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Inequality in the Gain in Life Expectancy at Birth in India During 1976-2020

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Background

The world population is estimated to have increased from around 2.5 billion in 1950 to more than 8 billion in 2023 (United Nations, 2024), an increase of almost 6 billion over a period of 70 years. This increase in world population poses challenge to achieving development goals and ensuring sustainability. The increase human longevity has been a factor in the increase in world population. The life expectancy at birth (LEB), the universally used indicator of human longevity, is estimated to have increased from around 46 years more than 73 years between 1950 and 2023 (United Nations 2024). The increase in LEB has, however, not been uniform across countries and within countries (United Nations, 2022). The differences or the inequality in the increase in LEB across countries and within countries is now getting increased attention from the international community because these inequalities are unfair and beyond the control of individuals and there is evidence that this inequality is increasing. The United Nations Sustainable Development Agenda calls for healthy life and well-being for all at all ages (United Nations, 2015).

Different arguments have been put forward to explain differences in LEB across countries. One argument is that these differences may be due to differences in social and health policies (United Nations, 2022). Health policy can play a dominating role in controlling a wide range of diseases responsible for differences in child mortality and hence in reducing the inequality in LEB as the increase in LEB is strongly related to the decrease in mortality in the first five years of life. The other argument points to differences in social and economic status as a key determinant of the inequality in LEB across populations. The inequality in LEB driven by social and economic differences can also manifest through access and use of health care services and in terms of technological innovations in medicine and preventive health (Braveman et al, 2011). The inequality in LEB by social and economic status is also different for males and females (Kinge et al, 2019; Mackenbach et al, 2019; Case and Deaton, 2021). On the other hand, inequality in LEB within a country may reflect the disparity in social and economic status across different population groups within the country. These differences manifest in many ways including unequal access to and utilisation of health care services, and differential access and adoption of health care innovations. The within-country inequality in LEB has an impact on the LEB of the country as the LEB of the country is the weight sum of the LEB of different population groups within the country. Historical data on mortality also reveal that LEB and inequality in LEB are usually negatively correlated (Fuchs and Eggleston, 2018). Directing health policy towards reduction in within-country inequality in LEB may, therefore, contributes to accelerating gain in LEB in the country.

The inequality in LEB across countries or across population groups within the country is the result of both initial differences in LEB and differences in the gain in LEB over time. Globally, LEB has converged across countries (Liou et al, 2024). However, life expectancy at age 65 has diverged during 1960-2015, both globally and within different regions of the world (Aksan and Chakraborty, 2023), despite convergence in LEB. Understanding the inequality in LEB across population groups in a country is important for determining appropriate health policies and interventions as such an understanding provides insights into disparities in health and mortality across population groups within the same country. The LEB is also the universally used indicator of population health. The inequality in LEB, reflects disparity in population health across population groups. The World Health Organization has recommended LEB as one of the indicators to monitor health for the sustainable development goals (SDGs) laid down in the 2030 Agenda for Sustainable Development Agenda adopted by the United Nations (WHO, 2016).

It is in the above context that the present paper analyses the inequality in the gain in LEB across states and Union Territories of during the period 1970-2020. The LEB in India remains low by international standards. India ranked 153 in terms of LEB among 236 countries and areas of the world for which estimates of LEB have been prepared by the United Nations in 2023 (United Nations, 2024). By comparison, China ranked 77; Sri Lanka ranked 85; Bangladesh ranked 125; and Bhutan 168. The relatively low LEB in India vis-à-vis other countries and areas of the world has implications to both demographic transition and social and economic development of the country. According to the estimates prepared by the United Nations, LEB in India increased from around 41 years in 1950 to 72 years in 2023 (United Nations, 2024). On the other hand, according to the Registrar General and Census Commissioner of India, LEB in India increased from around 52 years during 1976-1980 to around 70 years during 2016-2020 (Government of India, 2022). Both United Nations estimates and official estimates also suggest that the gain in female LEB in the country has been faster than the gain in male LEB. Official estimates suggest that the average length of life of an Indian increased at around 5.8 months per year, on average, between 1976-1980 and 2016-2020 whereas male LEB increased at around 4.8 months per year, on average, but female LEB increased, on average, by almost 6 months per year during this period.

The low gain in LEB in India has been associated with a high degree of disparity or inequality in gain in LEB within the country. Across the 15 states of the country for which estimates of LEB are available for the periods 1976-1980 and 2016-2020, the gain in LEB has ranged from more than 6 months per year in Andhra Pradesh, Odisha, Tamil Nadu, and Uttar Pradesh to around 3 months per year in Kerala. The gain in LEB has also varied across the 4 mutually exclusive population sub-groups – rural male, rural female, urban male, urban female – within the country. In rural females, increased by more than 6 months per year, on average, between 1976-1980 and 2016-2020 but less than 4 months per year, on average, in urban males. Among the 60 mutually exclusive population groups within the country (15 states and 4 sub-groups in each state), LEB increased by at least 6 months per year, or by at least 2.5 years per quinquennial, on average, in only 10 population groups.

Reasons for the inequality or the disparity in the gain in LEB within India, are not known at present. A part of the unevenness in the gain in LEB in a given period is attributed to the variation in LEB at the beginning of the period. Since, there is a biological limit to human lifespan, the relationship between the gain in LEB during a period and LEB at the beginning of the period is convex - the higher the LEB at the beginning of the period the slower the gain in LEB during the period (Preston et al, 1972). Improvement in LEB has also been found to be influenced by policies that allow advances in income, salubrity, education, sanitation, and medicine, with the mix varying over age, period, cohort, place, and diversity (Oeppen and Vaupel, 2002). It has, therefore, been emphasised that slowing down of the gain in LEB with the improvement in mortality should be distinguished between the slowing down due to what is known as the ceiling effect and slowing down attributed to inappropriate or ineffective policies and their implementation, misapplication of health technology and other factors that have an impact on the health of the people (Cardona and Bishai, 2018).

The gain in LEB reflects cumulative decrease in mortality in different ages. The relationship between the gain in LEB and improvement in mortality in different ages is, however, complex (Pollard, 1982). Contribution of the same amount of the decrease in the risk of death in different ages to the gain in LEB, is different. The contribution mortality improvement on the gain in LEB is larger when mortality improvement in mortality is more dispersed compared to when it is less dispersed across the life span (Glei and Horiuchi, 2007). Analysis of the unevenness or the inequality in the gain in LEB, therefore, requires decomposing the gain in LEB into the gain attributed to the improvement in mortality in different ages of the life span. This decomposition analysis is also relevant for the formulation of the health policy and for planning for the delivery of health care services as it helps in targeting mortality reduction efforts to their maximum efficiency and thereby contributes to the reduction in the unevenness or the inequality in the gain in LEB.

In this paper, we analyse the inequality in the gain in LEB within India during the 40 years period between 1976-1980 and 2016-2020. We decompose the gain in LEB during 1976-2020 into the gain attributed to the improvement in mortality in different ages of the life span to analyse the reason behind the difference in the gain in LEB within the country in terms of the difference in the improvement in mortality in different ages. The analysis has been carried out for the 60 mutually exclusive population groups within the country (15 states and 4 mutually exclusive population sub-groups in each state – rural male, rural female, urban male, urban female). The analysis shows that the improvement in mortality in India during the 40 years between 1976-1980 and 2016-2020 has not been dispersed across all ages of the life span but has largely been concentrated to the younger ages and there is variation in the age pattern of the improvement in mortality which has implications for the gain in LEB. Since the inequality in the gain in LEB reflects the inequality in the improvement in population health, there is a need of adopting a decentralised approach to health policy formulation and for planning and programming for health care services delivery to meet the health needs of the people.

The paper is divided into eight sections including this introduction. The next section outlines the method adopted for the analysis while the third section describes the data source. The analysis is based on the age-specific mortality rates obtained through the official sample registration system of the country. An overview of the variation in the gain in LEB in during 1976-2020 within the country has been presented in section four while section five decomposes the variation in LEB into variation common to all population groups and variation specific to each population group. This decomposition analysis reveals that most of the disparity or the inequality in the gain in LEB across mutually exclusive population groups within India is due to the variation in the gain in LEB common to all population groups. Section six of the paper analyses the contribution of the improvement in mortality in different ages to the gain in LEB in the country and in different population groups within the country. Section seven decomposes the difference in the gain in LEB between two population groups into gain attributed to improvement in mortality in different ages of the life span. The eighth and the last section of the paper discusses the findings of the analysis and discusses their implications from the perspective of the health policy and the health care system.

The Method

Let the population is cross classified into r rows or states ($i=1,....,r$) and c columns or mutually exclusive population sub-groups in each state ($j=1,...c$) so that the population is divided into $n=r$xc mutually exclusive population groups. Let e denotes the LEB and ∇_{ij} denotes the gain in LEB in sub-group j of the geopolitical unit i between time t_1 and t_2 ($t_2>t_1$), whereas $\nabla_{..}$ denotes the average gain in LEB across n mutually exclusive population groups in the population. Then ∇_{ij} can be written as

$$e_{ij}^{2} - e_{ij}^{1} = \nabla_{ij} = \nabla_{..} \times \nabla_{i.} \times \nabla_{.j} \times \frac{\nabla_{ij}}{\nabla_{..} \times \nabla_{i.} \times \nabla_{.j}} \quad (1)$$

Here, $\nabla_{i.}$ is the average of the gain in LEB across c population sub-groups in the state i; and $\nabla_{.j}$ is the average of the gain in LEB across r states in population sub-group j. Equation (1) can be written as

$$\frac{\nabla_{ij}}{\nabla_{..}} = \frac{\nabla_{i.}}{\nabla_{..}} \times \frac{\nabla_{i.}}{\nabla_{..}} \times \frac{\left(\frac{\nabla_{ij}}{\nabla_{..}}\right)}{\left(\frac{\nabla_{i.}}{\nabla_{..}} \times \frac{\nabla_{i.}}{\nabla_{..}}\right)} \quad (2)$$

or

$$\frac{\nabla_{ij}}{\nabla_{..}} = m_{i.} \times m_{.j} \times m_{ij} \quad (3)$$

where

$$m_{i.} = \frac{\nabla_{i.}}{\nabla_{..}} \tag{4}$$

$$m_{.j} = \frac{\nabla_{i.}}{\nabla_{..}} \tag{5}$$

$$m_{ij} = \frac{\left(\frac{\nabla_{ij}}{\nabla_{..}}\right)}{\left(\frac{\nabla_{i.}}{\nabla_{..}} \times \frac{\nabla_{i.}}{\nabla_{..}}\right)} \tag{6}$$

Equation (3) suggests that the difference in the gain in LEB in a population group relative to the average gain in LEB across all population groups is determined by three multipliers $m_{i.}$, $m_{.j}$, and m_{ij}. This means that the gain in LEB in a population group can be decomposed into two components, an average component which is determined by the average gain in LEB in different states across population sub-groups ($m_{i.}$), and average gain in different population sub-groups across states ($m_{.j}$), and a component specific to the population group which is determined by the multiplier m_{ij}.

The disparity or the inequality in the gain in LEB across n mutually exclusive population groups may now be measured in terms of the Theil entropy index (Shorrocks, 1980) and is defined as:

$$I = \frac{1}{n}\sum_{i=1}^{r}\sum_{j=1}^{c}\frac{\nabla_{ij}}{\nabla_{..}} \times ln\left(\frac{\nabla_{ij}}{\nabla_{..}}\right) \tag{7}$$

Since,

$$ln\left(\frac{\nabla_{ij}}{\nabla_{..}}\right) = \ln\left(m_{i.} \times m_{.j} \times m_{ij}\right) = \ln(m_{i.}) + \ln\left(m_{.j}\right) + \ln\left(m_{ij}\right) \tag{8}$$

equation (7) can be written as

$$I = \frac{1}{n}\sum_{i=1}^{r}\sum_{j=1}^{c}\frac{\nabla_{ij}}{\nabla_{..}} \times \ln(m_{i.}) + \frac{1}{n}\sum_{i=1}^{r}\sum_{j=1}^{c}\frac{\nabla_{ij}}{\nabla_{..}} \times \ln\left(m_{.j}\right) + \frac{1}{n}\sum_{i=1}^{r}\sum_{j=1}^{c}\frac{\nabla_{ij}}{\nabla_{..}} \times \ln\left(m_{ij}\right) \tag{9}$$

or

$$I = I_r + I_c + I_{rc} \tag{10}$$

where

$$I_r = \frac{1}{n}\sum_{i=1}^{r}\sum_{j=1}^{c}\frac{\nabla_{ij}}{\nabla_{..}} \times \ln(m_{i.}) \tag{11}$$

$$I_c = \frac{1}{n}\sum_{i=1}^{r}\sum_{j=1}^{c}\frac{\nabla_{ij}}{\nabla_{..}} \times \ln\left(m_{.j}\right) \tag{12}$$

$$I_{rc} = \frac{1}{n}\sum_{i=1}^{r}\sum_{j=1}^{c}\frac{\nabla_{ij}}{\nabla_{..}} \times \ln(m_{i.}) \tag{13}$$

Equation (13) decomposes the inequality in the gain in LEB into three components – inequality in the gain in LEB across states, inequality in the gain in LEB across population sub-groups, and inequality in the gain in LEB that is specific to the population group. The polishing technique first proposed by Tukey (1977) has been used to fit equation (13). It is a non-parametric method. It successively sweeps the polishing function out of rows, then sweeps the polishing function out of columns, then rows, then columns, and so on, and accumulates them in 'all', 'row', and 'column' registers to obtain, respectively, values of $\nabla_{..}$, $m_{i.}$, and $m_{.j}$, and leaves behind residuals (m_{ij}). The geometric mean has been used instead of median and arithmetic mean as the polishing function. The median is not based on values in the dataset whereas use of the arithmetic mean is not appropriate when the underlying data are not statistically normally distributed. An undesirable property of the arithmetic mean is that it implies full compensability in the sense that below average values in the data can be compensated by above average values in the data. The use of geometric mean as the polishing function is preferred as it addresses the problems associated with median and arithmetic mean as the polishing function.

The gain in e between two points in time t_1 and t_2 ($t_2 > t_1$) may also be written as

$$e_2 - e_1 = \nabla = \frac{\nabla}{\ln(g_2/g_1)} \times \ln(g_2/g_1) = K_{21} \times \ln(g_2/g_1) \tag{14}$$

where

$$K_{21} = \frac{\nabla}{\ln(g_2/g_1)} \tag{15}$$

and g denotes the geometric mean of the age-specific mortality rates m(x). Equation (14) can now be written as

$$\nabla = \frac{K_{21}}{n} \times \sum_{x=1}^{n} \ln\left(\frac{m_2(x)}{m_1(x)}\right) = \sum_{x=1}^{n} \frac{K_{21}}{n} \times \ln\left(\frac{m_2(x)}{m_1(x)}\right) = \sum_{x=1}^{n} \nabla(x) \tag{16}$$

$$\nabla(\mathrm{x}) = \frac{K_{21}}{n} \times \ln\left(\frac{m_2(x)}{m_1(x)}\right) \tag{17}$$

Equation (16) decomposes the gain in e into the gain attributed to the improvement in mortality in different ages. The difference in the gain in e between two populations A and B, may be decomposed as

$$\nabla^{AB} = \nabla^{A} - \nabla^{B} = \sum_{x=1}^{n} \nabla^{A}(\mathrm{x}) - \sum_{x=1}^{n} \nabla^{B}(\mathrm{x}) = \sum_{x=1}^{n} \left(\nabla^{A}(\mathrm{x}) - \nabla^{B}(\mathrm{x}) \right) \tag{18}$$

Following Kitagawa (1950), we can write

$$\nabla^{AB} = \sum_{x} \frac{(K_{21}^{A} - K_{21}^{B}) \times \left(\ln\left(\frac{m_2^{A}(x)}{m_1^{A}(x)}\right) + \ln\left(\frac{m_2^{B}(x)}{m_1^{B}(x)}\right) \right)}{2n} + \sum_{x} \frac{(K_{21}^{A} + K_{21}^{B}) \times \left(\ln\left(\frac{m_2^{A}(x)}{m_1^{A}(x)}\right) - \ln\left(\frac{m_2^{B}(x)}{m_1^{B}(x)}\right) \right)}{2n} \tag{19}$$

or

$$\nabla^{AB} = \sum_{x} \left[\frac{(K_{21}^{A} - K_{21}^{B}) \times \ln\left(m_2^{A}(x) \times m_2^{B}(x)\right)}{2n} - \frac{(K_{21}^{A} - K_{21}^{B}) \times \ln\left(m_1^{A}(x) \times m_1^{B}(x)\right)}{2n} + \frac{(K_{21}^{A} + K_{21}^{B}) \times \ln\left(\frac{m_2^{A}(x)}{m_2^{B}(x)}\right)}{2n} - \frac{(K_{21}^{A} + K_{21}^{B}) \times \ln\left(\frac{m_1^{A}(x)}{m_1^{B}(x)}\right)}{2n} \right] \tag{20}$$

Let us define

$$\beta(x) = \sqrt{m^{A}(x) \times m^{B}(x)} \tag{21}$$

$$\alpha(x) = \sqrt{\frac{m^{A}(x)}{m^{B}(x)}} \tag{22}$$

then, equation (20) reduces to

$$\nabla^{AB} = \left[\frac{1}{n} \sum_{x} \left(K_{21}^{A} - K_{21}^{B} \right) \times \ln\left(\frac{\beta_2(x)}{\beta_1(x)}\right) \right] + \left[\frac{1}{n} \sum_{x} \left(K_{21}^{A} + K_{21}^{B} \right) \times \ln\left(\frac{\alpha_2(x)}{\alpha_1(x)}\right) \right] \tag{23}$$

Equation (23) is the product-ratio decomposition of the difference in the gain in LEB between two populations. The two components of the difference in the gain in LEB are virtually independent of each other (Tukey, 1977). The first component on the right-hand side of the equation (23) gives the contribution of the difference in the improvement in the average mortality between the two populations, measured in terms of the geometric mean. The second component on the right-hand side of the equation (23), on the other hand, gives the contribution of the difference in the improvement in the age-specific mortality rates in the two populations measured in terms of the ratio of the improvement in mortality between the two populations. The ratio of the improvement in age-specific mortality rates between two populations is argued to be the more appropriate indicator for analysing the difference in mortality between two populations than the arithmetic difference of the mortality rates as the ratio is less sensitive to the level of mortality than the arithmetic difference (Bergeron-Boucher et al, 2018). It may be noticed that the equation (23) also accounts for the difference in mortality rates between the two populations at time t_1.

Data Source

The analysis is based on the age-specific death rates available from the official sample registration system of the Government of India for the period 1976-1980 and 2016-2020 (Government of India, 1985; 2022). The sample registration system is a large-scale demographic sample survey based on the mechanism of the dual record system (Government of India, 2022). It is the only source in India that provides estimates of the age-specific death rates for the country and for selected states on an annual basis. These estimates are available for the total population and for the four mutually exclusive population sub-groups – rural male, rural female, urban male, and urban female – for the country and for the selected states of the country. The annual estimates of age-specific death rates available through the sample registration system are, however, known for year-to-year fluctuations of unknown origin and, therefore, it is the standard practice to use five years average of the age-specific death rates for the construction of abridged life tables. The use of five years average age-specific death rates also augments the sample size (Government of India, 2022).

The age specific death rates are available from the sample registration system for the period 1976-1980 and 2016-2020 for the country and for 15 states of the country for the total population and for four mutually exclusive sub-groups of population – rural male, rural female, urban male, urban female. The analysis has, therefore, been confined to these 15 states only. Estimates of age-specific death rates are not available for other states and Union Territories of the country either from the sample registration system or from any other source. Estimates of age-specific death rates for 1976-1980 and 2016-2020 are, however, not strictly comparable for three states - Andhra Pradesh, Madhya Pradesh, and Uttar Pradesh – because of the changes in the administrative boundaries. These three states, as they existed during 1976-1980 have been divided into six states Andhra Pradesh and Telangana, Chhattisgarh and Madhya Pradesh, and Uttar Pradesh and Uttarakhand respectively during the period 2016-2020. We have, however, assumed that the difference in the age-specific death rates due to the change in the administrative boundaries of these three states is only marginal as far as the gain in LEB is concerned. The analysis, therefore, has been carried out for the 60 mutually exclusive population groups within the country.

It may also be pointed out that the abridged life tables prepared by the Government of India for the period 1976-1980 are based on a different methodology than the methodology used for the construction of life tables for the period 2016-2020 and, therefore, the life tables for the period 1976-1980 are not comparable with the life tables for the period 2016-2020. Moreover, the age-specific death rates for the period 1976-1980 are available up to 70 years of age only whereas the age-specific death rate for the period 2016-2020 are available up to 85 years of age. We have, therefore reconstructed the abridged life tables for India and for its 15 states for the period 1976-1980 using the MORTPAK software package of mortality measurement developed and made available by the United Nations (United Nations, 2013) as the MORTPAK software has been used for the construction of abridged life tables for the period 2016-2020 by the Government of India.

The estimates of LEB, along with the age-specific death rates for the period 1976-1980 and 2016-2020 for each of the 60 mutually exclusive population groups constitute the basic data set for the present analysis. Using the estimates of LEB for the period 1976-1980 and 2016-2020, the gain in LEB in the country and in each mutually exclusive population group within the country has been measured in terms of the arithmetic difference between and the ratio of the LEB during 2016-2020 and the LEB during 1976-1980. A decomposition methodology has then been used to analyse the contribution of the improvement in mortality in different age groups to the gain in LEB in different population groups. Finally, the difference in the gain in LEB between two mutually exclusive population groups has also been decomposed into the difference attributed to the change in the ratio component and the change in the product component of the improvement in mortality in different age groups in the two population groups.

Gain in LEB in India 1976-2020

Table 1 presents estimates of LEB during 1976-1980 and the gain in LEB during 1976-2020 in India and in 15 states of the country for the total population and for the 4 mutually exclusive sub-groups of population – rural male, rural female, urban male, and urban female. In India, the LEB increased by almost 18 years during the 40 years period under reference, which implies, on average, an increase of less than 0.5 years per year. The increase in LEB has been different from this national average in the four mutually exclusive sub-groups of population. The increase has been the highest in rural females but the slowest in urban males. During 1976-1980, the LEB in urban males in the country was almost 10 years higher than the LEB in rural females. However, because of the relatively faster increase in LEB in rural females during 1976-2020, this difference reduced to less than 2 years during 2016-2020. Table 1 also reveals that the increase in LEB during 1976-2020 has been substantially slower in the urban population of the country as compared to the increase in its rural population. During 1976-1980, the LEB in the urban population of the country was around ____ years higher than the LEB in the rural population.

Across the 15 states of the country included in the present analysis, the improvement in LEB during 1976-2020 has varied widely for the total population and for the four mutually exclusive population groups. In Punjab and Kerala, the LEB increased by less than 10 years or by less than 3 months per year on average whereas the gain in LEB was more than 20 years or more than 6 months per year on average in Odisha, Tamil Nadu, and Uttar Pradesh. The are the only three states in the country where LEB increased by more than 6 months per year during 1976-2020. The gain LEB has been the most rapid in Odisha where the LEB increased by more than 21 years between 1976-1960 and 2016-2020. On the other hand, Punjab and Kerala are the only two states in which the LEB increased by less than 10 years during this period. During 1976-1980, the LEB in Kerala was the highest among the 15 states while the LEB in Punjab was the second highest. On the other hand, the LEB in Uttar Pradesh was the lowest while that in Odisha was the second lowest across the 15 states (Table 1).

The gain in LEB across the four mutually exclusive population sub-groups has also been different in each of the 15 states. The gain in LEB in urban females has been the slowest across the four mutually exclusive population groups in Andhra Pradesh, Assam, Karnataka and Madhya Pradesh but the fastest in Haryana and Kerala. On the other hand, the gain in LEB in rural females has been the fastest across the four mutually exclusive population groups in 13 of the 15 states included in the analysis. There is no state in which the gain in LEB in either males or urban males has been the fastest across the four population groups. The gain in LEB in rural females was at least 20 years in 9 of the 15 states but is no state in which the gain in rural males has been at least 20 years during the period under reference. There is also no state where the LEB increased by at least 20 years in either rural males or in urban males whereas, there is only one state – Haryana - which the gain in LEB has been more than 20 years in urban females.

Among the 60 mutually exclusive population groups (15 states $\times$ 4 mutually exclusive population groups), the gain in LEB has been the most rapid in rural females in Uttar Pradesh but the lowest in urban males in Punjab. There are 8 population groups in which the gain in LEB has been less than 10 years whereas in 9 population groups, the gain in LEB has been at least 20 years. The within-state inequality in the gain in LEB has been the highest in Haryana followed by Himachal Pradesh and Odisha but the lowest in Kerala. In Haryana, LEB increased by around 8 years in urban males but more than 22 years in urban females. Similarly, LEB increased by more than 23 years in rural females in Himachal Pradesh but by just 8 years in urban males. By contrast, the increase in LEB in Kerala across the four mutually exclusive population groups ranged between 8.7 to 10.8 years. In Tamil Nadu also, the within-state, across population groups, inequality in the gain in LEB has been quite low whereas this inequality is found to be very high in Andhra Pradesh, Karnataka, Madhya Pradesh, and Uttar Pradesh. In these states, gain in LEB appears to have largely been confined to specific population groups only and not dispersed across all population sub-groups.

Table 1: The life expectancy at birth during 1976-1980, gain in the life expectancy at birth during 1976-2020, and within-state inequality in the gain in the life expectancy at birth in India and states.

Country/State	Life expectancy at birth during 1976-80 (years)					Gain in life expectancy at birth during 1976-2020 (years)					Gain
	Total	Rural male	Rural female	Urban male	Urban female	Total	Rural male	Rural female	Urban male	Urban female	inequality
India	51.9	50.8	49.7	59.3	60.7	18.0	16.3	20.4	12.6	13.9	0.189
Andhra Pradesh	52.8	50.1	52.2	59.3	62.0	17.8	17.9	19.4	12.3	11.7	0.219
Assam	50.9	50.4	50.1	58.1	64.0	17.0	15.8	17.2	15.1	11.0	0.157
Gujarat	52.0	50.0	51.4	56.1	56.2	18.5	15.9	21.7	14.9	17.3	0.149
Haryana	54.5	55.3	51.1	61.0	52.8	15.4	10.7	20.8	8.5	22.2	0.387
Himachal Pradesh	56.2	57.3	54.0	66.7	66.7	17.4	12.6	23.2	8.0	14.3	0.381
Jammu & Kashmir	56.0	56.2	53.1	63.1	65.1	18.3	14.9	21.5	12.9	15.4	0.199
Karnataka	56.5	54.1	54.5	61.2	66.1	13.4	11.9	16.0	10.7	8.7	0.225
Kerala	65.4	63.3	67.8	62.9	67.2	9.6	9.0	10.3	8.7	10.8	0.092
Madhya Pradesh	48.9	48.1	46.9	56.3	59.5	18.6	16.2	21.8	13.0	12.9	0.227
Maharashtra	56.2	53.3	54.7	60.9	63.1	16.7	16.8	18.4	12.5	12.9	0.166
Odisha	48.8	49.3	47.2	57.5	59.1	21.5	19.4	23.8	10.1	11.1	0.356
Punjab	63.2	61.5	61.8	66.5	69.3	9.3	7.7	11.1	6.8	8.8	0.186
Rajasthan	51.1	49.6	49.9	58.6	58.9	18.2	16.2	21.3	12.9	14.7	0.192
Tamil Nadu	53.0	50.8	50.5	58.8	59.9	20.1	17.5	22.4	14.9	18.3	0.147
Uttar Pradesh	45.5	47.5	41.3	55.7	53.2	20.5	16.7	24.6	13.4	16.1	0.236

Source: Author

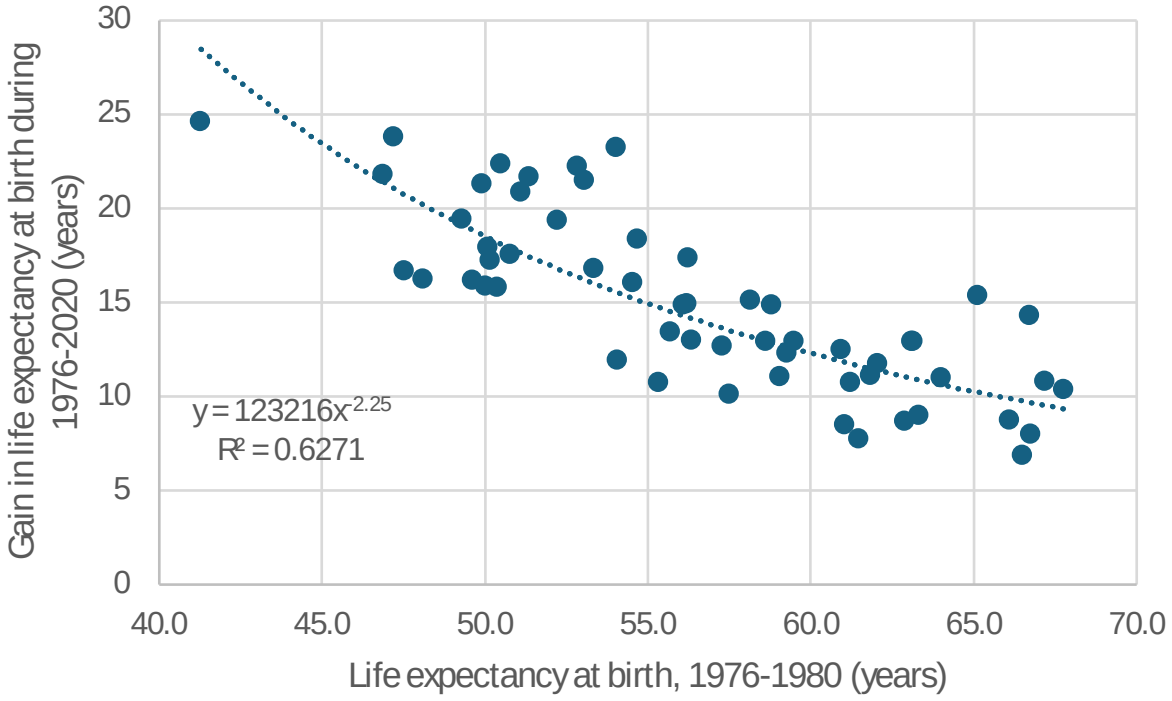

Figure 1: The life expectancy at birth during 1976-1980 and the gain in the life expectancy at birth during 1976-2020 in mutually exclusive population sub-groups in India.
Source: Author, based on table 1.

The gain in LEB during 1976-2020 across the 60 mutually exclusive population groups within the country appears to be associated with the level of LEB during 1976-1980 as may be seen from the figure 1 – the lower the LEB during 1976-1980 the higher the gain in LEB during 1976-2020 and vice versa. The relationship, however, is not very strong as the coefficient of determination, R^2, is only around 60 per cent and there are notable exceptions. For example, the LEB in urban females in Jammu and Kashmir was more than 65 years during 1976-1980, while the gain in LEB in this population group during the period 1976-2020 has also more than 15 years. Similarly, LEB in urban females in Himachal Pradesh was 66.7 years during 1976-1980 but the gain in LEB during the period 1976-2020 has been more than 14 years. In rural females in Himachal Pradesh also, the LEB during 1976-1980 was around 54 years but the gain in LEB during the period 1976-2020 was more than 23 years so that this population group is an outlier as regards the gain in LEB. On the other hand, the LEB in rural males in Madhya Pradesh was only around 48 years during 1976-1980 but the gain in LEB has been around 16 years during the period 1976-2020. It is obvious from the figure 1 that the unevenness or the inequality in the gain in LEB across 60 mutually exclusive population groups within India during the period 1976-2020 cannot be explained by the variation in LEB across the 60 mutually exclusive population groups during 1976-1980 alone. There are other factors also, the variation in which appears to have contributed to the unevenness or the inequality in the gain in LEB during the period 1976-1980 across the 60 mutually exclusive population groups, although the level of LEB during 1976-1980 has been a factor in deciding the gain in LEB during the period 1976-2020.

The United Nations has developed model mortality improvement trajectories based on the increase in LEB in different countries of the world during the period 1950-2005, covering the LEB between 50 years to 85 years (United Nations, 2004). These model mortality improvement trajectories are expressed as annual increment in LEB at a given level of LEB but are presented as quinquennial

increments and are christened as very fast (VF) improvement; fast (F) improvement; medium (M) improvement; slow (S) improvement; and very slow (VS) improvement. A comparison of the gain in LEB in different mutually exclusive population groups within India during the period under reference with the gain in LEB according to the medium (M) model mortality improvement trajectory of the United Nations is presented in table 2. In India, the actual gain in LEB during the period 1976-2020 has been less than the gain expected according to the medium model mortality improvement trajectory of the United Nations in both urban males and urban females with substantial gap in urban males. In rural males and rural females, the actual gain in LEB has been more than the expected gain, although the gap between the expected and the actual gain is marginal. On the other hand, out of the 60 mutually exclusive population groups, the actual gain in LEB has been less than the expected one in 39 or almost two-third of the mutually exclusive population groups within the country. There is no state where the actual gain in LEB in urban males has been more than the expected gain in LEB during the period under reference whereas the actual gain in LEB in rural females has been more than the expected one in 10 of the 15 states. Similarly, the actual gain in LEB in rural males has been more than the expected gain in 7 states while the actual gain in LEB in urban females has been more than the expected gain in 11 states. Table 2 suggests that gain in LEB during the period 1976-2020 in different population groups has not been the same. More specifically, the gain in LEB in urban males has been particularly slower than the expected gain in LEB according to the medium trajectory of the model mortality improvement trajectories developed by the United Nations based on the mortality improvement experience in different countries of the world during the period 1950 through 2005.

Table 2: Actual and expected gain in LEB in different mutually exclusive population groups within India during 1976-2020.

India/States	Rural male		Rural female		Urban male		Urban female	
	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual
India	67.0	67.2	69.0	70.1	75.0	71.9	75.0	74.5
Andhra Pradesh	66.0	68.0	72.0	71.6	75.0	71.6	76.0	73.8
Assam	67.0	66.2	71.0	67.4	75.0	73.3	77.0	75.0
Gujarat	66.0	65.9	71.0	73.1	74.0	70.9	74.0	73.6
Haryana	70.0	66.1	71.0	71.9	76.0	69.5	72.0	75.1
Himachal Pradesh	71.0	69.9	73.0	77.2	78.0	74.7	78.0	81.0
Jammu & Kashmir	71.0	71.1	73.0	74.6	77.0	76.0	77.0	80.5
Karnataka	70.0	66.0	73.0	70.6	76.0	71.9	78.0	74.8
Kerala	74.0	72.3	79.0	78.1	76.0	71.5	79.0	77.9
Madhya Pradesh	64.0	64.3	67.0	68.7	74.0	69.3	75.0	72.4
Maharashtra	69.0	70.2	73.0	73.0	76.0	73.4	77.0	76.1
Odisha	66.0	68.7	67.0	71.0	74.0	67.6	75.0	70.1
Punjab	73.0	69.2	76.0	72.9	78.0	73.3	79.0	78.1
Rajasthan	66.0	65.8	69.0	71.2	75.0	71.5	75.0	73.6
Tamil Nadu	67.0	68.3	71.0	72.9	75.0	73.7	75.0	78.2
Uttar Pradesh	64.0	64.2	59.0	65.9	74.0	69.1	73.0	69.3

Source: Author

The gain in LEB in a population group can be decomposed into the grand average or the geometric mean of the gain in LEB across the 60 mutually exclusive population groups and the state multiplier, the population sub-group multiplier and the residual multiplier in conjunction with equation (3). Results of this decomposition exercise are presented in table 3. The grand average or the geometric mean of the gain in LEB across the 60 mutually exclusive population groups in the country is estimated to be around 14.2 years. The average (geometric mean) of the gain in LEB across the four mutually exclusive sub-groups is more than 27 per cent higher than the grand average in Tamil Nadu but more

than 40 per cent lower than the grand average in Punjab. There are four states where the average of the gain in LEB across the four mutually exclusive population sub-groups is lower than the grand average as the multiplier ($m_{i.}$) was less than 1. In the remaining states, the average of the gain in LEB across the four mutually exclusive population sub-groups is higher than the grand average. On the other hand, the average of the gain in LEB in rural males across 14 states is almost the same as the grand average, whereas the average of the gain in LEB in rural females is 34 per cent higher than the grand average. Similarly, the average of the gain in LEB in urban males is around 20 per cent lower than the grand average, whereas in case of urban females, the average gain in LEB is found to be only about 6 per cent lower than the grand average.

Lastly, the gain in LEB that is not explained by the grand average, the state effect and the population sub-group effect is found to be the highest in urban females in Haryana but the lowest in urban males in Himachal Pradesh. In urban females in Haryana, the gain in LEB is more than 65 per cent higher than the gain in LEB determined by the grand average, the state effect, and the population sub-group effect. On the other hand, the gain in LEB in urban males in Himachal Pradesh is almost 26 per cent lower than the gain in LEB determined by the grand average and the corresponding state and population sub-group effects. It may also be seen from table 3 that in 28 of the 60 mutually exclusive population sub-groups, factors specific to the population sub-groups contribute to slow down the gain in LEB during the period 1976-2020 relative to the gain in LEB determined by the grand average and the respective state and population sub-group effects. The gain in LEB in a population sub-group which is determined by the grand average and the corresponding state, and population sub-group effects may be perceived as the statistically normal gain in LEB for that population sub-group. The deviation from this statistically normal gain in LEB may be attributed to the factors that are specific to the population sub-group.

Table 3: Decomposition of the gain in life expectancy at birth across 60 mutually exclusive population groups in India during 1976-2020. Results of the polishing exercise.

State	Grand average	Sub-group multiplier			
		Rural male	Rural female	Urban male	Urban female
	14.197	0.999	1.340	0.798	0.937
	State multiplier	Residuals			
Andhra Pradesh	1.055	1.199	0.966	1.031	0.837
Assam	1.027	1.085	0.881	1.301	0.804
Gujarat	1.216	0.922	0.938	1.079	1.073
Haryana	1.010	0.750	1.084	0.743	1.655
Himachal Pradesh	0.952	0.936	1.283	0.738	1.129
Jammu & Kashmir	1.118	0.940	1.011	1.019	1.033
Karnataka	0.815	1.033	1.034	1.161	0.806
Kerala	0.680	0.930	0.800	1.127	1.193
Madhya Pradesh	1.099	1.041	1.043	1.044	0.883
Maharashtra	1.052	1.127	0.917	1.046	0.925
Odisha	1.062	1.291	1.177	0.840	0.783
Punjab	0.596	0.913	0.979	1.012	1.105
Rajasthan	1.126	1.012	0.994	1.013	0.982
Tamil Nadu	1.274	0.971	0.923	1.031	1.081
Uttar Pradesh	1.215	0.968	1.064	0.976	0.995

Source: Author

Table 3 suggests that the inequality in the gain in LEB across 60 mutually exclusive population groups within India may be explained in terms of the equality in the gain across states, inequality in the gain across the four mutually exclusive sub-groups of population, and inequality in the residual

component of the gain in LEB. The Theil entropy index of inequality in the gain in LEB relative to the expected gain in LEB across 60 mutually exclusive population groups is estimated to be 0.099. The Theil entropy index of inequality is zero when the actual gain in LEB is the same as the expected gain in LEB in all the 60 mutually exclusive population groups or the ratio of the actual to expected gain in LEB is 1. Equation (10) suggests that the inequality in the in LEB attributed to the variation in the residual component of the gain in LEB accounts for only about 20 per cent of the total inequality in the gain in LEB across 60 mutually exclusive population groups within the try. The rest of the inequality is attributed to the variation in the gain LEB across states and variation in the gain in LEB across four mutually exclusive population sub-groups almost equally. This means that the inequality in the gain in LEB within the country is largely determined by the variation across states in the average of the gain LEB across mutually exclusive population sub-groups and variation across mutually exclusive population sub-groups in the average of the gain in LEB across states. The inequality in the gain in LEB attributed to the factors specific to different mutually exclusive population groups within the country accounts for around 20 per cent of the total inequality in the gain in LEB across the 60 mutually exclusive population groups within the country. There are 12 population groups in which the actual gain in LEB has been at least 10 per cent higher than the expected gain in LEB determined by the grand average and corresponding state and population sub-group effects due to factors specific to population groups. Similarly, there are 11 population groups in which the gain in LEB has been at least 10 per cent lower than the expected gain. In the remaining 37 population groups, the population group specific factors account for less than ±10 per cent of the difference between the actual and the expected gain in LEB. In these population groups, the variation in the gain in LEB is almost entirely determined by the average of the gain in LEB across mutually exclusive population sub-groups and by the average of the gain in the population sub-group across states.

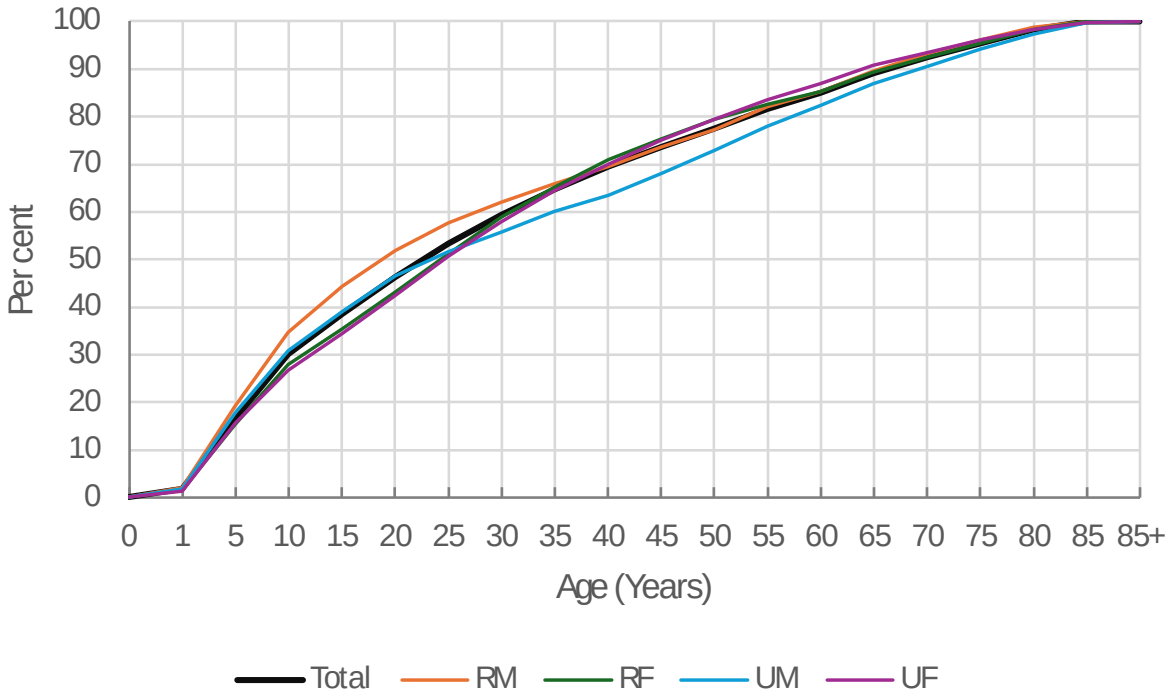

Figure 2: Proportionate (per cent) contribution of the improvement in mortality in different ages to the gain in the life expectancy at birth during 1976-2020 in India.
Source: Author

Contribution of the Improvement in Age-specific Mortality

Table 4 gives the proportionate contribution of the improvement in age-specific mortality rates to the gain in LEB. Almost 39 per cent of the gain in LEB in India during the period 1976-2020 is attributed to the improvement in mortality in the first 15 years of life; another 39 per cent to the improvement in mortality in 15-49 years of life, while the remaining 22 per cent to the improvement in mortality in population aged 50 years and above. The improvement in mortality in population aged 70 years and above accounted for only around 7 per cent of the gain in LEB so that the cumulative distribution of the proportionate contribution of the improvement in mortality in different ages to the gain in LEB is convex in shape (Figure 2). Almost 80 per cent of gain in LEB in India during the period 1976-2020 is attributed to the improvement in mortality in population below 50 years of age.

The contribution of mortality improvement in different ages to the gain in LEB is different in the four mutually exclusive population sub-groups. In rural males, almost 45 per cent of the gain in LEB is attributed to mortality improvement in the first 15 years of life but this proportion is less than 33 per cent in rural females. In the urban areas, the gain in LEB attributed to mortality improvement in the first 15 years of life is higher in males than in females but the male-female gap in the urban population is smaller to that in the rural population. The gain in LEB attributed to mortality improvement in 15-49 years of age is substantially higher in females than in males in both rural and urban areas but the gain in LEB attributed to mortality improvement in 50-69 years of age is higher in males than in females. In the age group 70 years and above the contribution of mortality improvement to the gain in LEB is higher in females in the rural population but in males in the urban population.

The contribution of mortality improvement in different age groups to the gain in LEB is different in different states. The proportionate contribution of the improvement in mortality in the age groups <5 years, 5-14 years, 15-49 years, 50-69 years, and 70 years and above to the gain in LEB is shown in figure 3. The contribution of mortality improvement in the first 5 years of life is higher than the national average in 6 states, but below the national average in 3 states. The contribution of mortality improvement in 5-14 years of age is around 25 per cent in Karnataka, but only 18 per cent in Odisha against the national average of 22 per cent. The contribution of mortality improvement in 15-49 years of age is 40 per cent in Rajasthan but only 34 per cent in Haryana and Uttar Pradesh against the national average of 39 per cent. The contribution of mortality improvement in 50-69 years of age is 18 per cent in Assam and Odisha, but only 7 per cent in Haryana. In the age group 70 years and above, this contribution is 13 per cent in Odisha, but only 5 per cent in Madhya Pradesh against the national average of 7 per cent. In Karnataka, there has been virtually no improvement in mortality in this age group during the period under reference.

The male-female difference in the contribution of mortality improvement in different ages to the gain in LEB is also different. The contribution of male mortality improvement in the age-group 1-5 years is higher than that in female mortality in all population groups except Karnataka, Rajasthan, and Uttar Pradesh, where the contribution of urban female mortality improvement to the gain in LEB has been higher than that of urban male mortality. The same is the situation in 5-14 years of age, although there are exceptions, the most notable is in Himachal Pradesh where mortality increased, instead decreased, in urban males. On the other hand, in the age group 15-49 years, the contribution of the improvement in female mortality has been higher than that in male mortality in all states except in the urban population of Himachal Pradesh and Punjab. In Himachal Pradesh, the contribution of the improvement in female mortality aged 15-49 years in the urban population to the gain in LEB is less than that the male mortality, whereas there is little difference in the contribution in the urban population of Punjab. In ages 50 years and above also, the contribution of the improvement in male mortality to the gain in LEB has, in general, been higher relative to the contribution of the improvement in female mortality, but there are important exceptions to this common pattern as may be seen from the figure 3.

Table 4: Proportionate (per cent) contribution of the improvement in mortality in different age-groups to the gain in life expectancy at birth (years) in India and selected states during 1976-2020.

Country/State	Sub-group	Gain in LEB (Years)	Age (Years)																		
			<1	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
India	All	18.02	1.71	14.94	13.45	8.42	7.68	7.06	6.24	5.24	4.70	4.28	3.92	4.09	3.32	4.17	3.35	2.95	2.68	1.69	0.11
	RM	16.33	2.00	17.15	15.52	9.79	7.40	5.93	4.17	3.94	3.73	3.92	3.82	4.62	3.14	4.52	3.61	2.84	2.63	1.26	0.00
	RF	20.42	1.54	13.90	12.48	7.43	7.74	8.15	7.73	6.22	5.75	4.46	4.03	3.09	2.81	3.93	3.26	2.86	2.82	1.69	0.11
	UM	12.60	1.83	15.84	13.08	8.36	7.36	5.11	4.10	4.37	3.34	4.59	4.88	5.12	4.32	4.69	3.64	3.65	3.09	2.39	0.24
	UF	13.85	1.38	14.24	11.03	7.80	8.04	8.24	7.18	6.44	5.74	5.04	4.24	4.19	3.39	3.77	2.76	2.71	2.06	1.61	0.14
Andhra Pradesh	All	17.81	1.84	13.78	14.80	8.55	8.23	5.49	6.38	4.99	4.60	3.34	2.92	3.11	3.15	3.65	3.91	3.61	3.42	3.64	0.58
	RM	17.93	2.03	13.40	16.11	6.82	7.29	6.16	4.63	3.84	2.89	2.57	2.61	2.38	3.06	3.92	5.30	5.25	5.24	5.58	0.92
	RF	19.39	1.72	13.78	15.11	9.32	7.91	7.65	7.42	6.14	5.20	3.33	2.70	2.95	2.38	3.16	2.73	2.54	2.22	3.16	0.58
	UM	12.31	1.57	12.42	11.66	13.06	7.57	7.07	3.48	4.70	7.23	4.64	4.30	3.77	5.05	5.08	3.97	2.47	2.78	-0.28	-0.53
	UF	11.74	1.04	12.21	9.53	9.17	10.35	12.06	7.73	4.22	8.58	3.85	1.41	3.51	3.76	3.30	2.90	3.02	1.53	1.66	0.18
Assam	All	17.05	1.43	11.38	13.71	8.12	5.77	5.77	5.97	5.73	5.40	4.53	5.94	4.66	4.55	4.72	3.95	3.42	3.15	1.73	0.07
	RM	15.80	1.43	12.65	15.88	9.26	4.01	4.63	5.66	3.89	4.79	3.02	5.57	3.86	3.94	3.85	3.95	4.97	4.55	3.63	0.45
	RF	17.23	1.13	10.25	12.31	7.86	7.24	6.74	7.05	8.47	6.11	6.48	6.33	4.83	4.38	5.38	3.36	1.50	1.73	-0.67	-0.46
	UM	15.13	3.93	21.00	11.85	5.48	2.47	1.32	2.33	-0.76	1.42	4.49	6.21	6.14	6.54	7.17	6.52	4.88	4.91	3.70	0.40
	UF	10.98	3.04	18.08	16.75	0.47	5.17	8.49	12.24	6.32	6.20	6.59	4.57	4.70	4.40	4.34	2.29	0.94	-1.32	-2.54	-0.73
Gujarat	All	18.52	1.51	16.46	12.69	11.13	7.86	6.37	6.72	5.97	4.87	5.16	2.45	3.99	2.62	3.30	2.75	2.75	2.31	1.13	-0.03
	RM	15.89	1.60	19.37	15.92	11.72	6.77	3.44	4.45	4.39	3.33	4.92	2.95	4.79	2.34	4.05	3.80	2.68	2.92	0.74	-0.19
	RF	21.69	1.30	14.01	9.66	9.72	7.67	8.64	8.07	7.87	5.72	4.05	3.49	3.65	2.64	3.85	3.31	2.55	2.18	1.52	0.09
	UM	14.85	1.56	18.64	16.34	11.66	6.45	4.67	5.32	4.66	4.53	6.14	4.21	5.22	3.73	3.42	1.29	2.60	1.09	-0.96	-0.57
	UF	17.34	1.41	15.89	10.71	11.26	10.04	6.33	7.42	6.10	4.95	4.50	0.13	1.77	1.98	1.77	2.97	3.96	4.08	4.12	0.62
Haryana	All	15.42	1.81	16.79	15.86	9.31	8.50	5.94	4.86	3.95	5.26	3.45	2.05	1.74	1.14	1.61	2.57	3.29	5.37	5.50	1.00
	RM	10.74	2.97	24.90	23.96	13.31	6.87	-0.83	0.32	0.91	4.68	3.08	-1.49	-4.06	-5.01	1.04	1.72	4.49	10.00	10.91	2.23
	RF	20.84	1.30	12.20	12.83	7.03	8.86	8.17	6.60	6.87	5.87	5.66	4.47	3.26	2.50	2.34	2.23	2.67	3.36	3.25	0.52
	UM	8.49	1.36	24.97	12.66	11.57	10.41	1.06	-0.05	-1.87	2.17	0.13	2.44	5.50	5.91	2.63	4.07	3.44	7.83	5.03	0.72
	UF	22.22	1.33	10.75	10.46	6.57	8.58	9.66	9.14	6.97	7.94	5.66	4.20	3.43	2.43	0.62	3.13	2.63	2.39	3.49	0.63
Himachal Pradesh	All	17.36	1.76	10.84	14.96	10.13	6.76	4.76	5.85	7.09	4.74	3.70	5.03	4.54	3.53	3.62	3.05	2.96	2.61	3.45	0.62
	RM	12.64	1.95	15.50	29.93	8.12	4.27	-0.23	3.64	7.95	4.00	2.39	5.03	2.22	2.51	2.25	1.75	3.01	1.67	3.37	0.65
	RF	23.24	1.57	7.91	8.58	10.05	6.57	6.93	6.79	6.49	5.58	4.71	5.46	5.91	3.90	4.67	4.10	2.95	3.37	3.79	0.67
	UM	7.95	3.50	21.30	3.55	-6.10	4.89	0.21	9.60	12.18	5.76	16.14	6.53	7.56	10.98	6.03	2.16	1.97	2.00	-5.94	-2.31
	UF	14.29	1.39	4.09	7.14	6.90	8.08	12.50	5.73	3.82	6.10	3.29	6.02	10.48	6.98	3.61	2.93	4.77	2.68	3.08	0.43
Jammu & Kashmir	All	18.30	0.93	14.98	9.33	5.36	6.44	7.62	7.05	4.40	5.21	4.66	4.16	4.18	3.66	3.75	4.31	4.57	4.88	4.03	0.48
	RM	14.90	1.33	17.78	13.22	8.82	7.83	4.55	3.51	2.03	2.72	3.35	2.65	3.90	3.33	3.41	4.79	5.32	6.06	4.84	0.57
	RF	21.52	0.69	12.67	7.31	4.87	7.88	9.29	8.09	5.05	5.78	5.55	4.55	4.11	3.70	4.12	3.88	4.34	4.66	3.20	0.25
	UM	12.90	0.65	26.98	8.50	-4.85	3.99	9.14	9.61	1.11	4.61	2.36	4.38	6.39	6.05	3.43	5.16	4.11	3.96	3.86	0.56
	UF	15.36	0.64	14.46	9.15	5.75	4.02	5.77	6.51	8.31	10.82	4.33	5.74	2.59	1.43	4.34	3.99	4.06	3.97	3.70	0.43

Country/State	Sub-group	Gain in LEB (Years)	Age (Years)																		
			<1	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Karnataka	All	13.36	1.88	17.24	15.72	11.33	9.44	6.37	6.23	5.58	4.72	3.18	3.63	4.35	3.16	4.25	2.87	0.07	1.51	-1.09	-0.45
	RM	11.94	2.74	21.89	20.36	17.31	11.82	3.96	2.85	1.30	0.91	2.07	1.11	4.48	4.15	3.86	3.14	-0.86	1.96	-2.26	-0.77
	RF	16.05	1.40	14.67	14.75	9.72	6.75	7.44	8.72	8.50	6.88	4.96	4.11	3.66	2.61	4.49	1.99	0.58	1.53	-1.97	-0.77
	UM	10.72	1.93	14.93	10.02	6.35	7.77	1.11	1.92	5.86	5.71	1.76	7.66	7.69	1.89	2.99	6.34	2.89	4.68	7.08	1.43
	UF	8.74	1.45	18.72	13.61	7.73	13.61	10.51	5.56	7.44	6.47	3.53	4.41	2.22	3.20	4.95	1.39	-2.07	-0.60	-1.77	-0.34
Kerala	All	9.64	2.49	15.10	14.44	9.10	5.70	4.76	5.21	7.16	5.20	5.27	4.00	3.19	3.94	3.79	2.42	3.04	3.23	1.84	0.11
	RM	8.96	3.40	17.09	13.94	8.54	5.05	4.74	4.65	5.00	4.94	5.78	4.48	3.67	3.55	3.12	2.92	2.79	3.61	2.45	0.28
	RF	10.35	1.88	14.30	16.50	13.05	6.00	4.51	7.33	4.32	4.33	5.63	3.84	2.42	2.94	3.32	2.47	2.26	3.15	1.66	0.08
	UM	8.67	1.70	14.01	17.38	6.14	3.26	5.26	2.72	10.55	5.93	5.94	4.17	4.04	4.16	4.62	2.04	3.69	2.72	1.57	0.09
	UF	10.78	2.34	12.71	4.98	7.27	5.04	4.48	5.71	6.95	7.91	4.96	4.68	3.86	5.74	6.15	4.13	5.15	4.66	3.04	0.23
Madhya Pradesh	All	18.56	1.60	14.90	12.96	8.95	6.65	6.90	6.49	6.14	4.29	5.19	3.56	5.93	2.50	5.01	3.44	3.15	2.15	0.41	-0.22
	RM	16.23	2.02	18.48	16.61	10.32	5.17	5.71	4.37	4.11	1.23	4.78	2.29	9.19	1.92	5.60	3.32	3.29	3.86	-1.31	-0.96
	RF	21.81	1.34	12.60	10.95	7.72	7.65	8.12	7.51	6.92	6.99	6.71	5.14	4.08	2.07	5.81	3.53	2.66	0.75	-0.27	-0.28
	UM	12.99	1.52	18.38	9.54	9.92	3.52	-1.56	-0.16	4.19	1.25	2.63	2.68	6.58	4.60	3.03	6.60	7.72	8.11	9.64	1.82
	UF	12.90	1.26	13.01	8.22	11.53	7.11	8.04	8.73	8.64	7.39	6.29	4.46	3.61	2.22	3.56	1.42	2.61	0.95	0.90	0.05
Maharashtra	All	16.70	1.98	14.80	14.30	8.57	7.04	7.26	6.20	4.98	4.19	3.50	3.66	3.63	3.17	3.88	3.64	3.67	2.97	2.33	0.23
	RM	16.82	1.99	14.67	15.40	11.37	6.99	5.31	4.74	3.13	2.91	3.31	3.48	3.34	1.98	3.79	4.35	4.51	4.19	3.97	0.55
	RF	18.35	1.59	13.20	13.95	7.82	7.88	9.15	6.59	6.80	5.44	3.25	2.74	2.89	2.93	4.14	3.75	3.47	2.69	1.65	0.07
	UM	12.46	2.34	18.46	11.70	5.39	9.67	6.70	4.40	5.63	2.93	3.83	5.22	5.09	4.99	3.85	3.51	2.83	1.99	1.39	0.08
	UF	12.94	2.06	17.40	13.18	3.82	5.23	9.38	9.68	5.93	7.20	4.51	4.27	3.35	4.02	3.21	1.91	2.68	1.71	0.56	-0.12
Odisha	All	21.47	1.61	11.59	11.59	6.79	7.73	6.61	5.65	4.83	4.38	3.39	4.34	5.18	4.89	4.56	3.63	4.42	3.54	4.47	0.79
	RM	19.44	1.67	13.40	14.18	6.84	8.33	5.84	2.98	2.53	4.11	3.08	4.92	6.24	5.46	5.32	3.76	3.79	2.75	4.05	0.74
	RF	23.78	1.48	10.30	9.52	6.83	5.57	6.77	7.70	6.52	4.81	3.42	4.33	4.30	4.43	4.16	4.03	5.10	4.72	5.16	0.86
	UM	10.10	2.98	16.40	15.60	10.11	7.89	7.56	5.33	5.50	3.25	7.79	4.72	8.31	9.03	9.13	3.64	-1.04	-5.42	-8.76	-2.01
	UF	11.05	1.79	13.46	19.42	7.53	13.19	9.93	5.52	8.40	6.74	5.09	3.34	5.66	3.90	3.36	0.95	-0.89	-2.61	-3.93	-0.85
Punjab	All	9.26	4.91	33.99	25.94	20.09	11.67	7.07	8.81	5.04	2.24	-1.56	-2.79	-1.00	-6.43	1.28	-3.55	-2.10	-1.34	-1.96	-0.28
	RM	7.71	7.73	50.86	41.33	17.59	13.52	11.04	2.91	-2.51	-3.82	-6.02	-8.40	-11.88	-15.53	-1.73	-4.61	-1.30	3.80	5.51	1.49
	RF	11.10	4.00	30.20	26.73	21.27	9.64	4.63	13.74	9.44	6.09	2.48	-0.23	-2.80	-7.44	-0.55	-4.54	-3.43	-4.00	-4.46	-0.74
	UM	6.82	3.65	23.00	15.12	16.37	20.44	9.00	14.47	1.60	-1.47	-4.84	-4.76	5.36	3.07	1.78	-0.03	-1.01	0.33	-1.66	-0.40
	UF	8.75	3.09	21.45	12.88	12.35	-0.16	4.52	7.29	8.77	4.28	4.83	4.10	9.71	4.83	5.88	-1.01	0.65	-0.94	-1.96	-0.56
Rajasthan	All	18.23	1.33	14.12	15.22	8.28	8.64	7.08	6.05	5.33	5.11	3.63	3.76	4.00	1.62	3.38	3.18	3.76	3.18	2.19	0.15
	RM	16.15	2.08	21.92	18.35	13.12	8.83	5.19	2.66	3.22	3.97	1.78	4.27	5.76	1.10	3.44	2.07	2.47	1.37	-1.02	-0.57
	RF	21.28	1.00	10.08	14.13	5.04	8.25	8.19	8.17	6.83	6.72	4.55	3.63	3.18	0.74	3.91	4.27	4.54	4.01	2.60	0.17
	UM	12.91	0.85	12.54	14.92	9.95	6.10	2.77	5.52	3.21	4.56	4.20	4.66	2.88	3.55	4.91	3.92	4.55	4.41	5.49	1.01
	UF	14.69	0.66	13.31	12.59	10.41	10.18	5.07	5.92	3.84	4.32	6.64	2.08	2.97	2.37	0.30	2.26	4.48	5.38	6.13	1.10
Tamil Nadu	All	20.14	1.83	15.21	12.51	8.76	7.12	5.77	5.43	4.75	4.46	4.05	3.68	3.79	4.04	4.53	3.76	3.56	3.27	3.05	0.43
	RM	17.54	2.53	19.36	15.51	10.94	8.20	5.69	5.40	4.51	3.24	1.75	2.90	2.21	2.57	3.57	2.94	2.57	3.13	2.62	0.39
	RF	22.38	1.71	13.43	11.45	7.33	7.70	6.67	6.50	4.69	6.40	4.05	4.92	4.01	5.12	4.51	3.98	2.52	2.80	1.98	0.24

Country/State	Sub-group	Gain in LEB (Years)	Age (Years)																	
			<1	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
	UM	14.87	1.79	18.41	10.61	8.97	4.89	5.35	5.27	3.88	3.08	4.71	2.57	3.30	3.28	5.40	4.08	5.13	4.26	4.39	0.63
	UF	18.32	1.23	11.84	12.22	7.99	6.87	5.54	6.47	4.96	3.99	6.78	4.39	5.72	4.40	4.55	3.66	3.54	2.80	2.70	0.34
Uttar Pradesh	All	20.51	1.53	18.30	14.89	8.40	8.54	8.14	6.47	4.76	3.65	4.01	2.76	2.72	2.31	3.26	3.14	2.69	3.37	1.16	-0.10
	RM	16.68	1.90	22.49	18.56	11.64	9.49	6.15	4.72	2.29	2.51	4.19	3.09	3.65	2.37	3.37	3.26	1.22	1.61	-1.74	-0.78
	RF	24.61	1.46	17.13	13.09	6.07	9.13	8.15	6.96	6.13	4.16	3.93	1.63	1.23	1.30	3.19	3.53	3.81	5.32	3.44	0.35
	UM	13.44	1.22	14.49	20.09	9.49	10.93	4.97	6.17	3.37	1.62	6.17	4.63	4.41	2.48	2.90	1.13	2.82	1.89	1.18	0.04
	UF	16.08	0.76	16.52	12.26	10.42	7.77	7.76	6.46	6.09	6.23	2.80	3.69	2.20	2.11	3.80	3.30	2.88	3.64	1.39	-0.07

Source: Author

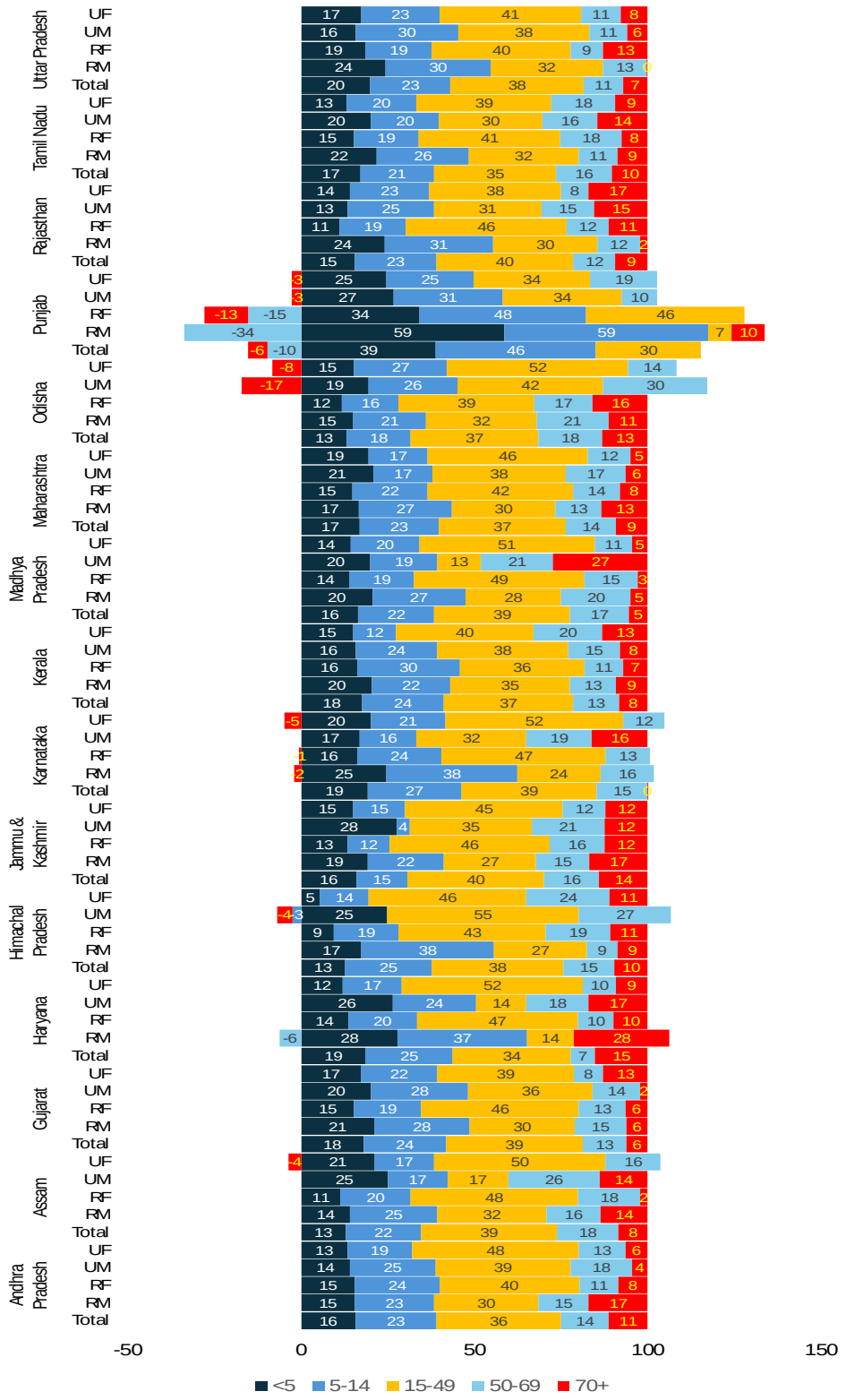

Figure 3: Proportionate (per cent) contribution of the improvement in age-specific mortality rates to the gain in LEB during 1976-2020 in states of India.
Source: Author

Figure 3 also shows that in some mutually exclusive population groups within the country, mortality has not decreased in all ages of the life span but has increased in some ages but decreased in other ages during the 40 years between 1976-1980 and 2016-2020 according to the evidence available from the official sample registration system. The increase in mortality in these population groups has contributed to loss, instead gain, in LEB. In Punjab, the entire gain in LEB during the period under reference has been due to the improvement in mortality in ages below 50 years as the mortality increased, instead decreased, in ages 50 years and above in the state between 1976-1980 and 2016-2020. This has particularly been the case in the rural females of the state, whereas, in rural males, there has been a marked increase in mortality in the age group 50-69 years, although mortality in ages 70 years and above decreased. In Odisha also, there has been a marked increase in mortality in ages 70 years and above in both males and females in the urban areas, although mortality decreased in the rural areas. In addition to Punjab and Odisha, mortality appears to have increased during the 40 years between and 2016-2020 in ages 70 years and above in urban females in Assam, urban males in Himachal Pradesh, in rural males and urban females in Karnataka. Mortality also increased in the age group 50-69 years in rural males in Haryana and males in Himachal Pradesh. and, therefore, contributed to the loss, instead of the gain in LEB in the respective population group. The very slow gain in LEB in Punjab during the 40 years under reference be attributed to the increase in mortality in ages 50 years and above during the period under reference. Similarly, the gain in LEB in the urban areas of Odisha have been mor rapid if the mortality in ages 70 years and above would have not increased during the period under reference.

Decomposition of the Difference in the Gain in LEB

The difference in the gain in LEB between two population groups can be decomposed into two nearly independent product and ratio components in conjunction with equation (19). The results of this decomposition exercise for the four mutually exclusive population groups in India are presented in table 5 which shows that the contributors to the difference in the gain in LEB between different population groups have been different. The gain in LEB during 1976-2020 in rural females in India was 4.1 years higher than the gain in LEB in rural males because of the more rapid improvement in mortality in rural females relative to rural males in the age group 35-79 years. In ages less than 35 years and in ages 80 years and above, mortality improvement in rural males has been more rapid than that in rural females. On the other hand, the gain in LEB in urban females has been around 1.3 years higher than that in urban males because the improvement in urban female mortality was more rapid than that of urban male mortality in ages 1-39 years. In the first year of life and in ages 40 years and above, improvement in urban male mortality has been more rapid than that in urban female mortality in the country. The difference in the gain in LEB between rural females and rural males has been due to relatively faster improvement in female mortality in older ages excluding very old ages, whereas the difference in the gain in LEB between urban females and urban males has been due to relatively faster improvement in female mortality in younger ages excluding the first year of life. Similarly, the gain in LEB in rural males in the country during 1976-2020 has been found to be around 3.7 years more than the gain in LEB in the urban males because the improvement in mortality in rural males has been more rapid than the improvement in mortality in urban males in all but 4 age groups, 45-49 years; 55-59 years; and 80 years and above. On the other hand, the gain in LEB in rural females of the country during 1976-2020 has been found to be almost 7 years higher than the gain in LEB in urban females because the improvement in mortality in rural females during this period has been more rapid than the improvement in mortality in urban females in all ages of the life span.

The difference in the gain in LEB between two population groups is the sum of the difference in the improvement in average mortality between the two population groups or the product component of the difference and difference in the ratio of the improvement in mortality between the two population groups or the ratio component. For example, the difference in the gain in LEB between rural males and

urban males is around 4.4 years due to the product component, but around -0.7 years due to the ratio component or the difference in the improvement in the age-specific mortality rates between the two population groups was -0.7 years so that the net difference in the gain in LEB between rural males and urban males was around 3.7 years. On the other hand, difference in the gain in LEB between rural females and urban females is around 6.3 years due to the product component, but 0.3 years due to the ratio component so that the net difference in the gain in LEB between rural females and urban females is around 6.6 years. In case of the difference in the gain in LEB between urban females and urban males, however, the product component accounts for a gain of -1.3 years, but the ratio component accounts for a gain of around 2.6 years so that the difference in the gain in LEB between two population groups is around 1.3 years.

Table 5: Decomposition of the difference in the gain in life expectancy at birth during 1976-2020 between different population sub-groups in India into ratio and product components.

Age	Difference in the gain in life expectancy at birth (years) between											
	Rural female-rural male			Urban female-urban male			Rural male-urban male			Rural female-urban female		
	Ratio	Product	Total	Ratio	Product	Total	Ratio	Product	Total	Ratio	Product	Total
<1	-0.07	-0.66	-0.74	-0.01	0.01	-0.01	0.01	0.09	0.10	0.03	0.11	0.14
1-4	-4.24	-11.02	-15.26	0.19	0.05	0.24	0.08	0.43	0.51	-0.02	0.60	0.58
5-9	-3.36	-10.81	-14.17	0.06	0.08	0.14	0.27	0.52	0.79	0.31	0.64	0.95
10-14	0.13	-1.95	-1.81	0.14	0.01	0.15	0.15	0.47	0.63	-0.05	0.59	0.55
15-19	-10.75	-10.30	-21.05	0.28	0.05	0.33	-0.05	0.33	0.28	-0.03	0.47	0.44
20-24	-18.54	-6.34	-24.88	0.56	0.01	0.57	0.09	0.31	0.40	0.01	0.45	0.46
25-29	-23.26	-6.14	-29.40	0.52	-0.04	0.49	-0.02	0.29	0.27	0.13	0.53	0.66
30-34	-16.40	9.42	-6.98	0.39	-0.12	0.27	-0.09	0.27	0.17	-0.02	0.44	0.42
35-39	-14.85	18.31	3.46	0.41	-0.17	0.24	0.03	0.25	0.28	0.02	0.37	0.39
40-44	-7.50	24.62	17.11	0.18	-0.22	-0.04	-0.13	0.22	0.09	-0.10	0.34	0.24
45-49	-5.72	26.52	20.80	0.04	-0.21	-0.17	-0.19	0.14	-0.06	-0.03	0.18	0.15
50-54	2.22	18.64	20.86	0.01	-0.19	-0.18	-0.11	0.13	0.01	-0.20	0.25	0.05
55-59	-2.14	22.07	19.94	-0.02	-0.13	-0.14	-0.21	0.21	0.00	-0.10	0.18	0.08
60-64	-2.47	17.64	15.17	0.00	-0.13	-0.13	-0.06	0.16	0.11	0.04	0.19	0.24
65-69	-2.60	14.05	11.46	-0.03	-0.11	-0.13	-0.03	0.13	0.10	0.10	0.17	0.27
70-74	-3.58	10.93	7.34	-0.03	-0.09	-0.12	-0.15	0.17	0.02	0.04	0.22	0.26
75-79	-4.19	7.50	3.31	-0.06	-0.07	-0.13	-0.09	0.14	0.05	0.15	0.20	0.35
80-84	-3.69	3.35	-0.34	-0.04	-0.06	-0.10	-0.18	0.16	-0.02	0.02	0.27	0.29
85+	-0.56	-0.17	-0.73	-0.01	-0.01	-0.01	-0.04	0.03	-0.01	-0.01	0.05	0.04
All ages			4.09			1.26			3.73			6.56

Source: Author

Across the 60 mutually exclusive population sub-groups, the gain in LEB has been the lowest in urban males in Punjab (6.8 years) but the highest in rural females in Uttar Pradesh (24.6 years) during the period 1976-1980 through 2016-2020. This means that there is a difference of 17.8 years between the gain in LEB in rural females in Uttar Pradesh and urban males in Punjab. Table 6 decomposes the difference in the gain in LEB between rural females in Uttar Pradesh and urban males in Punjab. Almost two-third of the difference in the gain in LEB between the two population groups is attributed to the difference in the ratio component while the product component accounts for around one-third of this difference. Mortality improved in all ages in rural females in Uttar Pradesh during the period under reference, but this has not been the case in urban males in Punjab. The also shows that the product component of the difference in the gain in LEB between the two population groups contributed to increase the difference in the gain in LEB in all ages. However, the ratio component of the difference contributed to the decrease, instead increase, in the difference in the gain in LEB between the two population groups in the age groups 0-1 year; 10-19 years; 25-29 years; and 50-59 years thereby decreasing the contribution of the ratio component.

Table 6: Decomposition of the difference in the gain in life expectancy at birth in rural females in Uttar Pradesh and urban males in Punjab during 1976-2020.

Age	Difference in the gain in the life expectancy at birth (years)	Components of the difference in the gain in the life expectancy at birth	
		Ratio component (years)	Product component (years)
<1	0.061	-0.096	0.156
1-4	1.971	1.224	0.747
5-9	1.948	1.226	0.722
10-14	0.045	-0.541	0.586
15-19	0.381	-0.318	0.699
20-24	1.202	0.812	0.390
25-29	0.496	-0.111	0.607
30-34	1.479	1.224	0.256
35-39	1.358	1.133	0.226
40-44	1.603	1.478	0.125
45-49	0.973	0.939	0.035
50-54	-0.254	-0.351	0.098
55-59	-0.012	-0.064	0.051
60-64	0.559	0.523	0.036
65-69	1.019	0.818	0.201
70-74	1.337	0.996	0.340
75-79	1.668	1.186	0.482
80-84	1.671	0.990	0.681
85+	0.283	0.129	0.155
All ages	17.788	11.195	6.593

Source: Author

Discussion and Conclusions

The analysis highlights the unevenness in the gain in LEB during 1976-2020 in India which has implications for the improvement in LEB in the country as reducing within-country inequality or disparity in the gain in LEB may contribute to accelerating the pace of improvement in LEB in the country. It may be argued that a part of the inequality in the gain in LEB may be attributed to the non-linear relationship between the gain in LEB in a period and the level of LEB at the beginning of the period. However, even after taking into consideration the non-linear relationship between the level of LEB and the gain in LEB, there exists substantial inequality in the gain in LEB within the country. Out of the 60 mutually exclusive population groups within the country, cross classified by state and four mutually exclusive population sub-groups in each state – rural male, rural female, urban male, urban female – the gain in LEB during 1976-2020 is found to be slower than expected in around two-third of the mutually exclusive population groups. The analysis also suggests that the improvement in mortality in the first 15 years of life has accounted for almost 40 per cent of the gain in LEB in the country, whereas the contribution of the mortality improvement in ages 70 years and above has been only around 7 per cent.

The LEB is the universally used indicator of population health, although it has many limitations. The most important limitation of LEB as the measure of population health is that it reflects the average length of life of a hypothetical, not the actual, population. In any case, inequality in the gain in LEB reflects the variation in the improvement in population health within the country which needs attention at the level of the health policy and in planning for the delivery of health care services. However, national health policies in India have rarely taken cognizance of the inequality in the gain in LEB within the

country. One of the goals of the latest health policy of India is to achieve an LEB of 70 years by the year 2025 (Government of India, 2017). This goal appears to have already been achieved but the challenges related to the variation in LEB within the country resulting from the inequality in the gain in LEB remain. The Registrar General and the Census Commissioner of India has been producing abridged life tables and providing estimates of LEB for mutually exclusive population groups within the country since 1970. There has, however, been rarely any attempt to analyse the variation or the inequality in the gain in LEB across mutually exclusive population groups within the country and to incorporate this inequality in planning and programming for the delivery of health care services. The present analysis advocates a strong case for adopting a decentralised approach towards improving population health within the country.

The determinants of LEB are well known and can be categorised into two broad categories – factors exogenous and factors endogenous to the health care delivery system. A recent study has identified seven factors that have a potential impact on LEB: 1) health care expenditures; 2) health financing policies; 3) elements of medical care; 4) health habits; 5) social determinants; 6) social spending; and 7) other external factors, after an extensive review of the available literature (Roffia et al, 2022). Factors endogenous to the health care delivery system that influence human longevity are related to per capita expenditure on health and the organisation of health care delivery services. It has been observed that an increase of 10 per cent in health spending per capita in real terms is associated with a gain of 3.5 months in LEB in the OECD countries (OECD, 2019). In the African countries, the gain in LEB has been found to be associated with the increase in health spending, urbanisation, and improved water access (Salami et al, 2019). The per capita expenditure on health may further be distinguished between per capita private expenditure on health and per capita public expenditure on health and the impact of the increase in the per capita public health expenditure on the gain in LEB is found to be more than the increase in per capita private health expenditure (Raeesi et al, 2018; Novignon et al, 2012). However, the public expenditure on health in India remains low as the proportion of government health expenditure to total government expenditure in 2020 is estimated to be only around 3.3 per cent (WHO, 2023). At the same time, little is known about how per capita public health expenditures varies across mutually exclusive population groups within the country.

The health care delivery system in India is a mix of public and private health care delivery system. A comprehensive review of the health care delivery system in India has been carried out elsewhere (Selvaraj et al, 2022). The private health care delivery system in the country is heavily concentrated in big cities and large towns and is costly. It primarily provides institution-based curative health care services which leads to high per capita private health expenditure. The public health care system focuses primarily on health promotion and health prevention mainly in the rural areas. The presence of public health care system in the urban areas is minimal and is limited primarily to the delivery of hospital-based curative services. The health care services available through the public health care system are either free of cost or are available at an affordable cost. The public health care system in India has always been preoccupied with the delivery of maternal and child health care services. This is reflected through the national level programmes launched by the Government of India from time to time. In 1978, the Government of India launched the Expanded Programme of Immunisation (EPI) which was directed towards preventing deaths in children from vaccine preventable diseases (Basu, 1980). In 1985, the EPI was replaced by the Universal Immunisation Programme (UIP) which was converted into the National Technology Mission on Immunisation in 1986 (Government of India, 1985; 1986). In 1992, the Child Survival and Safe Motherhood (CSSM) Project was launched with support from the World Bank which was subsequently expanded into the Reproductive and Child Health (RCH) Programme in 1997 (World Bank, 1991). The RCH Programme subsequently became the lead programme of the National Rural Health Mission (NRHM) launched in 2005 (Government of India, 2005a; 2014). Currently, the maternal and child health care services delivered through the public health care system of the country are organised following the RMNCAH+N approach that is directed towards reducing maternal and child morbidity and mortality (Government of India, 2005b; 2013a). There are others disease specific programmes launched

in India from time to time but the preoccupation of the public health care system in India has always been on improving maternal and child health and reducing maternal and child mortality. This preoccupation appears to have resulted in substantial improvement in the probability of survival in the first 15 years of life, especially, in the first 5 years of life and in the reduction of female reproductive mortality but meeting the health needs of the older population appears to have received only a residual attention. The focus on the rural areas in the organisation of public health care delivery services is reflected in above average gain in LEB in the rural areas, especially, rural females whereas the gain in LEB in the urban areas has lagged. The Government of India launched the National Urban Health Mission only in 2013 to specifically address the concerns related to the health of the urban population of the country (Government of India, 2013b) but the National Urban Health Mission and the National Rural Health Mission were soon merged to constitute the National Health Mission (Government of India, 2016). In 2018, the Government of India has launched the Ayushman Bharat scheme to improve the health of the population through universal health coverage and drastically reduce or eliminate health care-related impoverishment. The Ayushman Bharat is a publicly financed health insurance scheme for the socioeconomically deprived rural and selected occupational category of the urban population (Keshri and Gupta, 2020).

The present analysis has two imperatives as regards population health in India. The first imperative is to explore further the factors both exogenous and endogenous to the health care delivery system that are responsible for the variation or the inequality in the gain in LEB across mutually exclusive population groups within India. The inequality in the gain in LEB within India is quite marked. An understanding of the factors is important as the reduction in the inequality in the gain in LEB within the country may contribute to accelerating in the gain in LEB in the country. It is not known, at present why the gain in LEB has been uneven, more than expected in some mutually exclusive population groups but less than expected in others. In Karnataka, Kerala and Punjab, the gain in LEB has been less than expected gain in all the four mutually exclusive population groups whereas the gain in LEB in Tamil Nadu has been more than expected in all population groups. In other states of the country, the gain in LEB has been more than expected in some population groups but less than expected in others.

The second imperative of the present analysis is that health policy and planning for meeting the health needs of the people of the country must move from the existing highly centralised approach to a decentralised approach to achieve the goal of universal health coverage. Setting up separate population health goals for different mutually exclusive population groups within the country may be a beginning in this direction. These goals may be defined in terms of either LEB or some other appropriate indicator of population health. Estimates of LEB are available for 88 mutually exclusive population groups, cross-classified by 22 states and 4 mutually exclusive population sub-groups in each state, of the country for the period 2016-2020 which may serve the basis for setting up population group-specific population health goals. Such an approach may lead to reducing within-country inequalities in population health thereby may contribute to accelerated improvement in population health in the country which remains low by international standards.

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