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Correlation between Human Development Indices and Epidemiological Transition Ratio among Indian States

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ABSTRACT

Context: With almost one-fifth of the world's population living in India, the health status and the drivers of health loss are expected to vary between different parts of the country and between the states. In 2016, 55% of the total disease burden in India was caused by NCDs, 33% by CMNNDs, and 12% by injuries. There are recognizable interconnections between health, particularly NCDs, and sustainable development. Addressing them requires careful attention to underlying social, cultural, economic, political, and environmental determinants that operate at societal level and in turn influence the behavioural risk factors.
Objective: To analyze the correlation between Human development Indices and Epidemiological transition Ratio among Indian states.
Design and Methods: Correlation non-experimental study based on, human development index data (UNDP) HDI -India 2019 and epidemiological transition ratio (ETR) of India states and Delhi taken from – ICMR -India states disease burden 2017.
Statistical analysis used: Spearman Rank Order correlation coefficient
Results: The association between the human development indices and epidemiological transition ratio is statistically significant indicating a positive relationship between the HDI indices education, income and Health with non-communicable diseases and injury.
Conclusions: The combination of a double burden of disease with high morbidity rates presents challenges for improving the overall health status of the population and necessitates a comprehensive policy and action to prevent and control this burden.

Keywords: BMI, DALYs, EAG, GDP, HDI

INTRODUCTION

Over time, mortality and disease patterns in human populations transitioned from very high and fluctuating mortality in younger age groups, majorly caused by infectious diseases and nutritional deficiencies to relatively stable low mortality concentrated at older ages, largely caused by non-communicable diseases and injuries.[1] The first phase of the transition was characterized by high, fluctuating mortality dominated by epidemics of infectious diseases, famines and wars. Thereafter, mortality rates declined progressively and degenerative diseases started to replace infectious diseases as the major causes of morbidity and death. Finally, in later stages of the transition, non-communicable diseases such as cardiovascular diseases, diabetes and cancers, and accidents became the main

causes of death, and mortality rates eventually stabilized at relatively low levels.[1-3]

The epidemiological transition occurs when a country undergoes the process of transitioning from developing nation to developed nation status. The developments of modern healthcare and medicine such as antibiotics which drastically reduced infant mortality rates and extended average life expectancy and subsequent declines in fertility rates, reflects a transition to chronic and degenerative diseases as more important causes of death.[1]

Health burden in India is from communicable diseases such as diarrhoea, lower respiratory infections, tuberculosis, and neonatal disorders which are reduced yet remains high. Equally, loss of health due to non-communicable conditions such as heart disease, stroke, and diabetes is rising. This can be measured through Epidemiological Transition Ratio which is defined as the ratio of Disability-adjusted life years (DALYs) caused by Communicable, Maternal, Neonatal and Nutritional Diseases (CMNNDs) to those caused by Non-Communicable Diseases (NCDs) and injuries. A ratio more than one indicates a higher burden of CMNNDs than NCDs and injuries, while a ratio less than one indicates the vice-versa. The lower the ratio, the greater the contribution of NCDs and injuries to a state's overall disease burden.[4]

Conceptually, the theory of epidemiologic transition focuses on the complex change in patterns of health and disease *and* on the interactions between these patterns and their demographic, economic and sociologic determinants, and consequences [5], which can be measured by Human Development Index (HDI) which is a statistic composite index of life expectancy, education, and per capita income indicators, which are used to rank countries into four tiers of human development. A country scores a higher HDI when the lifespan is higher, the education level is higher, and the gross national income GNI (PPP) per capita is higher. It was further used to measure a country's development by the United Nations Development Programme (UNDP) HDI measures as

- A long and healthy life: Life expectancy at birth
- Education index: Mean years of schooling and Expected years of schooling
- A decent standard of living: Gross National Income (GNI) per capita Purchasing Power Parity (PPP international dollars)[6]

In its 2010 Human Development Report, the UNDP began using a new method of calculating the HDI. The following three indices are used:

1. Life Expectancy Index LEI = (LE - 20) / (85-20), LE is life expectancy

LEI is 1 when Life expectancy at birth is 85 and 0 when Life expectancy at birth is 20.

2. Education Index, EI= (MYSI + EYSI)/2

Where,

- MYSI = MYS/15, where MYSI is the mean years of schooling index Fifteen is the projected maximum of this indicator for 2025.
- EYSI = EYS/18, where EYSI is the expected years of schooling index Eighteen is equivalent to achieving a master's degree in most countries.

3. INCOME INDEX, II =

[ln (GNI per capita) - ln(100)]/[ln(75,000) - ln(100)]

II is 1 when GNI per capita is $75,000 and 0 when GNI per capita is $100.

The geometric means of these components equals the[6]

HDI = [LEI * HI * II] ^(1/3)

Over the years, India's HDI rank has improved steadily due to reduction in absolute poverty, along with gains in life expectancy, education, and access to health care.[7]In low- and middle-income countries, an increasing number of studies show associations between NCDs and certain

social determinants, particularly education and income levels.[8]

Objectives:

General Objectives:

To analyze the correlation between Human development Indices and Epidemiological transition Ratio among Indian state.

Specific Objectives:

1. To review the epidemiological transition ratio and respective human development indices of Indian states
2. To prove the hypothesis between human development Indices and Epidemiological transition ratio of Indian states.

Subjects and Methods

Study is based on Secondary sources of data. The human development index data taken from United national development program (UNDP) HDI -India 2019 and epidemiological transition ratio (ETR)status of India states taken from -Indian Council of Medical Research study -India states disease burden 2017) used for analysis.

STUDY DESIGN

The correlation non-experimental study design was used in the study.

Variables

Human Development Index and Epidemiological Transition Ratio

Inclusion Criteria

All Indian states and Delhi

Exclusion Criteria

All Union Territory as per Indian administrative division 2017

Data Analysis Methods

Spearman Rank Order correlation coefficient was used for data analysis.

$$r_s = 1 - \frac{6\sum d^2}{n(n^2-1)}$$

Values always range between

-1 (strong negative relationship)

+1 (strong positive relationship).

Values at or close to zero imply weak or no linear relationship.

Data Analysis Method - Spearman Rank Order correlation coefficient:

S.no	States	HDI= X	Rank X	ETR =Y	Rank Y	D	d^2
1	Kerala	0.779	1	0.16	1	0	0
2	Goa	0.761	2	0.21	2	0	0
3	New Delhi	0.746	3	0.38	11.5	-8.5	72.25
4	Himachal Pradesh	0.725	4	0.30	5	-1	1
5	Punjab	0.723	5	0.29	4	1	1
6	Sikkim	0.716	6	0.45	15.5	-9.5	90.25
7	Haryana	0.708	7.5	0.40	13	-5.5	30.25
8	Tamil Nadu	0.708	7.5	0.26	3	4.5	20.25
9	Mizoram	0.705	9	0.53	20	-11	121
10	Maharashtra	0.696	10.5	0.33	6.5	4	16
11	Manipur	0.696	10.5	0.42	14	-3.5	12.25
12	Jammu and Kashmir	0.688	12	0.34	8.5	3.5	12.25
13	Uttarakhand	0.684	13	0.46	17.5	-4.5	20.25
14	Karnataka	0.682	14	0.34	8.5	5.5	30.25
15	Nagaland	0.679	15	0.47	19	-4	16
16	Gujarat	0.672	16	0.46	17.5	-1.5	2.25
17	Telangana	0.669	17	0.38	11.5	5.5	30.25
18	Arunachal Pradesh	0.660	18	0.55	21	-3	9
19	Tripura	0.658	19	0.45	15.5	3.5	12.25
20	Meghalaya	0.656	20	0.64	26	-6	36
21	Andhra Pradesh	0.650	21	0.37	10	11	121
22	West Bengal	0.641	22	0.33	6.5	15.5	240.25
23	Rajasthan	0.629	23	0.66	27	-4	16
24	Assam	0.614	24	0.62	25	-1	1
25	Chhattisgarh	0.613	25	0.60	23.5	1.5	2.25
26	Madhya Pradesh	0.606	26	0.60	23.5	2.5	6.25
27	Orissa	0.606	26	0.58	22	4	16
28	Jharkhand	0.599	28	0.69	29	-1	1
29	Uttar Pradesh	0.596	29	0.68	28	1	1
30	Bihar	0.576	30	0.74	30	0	0
$\sum d^2 = 937.5$							

$$r_s = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$$

Where,

r_s =Spearman correlation coefficient

d = difference between ranks and d^2 = difference squared

n = number of pairs of data

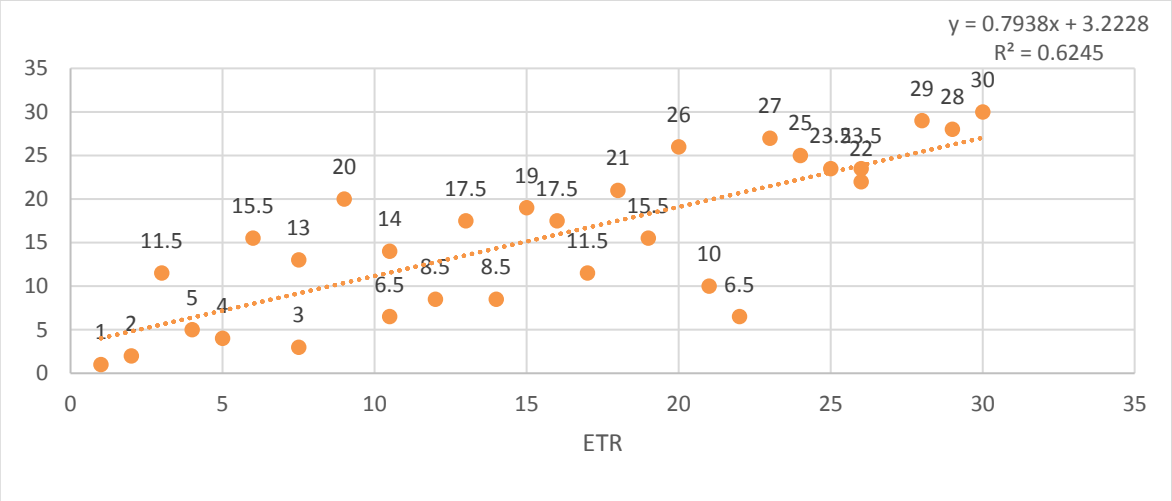
Result Details

X Rank	Mean Rank: 15.5	Standard Deviation 8.8
Y Rank	Mean Rank: 15.5	Standard Deviation 8.8

1-(6×937.5)/30(900-1)=0.792

By normal standard the association between the human development indices and epidemiological transition ratio has been considered statistically significant.

Therefore, this indicates a positive relationship between HDI and ETR.



RESULTS

There appears to be a Positive correlation value (0.78). There is a 0.1% probability that null hypothesis is correct p=0.001 (99.9% statistical significance level). Accordingly, the result accepts the alternate hypothesis (that there is a positive correlation between Human Development Indices and Epidemiological Transitions).

The state Kerala (HDI rank-1 and ETR Rank 1), Goa (HDI rank-2 and ETR Rank 2) Himachal Pradesh(HDI rank-5 and ETR Rank 4) and Punjab (HDI rank-5 and ETR Rank 4) have linear relationship between HDI and ETR (High rank in HDI and ETR).

The bottom rank states Bihar (HDI rank-30 and ETR Rank 30), Uttar Pradesh (HDI rank-29 and ETR Rank 28), Jharkhand (HDI rank-28 and ETR Rank 29), Assam (HDI rank-24 and ETR Rank 25), Chhattisgarh(HDI rank-25 and ETR Rank 23.5) and Madhya Pradesh(HDI rank-26 and ETR Rank 23.5) also have a linear relationship (Low rank HDI to respective ETR).

The States Delhi (HDI rank-3 and ETR Rank 11.5), Haryana (HDI rank-7.5 and ETR Rank 13), Sikkim (HDI rank-6 and ETR Rank 15.5) and Mizoram (HDI rank-9 and ETR Rank 20) does not show a linear relationship (It shows, high HDI but low rank in ETR).

Andhra Pradesh (HDI rank-21 and ETR Rank 10) and West Bengal (HDI rank-22 and ETR Rank 6.5) have Low rank in HDI respective to their ETR. Rest of state have moderate relationship to HDI and ETR.

DISCUSSION

The wide variations between the states in this epidemiological transition are reflected in the range of the contribution of major disease groups to the total disease burden in 2016: 48% to 75% for non-communicable diseases, 14% to 43% for infectious and associated diseases, and 9% to 14% for injuries. Kerala, Goa, and Tamil Nadu have the largest

dominance of non-communicable diseases and injuries over infectious and associated diseases, whereas this dominance is present but relatively the lowest in Bihar, Jharkhand, Uttar Pradesh, and Rajasthan.

However, the magnitude and causes of disease burden and the risk factors vary greatly between the states. The change to dominance of NCDs and injuries over CMNNDs occurred about a quarter century apart in the four ETL state groups. Nevertheless, the burden of some of the leading CMNNDs continues to be very high, especially in the lowest ETL states. This comprehensive mapping of inequalities in disease burden and its causes across the states of India can be a crucial input for more specific health planning for each state.

The major risk factors for NCDs, including high systolic blood pressure, high fasting plasma glucose, high total cholesterol, and high body-mass index, increased from 1990 to 2016, with generally higher levels in higher ETL states; ambient air pollution also increased and was highest in the low ETL group. The incidence rate of the leading causes of injuries also increased from 1990 to 2016. The five leading individual causes of DALYs in India in 2016 were ischemic heart disease, chronic obstructive pulmonary disease, diarrheal diseases, lower respiratory infections, and cerebrovascular disease; and the five leading risk factors for DALYs in 2016 were child and maternal malnutrition, air pollution, dietary risks, high systolic blood pressure, and high fasting plasma glucose. Behind these broad trends many variations existed between the ETL state groups and between states within the ETL groups. Of the ten leading causes of disease burden in India in 2016, five causes had at least a five-time difference between the highest and lowest state-specific DALY rates for individual causes.

Health status improving, but major inequalities between states:

Life expectancy at birth improved in India from 59.7 years in 1990 to 70.3 years in 2016 for females, and from 58.3 years to 66.9 years for males. There were, however, continuing inequalities between states, with a range of 66.8 years in Uttar Pradesh to 78.7 years in Kerala for females, and from 63.6 years in Assam to 73.8 years in Kerala for males in 2016. The per person disease burden measured as DALYs rate dropped by 36% from 1990 to 2016 in India, after adjusting for the changes in the population age structure during this period. But there was an almost two-fold difference in this disease burden rate between the states in 2016, with Assam, Uttar Pradesh, and Chhattisgarh having the highest rates, and Kerala and Goa the lowest rates. While the disease burden rate in India has improved since 1990, it was 72% higher per person than in Sri Lanka or China in 2016. The under-5 mortality rate has reduced substantially from 1990 in all states, but there was a four-fold difference in this rate between the highest in Assam and Uttar Pradesh as compared with the lowest in Kerala in 2016, highlighting the vast health inequalities between the states.

Large differences between states in the changing disease profile:

Of the total disease burden in India measured as DALYs, 61% was due to communicable, maternal, neonatal, and nutritional diseases (termed infectious and associated diseases in this summary for simplicity) in 1990, which dropped to 33% in 2016. There was a corresponding increase in the contribution of non-communicable diseases from 30% of the total disease burden in 1990 to 55% in 2016, and of injuries from 9% to 12%. Infectious and associated diseases made up the majority of disease burden in most of the states in 1990, but this was less than half in all states in 2016. However, the year when infectious and associated diseases transitioned to less than half of the total disease burden ranged from 1986 to 2010 for the various state groups in different stages of this transition. The wide variations between the states in this epidemiological transition are reflected in the range of the contribution of major disease groups to the total disease burden in 2016: 48% to 75% for non-communicable diseases,

14% to 43% for infectious and associated diseases, and 9% to 14% for injuries. Kerala, Goa, and Tamil Nadu have the largest dominance of non-communicable diseases and injuries over infectious and associated diseases, whereas this dominance is present but relatively the lowest in Bihar, Jharkhand, Uttar Pradesh, and Rajasthan.

Infectious and associated diseases reducing, but still high in many states:

The burden of most infectious and associated diseases reduced in India from 1990 to 2016, but five of the ten individual leading causes of disease burden in India in 2016 still belonged to this group: diarrhoeal diseases, lower respiratory infections, iron-deficiency anaemia, preterm birth complications, and tuberculosis. The burden caused by these conditions generally continues to be much higher in the Empowered Action Group (EAG) and North-East state groups than in the other states, but there were notable variations between the states within these groups as well. The range of disease burden or DALY rate among the states of India was 9 fold for diarrhoeal disease, 7 fold for lower respiratory infections, and 9 fold for tuberculosis in 2016, highlighting the need for targeted efforts based on the specific trends in each state. The burden also differed between the sexes, with diarrhoeal disease, iron-deficiency anaemia, and lower respiratory infections higher among females, and tuberculosis higher among males. The proportion of total disease burden caused by infectious and associated diseases was highest among children, which contributed to the disproportionately higher overall disease burden suffered by the under-5 years age group. For India as whole, the disease burden or DALY rate for diarrhoeal diseases, iron-deficiency anaemia, and tuberculosis was 2.5 to 3.5 times higher than the average globally for other geographies at a similar level of development, indicating that this burden can be brought down substantially.

Rising burden of non-communicable diseases in all states:

The contribution of most of the major non-communicable disease groups to the total disease burden has increased all over India since 1990, including cardiovascular diseases, diabetes, chronic respiratory diseases, mental health and neurological disorders, cancers, musculoskeletal disorders, and chronic kidney disease. Among the leading non-communicable diseases, the largest disease burden or DALY rate increase from 1990 to 2016 was observed for diabetes, at 80%, and ischemic heart disease, at 34%. In 2016, three of the five leading individual causes of disease burden in India were non-communicable, with ischemic heart disease and chronic obstructive pulmonary disease as the top two causes and stroke as the fifth leading cause. The range of disease burden or DALY rate among the states in 2016 was 9-fold for ischemic heart disease, 4-fold for chronic obstructive pulmonary disease, and 6-fold for stroke, and 4- fold for diabetes across India. While ischaemic heart disease and diabetes generally had higher DALY rates in states that are at a more advanced epidemiological transition stage toward non-communicable diseases, the DALY rates of chronic obstructive pulmonary disease were generally higher in the EAG states that are at a relatively less advanced epidemiological transition stage. On the other hand, the DALY rates of stroke varied across the states without any consistent pattern in relation to the stage of epidemiological transition. This variety of trends of the different major non-communicable diseases indicates that policy and health system interventions to tackle their increasing burden have to be informed by the specific trends in each state.

Increasing but variable burden of injuries among states:

The contribution of injuries to the total disease burden has increased in most states since 1990. The highest proportion of disease burden due to injuries is in young adults. Road injuries and self-harm, which includes suicides and non-fatal outcomes of self-harm, are the leading contributors to the

injury burden in India. The range of disease burden or DALY rate varied 3-fold for road injuries and 6 fold for self-harm among the states of India in 2016. There was no consistent relationship between the DALY rates of road injuries or self-harm versus the stage of epidemiological transition of the states. The burden due to road injuries was much higher in males than in females. The DALY rate for self-harm for India was 1.8 times higher than the average globally for other geographies at a similar level of development in 2016. India: Health of the Nation's States.

Unacceptably high risk of child and maternal malnutrition:

While the disease burden due to child and maternal malnutrition has dropped in India substantially since 1990, this is still the single largest risk factor, responsible for 15% of the total disease burden in India in 2016. This burden is highest in the major EAG states and Assam and is higher in females than in males. Child and maternal malnutrition contribute to disease burden mainly through increasing the risk of neonatal disorders, nutritional deficiencies, diarrhoeal diseases, lower respiratory infections, and other common infections. As a stark contrast, the disease burden due to child and maternal malnutrition in India was 12 times higher per person than in China in 2016. Kerala had the lowest burden due to this risk among the Indian states, but even this was 2.7 times higher per person than in China. This situation after decades of nutritional interventions in the country must be rectified as one of the highest priorities for health improvement in India.

CONCLUSION

India is currently experiencing the double burden of communicable and non communicable diseases. In recent decades, the age pattern of morbidity has been rising, primarily due to increased prevalence of chronic diseases, resulting in significant structural changes in disease patterns. India is experiencing rapid health transition, including increased life expectancy at old ages (e60 and above). However, the older population is living in poor health. Comprehensive health interventions are required for prevention and control of chronic diseases. However, the older population is living in poor health. Comprehensive health interventions are required for prevention and control of chronic diseases. In terms of mortality transition, In terms of mortality transition, India lags behind developed nations. The combination of a double burden of disease with high morbidity rates presents challenges for improving the overall health status of the population and necessitates a comprehensive policy and action to prevent and control this burden The changing pattern of diseases observed over recent years, from acute infectious and deficiency diseases to the chronic non-communicable diseases, is a continuous process of transformation with some diseases disappearing and others appearing or reappearing. Infectious diseases are still an important public health problem and a major cause of death and of illness and will continue to be so for future generations. At the same time, non-communicable diseases are coming to the forefront as causes of illness and death, especially in countries where it used to be possible to control many communicable diseases. This transition is very vulnerable as many biological, environmental, social, cultural and behavioural factors have been responsible for structuring these patterns in the community. It is subject to breaks in continuity, slowdowns or even reversals of the transition. Several stages of transition may overlap in the same country. This represents a challenge to national health. Epidemiologic surveillance has a major role to play in identifying the chances and in planning how to address them and should be given the attention it deserves. The public has a major role to play, and hence the necessity for public health education and promotion of healthy lifestyles. Health education efforts to achieve positive behavioural changes are essential for the prevention and control of

diseases. A carefully conceived media campaign can have a beneficial effect on changing behaviours related to the occurrence of diseases, such as smoking, obesity, alcohol consumption and other dangerous behaviour and promote healthy lifestyle. Burden of NCDs and their risk factors should be viewed broadly for their impact on life expectancy, quality of life, social and economic implications. India has to achieve the Sustainable Development Goal-3 to ensure healthy lives and promote well-being at all ages as well as Target 3.4 to reduce by one third the premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being. The fraternity of Community Medicine needs to rise to the occasion by contributing in a big way to prevent and control NCDs, particularly in the areas of surveillance, capacity building, health promotion, behaviour change communication, public health management and operational research for universal access, especially in the rural areas and urban poor communities.

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