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Infant Mortality in the Indian State: Trends, Patterns and Instability since 2001-02

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Abstract

Health is one of the major component of development. Health not only promotes social development but also enhances economic development of a nation. Health and education are the two important aspect of human capital formation. Health can be considered both input and output of development. After the constant effort of the United Nations through adopting two important vision named Millennium Development Goals and Sustainable Development Goals**,** study of health sector with a special focus on child mortality is necessary. On this background, this paper aims to analyse the trend, pattern and instability of the growth rate in India and it's different states for the time period 2001-02 to 2016-17. Taking data from different bulletins of Sample Registration System the study analyses the trend by fitting simple trend line and to measure the growth rate with structural break CUSUM and CUSUMSQ tests are conducted. Using Poirier's Spline Function Approach the growth rate for different regimes are calculated and the instability was measured by using Cuddy Della Valle index. The study concludes that the decline in mortality rate is slow in India with variations across states. The rate is found to be stable with Manipur and Kerala being the most successful states in terms of growth and instability whereas Madhya Pradesh is the least performing state. The study prescribes for a more articulated policy framework.

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1. Introduction

From Millennium Development Goals to Sustainable Development Goals, health remained as an important indicator of development. Improving health through reducing mortality of children and mothers is one of the major goals of all the countries globally. The target of Millennium Development Goals to reduce child mortality was taken over by the Sustainable Development Goals and a new target was set to reduce neonatal and under five mortality to at least 12/1000 and 25/1000 live births. After Millennium Development Goals was signed in the year 2000, all the 191 adopted various measures to achieve the targets. India is not an exception. India also adopted many pioneering measures and implemented various programmes to reduce child mortality. India framed two policies considering the account of MDGs namely, the National Population Policy 2000 and the National Health Policy 2002 (Ramachandran 2016). The programmes started paying off and the mortality rate started declining over the years. The Infant Mortality Rate (IMR) declined from 66 in 2001-02 to 34 in 2016-17. Infant mortality rate is one of the major indicator of development in health sector. Infant mortality rate may be defined as "The infant mortality rate is the number of deaths under one year of age occurring among the

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live births in a given geographical area during a given year, per 1,000 live births occurring among the population of the given geographical area during the same year." The importance of IMR can be well articulated from the targets set by both Millennium Development goals (goal 4) and Sustainable Development Goals (Goal 3). Various empirical study show the importance of infant mortality with economic growth and development (Weintraub, 1962; Measham et al, 1999; Ozcan, 2002; Berg et al, 2006; Acemoglu and Johnson, 2007; Arik and Arik, 2009). Weintraub (1962) in his study confirmed the Malthusian hypothesis that increment in income increases the birth rate but it reduces with urbanization and decrease in infant mortality. Martin et al, (1983) found relationship between level of economic development and mortality of the nation. They also have examined mortality differentials by socio-demographic and environmental factors, both at aggregate and individual levels within a nation. Measham et al, (1999) in their study found that infant mortality rate is affected by both income and non-income related factors. The study concluded that along with income changes immunization level and family planning programme also have a role in controlling IMR. Another study was conducted by Anand et al, (2000) where they found that to reduce the rate of infant mortality, development is not the predominant factor. They opined that apart from social development confined attention on health based intervention also can reduce the IMR. Ozcan (2002) in his study found with reduced mortality increases economic growth and thus the level of education and fertility changes. Berg et al, (2006) suggested that the effect of bad economic condition may result in high mortality in later life, therefore, they suggested a special attention on the neonatal care but Acemoglu, and Johnson, (2007) found no significant impact of life expectancy on GDP. Chaurasia (2020) found that the trend of decrease in Infant Mortality Rate has variation across states in India. On this background, we are intrigued to assess the growth of IMR in India across states and to investigate if there is any structural shift in the pattern of IMR. Further we have analysed the instability in the trend of IMR for the states taken into consideration. With the introduction of various programmes and schemes with the effort of the country to uplift the health sector, the pattern changes and thus it is important to study the trend and instability in the trend to better assess the success of the health sector.

The paper is organized as follows. The next section discusses the data sources of the study followed by the methods used to analyse the trend and instability in the trend. Section four presents the results of the study and finally the paper ends with a conclusion.

2. Data and Methods

The study is entirely based on secondary data collected from the Sample Registration System (SRS) Bulletin issued from 2001-02 to 2016-17. The states under SRS are divided into bigger states, smaller states and union territories. We have taken bigger states into consideration along with all the north eastern states. The states considered in this study are Andhra Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal, Arunachal Pradesh, Himachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, and Uttarakhand.

The present paper used the econometric models to assess the objectives of the study. The study mainly focuses on the growth and instability assessment of the Infant Mortality Rates in Indian states over the years of 2001-02 to 2016-17.

2.1. Growth Rate

The growth rate of the variable IMR is assessed for different regimes as Regime- I for 2001-02 to 2008-09, Regime- II for 2008-09 to 2016-17 and taking the whole years as Regime- III for 2001-02 to 2016-17. Following Poirier's (1974), spline function approach,

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the trend in the growth of several variables of interest is looked into for different regimes.

Assuming a linear time trend, the postulated model is

$$\left.\begin{aligned}\ln Y_t &= \alpha_1 + \beta_1 t + u_t \text{ for } 2002-2003 < t \le 2008-2009\\ \ln Y_t &= \alpha_2 + \beta_2 t + u_t \text{ for } 2008-2009 < t \le 2012-2013\end{aligned}\right\} \quad (1)$$

Let us define the following variables

$$w_{1t} = t; w_{2t} = \left\{\begin{array}{c} 0,\ t \le 2008-2009 \\ if \\ t-2008,\ 2008\text{-}2009<t \end{array}\right\} \quad (2)$$

and reparameterise the function as

$$\ln Y_t = \alpha_1 + \delta_1 w_{1t} + \delta_2 w_{2t} + u_t \quad (3)$$

The expression $[\exp(\beta_i)-1]*100$ will yield the percentage growth rate for the *ith* regime $i = 1, 2$ where $\beta_1 = \delta_1$ and $\beta_2 = \delta_1 + \delta_2$. Equation (3) will be used to compute the growth rates of desired variables for different regimes. Following Maity (2013) the growth rate for the entire period 2001–2002 to 2016–2017 will be computed by using the following equation:

$$\ln Y_t = \alpha + \beta t + u_t \quad (4)$$

2.2. Measurement of Instability

This section looks at the measures used to evaluate the instability in the IMR figures for India for different years. To measure the instability we can use coefficient of variations, dispersion or Cuddy Della Valle Index. Among all these measures Cuddy Della Valle Index is the most appropriate one as this index takes into account the time trend in a variable which is not captured by coefficient of variations (Sihmar, 2014). Therefore, we use Cuddy Della Valle (1978) index of instability for this purpose. Following Maity (2013) the Cuddy–Della Valle index is defined as follows:

$$I_X = CV\sqrt{1-\bar{R}^2} \quad (5)$$

where CV is the coefficient of variation and $\bar{R}^2$ is the corrected or the adjusted coefficient of multiple determination of the trend function that best fits the series of IMR. If $\bar{R}^2$ <0 then unadjusted is chosen.

2.3. Stationary

When we use time series data stationarity test is a must. If the data is not stationary the estimators will not be reliable for prediction and policy prescription. Therefore we feel that test of stationarity of the time series data used in our analysis is necessary. Therefore following Maity (2013) we have used the 'Phillips Perron' non-parametric test to test the presence of unit root in the time series data and the hypothesis of absence of unit root or stationarity has been accepted at 5% level.

3. Results

In this section we are going to discuss the results obtained after estimating the data on IMR in different states of India. We have observed the trend of decline in IMR in India over the time period of 2001-02 to 2016-17. The descriptive statistics of the output variable for different states is also calculated to further clarify the scenario. Further we have calculated the growth rate of IMR for different states in different regimes and the instability also.

3.1. Trend of Infant Mortality Rate in India

In this section we are going to discuss the trend of Infant Mortality Rate in India during the period of 2001-02 to 2016-17. The trend analysis gives us a clear vision about the success of the country in controlling mortality. Below Table 1 represents the trend results related to this research work and also we will try to give explanation about the results.

Table 1: Infant Mortality Rate of India from 2001-02 to 2016-17

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Year	IMR
2001-02	66
2002-03	68
2003-04	60
2004-05	58
2005-06	58
2006-07	57
2007-08	55
2008-09	53
2009-10	50
2010-11	47
2011-12	44
2012-13	42
2013-14	40
2014-15	38
2015-16	37
2016-17	34

Source: Sample Registration System Bulletin on different issues

Table 1 depicts the picture of infant mortality rates and it is observed that the rate is declining over time. During 2001-02 it was 66 per 1000 live births whereas in 2016-17 it is 34 per 1000 live births. In the Millennium Development Goals, one goal was to reduce child mortality. To achieve this goal various countries have taken several programmes and India is also included in those countries. To achieve the target 4 (a) of Millennium Development Goals India introduced several programmes to reduce the under-five mortality by 2015.After introducing those programmes the mortality rate has been on a declining trend. The Table 1 also confirms it. But it should be mentioned that though the table shows a declining trend in the rate but the rate of decrease is very slow. The current SDGs also set a benchmark to reduce the mortality. But this trend indicates that although India is proceeding towards achieving the goal of reduction in mortality rate but the success rate is very low. The table can be better understood with graphical presentation and hence below we present a bar diagram and a trend line is fitted on the basis of the table in the following two figures.

Figure 1: Infant Mortality Rate in India for the Year 2001-02 to 2016-17

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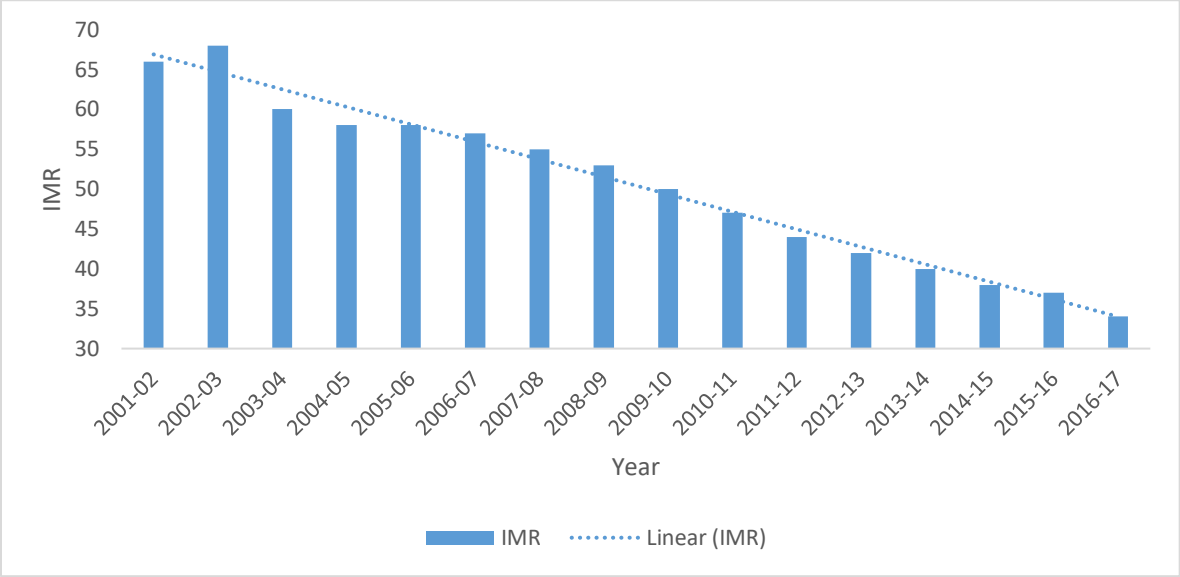
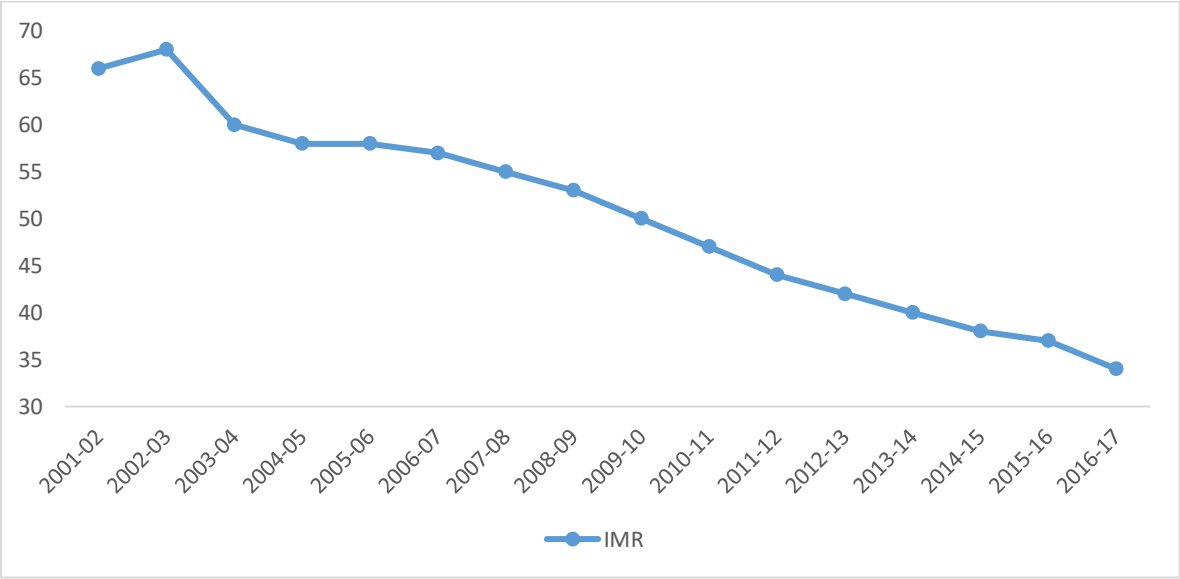


Source: Authors' construction on the basis of numbers in Table 1

Figure 1 is a diagrammatical representation of the trend of infant mortality rate in India. With the help of a simple bar diagram the trend is showed for the whole time period of 2001-02 to 2016-17. It is observed in the figure that the bars are declining over time in accordance with the data presented in above table. Thus the bar diagram supports the linear representation of the data. Below we fitted a trend line on the basis of the data provided in Table 1.

Figure 2: Trends of Infant Mortality Rate in India 2001-02 to 2016-17



Source: Authors' construction on the basis of numbers in Table 1

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Figure 2 is a representation of the trend line fitted on the basis of the Table 1. As it can be seen in the Figure 2 that the trend line is a linear one which implies that the rate of infant mortality is declining over the time period of 2001-02 to 2016-17. But the slope of the trend also supports the fact that the decline is mortality is very slow in India. On the other hand, though the trend of IMR is declining in India but there may be variations across the states. Therefore, below we represent the descriptive statistics of the IMR for different states to get an in depth picture of the IMR.

3.2. Descriptive Statistics of the IMR for Different States

The following table represents the descriptive statistics for India and different states of India. We have calculated mean, standard deviation, maximum, minimum and the range value of the rates of infant mortality. The descriptive statistics of a data helps us to better understand the nature of the data. Uniformity of any data assures the application of a single policy across the states.

Table 2: Descriptive Statistics of Infant Mortality Rate of India and it's States for the period of 2001-02 to 2016-17

State's/UT's	Mean	Std. Dev.	Min	Max	Range
Andhra Pradesh	52.73	11.54	34	71	37
Assam	61.53	8.89	44	73	29
Bihar	51.93	9.40	38	63	25
Chhattisgarh	55.93	12.05	39	80	41
Gujarat	51.20	12.02	30	68	38
Haryana	52.13	10.63	33	66	33
Himachal Pradesh	42.27	9.20	25	53	28
Jammu & Kashmir	43.60	9.12	24	54	30
Jharkhand	44.47	8.24	29	55	26
Karnataka	44.20	12.18	24	65	41
Kerala	13.00	1.60	10	16	6
Madhya Pradesh	68.80	13.45	47	89	42
Maharashtra	34.73	9.55	19	52	33
Odisha	65.80	14.57	44	90	46
Punjab	38.60	11.36	21	55	34
Rajasthan	62.20	13.06	41	81	40
Tamil Nadu	31.40	10.94	17	50	33

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Uttarakhand	46.73	9.74	32	62	30
Uttar Pradesh	63.27	14.75	34	83	49
West Bengal	36.07	7.49	25	52	27
Arunachal Pradesh	34.15	3.11	30	40	10
Manipur	12.38	2.29	9	16	7
Meghalaya	51.54	6.12	39	59	20
Mizoram	28.92	7.58	16	37	21
Nagaland	19.33	4.54	12	26	14
Sikkim	28.08	6.26	16	34	18
Tripura	29.92	5.07	20	39	19
India	51.27	10.35	34	68	34

Source: Authors' Calculation from Sample Registration System Bulletin, different issues

Table 2 reveals that the mean value of the state Manipur is the lowest in the table preceded by Kerala and Nagaland. Madhya Pradesh has the highest mean value of IMR followed by Odisha and Uttar Pradesh. The implication of the higher mean value is that the mortality rate in the particular state is high. Thus the Table 2 shows that the rate of Infant Mortality Rates in Madhya Pradesh, Odisha and Uttar Pradesh are quite high. It is notable from the Table 1 that among the twenty seven states considered for the study, nine states are having the mean value above the country average (51.27). The maximum and minimum values along with the range give us a clear idea about the success of the particular state in controlling the death of children within first year of birth. The lower value of the difference between highest and lowest values for Manipur and Kerala do not imply the unsuccessful effort of both the states. As the rate of mortality in these two states were minimum all through the time period, the range also gives a lower value. In the above Table 2 the standard deviation is also shown. Lower the value of the standard deviation better is the representation of the data for actual scenario. In case of standard deviation, Kerala shows the minimum value depicting uniformity of the data preceding by Manipur, Arunachal Pradesh, Nagaland and Tripura respectively. The lower value of the standard deviation in those states implies that a uniform policy may be applicable for the whole state as there is less deviation. Whereas in case of Odisha followed by Uttar Pradesh, Madhya Pradesh and Karnataka respectively, the standard deviation quite high is meaning a single policy for the entire state will not be successful. Because the higher value of standard deviation implies that the rate of infant mortality in some parts of the states are very low whereas in some parts of the states are very high. Therefore a single policy prescription will not be valid. It may also be noted from Table 2 that the values of the north eastern states are quite satisfactory with a low level of mean and standard deviation values. But the case of Assam is an exception where the mean value is as high as 61.53, which is an alarming condition. It indicates that Assam need more attention in the health sector and in controlling the mortality. The mean and standard deviation of thye entire India is also quite high implying a better and state specific policy prescription

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for the country. In the subsequent section we are going to discuss the growth rate and instability of the IMR for India and different states of India. The results are presented in Table 3.

3.3. Growth Rate in Different Regimes and Instability of the IMR

With the introduction of various policy and programmes the pattern and stability of mortality changed in India across states. Though the changes are not uniform across time and space. Thus a detailed analysis of the growth and instability of Infant Mortality Rate can help us to understand the state specific achievements and failures. Below Table 3 represents the same.

Table 3: Growth rate and instability of the IMR for India and its different states

Item → / States ↓	Growth rate of IMR for India and different states of India			Instability of IMR for India and different states of India	
	Regime-I (2001-02 to 2008-09)	***Regime-II (2008-2009 to 2016-2017)***	***Entire Regime (2001-02 to 2016-17)***	$\bar{R}^2$	***Cuddy Della Valle Index (I_x)***
Andhra Pradesh	-4.4940	-5.5598	-5.0269	0.9709	0.0099
Assam	-2.7025	-4.2427	-3.4726	0.8913	0.0122
Bihar	-3.1765	-3.4935	-3.3350	0.9189	0.0134
Chhattisgarh	-5.6205	-3.9670	-4.7937	0.9455	0.0123
Gujarat	-3.7361	-7.1829	-5.4595	0.9139	0.0192
Haryana	-3.0036	-5.9634	-4.4835	0.9103	0.0166
Jammu & Kashmir	-0.4059	-8.0748	-4.2404	0.6212	0.0400
Jharkhand	-3.0446	-5.6829	-4.3638	0.9198	0.0148
Karnataka	-5.5355	-7.9053	-6.7204	0.9605	0.0155
Kerala	4.2703	-4.5003	-0.1150	0.0249	0.0480
Madhya Pradesh	-3.9075	-4.9147	-4.4111	0.9776	0.0072
Maharashtra	-5.3593	-7.7662	-6.5627	0.9276	0.0224
Odisha	-4.9200	-4.9529	-4.9365	0.9873	0.0061
Punjab	-5.3108	-7.7065	-6.5087	0.9626	0.0169
Rajasthan	-3.8404	-5.4830	-4.6617	0.9579	0.0110
Tamil Nadu	-9.0415	-5.2214	-7.1315	0.9587	0.0210

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Uttar Pradesh	-3.5895	-6.3099	-4.9497	0.8481	0.0250
West Bengal	-6.5856	-3.2865	-4.9361	0.9119	0.0170
Arunachal Pradesh	-0.7545	1.9922	0.8478	0.2444	0.0221
Himachal Pradesh	-3.4639	-6.5812	-5.0226	0.8933	0.0207
Manipur	-1.8540	-2.3588	-2.1485	0.4271	0.0561
Meghalaya	0.5745	-5.4489	-2.9391	0.4516	0.0236
Mizoram	20.3765	-4.1840	6.0495	0.4801	0.0626
Nagaland	11.4507	-9.6933	-2.0046	0.1620	0.0786
Sikkim	0.1618	-9.6266	-5.5481	0.6933	0.0425
Tripura	1.7034	-3.9982	-1.6225	0.5527	0.0350
Uttarakhand	-5.2452	2.3459	-1.4496	0.6211	0.0340
India	-2.9910	-6.1370	-4.5640	0.9625	0.0104

Source: Authors' calculation based on SRS bulletin, various issues

The above Table 3 divides the entire time period of the Infant Mortality Rates into three different regimes namely, Regime I for 2001-02 to 2008-09, Regime II for 2008-09 to 2016-17 and Regime III for the entire time period of 2001-02 to 2016-17. Using CUSUM and CUSUMSQ tests a structural break point is determined at 2008-09. A close perusal of the table reveals that during the first regime the growth rate of Infant Mortality was negative for the states except for the north eastern states namely Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. But during the Regime II the entire states are experiencing a negative growth in the Infant Mortality Rate. It states the fact that there was a structural break in 2007-08 after which the mortality rate started declining more rapidly. This may be due to the various programmes introduced to control the mortality rates. It can be mentioned here that on 12th April 2005, a health scheme named National Rural Health Mission was launched with a vision to provide accessible, affordable and quality health care to the rural areas of the country, especially to the vulnerable groups. Therefore, the structural break may be the effect of that scheme, as we know that every programme has a lagged time period to reflect.

The instability of a data implies that the trend is going to pertain in the long run. To measure the instability we have used the Cuddy Della Valle Index. A lower value of the index implies lower instability of the pattern. Thus it is important to know whether the low values captured by a state is going to be persistent over time or it is just a short run phenomenon. The stability calculation of the trend help us to better frame the policies for future references. As the Table 3 reveals a lower values of Cuddy Della Valle index for almost all the states, we can assume that the current trend of Infant Mortality rates in the states are going to be persistent over time. This can be a matter of concern for the high mortality states like Madhya Pradesh and Odisha. As the value of the entire India is also comparatively lower at 1.12, India as a whole needs some serious economic and health sector intervention to prevent the mortality.

4. Conclusions

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From our above discussion it can be concluded that though the mortality in India is in declining trend but the lower pace of decline is a serious concern for the economy. The Ministry of Statistical and Programme Implementation Reported that India may miss the target set by Millennium Development Goals to reduce the mortality by 2015 (MoSPI, 2015) and even after the introduction of Sustainable Development Goals the target range seems far from achieving. Although the trend is not uniform and some states are successful in controlling the mortality and the growth was seen to be stable. Therefore, the states that are lagging behind may follow the techniques used by the successful states to pull behind the mortality rates. It should be mentioned that apart from economic factors there are many non-economic factors also that effect the mortality rates. The state as well as the country as a whole should consider those exogenous and endogenous factors of mortality and frame the proper policies. It can be suggested that the central and the state governments may collaborate for achieving the target. The National Health Policy, 2017 may play vital role in achieving the goals of SDGs and thus efforts should be made to make it successful. This study concentrates on the growth and instability of the mortality trend for the states, but the factors behind this trend is not considered here. This can be further considered to analyse the input behind the final outcome as Infant Mortality Rate.

References

1. Ramachandran, P. (2016). Millennium development goals (MDG): India's progress and way forward to sustainable development goals. *Proceedings of the Indian National Science Academy*, *82*(5), 1351-1365.
2. Weintraub, R. (1962). The birth rate and economic development: An empirical study. *Econometrica: Journal of the Econometric Society*, 812-817.
3. Measham, A., Krishna D. Rao, Jamison, D., Wang, J., & Alaka Singh. (1999). Reducing Infant Mortality and Fertility, 1975-1990: Performance at All-India and State Levels. *Economic and Political Weekly*, *34*(22), 1359-1367. Retrieved September 16, 2020, from http://www.jstor.org/stable/4408024
4. Kalemli-Ozcan, S. (2002). Does the mortality decline promote economic growth?. *Journal of Economic Growth*, *7*(4), 411-439.
5. Acemoglu, D., & Johnson, S. (2007). Disease and development: the effect of life expectancy on economic growth. *Journal of political Economy*, *115*(6), 925-985.
6. Van den Berg, G. J., Lindeboom, M., & Portrait, F. (2006). Economic conditions early in life and individual mortality. *American Economic Review*, *96*(1), 290-302.
7. Arik, H., & Arik, M. (2009). Is It Economic Growth or Socioeconomic Development? A Crosssectional Analysis of the Determinants of Infant Mortality. *The journal of developing areas*, 31-55.
8. Martin, L. G., Trussell, J., Salvail, F. R., & Shah, N. M. (1983). Co-variates of child mortality in the Philippines, Indonesia, and Pakistan: an analysis based on hazard models. *Population Studies*, *37*(3), 417-432.
9. Chaurasia, A. R. (2020). Long-term trend in infant mortality in India: a joinpoint regression analysis for 1981-2018. *medRxiv*.
10. Anand, K., Kant, S., Kumar, G., & Kapoor, S. K. (2000). "Development" is not essential to reduce infant mortality rate in India: experience from the Ballabgarh project. *Journal of Epidemiology & Community Health*, *54*(4), 247-253.
11. Maity, S. (2013). India's leather and manufactures export in the scenario of WTO: an

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ISSN: 0193-4120 Page No. 4100 - 4110

analysis trend and structural shift. *Managing Global Transitions*, *11*(3), 261.

12. Poirier, J. D. 1974. The Econometrics of Structural Change. Amsterdam: North-Holland.
13. Sihmar, R. (2014). Growth and instability in agricultural production in Haryana: A district level analysis. *International Journal of Scientific and Research Publications*, *4*(7), 1-12.
14. Ministry of Statistics and Programme Implementation (MOSPI) Millennium Development Goals India Country Report (2015), Retrieved from, http//mospi.nic.in/Mospi_new/upload/mdg, on 28 March 2019.