The Indian Geographical Journal
Volume 100 (1) June - 2025, pp 39-54
ISSN 0019-4824

MOTHER AND CHILD HEALTH CARE IN MADURAI DISTRICT: A STRUCTURAL EQUATION MODELLING APPROACH

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Abstract

Maternal and child health are vital components of a nation's overall well-being, especially in developing regions where healthcare access is limited. This study focuses on mother and child healthcare in Madurai District of Tamil Nadu state, where socio-economic pressures have led to challenges in maternal and child health, including concerning practice of female infanticide. Using a structured questionnaire survey, the data were collected from 650 mothers across 13 blocks of the district, with a random sample size of 50 mothers from each block, to evaluate the healthcare conditions and socio-economic factors affecting mothers and children. The variables encompassed socio-economic status, attitudes towards antenatal care, healthcare usage, childcare practices, health issues, and psychological well-being, were used for confirmatory factor analysis in SPSS. Structural Equation Modelling (SEM) and path analysis were attempted in AMOS software to explore relationships between these healthcare factors. Results reveal that infant mortality, and health challenges during pregnancy notably affect maternal and child healthcare in the district. The findings underscore improving healthcare accessibility and addressing socio-economic disparities to foster better health outcomes for mothers and children in Madurai District.

Keywords: Mother and child health, Health care utilisation, Infant mortality, SEM, Madurai district

1. Introduction

A healthy mother delivers a healthy baby, forming the foundation of a nation's future. Mothers and children are regarded as the most vulnerable members of society since they are more susceptible to health problems than other members of society.

Motherhood is the most significant role a woman can play in her life, yet it may also be life-threatening. (Baykemagn et al. 2024). During pregnancy, any woman can develop severe, life-threatening complications that require accessible and affordable medical care (Chaudhuri & Nath, 2019). Reproductive morbidities are the leading cause of women's ill health and death worldwide (Alicandro et al., 2023). It can be noted that younger women are at a higher risk of reproductive problems related to pregnancy, delivery, post-delivery, menstruation, menopause, and family planning than older women. Antenatal care, the care provided to pregnant women to ensure a safe pregnancy and the birth of a healthy baby, is crucial (Tripathy & Mishra, 2023).

In addition to public health factors, the study of location factors is essential for improving the quality of life for individuals and groups (Laatikainen et al., 2018; Saravanabavan et al., 2021, 2023). Spatial location has a significant influence on the risk of disease and various health effects (Balasubramani et al., 2024; Vinothini & Saravanabavan, 2023). There are many techniques involved in the location of health centres and their determinants of health variables. (Vinothini et al. 2024). In this context, the healthcare facilities in rural and urban areas of Madurai district are assessed in this study. The maternal mortality rate (MMR) and infant mortality rate (IMR) of the district was remained at 39.7 per one lakh live births and 9.5 per 1,000 live births, respectively, during 2023-24. The maternal mortality rate in the district is calculated during the period between when a woman conceives and 42 days after delivery, while infant mortality rate is calculated from day one of birth to till 365th day. The MMR and IMR of the district are below the state average. The state average of the same was recorded as 60 per one lakh live births and 13.7 per 1,000 live births (https://www.newindianexpress.com/states/tamilnadu/2024/Aug/22/infant-maternal-mortality-rates-below-state-average-in-madurai). The studies have also shown that integrated care models in rural Madurai significantly improved maternal and child health outcomes through coordinated care effects and community involvement (Saravanabavan et al., 2019). Antenatal care has a favourable impact on pregnancy since it allows for the early detection of risk factors and the early diagnosis of pregnancy difficulties such as premature delivery, as well as appropriate management (Silva et al., 2021). The use of health applications has also improved antenatal and postnatal care in both urban and rural settings of the district, although there are economic and educational disparities in healthcare access (Neethi Mohan et al., 2024). Although there is a system of healthcare in the district, many rural locations of the district are faced with unbearable socio-economic pressures, especially by the practice of female infanticide in certain specified communities. Parents are killing their female infant babies in the district by feeding them poison. An estimated 6,000 babies have been killed in the last decade alone (https://www.indiatoday.in/magazine/cover-story/story/19860615-women-of-kallar-community-in-tamil-nadu-kill-their-female-babies-by-feeding-them-poison-800940-1986-06-14).

Structural Equation Modelling (SEM), using Analysis of Moment Structure (AMOS) techniques, is widely applied to analyse healthcare datasets (Balaji et al., 2024; Saravanabavan et al., 2021a; Thakkar & Thakkar, 2020; Renugadevi& Vadivel, 2017). The

The purpose of SEM is to define a theoretical causal model consisting of a set of predicted covariances between variables and then test whether it is plausible when compared to the observed data (Cheung et al., 2024). In this regard, many research has attempted to study the spatial distribution of morbidity conditions and mortality of women during pregnancy. These models help to identify the risk factors of maternal morbidity and mortality. The present study focuses on examining the general health status of women, child health status, and socio-economic predictors of reproductive morbidities among mothers and children in Madurai District, South India. The research aims to identify key factors that influence maternal and child health outcomes in this district using hypothesis testing through path analysis with Structural Equation Modelling and provide insights into potential interventions to improve health and reduce disparities.

2. Methodology

2.1 Study area and Data sources

Madurai, the oldest historical city in Tamil Nadu, is centrally located in the southern part of Tamil Nadu with an area of 3,710 km² (Fig. 1). According to the 2023 Statistical Handbook, Madurai's population is approximately 3.6 million. The district's urban population accounts for 60.8%, with a population density of 819 persons per square kilometre. The recorded sex ratio stands at 990 females per 1,000 males, slightly lower than Tamil Nadu's state average of 996. The literacy rate in the district is 83.5%, surpassing the state average of 80.1% (Census, 2011). The district has made significant strides in healthcare, notably through the development of neonatal departments, which have helped reduce the Infant Mortality Rate. As of 2018, Madurai's IMR stood at 16.6 per 1,000 live births—0.6 points higher than the state average. However, the district's IMR was reduced to 9.5 per 1,000 live births in 2023-24. The district hosts numerous specialised private hospitals, nursing homes, and polyclinics. Socio-economic factors, particularly for patients visiting Primary Health Centres (PHCs), have a considerable impact on healthcare access and quality. There exists a strong correlation between income, education levels, and health outcomes, leading to significant disparities in healthcare utilisation. This study investigates the accessibility and quality of healthcare facilities in the context of the demographic and socio-economic conditions of PHC patients in Madurai District.

This study utilised both primary and secondary data sources. Primary data were collected via a structured questionnaire survey conducted in the 13 blocks of Madurai District. A uniform random sampling method was employed, selecting 50 mothers from each block, resulting in a total sample size of 650 respondents. The questionnaire captured details on socio-economic status, attitudes towards antenatal care providers, healthcare utilisation, childcare practices, health issues, and psychological conditions of mothers. Secondary data on reproductive health were gathered from the Statistical Cell at the District Health Office, Madurai.

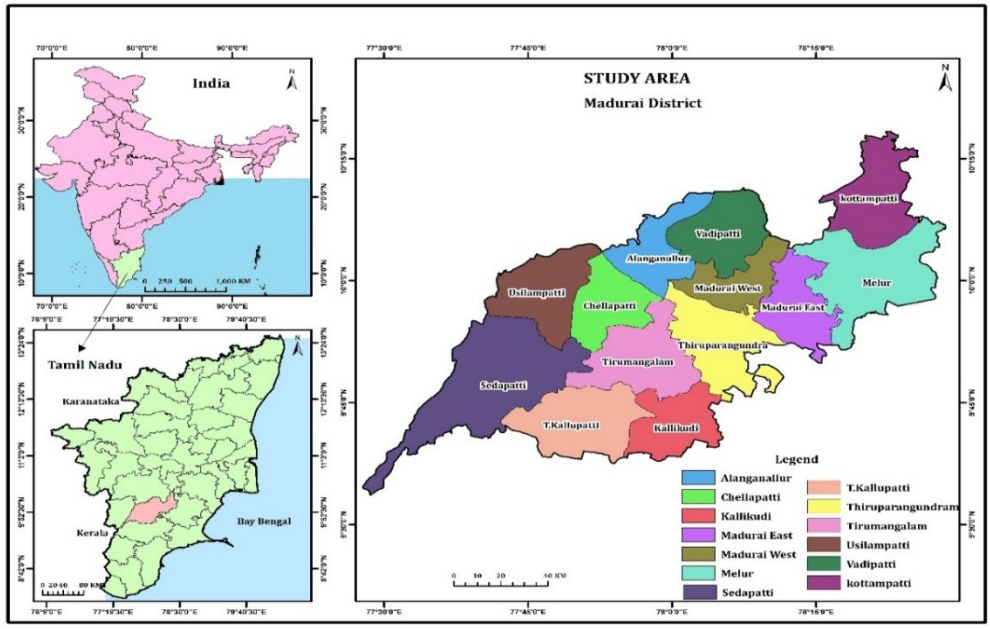

Fig. 1 Location of the study area.
Source: compiled by the authors

2.2 Tools and Techniques

Data were processed using SPSS for confirmatory factor analysis, while AMOS software facilitated factor analysis, discriminant validity tests, and path analysis through SEM. The bootstrap method was applied to examine indirect relationships. Mean factor scores were extracted and spatially represented using ArcGIS software to illustrate regional variations in healthcare determinants. Firstly, Exploratory Factor Analysis (EFA) was employed to identify latent factors contributing to the variation among observed variables. Subsequently, Confirmatory Factor Analysis (CFA) was conducted to validate the hypothesised factor structure, ensuring the data's fit to the proposed measurement model. Factor loadings of 0.6 or higher were set acceptable for dimensionality.

The analysis confirmed that the absolute fit indices were consistent with the sample data, indicating that the proposed path model achieved a satisfactory fit. Principal Component Analysis (PCA) identified nine components with eigenvalues exceeding 1.0. Path analysis, utilising simple and multiple regression models, was employed to assess causal relationships among the variables and identify mediation effects within the model. Pooled CFA ensured the reliability of items related to mother and child care in Madurai district. The results affirmed that the model's fit indices met recommended standards, enabling a comprehensive examination of the associations between various factors affecting mother-child healthcare in the study area.

3. Results and Discussion

3.1 Key dimensions of mother and child health Care

Factor analysis was employed to identify key dimensions of mother and child healthcare in Madurai District. Five principal factors were extracted, collectively explaining 70.20% of the total variance (Table 1). An eigenvalue threshold of 1.0 determined the number of extracted factors, and the block-wise distributions of factors scores are presented in Table 2.

Table 1: Rotated Component Matrices

Name of the Factor	Rotated Component Matrix					
		Component				
		1	2	3	4	5
Experience of Health Problems during the Pre-Natal Period	Experience any problems during the prenatal period	.88				
	Place of treatment for any problems during the prenatal period	.84				
	Treated for any problems during the prenatal period	.84				
	Reason for not visiting any gynaecologist	.70				
	Special care during menstruation	.68				
	Respiratory Disease Asthma	.61				
Health Problems during Pregnancy	Kidney Disease or Urinary Tract Infections		.88			
	Hepatitis liver disease Jaundice		.85			
	Tuberculosis		.84			
	Abnormal Pap smear		.77			
	Feel comfortable with the Sexual and reproductive health services in your area.		-.73			
Child Care	Duration of breastfeeding for your children			.86		
	Weight of the baby during delivery			.85		

	Any abnormalities during birth			.81		
	Type of labour and if complications			.81		
Infant Death	Number of Infant Deaths				.77	
	Educating pregnant women about their health conditions				.67	
	Satisfaction with your health				-.67	
Healthcare Utilization	Receive prenatal care during pregnancy					.90
	Medical check-ups during pregnancy					.88
Eigen Values		**3.80**	**3.58**	**2.95**	**1.87**	**1.82**
Percentage of Variance		**19.03**	**17.91**	**14.75**	**9.36**	**9.11**
Cumulative Percentage		**19.03**	**36.95**	**51.72**	**61.09**	**70.20**
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalisation. Rotation converged in 6 iterations.						

Table 2: Distribution of Factor Scores of the Structural Equation Model

Sl.No.	Name of the Block	F1	F2	F3	F4	F5
1	Kottampatti	0.37	0.12	0.01	0.083	0.07
2	Melur	-0.39	0.12	0.11	0.327	-0.69
3	Madurai East	-0.66	-0.15	-0.06	0.103	-0.50
4	Thiruparankundram	-0.48	-0.46	0.11	0.092	-0.21
5	Madurai West	0.68	0.17	-0.08	-0.507	0.60
6	Alanganallur	0.47	0.19	-0.10	-0.098	0.73
7	Vadipatti	0.37	0.12	0.01	0.083	0.07
8	Chellampatti	-0.39	0.12	0.11	0.327	-0.69
9	Thirumangalam	-0.66	-0.15	-0.06	0.103	-0.50
10	Kallikudi	-0.48	-0.46	0.11	0.092	-0.21
11	T. Kallupatti	0.68	0.17	-0.08	-0.507	0.60
12	Sedapatti	0.47	0.19	-0.10	-0.098	0.73
13	Usilampatti	0.37	0.12	0.01	0.083	0.07

Factor-I represents the experience of health problems during the prenatal period. Prenatal healthcare is essential for ensuring maternal and child health, as well as safe deliveries. This dimension emerged as the most significant, accounting for 19.03% of the total variance with an eigenvalue of 3.80 (Table 3). Six variables loaded positively on this factor, such as experiencing issues during pregnancy (0.88), treatment during the prenatal period (0.84), and absence of gynaecological consultations (0.70). These results indicate prevalent prenatal health challenges among women in the study area. Spatially, positive factor scores indicating satisfactory prenatal healthcare experiences were observed in T. Kallupatti (0.37), Madurai West (0.68), Sedapatti (0.47), Usilampatti (0.37), Vadipatti (0.37), Alanganallur (0.47), and Kottampatti (0.37). Conversely, negative scores in Chellampatti, Kallikudi, Thiruparankundram, Melur, Thirumangalam, and Madurai East suggest dissatisfaction with prenatal healthcare (Fig. 2).

Table 3: Factor I - Experience of Health Problems during the Pre-Natal Period

Variable Name	Factor Loading	Communalities
Experienced any problems during the prenatal period	0.88	0.83
Experienced any problems at the place of treatment during the prenatal period	0.84	0.77
Treated for any problems during the prenatal period	0.84	0.77
Not visiting a gynaecologist for treatment	0.70	0.59
Take any special care during menstruation	0.68	0.60
Experienced any respiratory disease/Asthma	0.61	0.53
Eigenvalue: 3.80	**Total Variance: 19.03**	

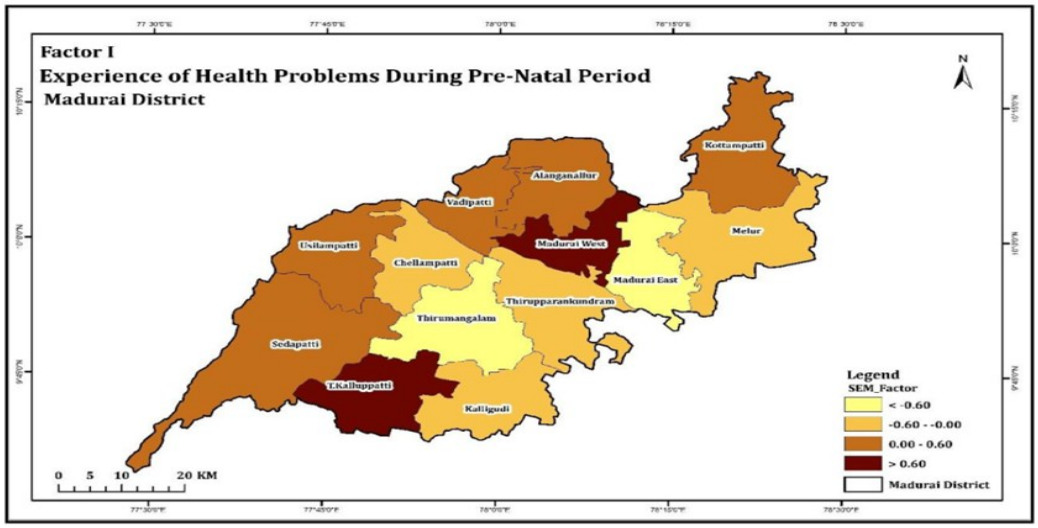

Fig. 2 Factor Score of Health problems during the pre-Natal Period in Madurai district

Factor-II is related to health problems during pregnancy. This dimension accounted for 17.91% of the variance with an eigenvalue of 3.58 (Table 4). Positively loaded variables include kidney diseases or urinary tract infections (0.88), hepatitis or jaundice (0.85), tuberculosis (0.84), and abnormal Pap smear results (0.77). A negative loading was observed for comfort with local sexual and reproductive health services (-0.73), highlighting service dissatisfaction. High positive factor scores were noted in Sedapatti, T. Kallupatti, Alanganallur, Madurai West, Usilampatti, and others, whereas Thirumangalam, Madurai East, Thiruparankundram, and Kallikudi showed lower scores (Fig. 3).

Table 4: Factor II - Health Problem during Pregnancy

Variable Name	Factor Loading	Communalities
Any kidney disease or urinary tract infections	0.88	0.77
Hepatitis liver disease /Jaundice	0.85	0.73
Tuberculosis	0.84	0.71
Abnormal Pap smear	0.77	0.62
Comfortable with sexual and reproductive health services	-0.73	0.55
Eigenvalue: 3.584	**Total Variance: 17.918**	

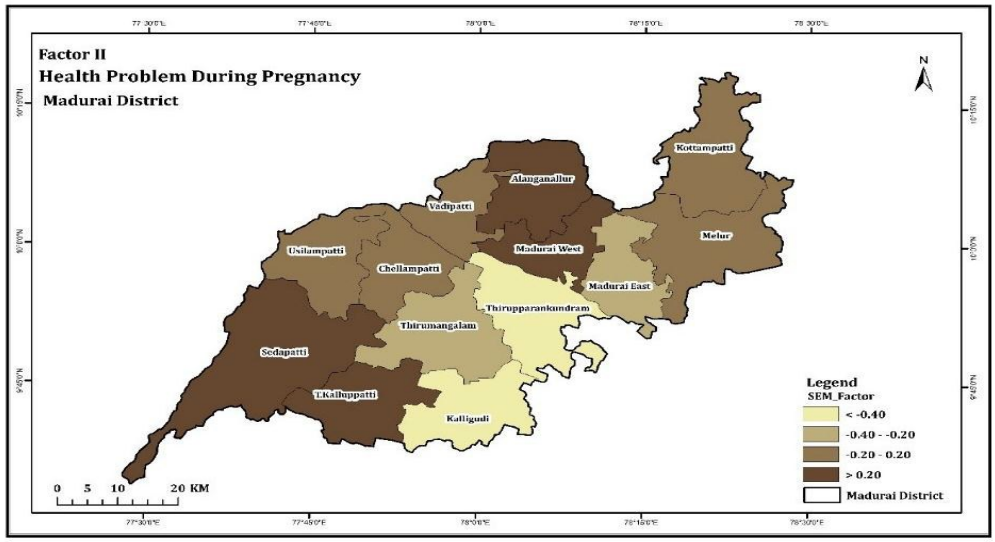

Fig. 3 Factor Score of Health problems during the Pregnancy Period in Madurai district

Childcare, vital for a nation's future, emerged as **Factor III**, with 14.75% variance and an eigenvalue of 2.95 (Table 5). Key variables included breastfeeding duration (0.86), baby weight at birth (0.85), birth abnormalities (0.81), and labour complications (0.81). High scores were concentrated in Chellampatti, Kallikudi, Thiruparankundram, Melur, and others, while low scores appeared in Thirumangalam, Madurai East, Sedapatti, T. Kallupatti, Alanganallur, and Madurai West (Fig. 4).

Table 5 Factor III: Child Care

Variable Name	Factor Loading	Communalitis
Time duration of breastfeeding your children	0.86	0.75
Weight of the baby during delivery	0.85	0.74
Abnormalities during birth	0.81	0.71
Types of labour and its complications	0.81	0.69
Eigenvalue: 2.95	**Total Variance: 14.75**	

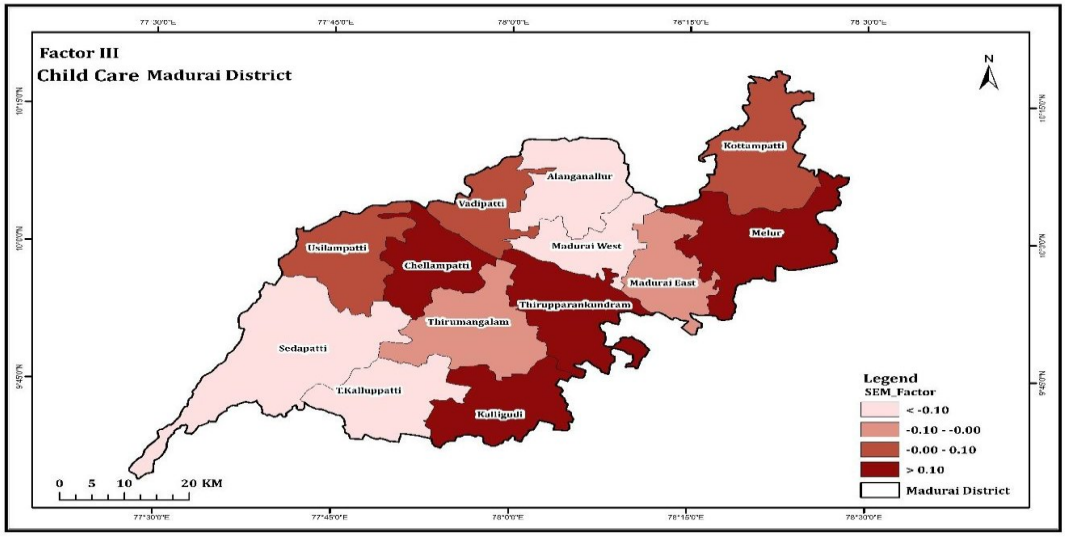

Fig. 4 Factor Score of Child Care in Madurai district

With 9.36% of the variance and an eigenvalue of 1.87 (Table 6), Infant Death ~~is~~ emerged as **Factor IV** includes positive loadings on the number of infant deaths (0.77) and health conditions of educated pregnant women (0.67), alongside a negative loading on satisfaction with personal health (-0.67). High infant death rates were found in Chellampatti, Melur, Usilampatti, and others, whereas Sedapatti, Alanganallur, T. Kallupatti, and Madurai West showed lower rates (Fig. 5).

Table 6: Factor IV - Infant Death

Variable Name	Factor Loading	Communalities
Number of infant deaths	0.77	0.73
Health condition of educated pregnant women	0.67	0.52
Satisfied with health condition	-0.67	0.63
Eigenvalue: 1.87	**Total Variance: 9.36**	

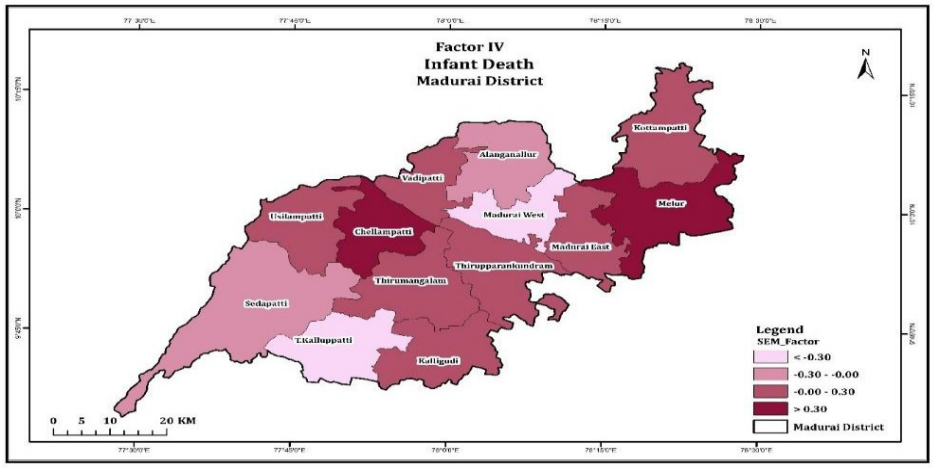

Fig. 5 Factor Score of Infant Death in Madurai District

Factor-V denotes utilisation of health care systems in the district. This last factor represents 9.11% of the variance with an eigenvalue of 1.82 (Table 7), with variables like prenatal care (0.90) and medical check-ups (0.88). High utilisation of health care is noted in Sedapatti, T. Kallupatti, Alanganallur, Madurai West, and others, while Thirumangalam, Kallikudi, Madurai East, Chellampatti, and Melur scored with lower utilization (Fig. 6).

Table 7 Factor V: Utilisation of Health Care

Variable Name	Factor Loading	Communalities
Prenatal care during pregnancy	0.90	0.84
Medical check-ups during pregnancy	0.88	0.87
Eigenvalue: 1.82	**Total Variance: 9.11**	

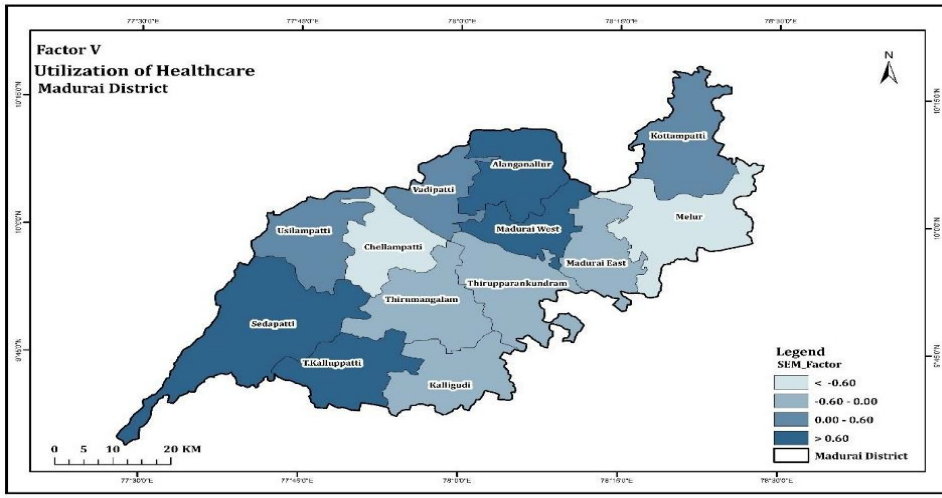

Fig. 6: Factor Score of Utilisation of Health care in Madurai district

3.2 Path Analysis with SEM

Structural Equation Modelling (SEM) using AMOS was used to evaluate the model's fit and confirming discriminant validity (Ahmad et al., 2016). This ensured that exogenous constructs were appropriately distinct. The fitness indexes are presented in Table 8. These metrics are used to determine how effectively the proposed model captures the covariance between all of the model's elements.

Table 8 Fitness Indexes

Name of the Category	Name of Index	Acceptance Level	Obtained Result	Literature
Factor Loading	Standardized Regression Weight	Weight ≥0.6	≥0.6	Hair et al (2020)
Absolute Fit	Chi-Square	P>0.05	0.095	
	Root Mean Square Error of approximation (RMSEA)	<0.08	0.043	Browne and Cudeck, (1992)
	Goodness of Fit Index (GFI)	>0.9	0.996	
Incremental Fit	Adjusted Goodness of Fit Index (AGFI)	>0.9	0.979	
	Comparative Fit Index (CFI)	>0.9	0.956	Bollen (1989)
	Tucker Lewis Index (TLI)	>0.9	0.854	
	Normated Fit Index (NFI)	>0.9	0.927	
Parsimonious Fit	Chi-Square/Degree of Freedom	<5.0	2.119	

3.3 Testing of Hypotheses

The study tested both direct and indirect relationships between the factors. The direct relationships are assessed with the hypotheses of:

H1: Infant death does not significantly impact childcare (p>0.05),

H2: Childcare significantly affects health problems during pregnancy (p=0.008).

H3: Infant death significantly impacts health problems during pregnancy (p=0.001).

H4: Health problems during pregnancy significantly influence prenatal health experiences.

In indirect relationships, the hypotheses are:

H5: Infant death indirectly affects health problems during pregnancy through childcare, but the effect is not significant (p=0.244).

H6: Infant death has a significant indirect effect on prenatal health problems via childcare (p=0.005).

H7: Infant death significantly influences healthcare utilisation indirectly through childcare (p=0.001).

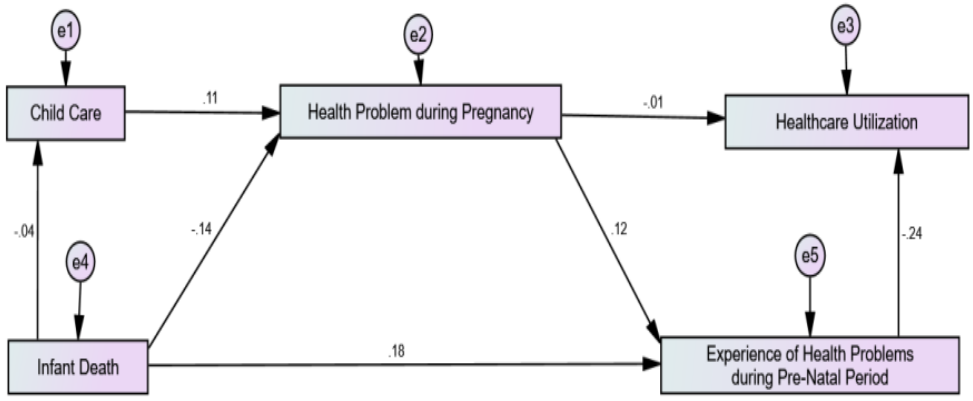

Fig 7: Unstandardised Model of Mediator Construct

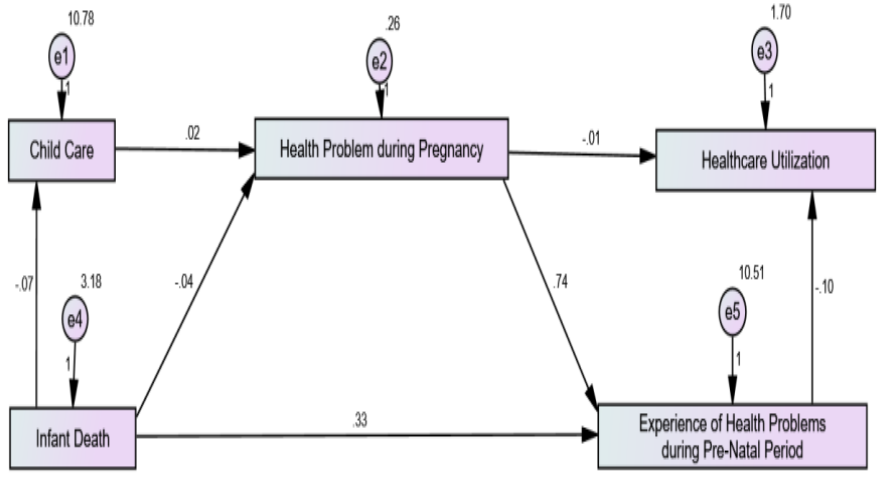

Fig. 8 Standardised Model of Mediator Construct

According to these assumptions, the outcomes such as regression weights, unstandardized and standardized factor model structures for every path, and its significance were extracted. Figs. 7 and 8 depict the SEM pathways, and Table 9 details the effects and confidence intervals.

Table 9: Infant Death and Health Problems during Pregnancy

Relationship			Standardised Indirect Effect			
			Estimates	95% Confidence Interval		Two Tailed Significance (BC)
				Lower Bound	Upper Bound	
Infant Death	Child Care	Health Problems during Pregnancy	0.005	-0.020	0.003	0.244
Infant Death	Child Care	Experience of Health Problems during the Pre-Natal Period	0.010	-0.041	-0.003	0.005**
Infant Death	Child Care	Utilisation of Healthcare	0.012	-0.062	-0.015	0.001**
Child Care	Health Problems during Pregnancy	Experience of Health Problems during the Pre-Natal Period	0.009	0.001	0.035	0.050*
Child Care	Health Problems during Pregnancy	Utilisation of Healthcare	0.005	-0.018	0.002	0.241
Health Problems during Pregnancy	Experience of Health Problems during the Pre-Natal Period	Utilisation of Healthcare	0.010	-0.050	-0.010	0.003**

*** Denotes significant at 1% level* Denotes significant at 5% level*

Direct Relationship of Mother and Child Healthcare: The results indicate that infant death goes up by 1 unit and child care goes down by 0.070 units. The regression weight for infant death in the prediction of child care is not significant, because the p-value is greater than 0.05. Therefore, the assumption (H_1) infant death was not having a significant impact on child care in this study area. However, child care has significant effect on health problems during pregnancy. The child care increase by 1 unit and health problem during pregnancy increases by 0.017 units, with p=0.008 at the 0.001 level (two-tailed). Also, infant death has significant effect on health problems during pregnancy. The infant death variable rises by one unit, but the health problem during pregnancy falls by 0.042. The regression weight for infant death is significant (p=0.001) at the 0.001 level (two-tailed). The health problems during pregnancy have significant effect on experience of health problems during pre-natal period. The variable of health problem during pregnancy ascends by 1 unit and the experience of health problems during the pre-natal period rises by 0.738 units, with the significance at 0.001 level (two-tailed).

Indirect Relationship of Mother and Child Variables: Initially, the experience of health problems during the prenatal period, health problems during pregnancy, child care, infant death, and utilization of healthcare constructs of six (6), five (5), four (4), three (3), and two (2) items respectively. The other items were dropped from the model for having factor loadings of lower than 0.6. The low reliability of the items may cause deviation to the model fit indexes measurement, hence were dropped from the model. Fig 7 and 8 illustrate the unstandardized and standardized estimates of direct and indirect effects of the exogenous construct towards the endogenous construct in the existence of the mediator construct. The six indirect effects are identified through one mediator (Table 9).

Infant death and health problems during pregnancy have significant indirect effects through child care. Table 9 shows how infant death's indirectly effects health problems during pregnancy. As a result, infant death increases by 0.005 for every one-unit increase in health problems during pregnancy in the study area. The construct of infant death has an indirect effect on the experience of health problems during the prenatal period through the mediator child care and its impact is 0.010. As a result, infant death increases by 0.010 for every one unit increase in experience of health problems during the prenatal period. The indirect effect of child care is having significant partial mediation at a 1.0 percent level between the construct of infant death and experience of health problems during the prenatal period(p=0.005). The exogenous path construct infant death has an indirect effect on the utilization of healthcare through the mediator child care and its impact is 0.012. As a result, infant death increases by 0.012 for every one unit increase in utilization of healthcare. The indirect effect of child care is having significant partial mediation at a 1.0 percent level between the construct of infant death and utilization of healthcare (p=0.001).

This present study has proven that the factors specifically experience of health problems during the prenatal period, health problems during pregnancy, child care, infant death and utilization of healthcare influence the mother and childcare in Madurai district. The results revealed that the socio-economic status significantly impacts access to nutrition, healthcare, and the overall utilisation of reproductive health services in the district. The likelihood and statistical association of essential elements estimate the goodness of fit of the structural model and represent an adequate description of mother and child healthcare indicators.

4. Conclusion

SEM and path analysis revealed significant direct and indirect relationships between mother and child health variables in Madurai district. Notably, prenatal care, regular medical check-ups, and effective healthcare utilisation are pivotal in enhancing child care and maternal health outcomes in the district. The findings underscore that both direct and indirect pathways, particularly childcare and infant mortality, play crucial roles in influencing maternal health problems during pregnancy and healthcare utilisation in the district. Policymakers should focus on improving healthcare accessibility and addressing socio-economic disparities to foster better health outcomes for mothers and children in Madurai District.

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