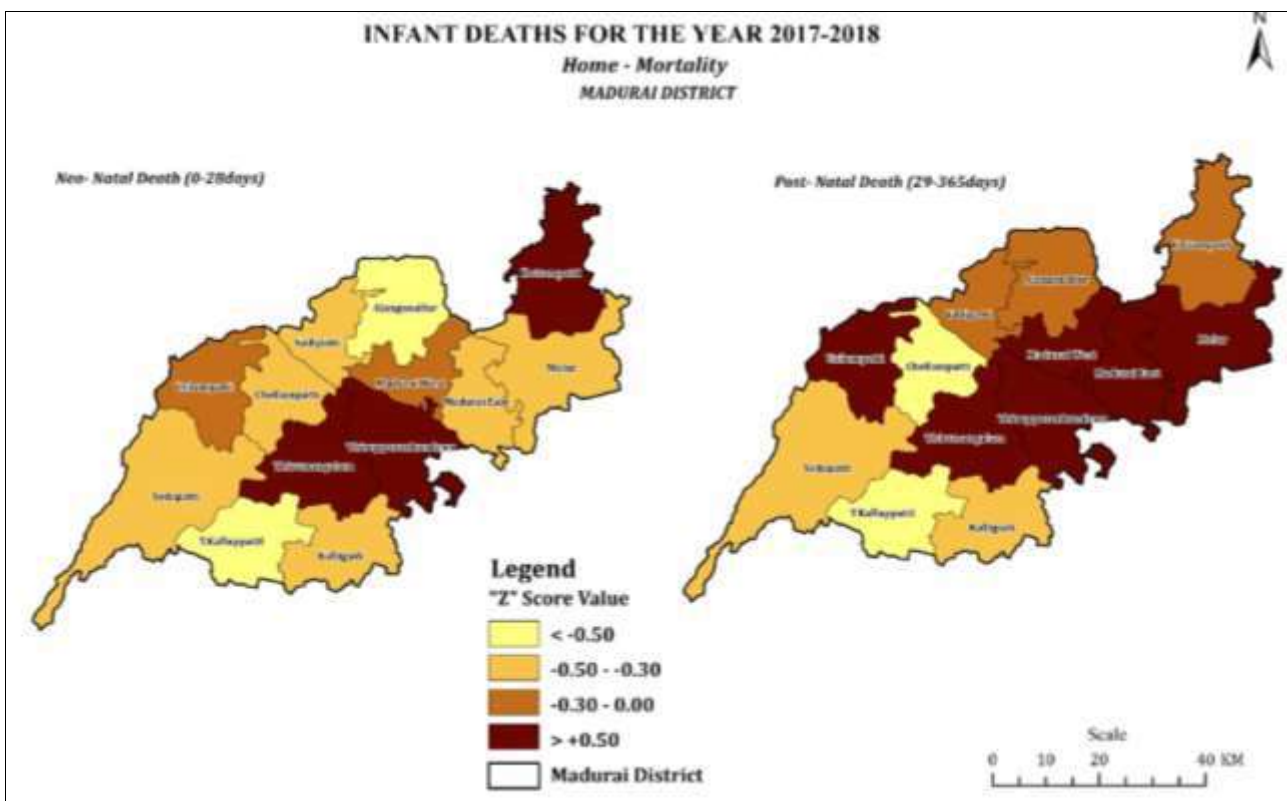

Fig 2: Neo-Natal and Post Natal Mortality at Home

Table 1: Neo-Natal and Post Natal Mortality at Home

S. No.	Name of the Block / Municipality	No. of Infant death ("Z" Score Value)		
		Neo-natal death (0-28days) Home	Post-natal death (29-365days) Home	Infant Death Home
1	Madurai East	-0.39845	-0.1423	-0.2667
2	Madurai West	-0.2435	-0.1423	-0.1920
3	Alanganallur	-0.5534	-0.2846	-0.4160
4	Vadipatti	-0.39845	-0.2846	-0.3414
5	Kottampatti	0.06641	-0.2846	-0.1173
6	Melur	-0.39845	-0.1423	-0.2667
7	Thiruparankundram	0.53127	0.0000	0.2560
8	Kallikudi	-0.39845	-0.4269	-0.4160
9	T. Kallupatti	-0.5534	-0.5692	-0.5654
10	Thirumangalam	0.06641	0.0000	0.0320
11	Chellampatti	-0.39845	-0.5692	-0.4907
12	Usilampatti	-0.2435	-0.1423	-0.1920
13	Sedapatti	-0.39845	-0.4269	-0.4160
	Mean	3.571428571	4	7.571428571
	Std. Deviation	6.453553413	7.027418828	13.39181315

a) Neo-Natal and Post Natal Mortality during Transit – (2017-2018)

The Neo natal death under the age group of 0 –28 days and post-natal death under the age group of 29-365 days at Madurai District in the year 2017-2018. Total recorded Infant Death during Transit is (2.42). More number of deaths in the infant occurs in Post-natal period that is (1.28) compared to Neo natal period which is recorded as (1.14) at Madurai District in the year 2017-2018. Table No. 2 shows that very highly Infant mortality during Transit in Madurai District (2017-2018) is recorded in the block of Melur which indicate positive "Z" score value is Melur (0.58). The High number of cases recorded in the blocks of Alanganallur (-0.09), Thirumangalam (-0.09), and T. Kallupatti (0.12). The moderate Infant Mortality during Transit recorded in the blocks of Thiruparankundram (-0.32), Kottampatti (-0.32), Madurai East (-0.32), Chellampatti (-0.32), and Sedapatti (-0.32). The low level of cases recorded among the blocks Vadipatti (-0.55), Madurai West (-0.55), Usilampatti (-0.55), and Kallikudi (-0.55) is shown in the Fig No.3.

Table 2: Neo-Natal and Post Natal Mortality during Transit

| S. No.	Name of the Block / Municipality	No. of Infant death ("Z" Score Value)		
		Neo-natal death (0-28days) Transit	Post-natal death (29-365days) Transit	Infant Death Transit
1	Madurai East	-0.52453	-0.11907	-0.32355
2	Madurai West	-0.52453	-0.5358	-0.55004
3	Alanganallur	-0.06557	-0.11907	-0.09707
4	Vadipatti	-0.52453	-0.5358	-0.55004
5	Kottampatti	-0.52453	-0.11907	-0.32355
6	Melur	0.3934	0.71439	0.5824
7	Thiruparankundram	-0.52453	-0.11907	-0.32355
8	Kallikudi	-0.52453	-0.5358	-0.55004
9	T. Kallupatti	0.85236	-0.5358	0.12942
10	Thirumangalam	-0.52453	0.29766	-0.09707
11	Chellampatti	-0.06557	-0.5358	-0.32355
12	Usilampatti	-0.52453	-0.5358	-0.55004
13	Sedapatti	-0.06557	-0.5358	-0.32355
	Mean	1.142857143	1.285714286	2.428571429
	Std. Deviation	2.178819118	2.399633672	4.415258259
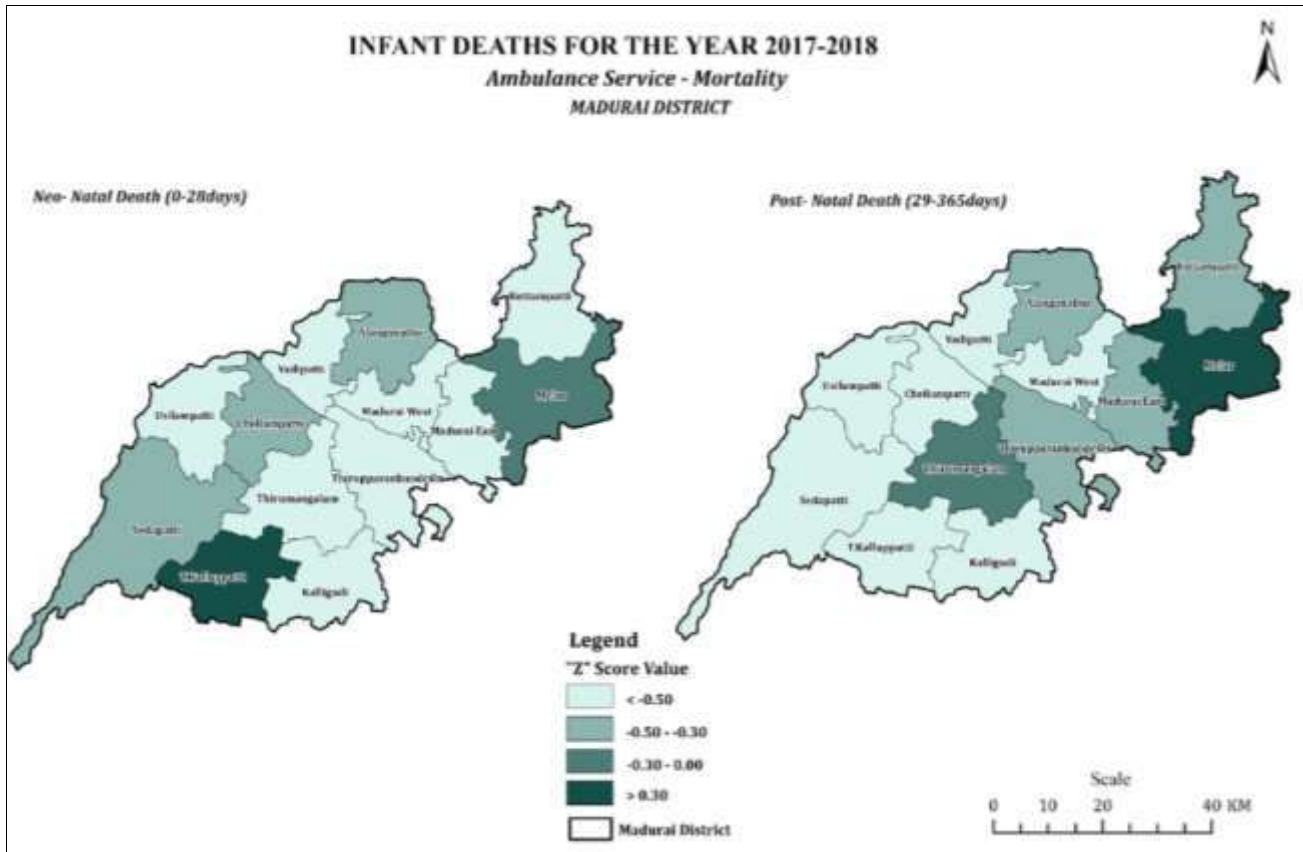
Fig 3: Neo-Natal and Post Natal Mortality during Transit

a) Neo-Natal and Post Natal Mortality at Private Hospitals – (2017-2018)

From the analysis, we can find that the Neo natal death age group of 0 –8 days and post-natal death age group of 29-365 days of the Madurai District in the year 2017-2018. Total recorded Infant Death at Private Hospital is (3.57). More number of deaths in the infant occurs in Neo natal period that is (2) compared to the postnatal period which is recorded as (1.57) in Madurai District in the year 2017-2018. The Table No.3 shows that very high Infant mortality at Private Hospital in Madurai District in the year 2017-

2018 is recorded in the blocks of Usilampatti, T.Kallupatti, Madurai East and Kottampatti which indicate positive "Z" score value is Usilampatti (0.06), T.Kallupatti (0.06), Madurai East (0.06) and Kottampatti (0.06). A high number of cases recorded in the blocks of Melur (-0.24), Madurai West (-0.08), and Thiruparankundram (-0.08). The moderate Infant Mortality in Private Hospital recorded in the block of Thirumangalam (-0.40). The low level of cases is recorded among the blocks Chellampatti (-0.55), Vadipatti (-0.55), Alanganallur (-0.55), Sedapatti (-0.55) and Kallikudi (-0.55) is shown in the Fig No.4

Table 3: Neo-Natal and Post Natal Mortality at Private Hospitals

| S. No.	Name of the Block / Municipality	No. of Infant death ("Z" Score Value)		
		Neo-natal death (0-28days) Private Hospital	Post-natal death (29-365days) Private Private Hospital	Infant Death Private Hospital
1	Madurai East	-0.27178	0.49695	0.0669
2	Madurai West	0.27178	-0.54665	-0.08921
3	Alanganallur	-0.54356	-0.54665	-0.55754
4	Vadipatti	-0.54356	-0.54665	-0.55754
5	Kottampatti	0	0.14909	0.0669
6	Melur	-0.54356	0.14909	-0.24532
7	Thiruparankundram	0	-0.19878	-0.08921
8	Kallikudi	-0.54356	-0.54665	-0.55754
9	T. Kallupatti	0.27178	-0.19878	0.0669
10	Thirumangalam	-0.54356	-0.19878	-0.40143
11	Chellampatti	-0.54356	-0.54665	-0.55754
12	Usilampatti	0.27178	-0.19878	0.0669
13	Sedapatti	-0.54356	-0.54665	-0.55754
	Mean	2	1.571428571	3.571428571
	Std. Deviation	3.679464844	2.874671505	6.405698013
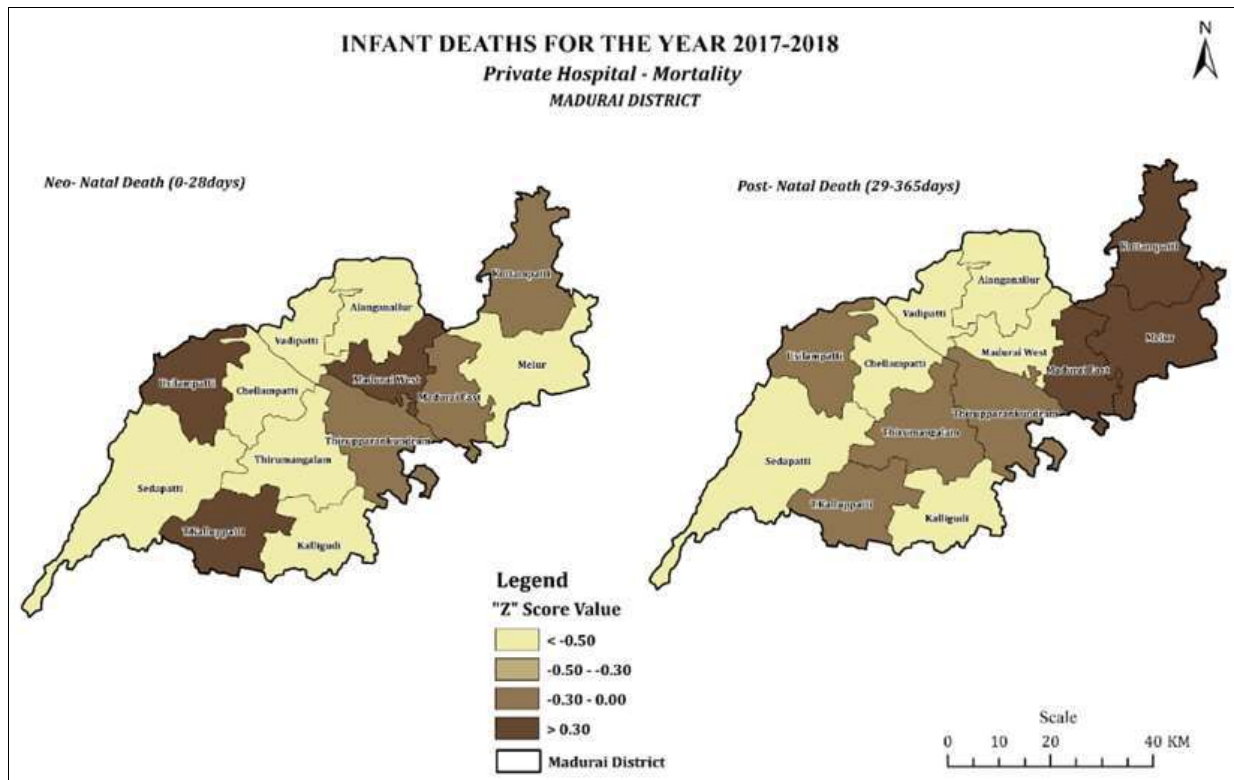
Fig 4: Neo-Natal and Post Natal Mortality at Private Hospitals

b) Neo-Natal and Post Natal Mortality at Taluk Head Quarters Hospitals – (2017-2018)
From the analysis, we can find that the Neo natal death age group of 0 –8 days and post-natal death age group of 29-365 days in the Madurai District (2017-2018). Total recorded Infant Death at District Head Quarters Hospital of the Madurai district in the year 2017-2018 is (2.57). More number of deaths in the infant occurs in Neo natal period that is (2) compared to the postnatal period which is recorded as (0.57) in Madurai District in the year 2017-2018. The Table No.4 shows that very high Infant mortality at District Head Quarters Hospital in Madurai district is recorded in the blocks of Usilampatti, Chellampatti and Sedapatti which indicate positive "Z" score value is Usilampatti (0.48), Chellampatti (0.48) and Sedapatti (0.69). The moderate Infant Mortality recorded in the blocks of Thirumangalam (-0.31), and T. Kallupatti (-0.31). The low level of cases recorded among the blocks Kallikudi (-0.51), Thiruparankundram (-0.51), Madurai East (-0.51), Madurai West (-0.51), Melur (-0.51), Vadipatti (-0.51), Alanganallur (-0.51), and Kottampatti (-0.51) is shown in the Fig No.5

Table 4: Neo-Natal and Post Natal Mortality at Taluk Head Quarters Hospitals

| S. No.	Name of the Block / Municipality	No. of Infant death ("Z" Score Value)		
		Neo-natal death (0-28days) Dist. HQ Hospital	Post-natal death (29-365days) Dist. HQ Hospital	Infant Death Dist. HQ Hospital
1	Madurai East	-0.5204	-0.46743	-0.51875
2	Madurai West	-0.5204	-0.46743	-0.51875
3	Alanganallur	-0.5204	-0.46743	-0.51875
4	Vadipatti	-0.5204	-0.46743	-0.51875
5	Kottampatti	-0.5204	-0.46743	-0.51875
6	Melur	-0.5204	-0.46743	-0.51875
7	Thiruparankundram	-0.5204	-0.46743	-0.51875
8	Kallikudi	-0.5204	-0.46743	-0.51875
9	T. Kallupatti	-0.2602	-0.46743	-0.31701
10	Thirumangalam	-0.2602	-0.46743	-0.31701
11	Chellampatti	0.7806	-0.46743	0.48993
12	Usilampatti	0.2602	1.16857	0.48993
13	Sedapatti	0.5204	1.16857	0.69167
	Mean	2	0.571428571	2.571428571
	Std. Deviation	3.843075691	1.222499691	4.956957592
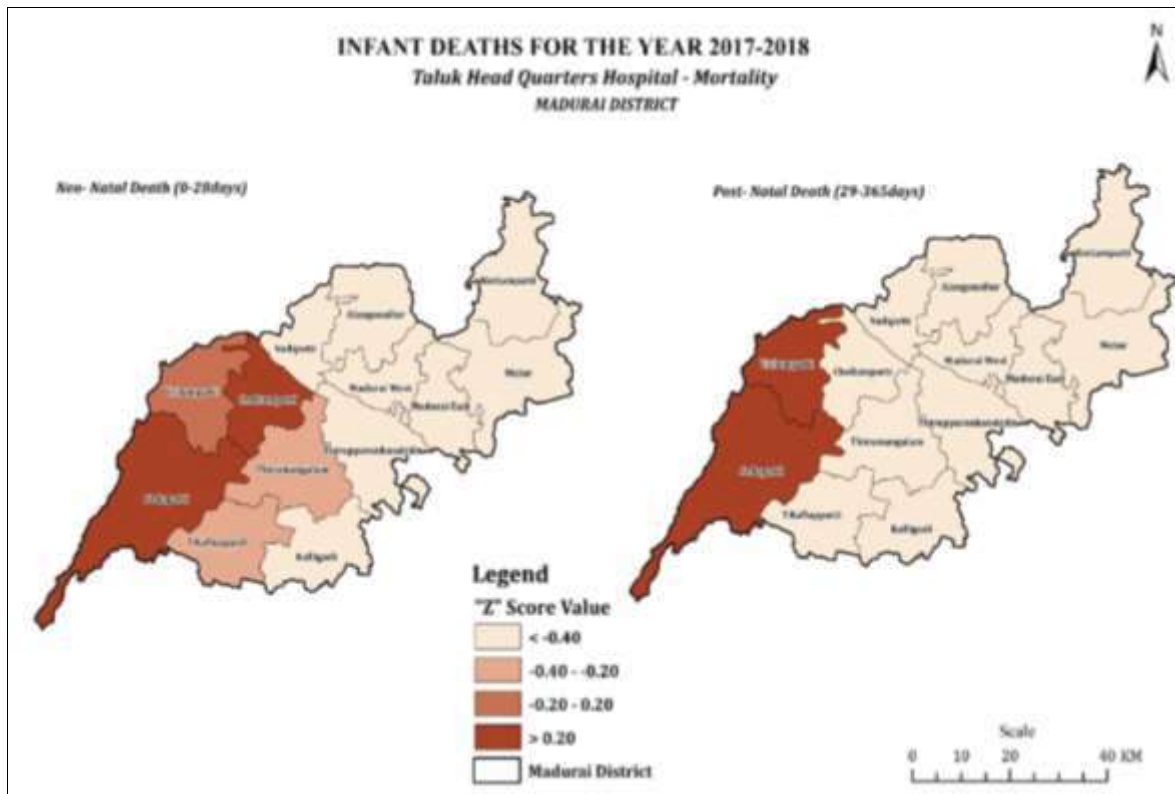
Fig 5: Neo-Natal and Post Natal Mortality at Taluk Head Quarters Hospitals

c) Infant Mortality Age Group 8-28 Days and 29-365 Days – (2017-2018)

From the analysis, we can find that the age group of 8 –28 days is highly prone to death. The Male infant who is highly affected than a female infant in Madurai District (i.e.,) Post Neo natal death in male children is (5.85) and (3.71) in Female Children. Many of the deaths occur before children turn one. The Table No.5 shows Male newborn who are very highly affected by Post neo natal mortality under the age group of 8-28 days are recorded very high at the blocks of Madurai East, Madurai West, Thiruparankundram, Chellampatti, Thirumangalam and T.Kallupatti which indicate positive "Z" score value is Madurai East (-0.08), Madurai West (-0.08), Thiruparankundram (-0.18), Chellampatti (-0.18), Thirumangalam (-0.18) and

T.Kallupatti (-0.08). The Highly registered cases are in the blocks of Kottampatti (-0.27), Alanganallur (-0.27), Kallikudi (-0.37), Usilampatti (-0.27). The low level of cases recorded among the blocks Melur (-0.47), Vadipatti (-0.47), and Sedapatti (-0.47) is shown in Fig No.6. The female infants are very highly registered among the blocks of Thiruparankundram (0.19) and Thirumangalam (0.04). The highly affected block is Alanganallur (-0.10). Moderately affected blocks in Madurai district are Melur (-0.26), Kottampatti (-0.26), Madurai East (-0.26), Madurai West (-0.26), Sedapatti (-0.26). The low level affected Female infant are among the blocks of Vadipatti (-0.41), Chellampatti (-0.41), Usilampatti (-0.41), T. Kallupatti (-0.41) and Kallikudi (-0.56).

Table 5: Infant Mortality Age Group 8-28 Days and 29-365 Days

S. No.	Name of the Block / Municipality	No. of Infant death ("Z" Score Value)			
		8- 28 days(M)	8- 28 days (F)	29- 365 days(M)	29- 365 days(F)
1	Madurai East	-0.08387	-0.26193	-0.1798	-0.32043
2	Madurai West	-0.08387	-0.26193	-0.33713	-0.07121
3	Alanganallur	-0.27958	-0.10914	-0.49446	-0.23735
4	Vadipatti	-0.47528	-0.41472	-0.1798	-0.4035
5	Kottampatti	-0.27958	-0.26193	-0.1798	-0.23735
6	Melur	-0.47528	-0.26193	-0.1798	-0.07121
7	Thiruparankundram	-0.18172	0.19645	-0.02248	0.01187
8	Kallikudi	-0.37743	-0.56751	-0.25847	-0.56965
9	T. Kallupatti	-0.08387	-0.41472	-0.49446	-0.32043
10	Thirumangalam	-0.18172	0.04365	-0.25847	-0.15428
11	Chellampatti	-0.18172	-0.41472	-0.49446	-0.48658
12	Usilampatti	-0.27958	-0.41472	-0.1798	-0.07121
13	Sedapatti	-0.47528	-0.26193	-0.1798	-0.48658
	Mean	5.857142857	3.714285714	7.285714286	6.857142857
	Std. Deviation	10.21956753	6.544857893	12.71237175	12.03748723

The age group between (29-365 days) Male and female infant mortality of the Madurai District, very highly affected cases male is registered in Thiruparankundram "Z" Score value is (-0.02), Highly affected blocks of Madurai district are Madurai East (-0.17), Kottampatti (-0.17), Melur (-0.17), Vadipatti (-0.17), Thirumangalam (-0.25), Kallikudi (-0.25), Usilampatti (-0.17) and Sedapatti (-0.17). The moderately recorded block is Madurai West (-0.33). The low level of cases recorded among the blocks of Alanganallur (-0.49), Chellampatti (-0.49) and T. Kallupatti (-0.49). The female infant mortality between the age group (29-365 days) of Madurai district. A very highly affected case is in the block

of Thiruparankundram "Z" Score value is (0.01). Highly affected blocks of Madurai District are Kottampatti (-0.23), Melur (-0.07), Madurai West (-0.07), Alanganallur (-0.23), Usilampatti (-0.07), Thirumangalam (-0.15). Moderately affected blocks are Madurai East (-0.32) and T. Kallupatti (-0.32). The low level of cases recorded among the blocks of Vadipatti (-0.40), Chellampatti (-0.48), Sedapatti (-0.48), and Kallikudi (-0.56). The occurrence and associated symptoms are more vulnerable among the children due to biological reasons and also due to the nutritional status of the children at the time illness occurrence (Eswari and Saravanabavan 2020) [4].
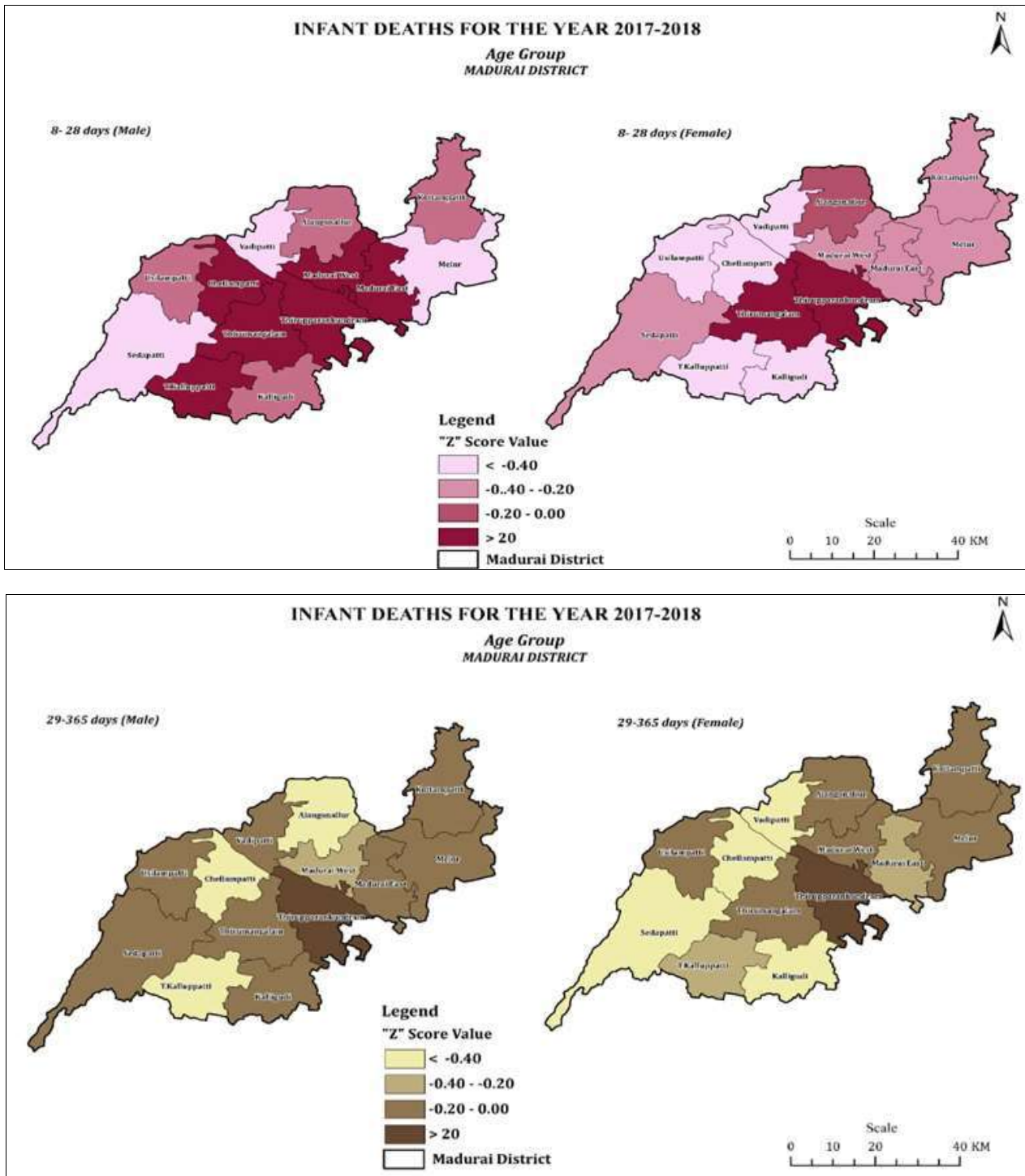

Fig 6: Infant Mortality Age Group 8-28 Days and 29-365 Days

Conclusion

This study concluded that infant neo natal and post neo natal male mortality rate is more compared with female mortality. GIS and Statistical techniques are used to analyze about the infant neo natal and post neo natal mortality rate. With the help of GIS software, it is very easy to map and locate the infant neo natal and post neo natal mortality rate affected regions. Findings of the study shows that the maximum affected are the male infants. This study lays a foundation for further investigation of the patterns and the risk factors of this infant mortality rate. Secondly, the results of this study demonstrate that GIS mapping techniques may be used as a tool to quickly display information and generate maps to highlight infant neo natal and post neo natal mortality affected regions for developing more effective control and prevention strategies. The maps could be used to suggest high risk areas where further investigation should be focused, to identify the high infant mortality rate and to implement possible control activities. Finally, the infant neo natal and post neo natal mortality data used in this study are quite comprehensive, covering the whole Madurai District for the year 2017-2018.

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