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Change in Life Expectancy at Birth in India 1998-2017

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Abstract

In this paper, we use official life tables of India to analyze the change in life expectancy at birth in India and selected states during 1998-2002 through 2013-2017. The analysis reveals a deceleration in the increase in the life expectancy at birth in the country and in most states because of the deceleration in the increase in female life expectancy at birth. Most of the increase in the life expectancy at birth is attributed to the increase in the person-years lived during the first 15 years of life, especially, during the first 5 years of life. Moreover, person-years lived in the age group 75 years and above appears to have decreased over time. In females, there is a marked decrease in person-years lived in the age group 50-75 years in recent years which appears to be responsible for the deceleration in the increase in female life expectancy at birth.

Key Words

India, States, Life expectancy at birth, Decomposition, Life tables

Introduction

The abridged life tables, prepared by the Registrar General and Census Commissioner of India from the age-specific death rates available through the official Sample Registration System (SRS) suggest that the life expectancy at birth (e_0) in India increased by more than 6 years from 62.9 years during 1998-2002 to around 69 years during 2013-2017 (Government of India, 2019). The increase has been more rapid in females (6.4 years) compared to males (5.9 years). When compared with United Nations model mortality improvement schedules (United Nations, 2004), male mortality improvement in India has been somewhere between slow to medium trajectory while female mortality improvement has been somewhere between medium to fast trajectory of improvement. The United Nations model mortality improvement schedules are based on the increase in life expectancy at birth in different countries of the world during 1950-2005, covering life expectancies between 50 and 85 years (United Nations, 2004). United Nations also estimate that e_0 in India was around 69 years during 2015-2020 which is 3 years lower than the world average of around 72 years (United Nations, 2019). India ranks 144 among 201 countries for which estimates of e_0 are prepared by the United Nations in 2019, which means that e_0 in India is low by international standards.

India was one of the signatories of the Programme of Action adopted at the 1994 International Conference on Population and Development at Cairo (United Nations, 1994). One of the goals of the Programme of Action was that every country would take appropriate steps to increase e_0 to more than 70 years by the year 2005 and to more than 75 years by the year 2015. Viewed from this perspective, the increase in life expectancy at birth in India has fallen substantially short of the commitment made way back in 1994. India's National Health Policy 2017 now aims at increasing e_0 to 70 years by 2025 (Government of India, 2017), which means a significant scaling down of the target compared to what was committed more than 25 years ago.

Within the country, there are marked gender and residence differentials and regional variations in e_0 which have persisted over time. The male e_0 was higher than female e_0 in up to 1980 but female e_0 exceeded male e_0 after 1980 and the gap widened till 2009-2013 but narrowed down subsequently (Government of India, 2019). On the other hand, urban-rural gap in e_0 decreased from around 11 years during 1970-1975 to around 4.8 years during 2004-2008 but has remained virtually unchanged since then (Government of India, 2019). Among 17 major states of the country – states with a population of at least 10 million – for which official abridged life tables are available, e_0 ranged from more than 75 years in Kerala to 65 years in Uttar Pradesh during 2013-2017 (Government of India, 2020). There are only six states, in addition to Kerala, where e_0 is estimated to be more than 70 years. The within-country disparity in e_0, based on the life expectancy in 17 states has, however, narrowed down from around 13.9 years during 1998-2002 to around 10.2 years during 2013-2017. Estimates of e_0 for smaller states and Union Territories of the country are not available.

Mortality in India has been subject to intensive research in the context of both demographic and epidemiological transition (Mari Bhat, 1987; Roy and Lahiri, 1987; Bhat and Navaneetham, 1991; Navaneetham, 1993; Chaurasia (Ranjan), 1993; Chaurasia, 2010; Yadav and Arokiasamy, 2020). These studies suggest that mortality transition in India has been associated with the concentration of deaths near the modal age-at-death, which has ranged from 75 years in rural men to 81 years in urban women (Yadav and Arokiasamy, 2020). There is also evidence of expansion in mortality in older ages, featured by a shift in the disease pattern from communicable to non-communicable diseases (Yadav and Arokiasamy, 2010). The epidemiological transition in India is characterized by dual burden of diseases and there is a strong disparity in the disease pattern within the country. In some states, burden of communicable diseases continues to be high whereas in other states, non-communicable diseases have gained prominence over time (India State-Level Disease Burden Initiative Collaborators, 2017).

Life expectancy at birth is the most widely used summary measure of population health (Wilmoth, 2000). Increase in e_0 can be attributed to several factors, including rising living standards, improved lifestyle, better education, and greater access to quality health services (OECD, 2021). It is also a useful measure of average life span (Aburto *et al*, 2020). It is recognized as one of the basic indicators of health

and social development in the minimum national social data set endorsed by the United Nations Statistical Commission. Norheim *et al,* (2014) have estimated that 40 per cent reduction in premature deaths in the world would result in an increase of 5 years in global e_0 under the assumption that mortality rates at ages 70 and over would decline as projected by WHO (WHO, 2013). Life expectancy at birth summarizes the survival experience of the entire population. The relationship between the two is reciprocal but complicated. The contribution of the increase in person-years lived in different ages to the increase in e_0 is, however, different for different ages (Pollard, 1982). Analyzing the change in e_0 is important as increasing the length of life has always been one of the key development agendas throughout the world. Improvement in people's health and reduction in mortality are the most proximate approaches of increasing the length of the life.

The present paper has two objectives. The first objective is to analyze the change in e_0 in India and in its selected states during the period 1998-2017. This analysis assumes that the trend in e_0 may not be linear (on a log scale) during the period because there have been major policy level changes in India after 2000. A new population policy was announced in 2000 (Government of India, 2000), followed by a new health policy in 2002 (Government of India, 2002). In 2005, the National Rural Health Mission was launched (Government of India, 2005) which was followed by the launch of National Urban Health Mission in 2013 (Government of India, 2013a). The two Missions have subsequently been subsequently clubbed into the National Health Mission in 2013 which aims at universal access to equitable, affordable, and quality health care services that are accountable and responsive to people's health needs (Government of India, 2013b). India has also recorded an unprecedented economic growth during this period (Government of India, 2018). It may, therefore, be hypothesized that policy level changes and the rapid economic growth during the period under reference may have resulted in the change in the trend in e_0.

The second objective of the paper is to analyze the extent to which change in the age-specific probabilities of death or, equivalently, age-specific probabilities of survival have contributed to the change in e_0. The change in the probability of death in different ages induces a change in e_0 but the contribution of the change in age-specific probability of death in different ages to the change in e_0 is different. The decomposition of the change in e_0 into the change attributed to the decrease or increase in the probability of death in different ages, therefore, can help to interpret the trend in e_0.

The paper is organized as follows. The next section of the paper describes the data used in the analysis. We use official life tables released by the Registrar General and Census Commissioner of India. The third section outlines the methods used in the analysis. The trend in e_0 in India is analyzed in section four of the paper. Section five decomposes increase in e_0 into the change in the survival experience in different ages. Section six analyses regional or inter-state variation in the trend in e_0 and the decomposition of the trend. Section seven discusses the findings of the analysis in the context of population health in India while the last section summarizes key findings of the analysis.

Materials and Methods

Data Source. The analysis is based on the abridged life tables prepared by the Registrar General and Census Commissioner of India using age-specific death rates available from India's official sample registration system (SRS). These abridged life tables are available for the country and for its 17 states having at least 10 million population at the 2011 population census. These 17 states accounted for more than 91 per cent population of the country at the 2011 population census. The abridged life tables are available for both sexes and separately for males and females, and rural and urban populations as well as for four mutually exclusive population groups – rural male; rural female; urban male; and urban female. Abridged life tables for smaller states and Union Territories are not available from SRS, although e_0 for India and it's all states and Union Territories have been estimated for the period 1990 through 2019 following indirect approach (Smits and Permanyer, 2019).

SRS is a large-scale demographic sample survey based on the mechanism of a dual record system which was launched in 1964-65 on a pilot basis to provide reliable estimates of fertility and mortality indicators. Since 1969-70, SRS covers the entire country (Government of India, 1971). Data from SRS are considered the most reliable of all death statistics available in India (Roy and Lahiri, 1988; National Population Commission, 2001; Mathers, Fat, Inoue, *et al.*, 2005). Saikia, Singh and Ram (2010) have compared age-specific death rates available from SRS with age-specific death rates estimated from the National Family Health Survey and found that, except possibly at older ages, the age-specific death rates based on SRS and NFHS show good concordance. For the construction of the life table, five-years average of age-specific death rates are used to adjust for sampling fluctuations and to augment sample size (Government of India, 2019) with the assumption that the five-years average refers to the mortality experience in the mid-year of the five-years interval. Thus, the abridged life table for the period 1998-02 is assumed to reflect the mortality experience in the year 2000. In situation where no death is reported under SRS in an age-group, the age-specific death rate for that age group is imputed based on a geographic approach (Government of India, 2019).

For the construction of life tables, five-years average age-specific deaths rates are converted into age-specific probabilities of death following the Greville method (Greville, 1943). However, some error in the conversion of age-specific death rates into age-specific probabilities of death in the age group 1-4 years was reported in the abridged life tables for the period 1996–2000 through 2002–2006 (Saikia, Singh, and Ram, 2010). These life tables have subsequently been reconstructed after correcting the inconsistent estimates of age-specific probability of death in the age group 1-4 years (Government of India, 2012). These reconstructed abridged life tables have been used in the present analysis.

Life tables for India have also been prepared by United Nations (United Nations, 2019) and World Health Organization (WHO, 2018). The estimate of e_0 based on SRS is found to be close to estimates prepared by both United Nations and World Health Organization. According to United Nations, e_0 increased in India by 2.24 years between 2005-10 and 2010-15 whereas the corresponding increase according to

official life tables was 2.22 years. Similarly, according to WHO, the increase in e_0 in India was 2.1 years between 2005-2010 and 2010-15. The UN and WHO life tables, however, are not available for rural and urban areas and for the states of the country. In view of strong residence and regional disparity in mortality in India that has persisted over time, any analysis of the change in life expectancy at birth in the country is incomplete without an analysis of within country, residence, and regional variation in the change in e_0.

Methods. The analysis has been carried out in two parts. The first part is devoted to analysing the trend in e_0 while the second part analyses the contribution of the change in age-specific survival probabilities to the change in e_0. The trend analysis has been carried out following the assumption that the change in e_0 during the period under reference may not be linear (on a log scale) as is generally assumed. The trend analysis, therefore, first identifies the time (year) when the trend in e_0 has changed so that the period under reference is divided into temporal segments. The trend analysis has then been carried out separately for each temporal segment assuming that the trend is linear (on a log scale) in the temporal segment.

There are different methods available for identifying the time (year) when the trend has changed. These include permutation test method (Kim, Fay, Feuer, *et al*., (2000), Bayesian Information Criterion (BIC) (Kim, Yu and Feuer, 2009), BIC3 (Kim and Kim (2016) and Modified BIC (Zhang and Siegmund (2007). The permutation test method is taken the gold standard, but the method is computationally very intensive. BIC performs well to detect a change with a small effect size but has a tendency of over-estimating number of times (years) when the trend has changed. Modified BIC is the most conservative but performs well to detect a change with a large effect size. Performance of BIC3 is comparable to that of the permutation test method.

The joinpoint regression analysis has been used for analyzing the trend in e_0. The joinpoint regression analysis is similar to the piecewise regression analysis. The only difference is that the time-points or joinpoints when the trend has changed are determined from the data in the joinpoint regression analysis, whereas they are decided or fixed beforehand in the piecewise regression analysis. Let y_i denotes the life expectancy at birth (e_0) for the year t_i such that $t_1<t_2<...<t_n$ and define the variable u_j as

$$u_j = \begin{cases} (t_i - k_j) & \text{if } t_i > k_j \\ 0 & \text{otherwise} \end{cases}$$

Where $k_1<k_2.....<k_j$ are joinpoints or the year when the trend has changed.
Then the joinpoint regression model is defined as

$$\ln y_i = \alpha + \beta_1 t_1 + \delta_1 u_1 + \delta_2 u_2 + ... + \delta_j u_j + \varepsilon_i \qquad (1)$$

Details of joinpoint regression analysis are given elsewhere (Kim *et al*, 2000; Kim *et al*, 2004). The trend in each temporal segment can be characterized through the annual per cent change (APC). The weighted average of APC in each temporal

segment gives the average annual per cent change (AAPC) during the entire reference period with weights equal to the length of the temporal segment. The AAPC is argued to be a better approach to describe the long-term trend when the trend changes over time in comparison to the commonly used approach in which a single regression line on a log scale is fitted for the entire reference period and the annual per cent change is calculated from the slope of the regression line (Clegg *et al*, 2009). AAPC permits comparison of trend in different temporal segments.

Actual calculations have been carried out using the Joinpoint Regression Program (National Institute of Health, 2013). The software requires specification of minimum (0) and maximum number of joinpoints (>0) up to a maximum of 9 joinpoints in advance. The program starts with 0 or the minimum number of joinpoints, which means a straight line fit on a log scale and tests whether more joinpoints need to be added to the model to better describe the trend. The statistical significance of the change in trend is tested through a Monte Carlo permutation method (Kim, Fay, Feuer et al., 2000). The number of joinpoint(s) are identified using the grid search method (Lerman, 1980) which allows a joinpoint to occur exactly at the year t. A grid is created for all possible positions of joinpoint(s) or combination of joinpoint(s), the model is fitted for each possible position and that position is selected which minimizes the sum of squared errors (SSE). In the present analysis, minimum and maximum number of joinpoint(s) have been set to 0 and 4 respectively.

Joinpoint regression analysis has frequently been used for analyzing trend in mortality and morbidity from specific causes (Tyczynski and Berkel, 2005; Doucet *et al*, 2016; John and Hanke, 2015; Akinyede and Soyemi, 2016; Mogos *et al*, 2016; Chatenoud *et al*, 2015; Missikpode *et al*, 2015; Rea *et al*, 2017; Qiu *et al*, 2008; Puzo *et al*, 2016). It has also been used for estimating population parameters under changing population structure (Gillis and Edwards, 2019). Chaurasia (2020a) has used joinpoint regression analysis to analyze the long-term trend in infant mortality in India and to analyze the trend in marital fertility (Chaurasia, 2020b). Joinpoint regression analysis has also been used to understand the rapid increase in life expectancy in Shanghai, China (Chen, *et al*, 2018) and in analyzing patterns and changes in life expectancy in China during 1990-2016 (Chen *et al*, 2020).

The second part of the analysis measures the contribution of the change in person-years lived in different age groups to the change in e_0. Different authors have used different approaches for the purpose (Chandra Sekar, 1949; Retherford, 1972; Keyfitz, 1977; Lopez and Ruzicka, 1977; Andreev, 1982; Pollard 1982; United Nations, 1982; Arriaga 1984; Pressat 1985; United Nations, 1985; Vaupel 1986; Das Gupta, 1993; Andreev, Shkolnikov, and Begun 2002; Canudas Romo, 2003; Vaupel and Canudas-Romo 2003; Beltr´an-S´anchez *et al*, 2008; Horiuchi *et al*, 2008; Firebaugh *et al*, 2014;). A comparison of some of these approaches has been given in Ponnapalli (2012). Arriaga method (Arriaga, 1984) is commonly used. It has, however, been found that the sum of the differences for different age groups in different sub-periods of a period does not equal to the sum of the difference for the entire period. Because of this limitation of the method, it difficult to make clear interpretations about how

the change in the risk of death in different age groups in different sub-periods contribute to the change in e_0 during the entire period.

In the present paper, we follow an alternative approach. We first express e_0 in terms of the years of life lost in different age groups and then decompose the change in e_0 in terms of the change in the years of life lost in different age groups. We proceed as follows:

If all births or the radix, l_0, of the life table survive up to age N, then number of person-years lived by l_0 births up to age N will be $N^{*}l_0$. However, if the survival probability in the first year of life $p_0<1$, then person-years lost in the first year of life is given by

$$ {}_1D_1 = l_0 - {}_1L_0, \tag{2}$$

and person-years lost up to N years of age due to mortality in the first year of life will be

$$D_1 = \sum_1^N {}_1D_1. \tag{3}$$

Similarly, person-years lost up to N years of age due to mortality in the second year of life is given by

$$D_2 = \sum_2^N {}_1D_2; \;\; {}_1D_2 = {}_1L_0 - {}_1L_1 \tag{4}$$

The total person-years lost due to mortality in different ages may now be calculated as

$$D = \sum_{i=1}^N D_i \tag{5}$$

The expectation of life at birth, e_0 may then be computed as

$$e_0 = \frac{N*l_0-D}{l_0} = N - \frac{D}{l_0} = N - \frac{\sum_{i=1}^N D_i}{l_0} \tag{6}$$

Now if e_0^1 is the life expectancy at birth at time 1 and e_0^2 is the life expectancy at birth at time 2, then, using equation (6), the difference $e_0^2 - e_0^1$ may be decomposed as

$$e_0^2 - e_0^1 = \frac{1}{l_0}\sum_{i=1}^N \left(D_i^1 - D_i^2\right) \tag{7}$$

Results

Changing Trend in e_0. The joinpoint regression analysis suggests that the trend in e_0 in India changed three times during the period 2000 (1998-2000) through 2015 (2013-2017) (Table 1). During 2000-2002, e_0 increased by 0.52 years per year, on average, but the increase decelerated to 0.36 years per year during 2002-2009. During 2009-2012, the increase in e_0 accelerated to 0.49 years per year but decelerated again to around 0.37 years per year during 2012-2015. If the increase recorded during 2000-2002 could have been sustained beyond 2002, e_0 in India would have increased to more than 71 years by 2015. The deceleration in the

increase in e_0 during 2000-2015 has resulted in a loss of more than two years in the increase in e_0 in the country.

The trend in e_0 has been different in males compared to females and in rural areas compared to urban areas. The trend in male e_0 changed two times whereas the trend in female e_0 changed three times during 2000-2015. During 2009-15, the increase in male e_0 accelerated but increase in female e_0 decelerated considerably so that female-male gap in e_0, which widened to around 3.5 years in 2011, narrowed down considerably to around 2.6 years in 2015. On the other hand, the trend changed three times in both rural and urban e_0 but the joinpoints have been different. The increase in rural e_0 has been more rapid than the increase in urban e_0 throughout the period under reference except during 2007-2011. The increase in urban *e0* appears to have stagnated during 2004-07 as the APC during this period is not found to be statistically significantly different from zero.

Among the four mutually exclusive population groups – rural male, rural female, urban male, and urban female - the increase in e_0 has been the fastest in rural females but the slowest in urban females. The increase in rural female e_0 was particularly rapid during 2000-2002 but the increase decelerated considerably after 2002 and was slower than the increase in rural male e_0 during 2012-2015. On the other hand, increase in e_0 stagnated in both urban males and urban females during 2004-2007. During 2012-2015, the APC in rural female e_0 was almost the same as that in urban female e_0 but the APC in rural male e_0 was higher than that in urban male e_0.

Decomposition of the Increase in e₀. Table 2 presents the relative contribution of the increase in person-years lived in different age groups to the increase in e_0. The increase in person-years lived in the first 15 years of life accounted for almost 75 per cent of the increase in e_0 with more than 58 per cent increase attributed to the increase in person-years lived in the first 5 years of life. The increase in the probability of survival in the first year of life, alone, accounted for more than 28 per cent of the increase in e_0. On the other hand, increase in person-years lived in the age group 15-50 years accounted for about 25 per cent of the increase in e_0 while increase in person-years lived in 50-75 years of age accounted for an increase of almost 14 per cent. By contrast, person-years lived in the age group 75 years and above decreased which resulted in a decrease of almost 14 per cent in e_0. There has been little change in the survival probability in the age group 75-85 years and this probability appears to have decreased since 2011.

The relative contribution of the increase in person-years lived in different age groups has been different in different time segments. During 2000-2002, increase in person-years lived in the first 15 years of life accounted for only around 50 per cent of the increase in e_0. During 2002-2009, this proportion increased to almost 85 per cent but decreased to 74 per cent during 2009-2012 and to less than 73 per cent during 2012-15. On the other hand, the contribution of the increase in person-years lived in the age group 15-50 years remained less than 25 per cent till 2012 but increased to almost 38 per cent during 2012-2015 whereas the contribution of the increase in person-years lived in the age group 50-75 years decreased from more than 30 per cent during 2000-02 to just around 8 per cent during 2002-2009

and then increased marginally during 2009-12 but decreased to around 10 per cent during 2012-2015. Finally, person-years lived in the age group 75 years and above decreased in all time segments and, therefore, contributed to the decrease, instead increase, in e_0. During 2012-2015, decrease in person years lived in this age group accounted for more than 20 per cent decrease in e_0.

The gender difference in the contribution of the increase in person-years lived in different age groups to the increase in e_0 is also quite marked. The contribution of the increase in person-years lived in the age group 0-50 years to the increase in e_0 has largely been the same in males and females, but the contribution of the increase in person-years lived in the age group 50-75 years to the increase in e_0 has been substantially higher in males compared to females because person-years lived by females in the age group 50-65 years decreased during 2012-15. On the other hand, person-years lived in the age group 75 years and above decreased in both females and males and, therefore, contributed to the decrease in e_0.

Similarly, more than 80 per cent of the increase in rural e_0 is attributed to the increase in person-years lived in the first 15 years of life but this proportion is just around 55 per cent in urban e_0. On the other hand, more than one third of the increase in urban e_0 is attributed to the increase in person-years in the age group 50-75 years but only about 8 per cent in rural e_0. There has been virtually little rural-urban difference in the contribution of the increase in person-years lived in the age group 15-50 years and 75 years and above to the increase in e_0. The relatively slow increase in urban e_0 relative to rural e_0 may be attributed to the relatively slow increase in person-years lived in the first 15 years of life in the urban areas. More specifically, the contribution of the increase in person-years lived in the age group 1-5 years was almost 35 per cent in rural e_0 but only 18 per cent in urban e_0.

Combining gender and residence differentials in the contribution of the increase in person-years lived in different age groups to the increase in e_0, the contribution of the increase in person-years lived in the first 15 years of life and in the age group 50-75 years becomes even sharper (Table 4). More than 80 per cent of the increase in rural male and rural female e_0 is attributed to the increase in person-years lived in the first 15 years of life but only around 50 per cent in urban males and less than 60 per cent in urban females. More than 33 per cent of the increase in rural male e_0 is attributed to the increase in person-years lived in the age group 1-4 years but this proportion is only around 16 per cent in urban males; the corresponding proportion for rural female is 36 per cent but only about 22 per cent in urban females. On the other hand, increase in person-years lived in the age group 50-75 years accounted for only about 4 per cent increase in rural female e_0 but more than 29 per cent increase in urban female e_0. In rural females, person-years lived in the age group 50-65 years decreased during 2012-15. Similarly, increase in person-years lived in this age group accounted for less than 12 per cent increase in rural male e_0 but more than 36 per cent increase in urban male e_0.

Inter-state Variation. The within country, across states, variation in e_0 in India is known for its strength and persistence. However, inter-state disparity in e_0 appears to have decreased over time. The decrease in inter-state disparity in e_0 appears to be

due to relatively faster increase in e_0 in those states where e_0 was low in 2000. The Spearman's rank order correlation coefficient between the rank of a state in e_0 in 2000 and the rank of the state in the increase in e_0 during 2000-2015 is estimated to be -0.534 while the regression coefficient of the increase in e_0 during 2000-2015 on the e_0 in 2000 is estimated to be -0.304. At the same time, inter-state coefficient of variation in e_0 decreased from 0.056 in 2000 to 0.039 in 2015. The increase in e_0 has been the fastest in Odisha but the slowest in Kerala. Odisha is the only state where e_0 increased by more than 9 years whereas Kerala is the only state where e_0 increased by less than 4 years during 2000-15.

The trend in e_0 has also varied across states. In Andhra Pradesh and Kerala, the trend changed four times whereas there has been no change in the trend in Madhya Pradesh which implies that e_0 in the state increased linearly (on a log scale) during 2000-2015. In majority of the states, however, the trend in e_0 changed three times. The APC in e_0 was the fastest in Jammu and Kashmir during 2000-2004 but the slowest in Kerala during 2013-2015. In seven states, increase in e_0 stagnated during at least one time-segment of the period 2000-15 identified through joinpoint regression analysis. In most of the states, increase in e_0 decelerated after 2011, particularly in female e_0. Assam and Odisha are the only two states where increase in e_0 did not decelerate. Similarly, Odisha is the only state where increase in female e_0 did not decelerate during the period under reference. In 9 states, female e_0 stagnated during 2013-2015, but there is no state where male e_0 stagnated during this period.

In most of the states, increase in e_0 has primarily been the result of the improvement survival probability in the first 15 years of life, particularly, in the first 5 years of life. Notable exceptions are Jammu and Kashmir and Kerala. In Jammu and Kashmir, close to half of the increase in e_0 is attributed to the increase in person-years lived in the age group 5-15 years. The increase in survival probability in the first 5 years of life accounted for only around 20 per cent increase in e_0 in the state. In Kerala, on the other hand, almost 42 per cent of the increase in e_0 is attributed to the increase in person-years lived in the age group 60-80 years.

In all but four-states – Haryana, Jammu and Kashmir, Kerala, and Punjab - person-years lived in the age group 75 years and above has decreased throughout the period under reference with the decrease being the most marked in Bihar. In On the other hand, person-years lived in the age group 60-75 years decreased over time in Haryana. Similarly, person-years lived in the age group 40-65 years decreased in Rajasthan and person-years lived in the age group 45-65 years decreased in Utter Pradesh and contributed to the deceleration in the increase in e_0.

Discussion

The present analysis reflects a deceleration in the increase in e_0 in India and in most of the states during 2000 (1998-2002) through 2015 (2013-2017). The deceleration in the increase in e_0 has been particularly marked in females in recent years. Another notable feature of is near stagnation of the increase in urban e_0 during 2004-2007 (2002-2006 through 2005-2009). The deceleration in the increase in female e_0 appears to be due to the decrease in person-years lived in the age group

40-65 years whereas near stagnation in urban e_0 during 2004-2007 appears to be due to the decrease in the person-years lived in age groups 25-55 years and in the age group 70 years and above. In some states of the country, increase in female e_0 appears to have even stagnated in recent years.

The analysis also reveals that the increase in e_0 has mostly been due to the improvement in survival chances in the first 15 years of life, especially, in the first 5 years of life. Contribution of the improvement in survival chances in other age groups to the increase in e_0 has relatively been small and person-years lived in the age group 75 years and above has decreased which resulted in a deceleration in the increase in e_0. There has also been little change in regional disparity in e_0. The rank of 7 states has not changed in terms of e_0 and there has been only a marginal change in the rank in other states. The 17 states of the country, however, converged over time. Siddiqui et al. (2020) also observed that life expectancy at birth in India converged across states during 1980-2015. The strength and persistence of within country disparity in the length of life was also reported by Saikia *et al* (2010). This disparity is primarily attributed to inter-state disparity in social and economic development (India State-Level Disease Burden Initiative Child Mortality Collaborators, 2020). It is also argued that poor quality of health care is a major driver of excess mortality (Kruk *et al*, 2018). The inter-state variation in per capita expenditure on health (Ganesan and Veena, 2018) suggests that the quality of health services varies widely across states, which may have an impact on inter-state disparity in e_0. However, irrespective of the level of social and economic development and quality of health care, improvement in the survival probability in the first 15 years of life has been the main contributor to the improvement in e_0 in all but two states of the country.

An important finding of the present analysis is the consistent decrease in person-years lived in the age group 75 years and above. It is argued that this decrease in may be the result of the improvement in registration of old age deaths under the Sample Registration System over time which might have resulted in either an increase or a retarded decrease in the probability of death in older ages leading to a decrease in person-years lived. It has, therefore, been suggested that life tables prepared by the United Nations and the World Health Organization should be used in place of the life tables prepared by the Registrar General and Census Commissioner of India. However, the life tables prepared by the United Nations confirm that the person years lived in the age group 75 years and above in the country has decreased during 2000-05 through 2015-20.

Reasons for the volatile trend in e_0, especially, deceleration in the increase in e_0 in females and in the urban areas in recent years are not known at present. The period 2000-2015 has been a period of rapid, rather unprecedented, economic growth in India. The gross domestic product of the country increased at a rate of almost 9 per cent per year during 2000-2010 and more than 7 per cent per year during 2010-17 (World Bank, 2018). At the same time, health care services in the country have undergone a paradigm shift with the launch of National Rural Health Mission in 2005 (Government of India, 2005) and National Urban Health Mission launched in 2013 (Government of India, 2013). It appears that dividends of India's

rapid economic growth could not be translated into social and human progress. Khodabakshi (2011) observed that the increase in the gross domestic product in India was ineffective in accelerating the increase in e_0. It is argued that factors such as greater equity, inclusive welfare system, high political participation, strong civil society and access to employment, housing, safe water, clean environment, and universal education determine how aggregate level economic growth impacts on population health as revealed through e_0 (Freeman et al, 2020). There is, however, evidence to suggest that income inequality in India has increased with the growth of the economy (Dang and Lanjouw, 2018). The income inequality in India is amongst the highest the world. India's economic growth has been driven largely by services rather than manufacturing sector and has been skill intensive rather than labor intensive (Kumar and Subramanian, 2011).

The National Rural Health Mission, launched in 2005, had focused, primarily, on reproductive and child health care in the rural areas of selected states of the country. There is, however, no study which has analyzed the impact of the Mission on e_0. Singh *et al* (2012) observed that the Mission had contributed, only marginally, in reducing the post-neonatal mortality rate, whereas Ebenezev (2019) analyzed the impact of the Mission in terms of reduction in infant mortality and found that the reduction in infant mortality had been faster in males compared to females. There is evidence that indicates that the Mission could not achieve targets in terms of reduction in infant and maternal mortality, and fertility (Prasad *et al*, 2017), while Hussain (2011) found that delivery of services under the Mission had fallen short of targets. The Mission was confined to rural areas of selected states only and, therefore, has little impact on the health of the urban population. To address the challenge of population health in the urban areas, the National Urban Health Mission was launched in 2013 with a focus on urban poor and other vulnerable population groups with a thrust on sanitation, clean drinking water and vector control and strengthening public health capacity of urban local bodies (Government of India, 2013). The two Missions have now been combined into the National Health Mission directed towards universal access to equitable, affordable, and quality health care services that are accountable and responsive to people's needs (Government of India, 2019). Both Missions have attempted to evolve a common platform for addressing wider social and economic determinants of population health but the effectiveness of the two Missions in operationalizing the common platform in the prevailing social, economic, and cultural context has, at best, been limited.

The relevance of decomposing the increase in e_0 in terms of the increase in person-years lived in different age groups should be obvious. This decomposition highlights the disparity in improvement in survival chances in different age groups. For example, deceleration in the increase in female e_0 appears to be largely due to the decrease in person-years lived in the age group 50-75 years. Similarly, there appears to be only a marginal improvement in survival probability in the age group 50-75 years in the rural areas while improvement in survival probability in the age group 0-15 years appears to be quite slow in the urban areas. Addressing these disparities may contribute to hastening the pace of improvement in e_0 in the country

which appears to be slow and decelerating and remains low by international standards.

It is also obvious that India has not been able to achieve the goal of an e_0 of 75 years by the year 2015 as laid down in the Plan of Action of the 1994 International Conference on Population and Development to which India is a signatory. The National Health Policy 2017, instead of addressing reasons for sluggish improvement in e_0 and proposing the approach to hasten the pace of improvement in e_0 has significantly scaled down the target of the increase in e_0 to 70 years by the year 2025 (Government of India, 2017). India remains amongst the poorest countries of the world in terms of population health as revealed through the level and the pace of improvement in e_0. If one goes by the goal set under the National Health Policy 2017, then there is every likelihood that the health of the people of the country will remain amongst the poorest in the world even after 10-20 years from now.

Limitations

The present analysis is based on the data available through India's official Sample Registration System. There have been concerns about the quality of data available through the system as under reporting of deaths in the system, especially, in the rural areas has been reported in many studies (Government of India, 1983; Government of India, 1988; Mari Bhat, 2002). It may be presumed that improvement in the reporting of deaths in the Sample Registration System might have influenced the trend in e_0. The reporting of deaths by age may also be associated with age miss-reporting that may also be higher in rural than in urban areas. More research is clearly warranted to shed light on these issues. Another limitation of the analysis is that it does not dwell upon factors that have caused/contributed to observed trends and patterns of decomposed findings. This has not been the scope of the paper.

Conclusions

The analysis reveals unsatisfactory trend in e_0 in India in recent years. There appears to be considerable deceleration in the increase in e_0 in the country and in most of its states. Among different mutually exclusive population groups, increase in female e_0 decelerated in both rural and urban areas of the country whereas there has been a period of stagnation in the urban areas. Most of the increase in e_0 is attributed to the increase in the person-years lived in the first 15 years of life whereas there has been a decrease in the person-years lived in the age group 75 years and above in all population groups. The analysis also reveals a decrease in person-years lived by females in the age group 50-75 years. There also appears little impact of the rapid economic growth that the country has witnessed in the recent past on the pace of increase in e_0. The differential improvement in the probability of survival in different age groups calls for integrating demographic factors in the delivery of health care. The development of health services in India has historically followed the epidemiological approach of health care that focuses on specific diseases or constellation of diseases, their modes of transmission, and prevention or treatment

(Gray, 1989). The present analysis suggests that a population wide approach of health care services delivery may contribute to effectively meeting health care needs of different population groups and hence accelerating the increase in e_0.

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Conflict of Interest

There is no conflict of interest.

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Table 1: Trend in life expectancy at birth in India 2000 (1998-2002) through 2015 (2013-17). Net increase; average annual per cent change (AAPC); and Annual percent change (APC) in different time segments.

Population groups	Net increase (years)	AAPC	APC in different time segments														
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Person	6.1	0.622*	0.823*					0.558*					0.738*			0.534*		
Male	5.9	0.613*	0.670*				0.448*								0.750*			
Female	6.4	0.643*	0.962*					0.618*				0.800*				0.606*		
Rural	6.1	0.631*	0.884*					0.573*					0.696*			0.491*		
Rural male	6.6	0.601*		0.653*					0.460*						0.683*			
Rural female	4.8	0.662*	1.002*							0.717*						0.256*		
Urban	5.7	0.455*		0.464*				0.099				0.705*				0.385*		
Urban male	5.1	0.498*		0.592*				0.100					0.715*				0.506*	
Urban female	4.5	0.416*		0.480*				0.143				0.716*				0.256*		

Source: Author's calculations

Remarks: The shaded cell indicates the joinpoint.

* APC and AAPC are statistically significantly different from zero.

Table 2: Contribution of the increase in person-years lived in different age groups to the increase in e_0 in India during 2000-2015

Age groups	Time segment									
	2000-02		2002-09		2009-12		2012-15		2000-15	
	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase
0	0.10	9.42	0.89	35.20	0.45	31.12	0.28	25.09	1.72	28.01
1-4	0.26	24.72	0.87	34.50	0.41	28.10	0.32	28.62	1.86	30.25
5-9	0.14	13.59	0.25	9.73	0.15	10.50	0.16	14.15	0.70	11.37
10-14	0.06	5.41	0.12	4.90	0.06	4.35	0.05	4.66	0.30	4.81
0-14	***0.55***	***53.14***	***2.13***	***84.33***	***1.08***	***74.07***	***0.82***	***72.52***	***4.58***	***74.45***
15-19	0.03	2.74	0.09	3.38	0.05	3.32	0.05	4.55	0.21	3.47
20-24	0.05	4.65	0.09	3.48	0.06	4.04	0.09	8.41	0.29	4.71
25-29	0.05	5.11	0.11	4.32	0.05	3.69	0.10	8.60	0.31	5.08
30-34	0.03	2.97	0.10	4.08	0.06	4.08	0.07	6.01	0.26	4.24
35-39	0.03	2.97	0.06	2.55	0.07	4.61	0.04	3.83	0.21	3.34
40-44	0.04	3.46	0.04	1.52	0.04	3.02	0.03	2.66	0.15	2.41
45-49	0.03	3.04	0.03	1.21	0.03	1.81	0.04	3.73	0.13	2.12
15-49	***0.26***	***24.93***	***0.52***	***20.53***	***0.36***	***24.56***	***0.42***	***37.78***	***1.56***	***25.39***
50-54	0.06	5.99	0.05	1.85	0.00	0.34	0.00	-0.25	0.11	1.81
55-59	0.09	8.55	0.16	6.27	-0.03	-2.37	-0.08	-7.40	0.13	2.11
60-64	0.07	7.07	0.12	4.60	0.04	2.61	-0.02	-2.09	0.20	3.32
65-69	0.06	5.56	0.01	0.44	0.10	7.17	0.11	10.14	0.29	4.68
70-74	0.03	3.23	-0.11	-4.19	0.09	5.96	0.11	10.05	0.13	2.08

Age groups	Time segment									
	2000-02		2002-09		2009-12		2012-15		2000-15	
	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase
50-74	***0.32***	***30.41***	***0.23***	***8.98***	***0.20***	***13.71***	***0.12***	***10.45***	***0.86***	***14.00***
75-79	-0.03	-2.55	-0.15	-6.04	0.05	3.72	0.03	2.37	-0.10	-1.60
80-84	-0.05	-5.05	-0.11	-4.48	-0.09	-6.15	-0.10	-8.85	-0.35	-5.78
85+	-0.01	-0.87	-0.08	-3.32	-0.14	-9.90	-0.16	-14.27	-0.40	-6.47
75+	***-0.09***	***-8.48***	***-0.35***	***-13.84***	***-0.18***	***-12.33***	***-0.23***	***-20.76***	***-0.85***	***-13.84***
All ages	1.04	100.00	2.52	100.00	1.46	100.00	1.12	100.00	6.15	100.00

Source: Author's calculations

Table 3: Contribution of the increase in person-years lived in different age groups to increase in e_0 in different population groups in India, 2000-2015

Age group	Gender				Residence			
	Male		Female		Rural		Urban	
	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase
0-1	1.77	30.11	1.61	25.08	1.72	28.41	1.22	25.06
1-5	1.70	28.88	2.10	32.56	2.08	34.46	0.89	18.34
5-10	0.58	9.91	0.82	12.68	0.76	12.51	0.41	8.36
10-15	0.26	4.42	0.33	5.19	0.33	5.45	0.15	3.10
0-15	*4.31*	*73.32*	*4.86*	*75.51*	*4.89*	*80.83*	*2.66*	*54.86*
15-20	0.18	3.05	0.25	3.91	0.24	4.00	0.10	2.12
20-25	0.21	3.51	0.37	5.81	0.33	5.52	0.14	2.91
25-30	0.24	4.05	0.38	5.95	0.33	5.51	0.22	4.52
30-35	0.24	4.01	0.29	4.48	0.25	4.12	0.24	4.90
35-40	0.20	3.45	0.22	3.34	0.20	3.23	0.19	3.84
40-45	0.17	2.82	0.14	2.11	0.12	1.98	0.18	3.65
45-50	0.13	2.28	0.13	1.96	0.09	1.53	0.18	3.74
15-50	*1.36*	*23.16*	*1.77*	*27.56*	*1.57*	*25.89*	*1.25*	*25.68*
50-55	0.18	3.13	0.04	0.56	0.03	0.49	0.24	4.87
55-60	0.19	3.27	0.05	0.71	0.01	0.14	0.34	6.94
60-65	0.24	4.04	0.17	2.58	0.10	1.71	0.39	8.02

Age group	Gender				Residence			
	Male		Female		Rural		Urban	
	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase
65-70	0.38	6.44	0.21	3.25	0.21	3.54	0.45	9.34
70-75	0.11	1.89	0.15	2.35	0.10	1.67	0.20	4.13
50-75	*1.11*	*18.78*	*0.61*	*9.45*	*0.46*	*7.56*	*1.61*	*33.30*
75-80	-0.16	-2.77	-0.03	-0.51	-0.09	-1.47	-0.09	-1.86
80-85	-0.38	-6.41	-0.33	-5.17	-0.36	-5.89	-0.29	-5.94
85+	-0.36	-6.08	-0.44	-6.85	-0.42	-6.93	-0.29	-6.03
75+	*-0.90*	*-15.26*	*-0.81*	*-12.53*	*-0.86*	*-14.28*	*-0.67*	*-13.84*
All ages	5.89	100.00	6.44	100.00	6.05	100.00	4.85	100.00

Source: Author's calculations

Table 4: Contribution of the increase in person-years lived in different age groups to increase in e_0 in different population groups in India, 2000-2015

Age group	Rural				Urban			
	Male		Female		Male		Female	
	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase
0-1	1.75	30.86	1.63	25.03	1.38	26.94	1.01	22.34
1-5	1.90	33.59	2.35	36.17	0.83	16.32	0.99	21.76
5-10	0.63	11.21	0.89	13.63	0.34	6.58	0.47	10.29
10-15	0.29	5.12	0.37	5.73	0.13	2.58	0.17	3.78
0-15	*4.57*	*80.78*	*5.24*	*80.55*	*2.68*	*52.42*	*2.64*	*58.17*
15-20	0.20	3.56	0.29	4.44	0.09	1.83	0.12	2.59
20-25	0.24	4.25	0.44	6.72	0.11	2.06	0.18	3.99
25-30	0.26	4.58	0.41	6.37	0.17	3.24	0.27	6.02
30-35	0.22	3.83	0.29	4.49	0.26	5.07	0.21	4.72
35-40	0.18	3.17	0.22	3.35	0.23	4.54	0.14	3.05
40-45	0.13	2.36	0.11	1.66	0.20	3.99	0.15	3.26
45-50	0.09	1.59	0.09	1.46	0.20	3.93	0.15	3.30
15-50	*1.32*	*23.35*	*1.85*	*28.49*	*1.26*	*24.67*	*1.22*	*26.93*
50-55	0.12	2.18	-0.06	-0.93	0.27	5.31	0.18	3.89
55-60	0.07	1.16	-0.07	-1.13	0.38	7.52	0.26	5.82
60-65	0.10	1.76	0.10	1.48	0.47	9.25	0.30	6.55

Age group	Rural				Urban			
	Male		Female		Male		Female	
	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase	Increase in e_0 (Years)	Per cent increase
65-70	0.30	5.27	0.15	2.24	0.56	10.87	0.36	7.94
70-75	0.08	1.36	0.13	2.01	0.19	3.81	0.22	4.89
50-75	*0.66*	*11.73*	*0.24*	*3.67*	*1.88*	*36.76*	*1.32*	*29.09*
75-80	-0.15	-2.61	-0.03	-0.49	-0.19	-3.64	0.02	0.41
80-85	-0.37	-6.58	-0.34	-5.19	-0.31	-6.13	-0.26	-5.76
85+	-0.38	-6.67	-0.46	-7.03	-0.21	-4.08	-0.40	-8.84
75+	*-0.90*	*-15.86*	*-0.83*	*-12.72*	*-0.71*	*-13.85*	*-0.64*	*-14.19*
All ages	5.65	100.00	6.50	100.00	5.10	100.00	4.53	100.00

Source: Author's calculations

Table 5: Trend in e_0 in selected states, 1998-2002 (circa 2000) through 2013-17 (circa 2015). Net increase; average annual per cent change (AAPC); and Annual percent change (APC) in different time segments.

State	Net increase (years)	AAPC	APC in different time segments														
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Andhra Pradesh	6.3	0.645*	0.987*			0.495			0.065			1.029*					0.440	
Assam	8.2	0.887*	0.807*													1.208*		
Bihar	5.9	0.589*	0.848*			0.081				1.015*					0.436*			
Gujarat	4.9	0.457*	0.373*									0.640*						
Haryana	4.6	0.450*	0.708*					0.037				0.725*					0.419*	
Himachal Pradesh	4.3	0.416*	0.811*			0.124*						0.625*						
Jammu and Kashmir	8.2	0.843*	1.554*					0.159				0.830*						
Karnataka	4.2	0.417*	0.567*					0.129			0.616*					0.126*		
Kerala	3.3	0.299*	0.930*			0.445*			0.030			0.240*					0.002	
Madhya Pradesh	7.9	0.828*	0.828*															
Maharashtra	6.3	0.607*	0.886*						0.330			0.648*				0.366*		
Odisha	9.3	0.990*	1.080*			0.712*						1.020*			1.342*			
Punjab	5.2	0.511*	0.835*					0.128				0.826*					0.204	
Rajasthan	5.2	0.532*	0.626*									0.424*						
Tamil Nadu	6.0	0.580*	0.732*					0.553*										
Uttar Pradesh	5.3	0.567*	0.599*													0.439*		
West Bengal	5.6	0.538*	0.788*						0.447*									

Source: Author's calculations

Remarks: The dark shaded cell is the joinpoint.

* Indicates APC or AAPC are statistically significantly different from zero.

Table 5 (*Cont*.): Trend in male e_0 in selected states, 2000(1998-2002) through 2015 (2013-17). Net increase; average annual per cent change (AAPC); and Annual percent change (APC) in different time segments.

Country/State	Net increase (years)	AAPC	APC in different time segments														
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Andhra Pradesh	7.0	0.749	0.872*				0.199					1.090*						
Assam	8.0	0.838	0.668*													1.309*		
Bihar	5.8	0.545	0.118											0.831*				
Gujarat	4.6	0.479	0.320*											0.619*				
Haryana	3.2	0.282	0.282*															
Himachal Pradesh	3.2	0.287	0.192*											0.430*				
Jammu and Kashmir	7.4	0.764	1.596*									0.463*						
Karnataka	5.1	0.536	0.690*					0.165				0.833*				0.430*		
Kerala	3.5	0.319	0.933*		0.348								0.187*					
Madhya Pradesh	6.7	0.706	0.706*															
Maharashtra	6.7	0.667	0.884*						0.314			0.707*						
Odisha	8.7	0.913	0.913*															
Punjab	5.0	0.526	0.840*				-0.101					0.840*						
Rajasthan	4.4	0.457	0.606*											0.328*				
Tamil Nadu	5.7	0.570	0.849*					0.478*								0.637*		
Uttar Pradesh	4.4	0.476	0.392*													0.708*		
West Bengal	6.1	0.599	0.717*					0.503*								0.700*		

Source: Author's calculations

Remarks: The shaded cell is the joinpoint.

* Indicates APC or AAPC are statistically significantly different from zero.

Table 5 (*Cont*.): Trend in female e_0 in selected states, 2000 (1998-2002) through 2015 (2013-17). Net increase; average annual per cent change (AAPC); and Annual percent change (APC) in different time segments.

Country/State	Net increase (years)	AAPC	APC in different time segments														
			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Andhra Pradesh	5.6	0.559	1.043*				0.119					1.029*			0.188			
Assam	8.4	0.924	0.924*															
Bihar	6.1	0.614	1.082*			0.289*				1.073*					0.133			
Gujarat	5.3	0.509	0.642*			0.358*						0.722*					0.298	
Haryana	6.4	0.605	1.396			0.624		0.063				0.723*					0.308	
Himachal Pradesh	5.4	0.513	1.158			0.054								0.836*				
Jammu and Kashmir	9.4	0.883	1.327*				0.029					1.366*					0.506	
Karnataka	3.1	0.302	0.605*			0.230*					0.541*				0.001			
Kerala	2.9	0.286	0.872*														0.141*	
Madhya Pradesh	9.3	0.968	1.062*											0.860*				
Maharashtra	5.8	0.543	0.828*							0.464*							-0.034	
Odisha	10.0	1.046	1.405*			0.623*								1.422*				
Punjab	5.7	0.540	0.950*			0.424*						0.716*					-0.218	
Rajasthan	6.0	0.592	0.627*								0.844*			0.332*				
Tamil Nadu	6.5	0.686	0.686*															
Uttar Pradesh	6.2	0.650	0.838*												0.135			
West Bengal	5.2	0.487	1.091*			0.732*			0.449*					0.189*				

Source: Author's calculations

Remarks: The dark shaded cell is the joinpoint.

* Indicates APC or AAPC are statistically significantly different from zero.

Table 6: Contribution of the increase in person-years lived in different age groups to the increase in e_0 (years) in selected states of India, 2000-2015.

Age group	Andhra Pradesh	Assam	Bihar	Gujrat	Haryana	Himachal Pradesh	Jammu and Kashmir	Karnataka	Kerala	Madhya Pradesh	Maharashtra	Odissa	Punjab	Rajasthan	Tamil Nadu	Uttar Pradesh	West Bengal
0	1.90	1.87	1.57	1.09	1.78	1.47	0.93	2.06	0.07	2.14	2.05	2.52	2.17	1.73	1.76	1.08	1.76
1-4	1.30	2.18	1.89	1.41	1.85	0.84	0.85	1.41	0.15	3.19	0.99	2.68	1.29	2.46	0.85	2.51	1.22
5-9	0.36	0.90	0.93	0.61	0.57	0.19	2.08	0.37	0.41	0.80	0.30	0.60	0.35	0.72	0.26	1.06	0.48
10-15	0.23	0.54	0.48	0.19	0.14	0.09	1.76	0.11	0.33	0.31	0.16	0.32	0.11	0.20	0.12	0.39	0.23
0-15	*3.79*	*5.49*	*4.87*	*3.30*	*4.35*	*2.58*	*5.62*	*3.95*	*0.96*	*6.44*	*3.50*	*6.13*	*3.92*	*5.11*	*2.99*	*5.04*	*3.68*
15-20	0.26	0.36	0.35	0.11	0.09	0.08	0.05	0.13	0.05	0.20	0.18	0.32	0.06	0.14	0.20	0.27	0.17
20-25	0.33	0.49	0.38	0.18	0.25	0.15	0.08	0.20	0.05	0.29	0.19	0.45	0.10	0.21	0.37	0.44	0.21
25-30	0.30	0.46	0.41	0.24	0.31	0.18	0.23	0.21	0.07	0.23	0.22	0.35	0.23	0.26	0.34	0.49	0.18
30-35	0.29	0.34	0.35	0.27	0.14	0.24	0.15	0.22	0.12	0.18	0.28	0.24	0.24	0.19	0.26	0.34	0.13
35-40	0.22	0.27	0.28	0.18	0.12	0.09	0.11	0.17	0.14	0.18	0.23	0.31	0.13	0.06	0.18	0.24	0.15
40-45	0.11	0.28	0.21	0.14	0.07	0.07	0.02	0.07	0.15	0.24	0.22	0.27	0.04	-0.01	0.19	0.07	0.12
45-50	0.10	0.39	0.31	0.19	-0.02	0.07	-0.07	0.09	0.14	0.19	0.28	0.14	-0.05	-0.03	0.13	-0.06	0.17
15-50	*1.61*	*2.59*	*2.29*	*1.30*	*0.98*	*0.88*	*0.57*	*1.08*	*0.73*	*1.52*	*1.62*	*2.07*	*0.76*	*0.82*	*1.67*	*1.78*	*1.13*
50-55	0.20	0.32	0.35	0.01	0.13	-0.01	0.12	0.22	0.12	0.17	0.19	0.18	-0.06	-0.16	0.11	-0.26	0.17
55-60	0.30	0.39	0.16	-0.11	0.14	-0.01	0.29	0.17	0.17	0.21	0.14	0.40	0.12	-0.21	0.35	-0.41	0.26
60-65	0.37	0.44	0.29	0.11	-0.33	0.19	0.27	-0.01	0.35	0.21	0.38	0.44	0.13	-0.07	0.50	-0.21	0.47
65-70	0.30	0.16	0.47	0.36	-0.48	0.48	0.37	0.07	0.37	0.33	0.50	0.16	0.01	0.11	0.51	0.12	0.50
70-75	0.15	-0.07	-0.18	0.18	-0.21	0.25	0.42	-0.09	0.34	0.07	0.48	0.11	0.12	0.13	0.35	0.13	0.19
50-75	*1.31*	*1.23*	*1.08*	*0.57*	*-0.74*	*0.90*	*1.47*	*0.36*	*1.34*	*1.00*	*1.70*	*1.28*	*0.32*	*-0.20*	*1.81*	*-0.63*	*1.59*
75-80	-0.08	-0.25	-0.52	-0.04	-0.02	-0.09	0.12	-0.11	0.34	-0.31	0.22	-0.19	0.16	-0.07	0.08	-0.02	-0.13
80-85	-0.26	-0.47	-0.83	-0.17	-0.02	-0.13	-0.08	-0.41	-0.02	-0.46	-0.35	-0.29	-0.01	-0.22	-0.28	-0.36	-0.35

Age group	Andhra Pradesh	Assam	Bihar	Gujrat	Haryana	Himachal Pradesh	Jammu and Kashmir	Karnataka	Kerala	Madhya Pradesh	Maharashtra	Odissa	Punjab	Rajasthan	Tamil Nadu	Uttar Pradesh	West Bengal
85+	-0.06	-0.36	-0.96	-0.11	0.05	0.10	0.49	-0.62	-0.03	-0.29	-0.45	0.20	0.11	-0.26	-0.18	-0.52	-0.29
75+	*-0.40*	*-1.08*	*-2.31*	*-0.31*	*0.00*	*-0.11*	*0.52*	*-1.13*	*0.28*	*-1.07*	*-0.58*	*-0.28*	*0.25*	*-0.55*	*-0.39*	*-0.90*	*-0.77*
All ages	6.31	8.24	5.93	4.85	4.59	4.25	8.18	4.26	3.32	7.90	6.24	9.21	5.26	5.18	6.08	5.29	5.63

Source: Author's calculations.

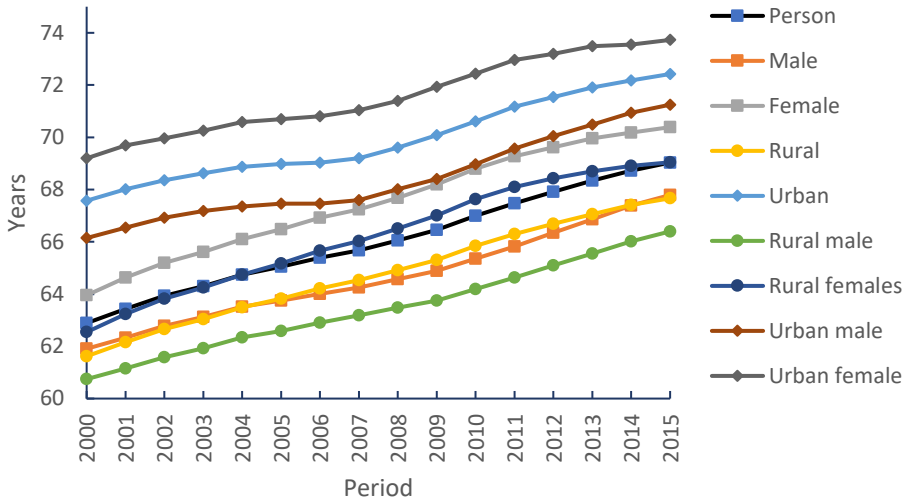

Figure 1: Trend in e_0 in India and different population groups, 2000-2015
Source: Author

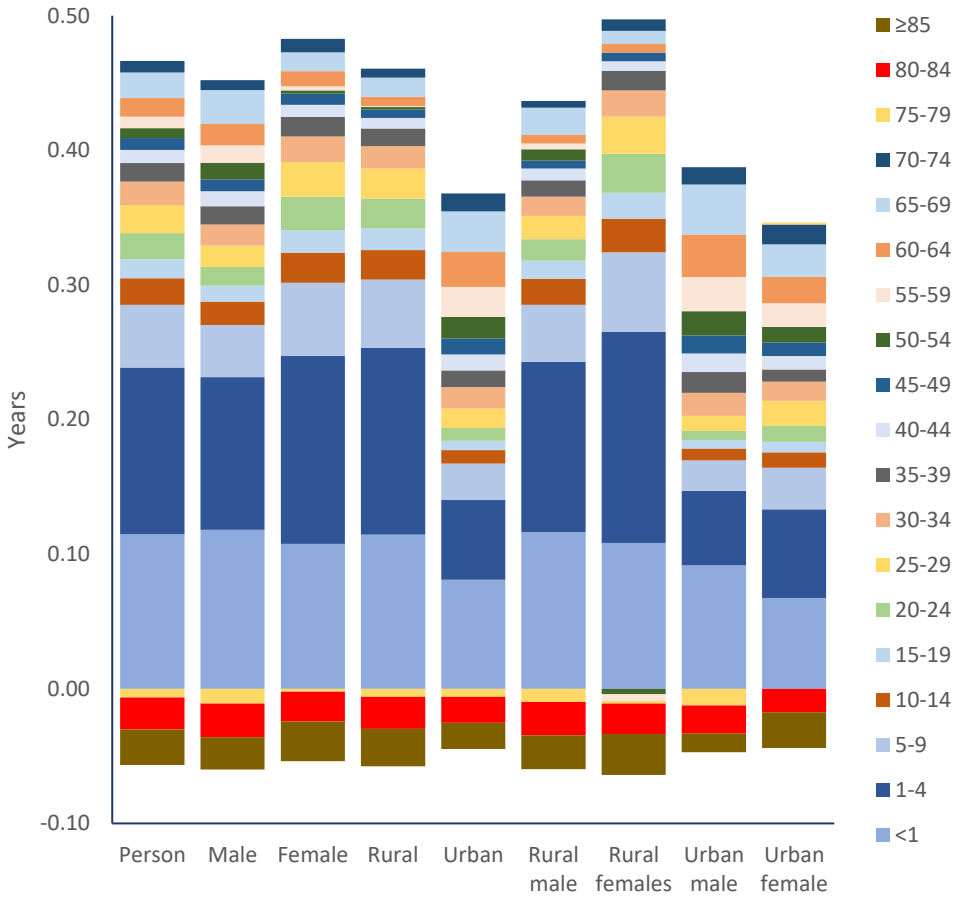

Figure 2: Decomposition of the average annual increase in e_0 in India and different population groups during 2000-2015
Source: Author

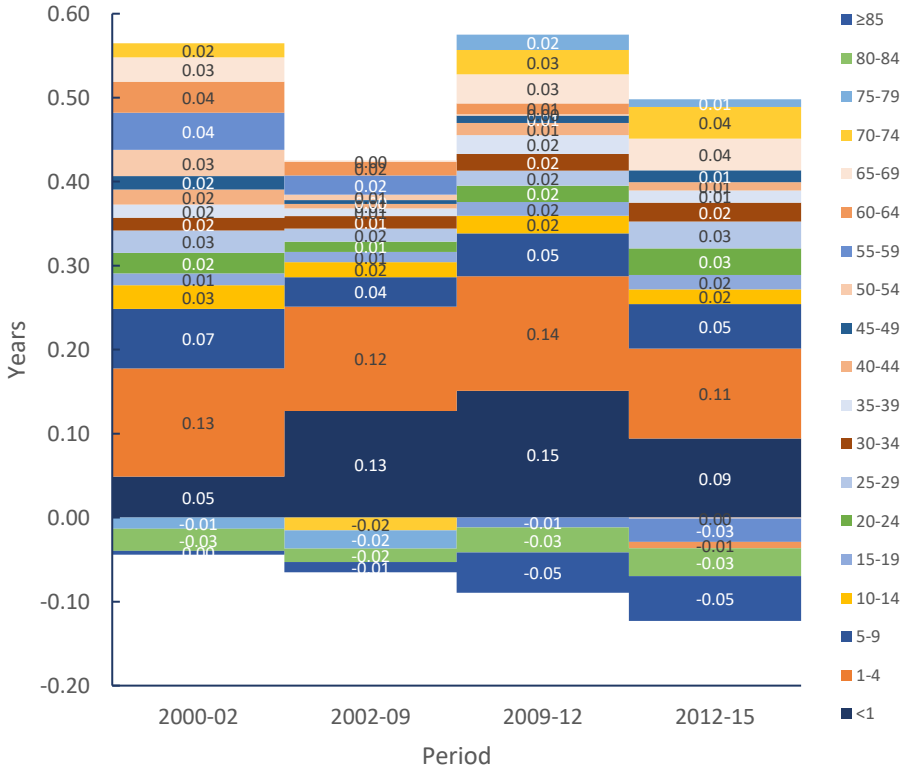

Figure 3: Decomposition of average annual increase in e_0 in different time segments of the period 2000-2015 in India
Source: Author

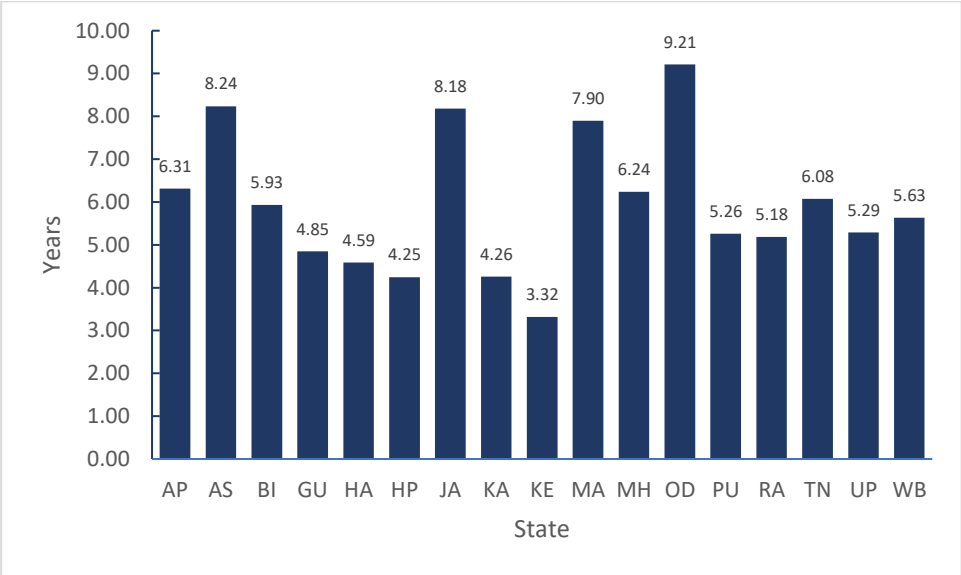

Figure 4: Increase in e_0 in states during 2000-2015
Source: Author

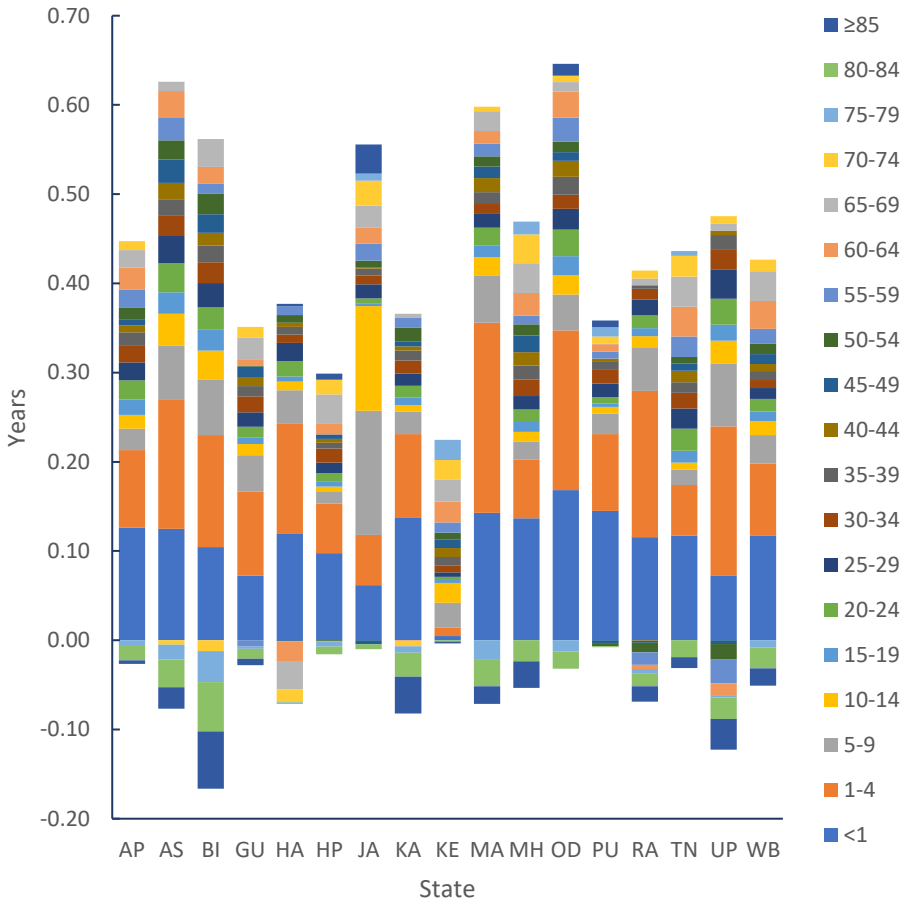

Figure 5: Decomposition of average annual increase in e_0 during 2000-2015 in states
Source: Author