

Original Article

DETERMINANTS OF HEALTHCARE ACCESS AND PATIENT SATISFACTION IN RURAL AND SEMI-URBAN MADURAI DISTRICT, INDIA: A GEO-MEDICAL ANALYSIS USING STRUCTURAL EQUATION MODELING

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Key Messages

1. Healthcare access strongly influences perceived healthcare infrastructure.
2. Health awareness improves healthcare utilization and patient satisfaction.
3. Structural equation modeling identifies key determinants for equitable primary healthcare planning.

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Abstract

Background: Equitable access to quality healthcare remains a major public health challenge in rural and semi-urban India. Healthcare utilization and patient satisfaction are influenced by socio-economic, demographic, infrastructural, and behavioral factors.

Objective: This study examined the determinants of healthcare access and patient satisfaction in rural and semi-urban areas of Madurai District, Tamil Nadu, using Structural Equation Modeling (SEM).

Methods: A community-based cross-sectional survey was conducted among 300 respondents during 2023–2024 using a structured questionnaire. Exploratory Factor Analysis (EFA) identified latent dimensions influencing healthcare access and patient satisfaction, while Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM) were used to evaluate the relationships among these constructs. Data suitability was assessed using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett’s Test of Sphericity.

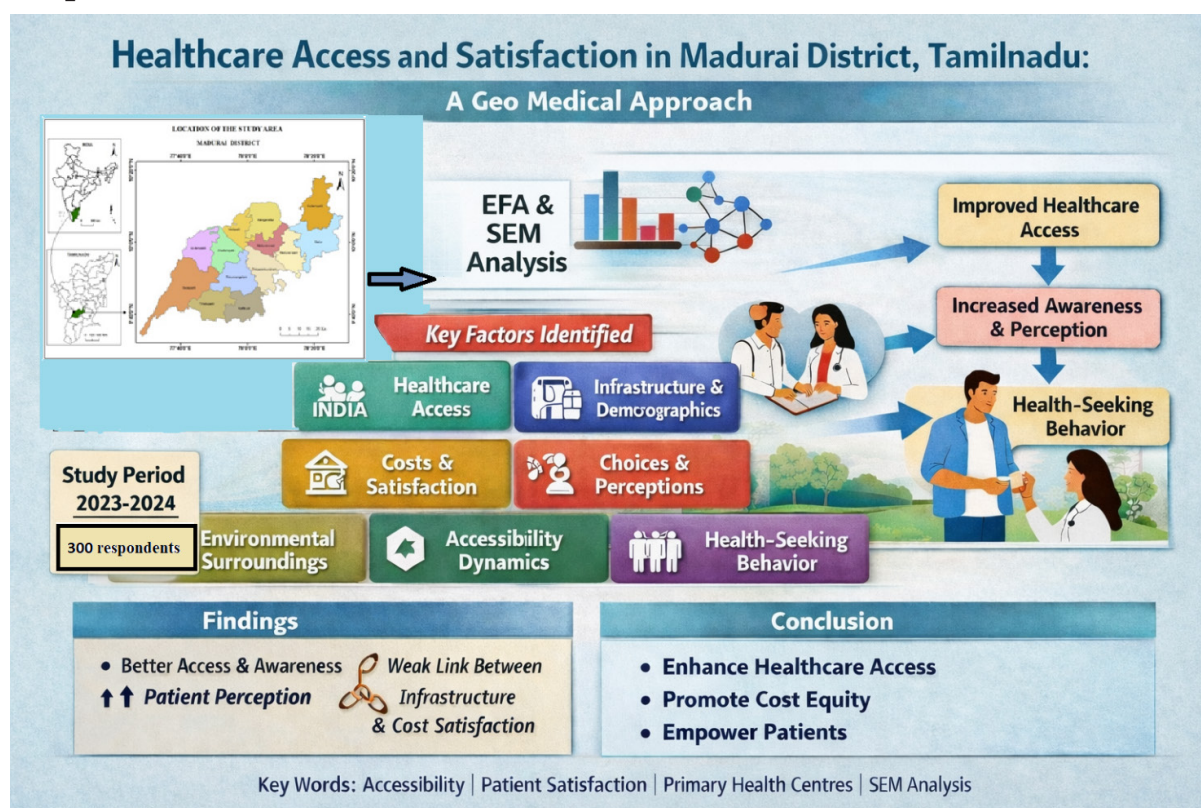
Results: Seven latent factors explained 71.28% of the total variance. The KMO value (0.720) and Bartlett's Test of Sphericity ($\chi^2 = 1629.172$, $df = 120$, $p < 0.001$) confirmed the suitability of the data for factor analysis. The SEM demonstrated an excellent model fit ($\chi^2/df = 0.436$, GFI = 0.998, CFI = 1.000, RMSEA = 0.001). Healthcare Access and Preferences ($\beta = 0.365$, $p < 0.001$) and Healthcare Behaviour and Awareness ($\beta = 0.173$, $p = 0.001$) significantly influenced Healthcare Infrastructure and Demographics, whereas the other latent constructs showed no significant effects.

Conclusion: Healthcare accessibility and community awareness are the principal determinants of perceived healthcare infrastructure and patient satisfaction. Strengthening healthcare accessibility, improving health literacy, and enhancing healthcare infrastructure through evidence-based policies may promote more equitable and patient-centered primary healthcare services in rural and semi-urban communities.

Keywords: Healthcare delivery; healthcare infrastructure, patients, satisfactio, health literacy

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Graphical Abstract:



1. Introduction

Access to quality healthcare is a fundamental component of universal health coverage and a key determinant of population health and well-being. Despite substantial progress in India's healthcare system through national initiatives such as Ayushman Bharat and the expansion of Primary Health Centres (PHCs), considerable disparities in healthcare accessibility and patient satisfaction persist, particularly in rural and semi-urban regions. These disparities arise from a complex interplay of geographical, socio-economic, infrastructural, environmental, and behavioural factors that influence healthcare utilization and health outcomes^{1,2,3}.

Healthcare accessibility extends beyond the physical availability of health facilities and encompasses affordability, acceptability, accommodation, and the quality of healthcare services. Patient satisfaction has become an important indicator of healthcare quality because it reflects patients' experiences with service delivery, healthcare infrastructure, interactions with healthcare providers, waiting times, treatment costs, and the overall quality of care. Previous studies have demonstrated that socio-economic status, educational attainment, travel distance, transportation availability, healthcare infrastructure, and community awareness significantly influence healthcare utilization and patient satisfaction in developing countries^{4,5,6}.

Tamil Nadu has one of the most extensive public healthcare systems in India; however, inequalities in healthcare accessibility continue to exist across urban, rural, and semi-urban communities. Although urban populations generally benefit from better-equipped healthcare facilities and specialized medical services, many rural and semi-urban areas continue to experience shortages of healthcare personnel, inadequate infrastructure, poor transportation networks, and an unequal distribution of healthcare resources. These challenges often delay treatment, reduce healthcare utilization, and adversely affect patient satisfaction^{7,8,9}.

Madurai District represents a geographically and socio-economically diverse region where rapid urban expansion coexists with large rural populations. Considerable variation exists in healthcare infrastructure, transportation accessibility, environmental conditions, and socio-economic development across the district. Previous studies conducted in Madurai have primarily examined the spatial distribution of Primary Health Centres, healthcare accessibility, travel behaviour, and disease distribution using Geographic Information Systems (GIS) and spatial analytical techniques^{10,11,12,13}. Although these studies have provided valuable insights into the geographical dimensions of healthcare accessibility, they have not comprehensively examined the complex causal relationships among healthcare access, patient behaviour, healthcare infrastructure, affordability, and patient satisfaction.

Structural Equation Modeling (SEM) has emerged as a powerful analytical technique for investigating multidimensional relationships among observed and latent variables. Unlike conventional regression methods, SEM enables the simultaneous examination of direct and indirect relationships while accounting for measurement error, thereby providing a more comprehensive understanding of the determinants influencing healthcare accessibility and patient satisfaction^{14,15}. Recent healthcare research has increasingly integrated SEM with geospatial approaches to examine healthcare inequalities, accessibility patterns, and service utilization across diverse populations^{16,17,18}.

Materials and Methods

Study Area

The study was conducted in Madurai District, located in the southern part of Tamil Nadu, India, between 9°30' and 10°50' N latitude and 77°00' and 78°30' E longitude (Figures 1 and 2). The district covers an area of approximately 3,741.73 km² and had a population of 3,038,252 according to the 2011 Census of India. Madurai comprises urban, semi-urban, and rural settlements, with considerable variation in socio-economic

and community health facilities. The district's geographical diversity and unequal distribution of healthcare resources make it an appropriate setting for investigating the determinants of healthcare accessibility and patient satisfaction.

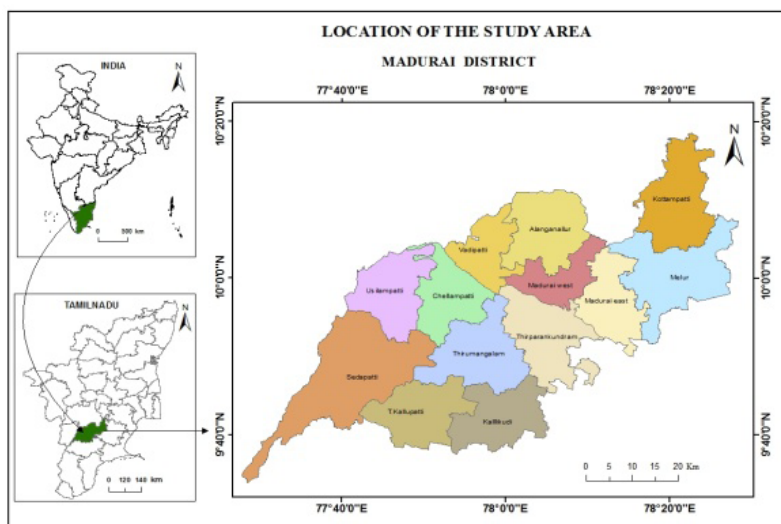


Figure 1. Location of the study area

A community-based cross-sectional study was conducted between January 2023 and December 2024 to investigate the determinants of health-care access and patient satisfaction among residents of rural and semi-urban areas of Madurai

District. The study employed a quantitative research design using a structured questionnaire to collect data on socio-demographic characteristics, healthcare accessibility, healthcare infrastructure, healthcare utilization, patient behaviour, treatment expenditure, environmental conditions, and satisfaction with healthcare services.

The minimum sample size was estimated using the standard formula for prevalence studies:

$$n = \frac{Z^2 \times p \times (1 - p)}{d^2}$$

n = Required sample size
 Z = Z value (standard normal deviate) at desired confidence level
 p = Expected prevalence or proportion (in decimal)
 d = Margin of error (precision) (in decimal)

where $Z = 1.96$ for a 95% confidence level, $p = 0.50$ (maximum variability), and $d = 0.05$ (5% margin of error). The calculated sample size was 384 participants. To compensate for potential

non-response, the target sample was increased by approximately 15%, resulting in an intended sample size of about 420 participants.

Due to field constraints and incomplete questionnaires, 300 completed responses were included in the final analysis. This sample size satisfies the recommended requirements for both Exploratory Factor Analysis (EFA) and SEM, as a minimum sample of 200–300 observations is generally considered adequate for reliable parameter estimation. A multistage sampling technique was employed. Initially, rural and semi-urban administrative units within Madurai District were identified. Subsequently, respondents were selected using simple random sampling to ensure representation across different socio-economic backgrounds, occupations, age groups, and genders.

Data Collection

Primary data were collected through face-to-face interviews using a pre-tested structured questionnaire. The questionnaire consisted of items covering:

- Socio-demographic characteristics
- Healthcare accessibility
- Availability of healthcare services
- Healthcare infrastructure
- Treatment expenditure
- Patient satisfaction
- Healthcare-seeking behaviour

Environmental and accessibility characteristics

The questionnaire was developed based on an extensive review of the published literature and validated healthcare accessibility frameworks. Prior to the main survey, it was pilot-tested to ensure clarity, consistency, and suitability for the study population.

Variables Included in the Analysis

The study evaluated multiple observed variables representing different dimensions of healthcare accessibility and patient satisfaction. These

variables included the availability of emergency healthcare, access to doctors, reasons for choosing healthcare facilities, treatment expenditure, patient satisfaction, travel time, proximity to health centres, environmental conditions, drinking water sources, and healthcare-seeking behaviour. Subsequently, these observed variables were grouped into latent constructs using Exploratory Factor Analysis (EFA).

Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics Version 26.0 and IBM SPSS AMOS Version 20.0.

Preliminary Analysis

Descriptive statistics were calculated to summarise respondents' characteristics and healthcare-related variables. Prior to factor analysis, the suitability of the dataset was evaluated using the Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity.

A KMO value greater than 0.60 and a statistically significant Bartlett's test ($p < 0.05$) were considered indicative of adequate intercorrelations among variables for factor analysis.

Exploratory Factor Analysis (EFA)

EFA was performed using Principal Component Analysis (PCA) with Varimax orthogonal rotation to identify the latent dimensions influencing healthcare accessibility and patient satisfaction. Factors with eigenvalues greater than 1.0 were retained according to the Kaiser criterion. Factor loadings greater than 0.50 were considered statistically significant. The cumulative percentage of explained variance was used to assess the adequacy of the extracted factor structure.

Confirmatory Factor Analysis (CFA)

CFA was subsequently conducted to validate the measurement model identified through EFA. Model adequacy was assessed using multiple goodness-of-fit indices, including:

Chi-square (χ^2)

Chi-square/degrees of freedom ratio (χ^2/df)

Goodness-of-Fit Index (GFI)

Adjusted Goodness-of-Fit Index (AGFI)

Normed Fit Index (NFI)

Relative Fit Index (RFI)

Comparative Fit Index (CFI)

Tucker–Lewis Index (TLI)

Incremental Fit Index (IFI)

Root Mean Square Error of Approximation (RMSEA)

Root Mean Square Residual (RMR)

The recommended threshold values reported in the literature were used to evaluate model fitness.

Structural Equation Modeling (SEM)

SEM was employed to examine the causal relationships among the latent constructs extracted through factor analysis. Both standardized and unstandardized regression coefficients were estimated.

The statistical significance of each hypothesized path was evaluated using:

Standardized regression coefficients (β)

Critical Ratio (C.R.)

Standard Error (S.E.)

p-values

Relationships with $p < 0.05$ were considered statistically significant.

Ethical Considerations

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki (2013) and the Indian Council of Medical Research (ICMR) National Ethical Guidelines (2017).

Participation in the study was entirely voluntary. Prior to data collection, the purpose of the study was explained to all participants, and verbal informed consent was obtained from each respondent. Participants were assured that their responses would remain confidential and anonymous

and would be used exclusively for research purposes.

As the study involved a non-interventional, community-based questionnaire survey without any clinical intervention, biological sample collection, or identifiable personal information, formal Institutional Ethics Committee approval was not required under the institutional policy in effect at the time of the study.

Data Availability

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

Results

Socio-Environmental Conditions and Patient Satisfaction

The socio-environmental assessment revealed considerable differences in healthcare accessibility and patient satisfaction between rural and semi-urban areas of Madurai District. Semi-urban areas demonstrated relatively better healthcare infrastructure, higher literacy levels, improved sanitation facilities, and greater accessibility to healthcare services compared with rural areas. In contrast, rural communities experienced longer travel distances to health facilities, inadequate transportation, limited availability of healthcare professionals, and lower household income levels, all of which adversely affected healthcare utilization and patient satisfaction.

Environmental conditions also influenced healthcare experiences. Poor sanitation, inadequate drinking water supply, and environmental pollution in certain localities contributed to negative perceptions of healthcare quality and delayed health-seeking behaviour. These findings suggest that both socio-economic and environmental factors play important roles in determining healthcare accessibility and patient satisfaction within the study area.

Exploratory Factor Analysis

Suitability of Data for Factor Analysis

Prior to factor extraction, the suitability of the dataset was evaluated using the Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity (Table 1). The KMO value of 0.720 indicated satisfactory sampling adequacy for factor analysis. Bartlett's Test of Sphericity was statistically significant ($\chi^2 = 1629.172$, $df = 120$, $p < 0.001$), confirming sufficient intercorrelations among the variables. These results demonstrate that the dataset was appropriate for Exploratory Factor Analysis.

Total Variance Explained

Principal Component Analysis with Varimax rotation extracted seven latent factors with eigenvalues greater than one. Collectively, these seven components explained 71.28% of the total variance, indicating that the extracted factor

structure adequately represented the underlying dimensions influencing healthcare accessibility and patient satisfaction (Table 1). The first factor, Healthcare Access and Preferences, accounted for 22.78% of the total variance and represented the largest contribution. The second factor, Healthcare Infrastructure and Demographics, explained 12.44% of the variance, followed by Healthcare Costs and Satisfaction (8.18%), Healthcare Choices and Satisfaction (8.10%), Healthcare Accessibility and Surroundings (7.06%), Healthcare Accessibility Dynamics (6.41%), and Healthcare Behaviour and Awareness (6.30%).

Table 1: Total variance explained by factor analysis

Component	Initial Eigen values		
	Total	% of Variance	Cumulative %
Healthcare Access and Preferences	3.645	22.783	22.783
Healthcare Infrastructure and Demographics	1.990	12.438	35.221
Healthcare Costs and Satisfaction	1.309	8.179	43.400
Healthcare Choices and Satisfaction	1.297	8.103	51.504
Accessibility and Surroundings	1.130	7.063	58.567
Healthcare Accessibility Dynamics	1.025	6.405	64.972
Healthcare Behaviour and Awareness	1.009	6.303	71.275

Source: Compiled by Authors

Factor I: Healthcare Access and Preferences

Healthcare Access and Preferences emerged as the dominant latent construct, accounting for 22.78% of the total variance (Table 2). Emergency healthcare facilities (loading = 0.951) and availability of doctors during night hours (loading = 0.937) exhibited the strongest factor

loadings, indicating that immediate access to emergency care and continuous medical services are critical determinants of healthcare accessibility. Preferences for private hospitals (loading = 0.782) and Primary Health Centres (loading = 0.735) also contributed substantially to this factor, suggesting that patients' healthcare choices are influenced by perceptions of service quality, accessibility, and availability.

Table 2. Healthcare access and preferences

Variable No.	Variable Name	Factor Loading	Communalities
Ha4	Emergency health facility	0.951	0.918
Ha8	Doctors' access at night	0.937	0.888
Ha13	Reasons for preferring Private hospitals	0.782	0.702
Ha11	Reasons for preferring the PHC service	0.735	0.569
Eigen value:3.356		Total Variance:20.972	

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalisation. Rotation converged in 7 iterations.

*Ha- Health access, Health availability.

Factor II: Healthcare Infrastructure and Demographics

The second factor explained 12.44% of the total variance and comprised gender (loading = 0.824), operational hours of healthcare centres (loading = 0.747), and healthcare facility avail-

ability (loading = -0.623) (Table 3). The findings indicate that demographic characteristics and operational efficiency influence perceptions of healthcare infrastructure. The negative loading for healthcare facilities suggests that deficiencies in available infrastructure negatively affect patients' perceptions of healthcare quality.

Table 3. Factor II: Healthcare infrastructure and demographics

Variable No.	Variable Name	Factor Loading	Communalities
Se4	Gender	0.824	0.724
Hi7	State the time of the Health Centre	0.747	0.631
Hi8	Facility in the Health Centre	-0.623	0.714
Eigen value:2.022		Total Variance:12.638	

*Se-Socio economic, Hi-Health index/Indicator.

Factor III: Healthcare Costs and Satisfaction

Healthcare Costs and Satisfaction accounted for 8.18% of the total variance (Table 4). Patients' perceptions of healthcare services (loading =

0.831) and treatment expenditure (loading = 0.710) were the principal contributors to this factor. The findings demonstrate that financial affordability and perceived service quality substantially influence overall patient satisfaction.

Table 4. Healthcare costs and satisfaction

Variable No.	Variable Name	Factor Loading	Communalities
Psy4	Opinion about the health services	0.831	0.753
Ex4	Money spent on treatment	0.710	0.702
Eigen value:1.269		Total Variance:7.934	

*Psy-Patients perception, Ex- Exposure/Experience

Factor IV: Healthcare Choices and Satisfaction

This factor explained 8.10% of the total variance (Table 5). Treatment satisfaction exhibited a strong negative loading (-0.822), whereas preference for healthcare facilities showed a positive

loading (0.640). These findings suggest that dissatisfaction with treatment negatively influences overall healthcare perception, whereas greater autonomy in selecting healthcare providers enhances patient satisfaction.

Table 5. Factor IV: Healthcare choices and satisfaction

Variable No.	Variable Name	Factor Loading	Communalities
Psy6	Treatment Satisfaction	-0.822	0.741
Hc8	Prefer the type of Health centre	0.640	0.514
Eigen value:1.220		Total Variance:7.626	

*Psy-Patients perception, Hc- Health care infrastructure

Factor V: Healthcare Accessibility and Surroundings

Healthcare Accessibility and Surroundings explained 7.06% of the total variance (Table 6). The surrounding environment (loading = 0.863) and

travel time to Primary Health Centres (loading = 0.619) significantly influenced perceived accessibility. These findings emphasize the importance of environmental conditions and geographical accessibility in determining healthcare utilization.

Table 6. Factor V: Healthcare accessibility and surroundings

Variable No.	Variable Name	Factor Loading	Communalities
Psy10	Surrounding Environment	0.863	0.782
Hc12	Time to reach the PHC centre	0.619	0.652
Eigen value:1.200		Total Variance:7.501	

*Psy-Patients perception, Hc- Health care infrastructure

Factor VI: Healthcare Accessibility Dynamics

Healthcare Accessibility Dynamics accounted for 6.41% of the total variance (Table 7). Proximity to healthcare centres demonstrated a strong

positive loading (0.828), confirming that shorter travel distances improve healthcare accessibility and utilization among rural populations.

Table 7. Factor VI: Healthcare accessibility dynamics

Variable No.	Variable Name	Factor Loading	Communalities
Hc9	Nearby Health Centre	0.828	0.702
Eigen value:1.184		Total Variance:7.401	

*Hc- Health care infrastructure availability/access

Factor VII: Healthcare Behaviour and Awareness

Healthcare Behaviour and Awareness explained 6.30% of the total variance (Table 8). Visiting healthcare centres showed a positive loading

(0.677), indicating proactive healthcare-seeking behaviour. Conversely, the source of drinking water exhibited a negative loading (−0.770), suggesting that poor environmental conditions are associated with lower health awareness and reduced healthcare utilization

Table 8. Factor VII: Healthcare behaviour and awareness

Variable No.	Variable Name	Factor Loading	Communalities
Le6	Source of drinking water	-0.770	0.726
Hc15	Visiting the health centre	0.677	0.686
Eigen value:1.153		Total Variance:7.203	

*Le-Level of environment, Hc- Health care infrastructure

Structural Equation Modeling

Model Fit Assessment

The goodness-of-fit statistics demonstrated that the structural equation model adequately represented the observed data (Table 9). The chi-square value was 2.181 with 5 degrees of freedom, yielding a non-significant p-value ($p = 0.824$), indicating no significant difference between the observed and estimated covariance matrices. The χ^2/df ratio (0.436) was substantially below

the recommended threshold of 5, confirming excellent model fit.

Additional fit indices further supported model adequacy, including GFI (0.998), AGFI (0.988), NFI (0.972), RFI (0.984), CFI (1.000), and IFI (1.038), all of which exceeded the recommended cutoff value of 0.90. The RMSEA (0.001) and RMR (0.018) indicated negligible approximation and residual errors, confirming that the proposed measurement model provided an excellent representation of the observed data.

Table 9: Fit statistics of the measurement model

Sl.No.	Fit statistic	Recommended	Obtained
1	Chi-Square	-	2.181
2	Df	-	5
3	Chi-Square significance	$P < 0.05$	0.824
4	Chi-Square/df	< 5.0	0.436
5	Goodness of Fit Index (GFI)	> 0.9	0.998
6	Adjusted Goodness of Fit Index (AGFI)	> 0.9	0.988
7	Normated Fit Index (NFI)	> 0.9	0.972
8	Relative Fit Index (RFI)	> 0.9	0.984
9	Comparative Fit Index (CFI)	> 0.9	1.000
10	Tucker Lewis Index (TLI)	> 0.9	1.205
11	Incremental Fit Index (IFI)	Approaches 1	1.038
12	Root mean square error of approximation (RMSEA)	< 0.05	0.001
13	Root Mean Square Residual (RMR)	< 0.02	0.018
14	Parsimony goodness-of-fit index (PGFI)	< 5.0	0.178

Structural Path Analysis

The standardized path coefficients are presented in Tables 10, 11, and 12 and Figures 2 and 3. Healthcare Access and Preferences showed the strongest positive influence on Healthcare Infrastructure and Demographics ($\beta = 0.365$, $p < 0.001$), supporting Hypothesis H2. Similarly, Healthcare Behaviour and Awareness had a significant positive effect on Healthcare Infrastructure and Demographics ($\beta = 0.173$, $p = 0.001$), supporting Hypothesis H1.

In contrast, Healthcare Choices and Satisfaction ($\beta = -0.087$, $p = 0.101$), Healthcare Accessibility and Surroundings ($\beta = -0.078$, $p = 0.142$), and

Healthcare Accessibility Dynamics ($\beta = 0.092$, $p = 0.086$) did not significantly influence Healthcare Infrastructure and Demographics. Furthermore, Healthcare Infrastructure and Demographics did not significantly affect Healthcare Costs and Satisfaction ($\beta = -0.012$, $p = 0.835$). Consequently, Hypotheses H3–H6 were not supported.

Overall, the SEM demonstrates that healthcare accessibility and patient awareness are the principal determinants of perceived healthcare infrastructure in Madurai District, whereas healthcare infrastructure alone does not directly influence patient satisfaction with healthcare costs.

Table 10: Regression weights for every path and its significance

Sl.No.	Construct	Path	Construct	Unstandardized co-efficient	S.E.	Standardized co-efficient	C.R.	P
1	Healthcare Infrastructure and Demographics	<---	Healthcare Behaviour and Awareness	0.238	0.074	0.173	3.231	0.001
2	Healthcare Infrastructure and Demographics	<---	Healthcare Access and Preferences	0.254	0.037	0.365	6.814	0.001
3	Healthcare Infrastructure and Demographics	<---	Healthcare Choices and Satisfaction	-0.065	0.040	-0.087	-1.641	0.101
4	Healthcare Infrastructure and Demographics	<---	Healthcare Accessibility and Surroundings	-0.099	0.067	-0.078	-1.467	0.142
5	Healthcare Infrastructure and Demographics	<---	Healthcare Accessibility Dynamics	0.171	0.100	0.092	1.718	0.086
6	Healthcare Costs and Satisfaction	<---	Healthcare Infrastructure and Demographics	-0.008	0.038	-0.012	-0.209	0.835

Table 11: Hypothesised relationship (path) between constructs in the model

Path Direction	Standardized Coefficient	P-value	Interpretation
1. Healthcare Behaviour and Awareness → Healthcare Infrastructure and Demographics	0.173	0.001	A positive and statistically significant effect. This implies that people's awareness and behaviour related to healthcare positively influence the availability and quality of healthcare infrastructure.
2. Healthcare Access and Preferences → Healthcare Infrastructure and Demographics	0.365	0.001	This is the strongest relationship among the paths. Indicates that better access and user preferences are strong predictors of infrastructure quality.
3. Healthcare Choices and Satisfaction → Healthcare Infrastructure and Demographics	-0.087	0.101	Although slightly negative, this path is not statistically significant. It suggests that personal choices and satisfaction do not directly affect the infrastructure and demographics meaningfully.
4. Healthcare Accessibility and Surroundings → Healthcare Infrastructure and Demographics	-0.078	0.142	The influence is again negative but not significant, indicating the surrounding environment's accessibility has minimal direct impact on infrastructure and demographics.
5. Healthcare Accessibility Dynamics → Healthcare Infrastructure and Demographics	0.092	0.086	While slightly positive, this path also lacks significance. It implies that dynamics like travel time or availability may not independently determine infrastructure outcomes.

Table 12: The Results of Hypothesis Testing for the Respected Path

Hypothesis of Path Analysis	Estimate	P-value
H ₁	0.238	0.001
H ₂	0.254	0.001
H ₃	-0.065	0.101
H ₄	-0.099	0.142
H ₅	0.171	0.086
H ₆	-0.008	0.835

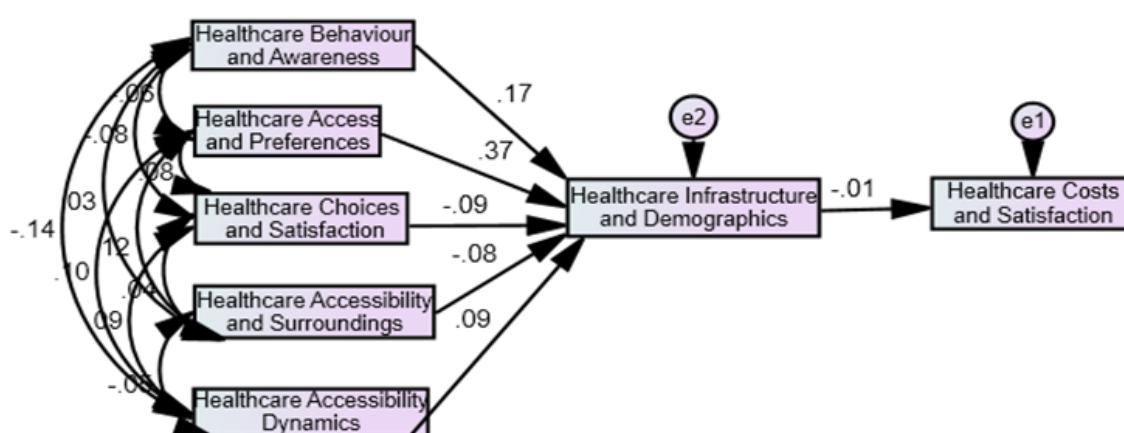


Figure 2. Unstandardized Structural Equation Model (Unstandardized Structural Equation Model Depicting the Influence of Healthcare Behaviour, Accessibility, and Preferences on Infrastructure and Cost Satisfaction)

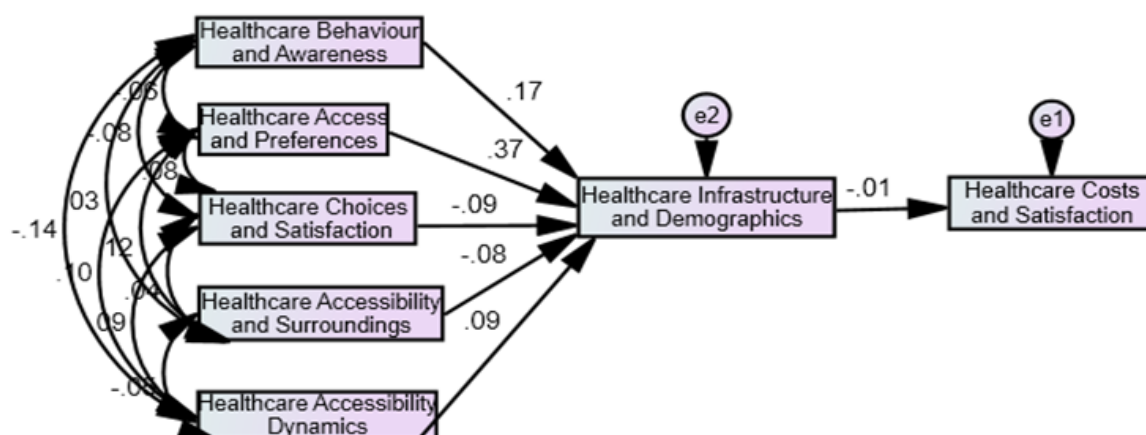


Figure 3. Standardised Structural Equation Model (Path Diagram Depicting the Relationships Among Healthcare Behaviour, Accessibility, Infrastructure, and Cost-related Satisfaction)

Discussion

This study investigated the determinants of healthcare access and patient satisfaction in rural and semi-urban areas of Madurai District using EFA and SEM. Seven latent constructs were identified, explaining 71.28% of the total variance in healthcare-related variables. The SEM results demonstrated an excellent model fit, indicating that the proposed conceptual framework adequately explains the relationships among healthcare accessibility, patient behaviour, healthcare infrastructure, and satisfaction. Overall, the findings highlight that healthcare access and patient awareness are the primary drivers of perceived healthcare infrastructure, whereas infrastructure alone does not directly influence satisfaction with healthcare costs.

The results indicate that Healthcare Access and Preferences was the most influential latent construct, accounting for 22.78% of the total variance. Emergency healthcare services, availability of doctors during night hours, and preferences for healthcare facilities were the strongest contributors to this factor. These findings suggest that timely availability of medical services and continuous access to healthcare professionals remain fundamental determinants of healthcare utilization. Similar observations have been reported by Penchansky and Thomas¹, who emphasized that accessibility involves not only the physical presence of healthcare facilities but also the availability and accommodation of services. Likewise, Gupta and Mohapatra² reported that unequal distribution of healthcare resources remains a major challenge for equitable healthcare delivery in India.

The structural equation model demonstrated that Healthcare Access and Preferences had the strongest positive effect on Healthcare Infrastructure and Demographics ($\beta = 0.365$, $p < 0.001$). This finding indicates that improvements in healthcare accessibility, service availability, and patient preferences substantially enhance perceptions of healthcare infrastructure. The result is consistent with previous studies showing that better access to healthcare services increases utilization, pa-

tient confidence, and perceived quality of care^{5,6}. For rural and semi-urban populations, reducing geographical barriers and improving service availability may therefore contribute substantially to strengthening healthcare systems.

Another important finding is the significant positive relationship between Healthcare Behaviour and Awareness and Healthcare Infrastructure and Demographics ($\beta = 0.173$, $p = 0.001$). Individuals who actively seek healthcare services and possess greater health awareness tend to perceive healthcare infrastructure more positively. Health literacy plays a crucial role in encouraging preventive healthcare practices, early diagnosis, and appropriate utilization of healthcare services. Similar findings have been reported in studies emphasizing that community awareness and health education significantly improve healthcare utilization and patient engagement, particularly in resource-constrained settings^{3,17}.

In contrast, Healthcare Choices and Satisfaction, Healthcare Accessibility and Surroundings, and Healthcare Accessibility Dynamics did not exhibit statistically significant relationships with Healthcare Infrastructure and Demographics. Although environmental conditions, transportation, and travel time influence healthcare accessibility, their direct effects were not statistically significant within the structural model. These variables may instead exert indirect influences through socio-economic status, health awareness, or access pathways. Similar observations have been reported in studies showing that contextual environmental factors often influence healthcare utilization indirectly through behavioural and socio-economic mechanisms rather than direct causal effects^{19,20}.

The pathway from Healthcare Infrastructure and Demographics to Healthcare Costs and Satisfaction was also statistically non-significant ($\beta = -0.012$, $p = 0.835$). This suggests that improvements in physical healthcare infrastructure alone are insufficient to enhance patient satisfaction with treatment costs. Patient satisfaction is a multidimensional construct influenced by affordability, service quality, provider communication, waiting time, medication availability, and

overall care experience. Consequently, investments in infrastructure should be complemented by financial protection mechanisms, improved service quality, and patient-centred care delivery. The socio-environmental assessment further demonstrated substantial inequalities between rural and semi-urban communities in Madurai District. Rural residents experienced greater travel distances, limited transportation facilities, lower household income, and fewer healthcare resources, all of which restricted access to healthcare services. Environmental challenges, including inadequate sanitation and poor drinking water quality, may further increase disease burden and delay healthcare utilization. These findings reinforce previous research highlighting that geographical location and socio-economic disadvantage remain important contributors to health inequalities in developing countries^{21,3}.

The present study has several strengths. First, it combines EFA and SEM to examine complex relationships among multiple determinants of healthcare accessibility and patient satisfaction. Second, it adopts a geo-medical perspective by integrating spatial, socio-economic, behavioral, and infrastructural dimensions within a single analytical framework. Third, the findings provide empirical evidence that may assist policy-makers in designing targeted interventions for improving healthcare accessibility and patient-centred service delivery in rural and semi-urban regions.

However, several limitations should be acknowledged. The study employed a cross-sectional design, limiting causal inference over time. Data were collected from a single district in Tamil Nadu; therefore, generalizability to other regions may be limited. In addition, questionnaire responses were self-reported and may be subject to recall or social desirability bias. Future research should consider longitudinal designs, larger multi-regional samples, and the integration of Geographic Information System (GIS)-based accessibility measures with healthcare utilization data to provide a more comprehensive understanding of healthcare inequalities.

Overall, the findings demonstrate that improving healthcare accessibility and strengthening community health awareness are likely to yield greater improvements in healthcare utilization and patient satisfaction than infrastructure development alone. Policies aimed at expanding healthcare services, improving transportation connectivity, enhancing health literacy, reducing financial barriers, and ensuring equitable distribution of healthcare resources are essential for achieving sustainable and inclusive primary healthcare delivery in rural and semi-urban areas of India.

Conclusion

This study investigated the determinants of healthcare access and patient satisfaction in rural and semi-urban areas of Madurai District, Tamil Nadu, using EFA and SEM. Seven latent factors explaining 71.28% of the total variance were identified, providing a comprehensive understanding of the multidimensional determinants influencing healthcare accessibility and patient satisfaction. The SEM demonstrated an excellent fit, confirming the robustness of the proposed conceptual framework.

The findings revealed that healthcare access and preferences and healthcare behaviour and awareness were the most significant determinants of perceived healthcare infrastructure. These results indicate that improving access to healthcare services, ensuring the availability of qualified healthcare professionals, strengthening emergency medical services, and enhancing community health awareness are fundamental to improving healthcare utilization and patient satisfaction. In contrast, healthcare infrastructure alone did not have a significant direct effect on healthcare costs and patient satisfaction, suggesting that satisfaction is shaped by a broader combination of accessibility, affordability, service quality, and individual healthcare experiences.

The study also identified persistent disparities between rural and semi-urban communities. Rural populations continue to face challenges related to transportation, geographical accessibil-

ity, limited healthcare resources, and socio-economic constraints, all of which restrict equitable access to quality healthcare services. Addressing these disparities requires integrated policy interventions that extend beyond infrastructure development to include improvements in healthcare affordability, workforce availability, health education, transportation connectivity, and equitable distribution of healthcare facilities.

Future research should expand this work by incorporating larger multi-regional samples, longitudinal study designs, and Geographic Information System (GIS)-based accessibility measures to further examine temporal and spatial variations in healthcare utilization and patient satisfaction. Such studies would provide stronger evidence to support sustainable healthcare planning and policy formulation.

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Conflict of Interest

The authors declare no conflict of interest related to this work.

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