Empirical analysis on health indicators of southern states of India and health determinants of Tamilnadu Vs Pudukkottai District

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Abstract: Good health is a vital requirement that greatly contributes to both enhanced labor productivity and human resource development. Health indicators and determinants are important heath care sectors. This paper analysis the health care sectors of southern states with all India. From the analysis, the average health sector rate for Andhra Pradesh, Karnataka, Kerala, Tamilnadu and all India of birth rate from 1995 to 2020 is 19.988, 19.976, 15.626, 16.792 and 23.265 respectively. The average rate of death is 7.546, 7.107, 6.642, 7.35 and 7.488 respectively. The average rate of infant mortality is 49.692, 41.730, 11.807, 33.230 and 52.346 respectively and the average rate of life expectancy 66.252, 67.076, 73.895, 68.585 and 65.766 respectively. The Significant progress has been achieved in the State of Tamilnadu concerning health indicators such as life expectancy at birth, infant mortality rate, and maternal mortality rate. Among the major States, Tamilnadu is positioned 'second highest' regarding life expectancy at birth, 'second lowest' just after Kerala concerning infant mortality rate and birth rate, 'third lowest' in terms of maternal mortality rate, and 'tenth lowest' in terms of death rate. The end of this paper were discussed about health determinants of Tamilnadu verses Pudukkottai District.

Keywords: Birth Rate, Death Rate, Infant Morality Rate, Life Expectancy, Health determinants.

1.Introduction

Tamilnadu is also among the initial states to attain a low Total fertility rate of 1. 7, which it has been consistently maintaining since 2005 [1]. Smallpox, polio, and guinea worm have been eliminated. Life expectancy at birth represents the average number of years a newborn is anticipated to live if current mortality rates remain unchanged.
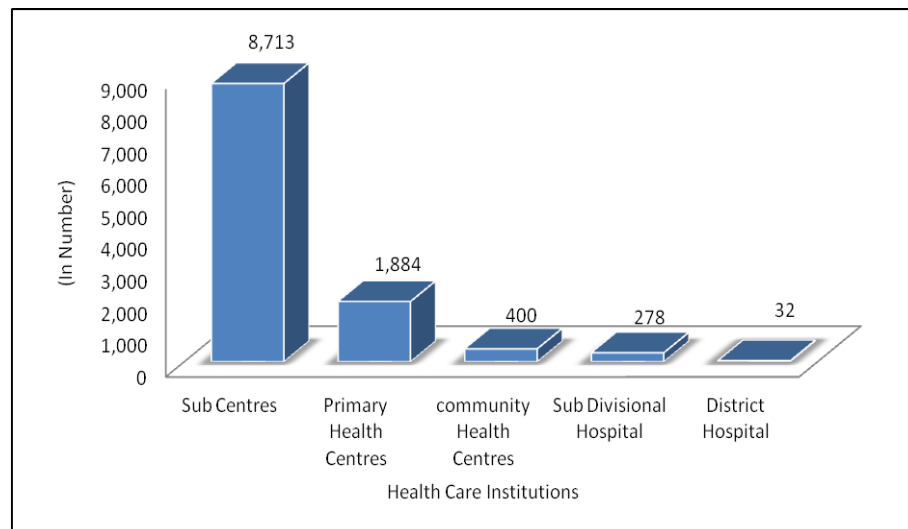
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Fig. 1 Rural Health Statistics in India

(Source: Rural Health Statistics 2019-20, Ministry of Health and Family Welfare, New Delhi, Government of India)

The enhancements in the prevention and control of significant childhood infectious diseases, nutritional status, housing conditions, and modern medical care have led to an increase in life expectancy in the State. The main goal of the Government of Tamilnadu is to provide accessible, affordable, equitable, and quality health care, particularly to the marginalized and vulnerable groups within the population. The State confronts various challenges in delivering efficient health services to its residents. The health sector consists of a combination of both public and private health care providers.

In the public sector, health services are provided through a network of health facilities including primary, secondary, and tertiary health care systems. The Primary healthcare system consists of Primary Health Centres and Health Sub-Centres. The secondary healthcare system includes District Head Quarters Hospitals, Taluk Hospitals, Women and Children Hospitals, Dispensaries, Mobile Medical Units, Police Hospitals,

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and Non-Taluk Hospitals, among others. The tertiary healthcare system encompasses multi-specialty hospitals. In addition to Government initiatives, the private sector also plays a role in the provision of Health Care Services[4]. As of 31st March 2020, there were 8713 Sub Centres, 1884 Primary Health Centres, 400 Community Health Centres, 278 Sub Divisional Hospitals, and 32 District Hospitals operational in the State of Tamilnadu (Figure 1). Of the total health care institutions, 8713 Sub Centres, 1420 Primary Health Centres, and 385 Community Health Centres were operational in rural areas [2-4].

In the current research, four essential health variables, namely life expectancy at birth (LEB), crude birth rate (CBR), crude death rate (CDR), and infant mortality rate (IMR), were selected to assess the health status levels of the population in Tamilnadu. These health variables are referred to as health indicators. Among these four health indicators, CBR, CDR, and IMR are categorized as reductionist indicators, while LEB is recognized as the positive increasing indicator.

These health indicators are affected by numerous determinants. In this research, eighteen variables, specifically the number of Primary Health Centres, population per bed ratio, number of doctors and nurses in primary health centres, population per doctor ratio, female literacy rate, per capita food availability, PHC per million population, per capita income at current prices, public health expenditure, literacy rate, employment in the organized sector, villages with drinking water provision, couple protection rate, fertility rate, sex ratio, population density, beds, and hospitals, were considered as determinants of health status in Tamilnadu State and Pudukkottai district.

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Improving population health is a topic of significant concern globally, and this is anticipated to be reflected in the measures taken by leaders to ensure better access to healthcare services [5]. Consequently, increasing public expenditure on healthcare has become a priority worldwide. Grigoli and Kapsoli [6] pointed out that inefficiencies undermine national initiatives aimed at reinforcing health systems. The World Health Report (WHR) 2010 estimated that approximately 20%–40% of resources in the health sector are squandered [7]. This can result in various negative health outcomes, impacting the general populace. In emerging economies, the health system faces fluctuating health costs, including gaps in safety, quality, access, and equity. The World Health Organization (WHO) [8] determined that a reduction in spending in the health sector may not lead to better outcomes or equitable utilization of health resources. Inefficiencies within the health sector manifest in various forms such as hospital management, admissions, and healthcare worker performance. Over the years, emerging economies have achieved notable advancements in improving health services by reducing non-communicable diseases and extending life expectancy. Nevertheless, the epidemiological shift, with the causes of death transitioning slowly from infectious to chronic diseases, places significant financial strain on healthcare systems in emerging countries. Therefore, the efficiency of financial and human resources allocated to health sectors in emerging economies becomes a crucial area of interest for researchers and decision-makers in the healthcare field. Previous studies have identified considerable inefficiencies in health spending among industrialized nations and other developing countries [9]. Given the increasing economic pressures facing emerging economies, policymakers, systems

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leaders, private payers, and consumers are exploring ways to minimize waste, boost efficiency, and enhance the value of healthcare [10-14].

2. Comparative Analysis of Health Indicators among Southern States

2.1 Birth Rate

In Fig. 2, A consistent decline in the crude birth rate of Tamilnadu was observed, dropping from 20. 3 per 1000 in 1995 to 13.2 per 1000 in 2020. During this same period, the crude birth rate at the all-India level also decreased from 28. 3 per 1000 to 20 per 1000.

It is noteworthy that the state's crude birth rate at 13.2 in 2020 was lower than the all-India rate of 20 [15-18]. Among both major and Southern States, Tamilnadu ranked second, following Kerala.

The State of Kerala Typically, rural areas exhibit a higher birth rate than urban areas. However, the birth rates in both urban and rural settings have continuously declined across the nation. Based on birth rate, rural Tamilnadu occupied the second best position among the Southern States during the study period. Both rural and urban Tamilnadu displayed significantly lower birth rates when compared to national averages. Besides the effective execution of the family planning program in the State by the successive Governments, extensive promotion of later marriages, a much broader spread of mass media enabling quicker dissemination of the small family norm, increasing literacy rates, enhancing the status of women, better road connectivity between rural and urban regions, higher involvement of females in non-farm activities, decreasing fertility rates, and rising

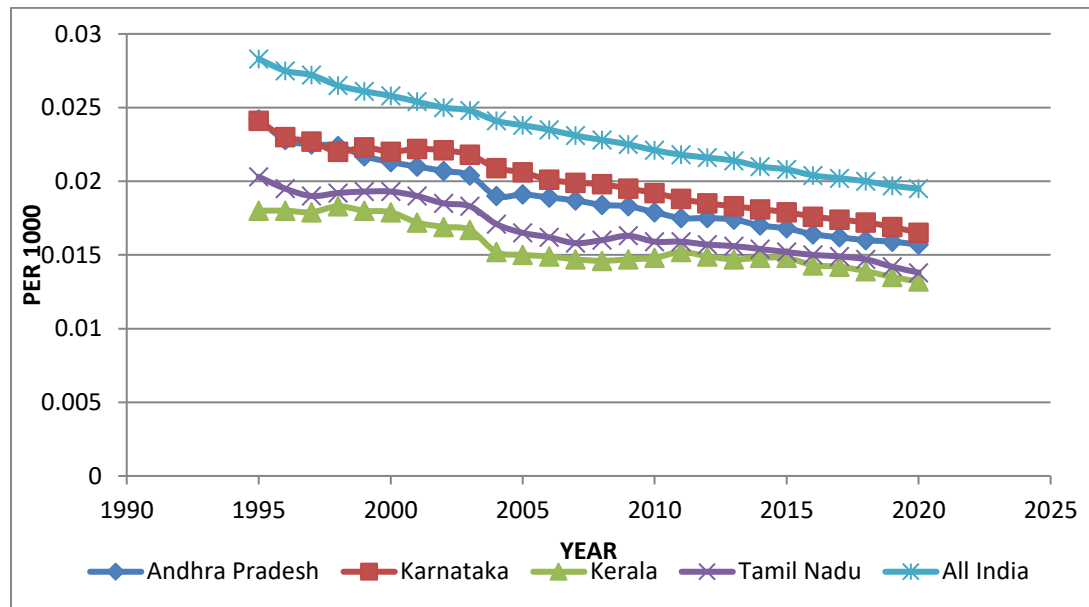aspirations of the populace concerning improved living standards are the factors behind this decline.

Fig. 2: Birth Rate - Southern States

(Source: Handbook of Statistics on Indian States 2015-16 & 2020-21, Reserve Bank of India, Mumbai)

Over the years, it has consistently decreased in the State. This was due to heightened health awareness among the public, rising educational levels, improving nutritional status, enhanced living standards, early detection, treatment, and control of epidemic outbreaks, convenient access to effective healthcare delivery systems, infectious disease prevention and control, implementation of modern medical practices in the diagnosis and treatment of various ailments, and efficient administration of universal immunization, along with improved road connectivity and easy transportation between rural and urban areas.
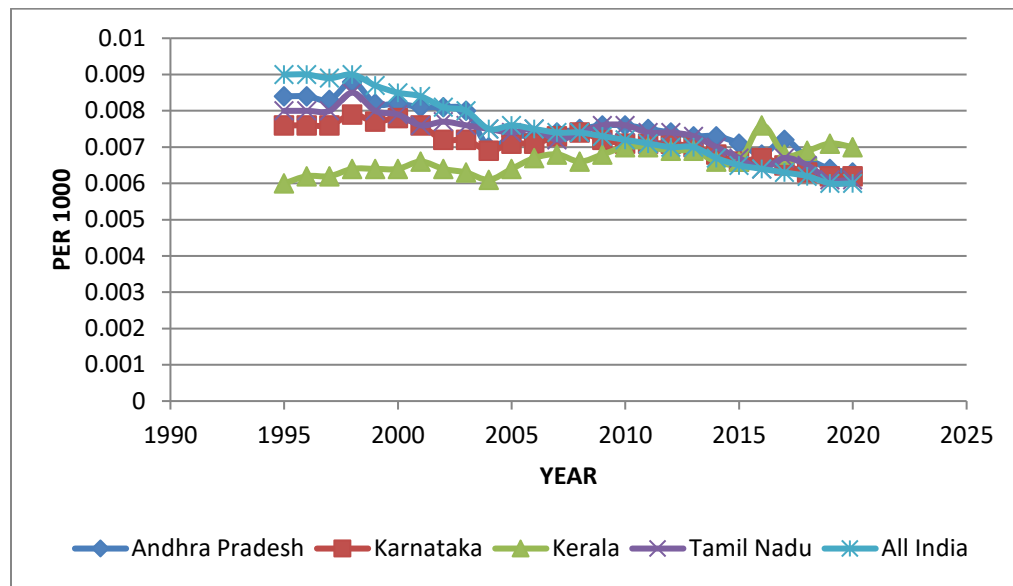
2.2 Death Rate

Fig. 3: Death Rate - Southern States

(Source: Handbook of Statistics on Indian States 2015-16 & 2020-21, Reserve Bank of India, Mumbai)

In Fig. 3, between 1995 and 2020, the crude death rate in the State fell from 8 per 1000 to 6.1 per 1000. However, the crude death rate in the State has been slightly higher than the all-India figure since 2009. This was primarily due to a greater number of deaths resulting from accidents and suicides occurring in the State.

Due to improved healthcare facilities, the death rate has decreased among the Southern States. However, since 2015, in all the Southern States, the death rate has been higher than the all-India figure. The death rate in the rural area exceeded that of the urban area. The death rate in rural Tamilnadu was the lowest among the southern states for the year 2016. It declined from 7. 9 in 2014 to 7. 1 in 2016. The disparity between the death rates in rural and urban areas was the least in Kerala and the most in Andhra Pradesh. During the year 2016, the urban death rate was 4. 9 in both Andhra Pradesh and

Karnataka. Surprisingly, both the rural and urban death rates for Kerala in 2016 were higher than the all-India average. One possible reason could be that the proportion of the elderly population is higher in Kerala during this decade[7].

2.3 Infant Mortality Rate

The combined actions of the State in executing several targeted initiatives such as the Dr. Muthulakshmi Reddy Maternity Benefit Scheme, Birth Companion Programme, 24x7 delivery centers at all Primary Health Centres, and controlling birth asphyxia and deaths from hypothermia, as well as implementing strategies for the reduction and management of Neo-Natal sepsis, educating pregnant mothers on exclusive breastfeeding, complementary foods, childcare practices, recognizing danger signs in ill newborns, and immunization against preventable diseases, along with the rise in female literacy rates and the increase in institutional deliveries, have greatly contributed to lowering the infant mortality rate (IMR) in Tamilnadu.

The IMR in the State fell from 54 per 1000 in 1995 to 13 per 1000 in 2020. The drop in IMR during these two years was notably more significant in Tamilnadu (39 per 1000) compared to the all-India figure (46 per 1000). Among the major States as well as the Southern States, Tamilnadu was ranked second, just behind Kerala.

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Fig. 4: Infant Mortality Rate - Southern State

(Source: Handbook of Statistics on Indian States 2015-16 & 2020-21, Reserve Bank of
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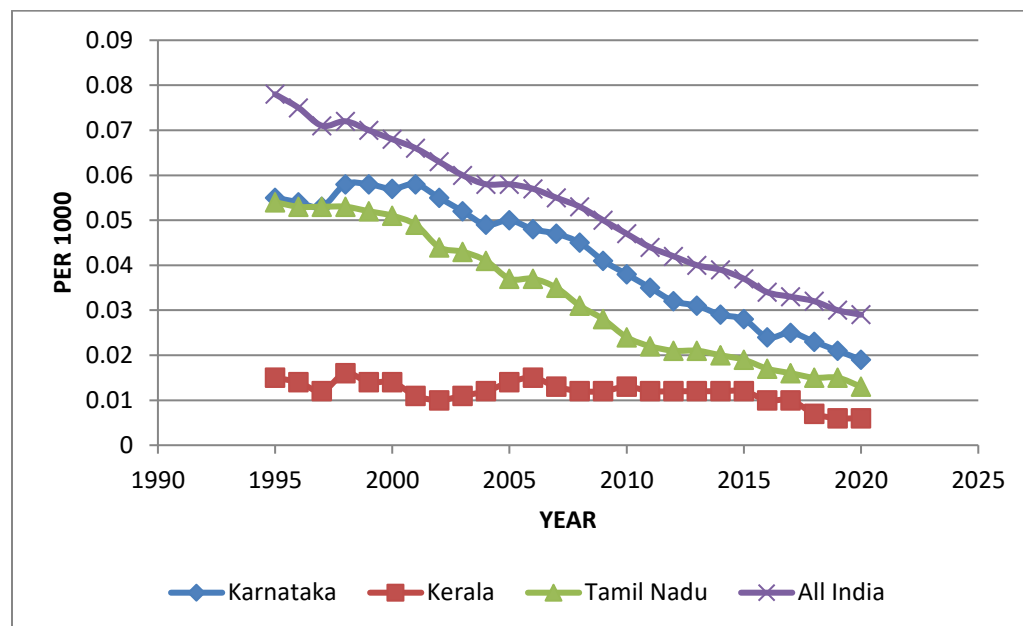Southern States, Tamilnadu was ranked second, just behind Kerala.

2.4 Life Expectancy at Birth

With advancements in preventing and managing major childhood infectious diseases,
nutritional conditions, living environments, and contemporary medical care contributed
to a rise in life expectancy in the State. Life expectancy at birth in Tamilnadu improved
from 64. 4 years (1995-99) to 72. 1 years (2014-18). At the national level, life expectancy
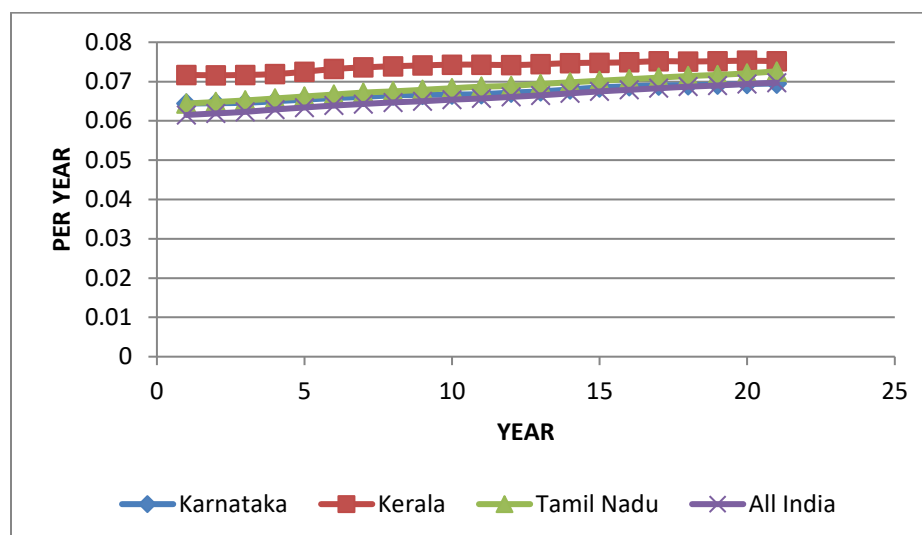increased from 61. 5 to 69. 4 years.

Fig. 5: Life Expectancy at Birth - Southern States

(Source: Handbook of Statistics on Indian States 2015-16 & 2020-21, Reserve Bank of India, Mumbai)

Tamilnadu, with a life expectancy at birth of 72. 1 years, ranked second among the Southern States, coming in just behind Kerala (75. 3 years) and significantly ahead of the national average (69. 4 years) during the 2014-18 period. However, it is important to note that consistently, in all the States and at the national level, life expectancy at birth is higher for females compared to males. This may be attributed to the higher prevalence of alcohol and tobacco consumption among the male population. The Government has implemented various initiatives to reduce tobacco use.

This remains a concern, and there is potential for progress.

3. Health Indicators of Tamilnadu

In India, especially after the Alma Ata declaration and the National Health Policy 1983 released by the Indian government, there was a decrease in indicators such as the birth rate, death rate, infant mortality, and an increase in life expectancy at birth. The patterns

in health indicators of Tamilnadu from 1995 to 2019 indicate notable progress in public health and healthcare delivery systems throughout this period. Life expectancy at birth displays a steady upward trend, rising from 64. 09 years in 1995 to 72. 18 years in 2019. This signifies ongoing enhancements in healthcare services, living standards, and overall well-being. Importantly, life expectancy saw a more significant increase after 2004, reflecting the effects of targeted health policies and programs enacted during this time. The birth rate has significantly decreased from 20. 3 per thousand in 1995 to 12. 4 per thousand in 2019. This trend indicates improved awareness and access to family planning initiatives, socio-economic advancement, and a transformation in societal attitudes toward smaller family norms. The decline in the birth rate is gradual and steady, showcasing Tamilnadu's achievement in population control efforts.

Table. 1 **Average rate of Birth, Death, Infant Morality and Life Expectancy**

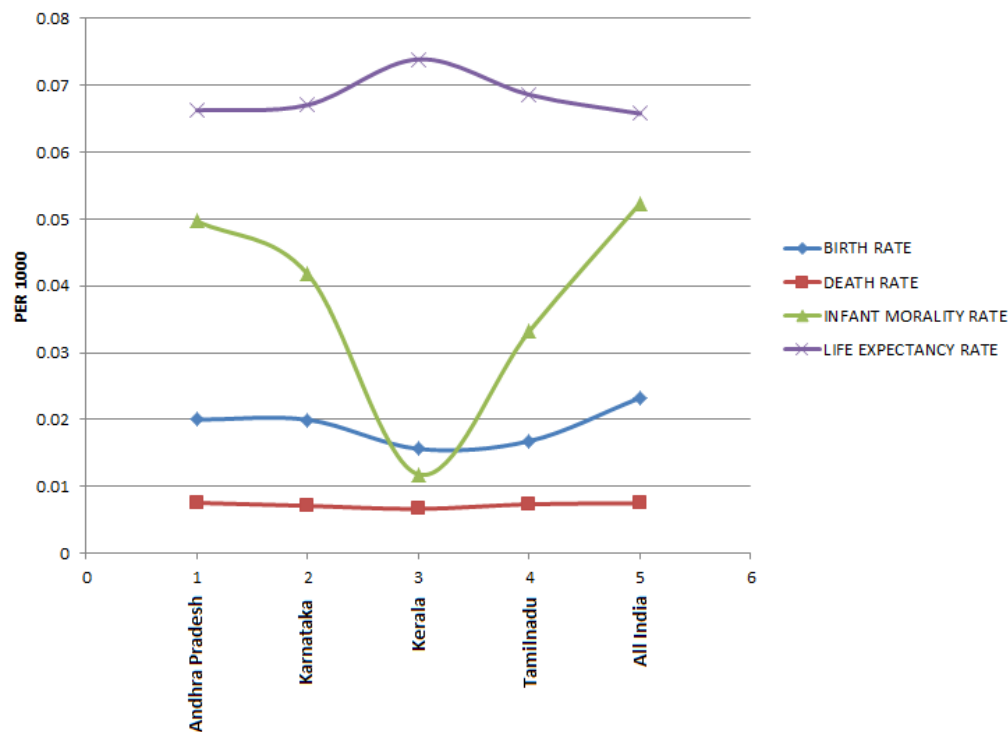| Health Indicators	Andhra Pradesh	Karnataka	Kerala	Tamilnadu	All India
Birth Rate	19.988	19.976	15.626	16.792	23.265
Death Rate	7.546	7.107	6.642	7.35	7.488
Infant Mortality Rate	49.692	41.73	11.807	33.23	52.346
Life Expectancy Rate	66.252	67.076	73.895	68.585	65.766

Fig. 6 Average rate of Birth, Death, Infant Morality and Life Expectancy

The death rate, which began at 8. 0 per thousand in 1995, experienced slight variations over the years but exhibited a general downward tendency, reaching its lowest level at 6. 4 per thousand in 2016. However, an increase to 8. 4 per thousand in 2019 suggests emerging health issues, potentially due to the onset of COVID-19, an aging population, or other factors necessitating further inquiry. The infant mortality rate (IMR) has experienced a remarkable decrease, falling from a peak of 54 per thousand in 1995 to merely 11. 1 per thousand in 2019. This significant decline underscores the effectiveness of maternal and child health initiatives, extensive immunization coverage, enhanced neonatal care facilities, and improved nutritional standards. The most considerable reduction in IMR took place during the early 2000s, reflecting the influence of targeted interventions in infant healthcare.

4. Health Determinants

As previously mentioned, health indicators are affected by numerous determinants. In this research, eighteen determinants, including the number of PHCs, population per bed ratio, number of doctors and nurses in primary health centers, population per doctor ratio, female literacy rate, per capita food availability, PHCs per million population, per capita income at current prices, public health expenditure, literacy rate, employment in the organized sector, availability of drinking water in villages, couple protection rate, fertility rate, sex ratio, population density, number of beds, and hospitals have been considered as determinants of health status in Tamilnadu and Pudukkottai district.

4.1 Health Determinants of Tamilnadu

The examination of health determinants in Tamilnadu from 1995-96 to 2019-2020, as shown in Table 5. 10, emphasizes notable trends across healthcare infrastructure, socio-economic factors, and demographic changes. These determinants signify the state's advancement in public health as well as areas that need attention. In terms of health infrastructure, the number of Primary Health Centres (PHCs) and Health Sub-Centres (HSCs) increased steadily from 10,106 in 1995-96 to 10,997 in 2019-20, showcasing a continual growth in healthcare accessibility. The population per bed ratio deteriorated slightly, rising from 1,926 in 1995-96 to 3,553 in 2019-20, suggesting increasing population pressure on healthcare infrastructure despite the growing number of facilities. The total number of beds in PHCs saw a notable rise from 19,812 in 1995-96 to 20,302 in 2019-20, indicating enhanced capacity in primary healthcare. Concerning the healthcare

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workforce, the count of doctors and nurses increased from 22,262 in 1995-96 to 26,024 in 2019-20, aiding improved healthcare delivery. Nevertheless, the population per doctor ratio remained fairly constant, revealing a requirement for proportional rises in healthcare staff to align with population growth. Regarding public health and nutrition, public health expenditure rose significantly from Rs. 1,012. 13 crores in 1995-96 to Rs. 4,985. 96 crores in 2019-20, highlighting the state's substantial investment in health infrastructure and services. Per capita food availability exhibited steady improvement, increasing from 143 kg in 1995-96 to 164. 6 kg in 2019-20, signifying better access to nutrition.

In relation to reproductive health, the fertility rate steadily decreased from 2. 1 in 1995-96 to 1. 6 in 2019-20, reflecting successful family planning initiatives. The couple protection rate demonstrated variations, rising from 54. 8 per cent in 1995-96 to 54. 5 per cent in 2019-20, suggesting a necessity for continued emphasis on reproductive health efforts. In terms of demographics and hygiene, the literacy rate enhanced from 65. 7 per cent in 1995-96 to 80. 4 per cent in 2019-20, promoting increased health literacy and better health practices. The number of villages with safe drinking water rose from 8,134 in 1995-96 to 15,979 in 2019-20, reflecting considerable improvements in hygiene and water supply.

Table 2: Results of Trends in Health Determinants of Tamilnadu State for the period
1995-96 to 2019-20

Sl. No.	Health Determinants	Coefficients		R^2
		a	**b**	
1.	Number of PHCs and HSCs (X_1)	9873.66	32.1031* (7.6414)	0.7174
2.	Population per Bed ratio (X_2)	1581.39	52.5177* (5.9672)	0.6076
3.	Number of Doctors and Nurses (X_3)	21677.25	146.3192* (9.4079)	0.7937
4.	Population per Doctor ratio (X_4)	20532.72	56.6031* (15.4461)	0.9121
5.	Female Literacy Rate (X_5)	68.0269	0.6071* (12.0508)	0.8633
6.	Per capita food availability (X_6)	129.6225	1.5173* (4.9618)	0.5170
7.	PHC per million population (X_7)	0.04073	0.0003715* (21.7724)	0.9537
8.	Per capita income at current prices (X_8)	9443.93	1018.5223* (1.9113)	0.1371
9.	Public Health Expedition (X_9)	2725.1208	21924.6399* (16.8467)	0.9250
10.	Literacy Rate (X_{10})	68.0269	0.6071* (12.0508)	0.8633
11.	Employment in Organized Sector (X_{11})	2451.1159	40.6215* (13.5136)	0.8881
12.	Number of Villages with Safe Drinking Water (X_{12})	11439.68	245.0492* (5.9301)	0.6046
13.	Couple Protect Rate (X_{13})	50.04	0.1662* (2.7072)	0.2416
14.	Fertility Rate (X_{14})	2.083	-0.02085 (-8.9705)	0.7777
15.	Sex Ratio (X_{15})	981.53	0.7162* (13.0085)	0.8803
16.	Density of Population per sq.km. (X_{16})	437.03	6.3638* (25.8476)	0.9667
17.	Number of Beds in PHCs (X_{17})	19885.17	15.8792* (11.6283)	0.8546

18.	Number of Hospital (X_{18})	311.52	0.5077* (6.1834)	0.6244

Source: Computed from secondary data.
Figures in parentheses are 't' values.
* Significant at 5 per cent level.

The sex ratio sustained relative stability at approximately 996 females per 1,000 males, indicating minimal changes in gender demographics. Population density escalated from 445 per sq. km in 1995-96 to 583 per sq. km in 2019-20, indicating demographic growth. Regarding socio-economic indicators, the female literacy rate showed remarkable improvement from 55. 41 per cent in 1995-96 to 77. 9 per cent in 2019-20, demonstrating progress in education and its beneficial impact on health awareness. Per capita income rose significantly, from Rs. 7,352 in 1995-96 to Rs. 19,951 in 2019-20, emphasizing strong economic growth contributing to improved living standards.

Employment in the organized sector grew from 2,898,800 in 1995-96 to 3,450,100 in 2019-20, indicating increased economic stability and its indirect effect on health outcomes. Tamilnadu has achieved notable advancements in enhancing health determinants over the last two decades, particularly in literacy, public health expenditure, and healthcare infrastructure. Nonetheless, challenges like population pressure on healthcare services and fluctuating reproductive health data emphasize areas for targeted interventions to ensure sustainable enhancements in health outcomes.

The linear regression formula

$$\hat{Y} = b_0 + b_1 X$$

$$b1 = \frac{SPxy}{SSx} = \frac{\Sigma(xi - \bar{x})(yi - \bar{y})}{\Sigma(xi - \bar{x})^2}$$

R Squares

$$R^2 = \frac{SSRegression x}{SStota} = \frac{\Sigma(\hat{y}i - \bar{y})^2}{\Sigma(yi - \bar{y})^2}$$

The Standard deviation of the residue is

$$MSresidual = S^2 res = \frac{\Sigma(\hat{y}i - \bar{y})^2}{n - 2}$$

(Source: https://www.statskingdom.com/)

Table 2 indicated that regarding the chosen health determinants in Tamilnadu for the period 1995-96 to 2019-20, all the determinants were significant and exhibited a positive trend except for the fertility rate, which implies favorable conditions to enhance the health status. Concerning health infrastructure (X1, X7, X17, X18), the count of PHCs and HSCs (X1) has a positive slope of 32. 1031, with an R² of 0. 7174, signifying a notable growth in these facilities over time, positively influencing access to healthcare. The number of beds in PHCs (X17) and the number of hospitals (X18) also reflect significant positive trends, with slopes of 15. 8792 and 0. 5077, and R² values of 0. 8546 and 0. 6244, respectively, emphasizing the growth of healthcare infrastructure. The PHCs per million population (X7) exhibit an almost steady rate of increase (slope 0. 0003715),

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with a high R^2 of 0. 9537, indicating consistent advancements in rural health accessibility.

In relation to human resources in healthcare (X3, X4), the number of doctors and nurses (X3) displays a dramatic yearly increase (slope 146. 3192) with a high R^2 of 0. 7937, indicating enhanced availability of the healthcare workforce. The population per doctor ratio (X4) demonstrates significant improvement with a negative slope of -56. 6031 and an R^2 of 0. 9121, reflecting less burden on individual doctors due to a rise in healthcare providers. Pertaining to public health and nutrition (X6, X9, X12), per capita food availability (X6) reveals a positive trend (slope 1. 5173), with an R^2 of 0. 5170, indicating gradual enhancements in nutritional access. Public health expenditure (X9) increased notably (slope 21924. 6399) with an R^2 of 0. 9250, underscoring enhanced investment in public healthcare. The number of villages with safe drinking water (X12) shows significant growth (slope 245. 0492) with an R^2 of 0. 6046, accentuating improvements in water accessibility and sanitation. Concerning fertility and reproductive health (X13, X14, X15), the fertility rate (X14) exhibits a consistent decline (slope -0. 02085) with an R^2 of 0. 7777, indicating successful family planning efforts. The couple protection rate (X13) improved marginally (slope 0. 1662) with a lower R^2 of 0. 2416, reflecting a slower yet positive trend in reproductive health practices. The sex ratio (X15) has risen annually (slope 0. 7162) with an R^2 of 0. 8803, indicating progress toward achieving gender balance. Regarding population dynamics (X2, X16), the population per bed ratio (X2) deteriorated (positive slope 52. 5177) with an R^2 of 0. 6076, suggesting escalating population pressure on healthcare facilities. The density of the population per

square kilometer (X16) shows a steady annual increase (slope 6. 3638) with an R^2 of 0. 9667, reflecting urbanization and demographic shifts. In reference to socio-economic factors (X5, X8, X11), the female literacy rate (X5) and overall literacy rate (X10) demonstrate significant enhancements with identical slopes (0. 6071) and high R^2 values (0. 8633), reflecting increased educational achievement and its beneficial effects on health awareness and outcomes. The per capita income (X8) has a considerable positive slope (1018. 5223), but with a low R^2 of 0. 1371, indicating that economic growth's impact on health outcomes in this analysis is limited. Employment in the organized sector (X11) rose significantly (slope 40. 6215) with an R^2 of 0. 8881, suggesting that economic stability contributes to improved health.

The analysis emphasizes Tamilnadu's considerable advancements in healthcare infrastructure, human resources, and public health factors over a period of 25 years. Notable enhancements in literacy, public health spending, and reproductive health highlight the effectiveness of the state's health policies. Nevertheless, the escalating population's impact on healthcare infrastructure necessitates ongoing investment to maintain these achievements and tackle emerging difficulties.

4.2 Health Determinants of Pudukkottai District

The health determinants of Pudukkottai District from 1995-96 to 2019-20 indicate significant patterns and alterations across various socio-economic, infrastructural, and demographic aspects. The number of PHCs and HSCs has consistently risen from 225 in 1995-96 to 349 in 2019-20, indicating a notable enhancement in healthcare accessibility. The population per bed ratio has slightly deteriorated, increasing from 726 in 1995-96 to

658 in 2019-20, signifying a growing population strain on existing healthcare facilities despite infrastructure improvements. The number of beds in PHCs has notably increased, from 952 in 1995-96 to 2,320 in 2019-20, showcasing efforts to boost healthcare capacity. The count of hospitals remained steady at 26 initially but rose to 38 by 2019-20, further enhancing health service provision [19].

Table 3 : Trends in Health Determinants of Pudukkottai District for the period from 1995-96 to 2019-20

Sl. No.	Health Determinants	Coefficients		R^2
		a	B	
1.	Number of PHCs and HSCs (X_1)	222.93	4.8946* 27.1508	0.9697
2.	Population per Bed ratio (X_2)	783.39	2.5946* 1.0561	0.04625
3.	Number of Doctors and Nurses (X_3)	865.67	-1.9685 -0.501	0.01079
4.	Population per Doctor ratio (X_4)	14857.15	-22.9387 -3.0767	0.2916
5.	Female Literacy Rate (X_5)	49.5444	1.0748* 14.4717	0.901
6.	Per capita food availability (X_6)	10.984	0.418* 7.5123	0.7105
7.	PHC per million population (X_7)	77.93	1.4023* 12.2013	0.8662
8.	Per capita income at current prices (X_8)	16082.49	2368.0454* 13.5426	0.8886
9.	Public Health Expedition (X_9)	25.0385	470.7811* 11.8117	0.8585
10.	Literacy Rate (X_{10})	66.1285	0.5857* 7.4761	0.7085
11.	Employment in Organized Sector (X_{11})	300.47	4.69* 16.0748	0.9183
12.	Number of Villages with Safe Drinking Water (X_{12})	715.3	1.6662* 8.7827	0.7703

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13.	Couple Protect Rate (X_{13})	50.824	-0.4268 -12.1493	0.8652
14.	Fertility Rate (X_{14})	1.913	-0.01177 -4.7977	0.5002
15.	Sex Ratio (X_{15})	1010.13	0.27* 4.7406	0.4942
16.	Density of Population per sq.km. (X_{16})	340.71	0.3054* 13.1188	0.8821
17.	Number of Beds in PHCs (X_{17})	933.77	49.4238* 12.1324	0.8649
18.	Number of Hospital (X_{18})	26.88	0.5477* 12.8826	0.8783

Source: Computed from secondary data.
Figures in parentheses are 't' values. * Significant at 5 per cent level.

The number of doctors and nurses showed variations, increasing from 790 in 1995-96 to 523 in 2019-20. The decline in recent years may indicate challenges in retaining or attracting medical professionals. The population per doctor ratio saw a slight improvement from 14,700 in 1995-96 to 14,579. 7 in 2019-20, indicating gradual decreases in workload per doctor. The female literacy rate increased significantly, from 43. 6 per cent in 1995-96 to 72. 9 per cent in 2019-20, reflecting the effectiveness of educational initiatives and their enduring influence on health awareness. Per capita income at current prices experienced a considerable increase, from Rs. 7,949 in 1995-96 to Rs. 64,064 in 2019-20, highlighting enhanced economic circumstances in the district. Employment in the organized sector also steadily grew, from 295,000 in 1995-96 to 397,000 in 2019-20, contributing to economic stability and indirectly fostering improved health outcomes. Public health spending surged significantly, from Rs. 2,584. 1 lakhs in 1995-96 to Rs. 10,988. 2 lakhs in 2019-20, underscoring rising governmental investment in healthcare. Per capita food availability increase substantially, from 13. 52 kg in 1995-96 to 26. 4 kg in 2019-20, indicating advancements in nutritional access and food

security.The fertility rate fell from 2. 1 in 1995-96 to 1. 7 in 2019-20, signifying effective family planning efforts and heightened awareness of reproductive health. The couple protection rate, on the other hand, dropped from 52. 9 percent in 1995-96 to 42. 0 percent in 2019-20, indicating a potential area needing renewed emphasis in health strategies. The literacy rate rose from 60. 7 percent in 1995-96 to 77. 3 percent in 2019-20, leading to enhanced health literacy and improved health practices. The number of villages with safe drinking water increased from 723 in 1995-96 to 767 in 2019-20, showcasing advancements in hygiene and water supply systems.

The sex ratio stayed stable at approximately 1,015 during the entire period, reflecting consistency in gender demographics. The population density per square kilometer gradually grew from 341 in 1995-96 to 347 in 2019-20, indicating moderate growth in the population. The examination of health determinants in Pudukkottai District reveals significant advancements in healthcare infrastructure, economic development, literacy, and public health funding. Nevertheless, challenges such as maintaining healthcare workforce levels, handling population pressures, and tackling the declining couple protection rate require focused interventions to secure ongoing enhancements in health outcomes.

The regression analysis of health determinants for Pudukkottai District from 1995-96 to 2019-20, as presented in Table 3, uncovers notable trends in various factors impacting health outcomes in the region. In terms of health infrastructure (X1, X7, X17, X18), the count of PHCs and HSCs (X1) has a positive slope of 4. 8946, with a substantial R^2 of 0. 9697, indicating a significant rise in healthcare facilities and better

accessibility for the community. The quantity of beds in PHCs (X17) and the number of hospitals (X18) also display significant positive trends, with slopes of 49. 4238 and 0. 5477, and R² values of 0. 8649 and 0. 8783, respectively, denoting consistent growth in healthcare infrastructure. The number of PHCs per million population (X7) has significantly risen (slope 1. 4023) with a strong R² of 0. 8662, implying improved health service coverage over time.

Concerning human resources in healthcare (X3, X4), the number of doctors and nurses (X3) shows a minor decline (negative slope of -1. 9685) with a very low R² of 0. 01079, suggesting potential difficulties in sustaining sufficient healthcare staff. The population per doctor ratio (X4) reflects improvement (negative slope -22. 9387) with an R² of 0. 2916, indicating a gradual decrease in the burden on individual healthcare practitioners. With respect to socio-economic factors (X5, X8, X10, X11), the female literacy rate (X5) and overall literacy rate (X10) indicate considerable growth with slopes of 1. 0748 and 0. 5857, and R² values of 0. 901 and 0. 7085, respectively, underscoring the district's advancement in educational accomplishments. The per capita income (X8) shows a pronounced positive trend (slope 2368. 0454) with a high R² of 0. 8886, indicating enhancing economic conditions that contribute to improved health. Employment in the organized sector (X11) has significantly risen (slope 4. 69) with a high R² of 0. 9183, showcasing the role of economic stability in fostering health. In terms of public health and nutrition (X6, X9, X12), per capita food availability (X6) and public health expenditure (X9) have increased significantly, with slopes of 0. 418 and 470. 7811, and R² values of 0. 7105 and 0. 8585, reflecting better nutrition and investment in

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healthcare. The number of villages with access to safe drinking water (X12) has also improved (slope 1. 6662) with an R^2 of 0. 7703, highlighting enhanced water accessibility and hygiene.Regarding fertility and reproductive health (X13, X14, X15), the fertility rate (X14) shows a slight decrease (negative slope -0. 01177) with a moderate R^2 of 0. 5002, indicating advancements in family planning initiatives. The sex ratio (X15) has improved (slope 0. 27) with an R^2 of 0. 4942, illustrating gradual progress toward gender balance. The couple protection rate (X13) presents a slight decline (negative slope –0. 4268) with an R^2 of 0. 8652, indicating some inconsistencies in reproductive health practices. In view of population dynamics (X2, X16), the population per bed ratio (X2) has worsened (positive slope 2. 5946) with a very low R^2 of 0. 04625, indicating rising population pressure on existing facilities. The density of population per square kilometer (X16) shows a consistent increase (slope 0. 3054) with an R^2 of 0. 8821, reflecting demographic growth and urbanization. The examination emphasizes the notable advancements in healthcare infrastructure, literacy, and economic metrics in Pudukkottai District during the study duration. Major investments in public health and the increase in access to safe drinking water have beneficially influenced health results. Nevertheless, issues like sustaining healthcare staff and addressing population strain on infrastructure demand ongoing attention to guarantee lasting enhancements.

5. Conclusion

This paper analyzed the various health care sectors like health indicators of southern states with all India and health determinants of Tamilnadu with Pudukkottai District. From the analysis, it is concluded that the Kerala state has lowest average birth

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rate, death rate and infant mortality rate is 15.676, 6.642 and 11.807 respectively and

highest life expectancy rate is 73.895. The health determinants of Taminadu with

Pudukkottai district R^2 value is estimated.

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