10.3197/JPS.63799977346503

RESEARCH ARTICLE

Inequality in the gain in life expectancy at birth in India, 1976–2020

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Abstract

The increase in human longevity has been a factor in the increase in world population but the increase in human longevity has not been uniform across countries and within countries and this inequality is increasing, which is a matter of concern as regards sustainable development. Understanding the inequality in the increase in human longevity is important for determining appropriate health policies by providing insights into disparities in population health and mortality. This article highlights the inequality in the gain in life expectancy at birth in India in the period 1976–2020. The difference in gain in life expectancy at birth has been decomposed into gain attributed to improvement in mortality at different ages. The article calls for a decentralised approach to health policy and planning to address the challenge of differential gain in life expectancy at birth across mutually exclusive population groups within the country; and argues that a reduction of inequality in the gain in life expectancy at birth within the country may contribute to accelerating the increase in life expectancy at birth for the country, which remains low by international standards.

Keywords

Gain in life expectancy at birth, Inequality, Decomposition, Mortality, India,

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Background

The world population is estimated to have increased from around 2.5 billion in 1950 to more than eight billion in 2023 (United Nations, 2024), an increase of almost six billion over a period of seventy years. This increase in global population presents challenges for achieving development goals and ensuring sustainability. The increase in 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 to more than 73 years between 1950 and 2023 (United Nations, 2024). However, this increase has not been uniform across or within countries (United Nations, 2022). Growing disparities in LEB are receiving increasing attention from the international community, as these inequalities are often unjust, beyond individual control and, in many cases, increasing. The United Nations Sustainable Development Agenda calls for healthy life and wellbeing 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 crucial role in controlling a wide range of diseases responsible for differences in child mortality and hence in reducing inequalities in LEB as improvements in LEB are strongly related to declines in mortality in the first five years of life. Another 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 to 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).

Within-country disparities in LEB often reflect variations in socioeconomic status across different population groups. These differences manifest in many ways including unequal access to and utilisation of health care services, and differential access to and adoption of health care innovations. The within-country inequality in LEB has an impact on the country's overall LEB since this is the weighted sum of the LEB of different population groups. 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, contribute to accelerating gain in LEB in the country.

The LEB in India remains low by international standards. The country ranked 153 in LEB among 236 countries and areas of the world for which LEB estimates have been prepared by the United Nations in 2023 (United Nations, 2024). By comparison, China ranked 77, Sri Lanka 85, Bangladesh 125 and Bhutan 168. The relatively low LEB in India vis-à-vis other countries and areas of the world has implications for both demographic transition and social and economic development of the country. According to United Nations estimates, LEB in India increased from around 41 years in 1950 to 72 years in 2023, an average annual increase of around five months per year (United Nations, 2024). On the other hand, the Registrar General and Census Commissioner of India estimates that LEB 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 LEB has been faster in females than in males. Official estimates also suggest that, on average, the length of life of an Indian increased by around 5.8 months per year between 1976–1980 and 2016–2020 with male LEB rising by 4.8 months per year and female LEB by nearly six months per year.

The low level of LEB in India is associated with a high degree of disparity or inequality in LEB within the country. Estimates of LEB for 88 mutually exclusive population groups (22 states and four mutually exclusive sub-groups in each state – rural male, rural female, urban male and urban female) in India are available through the official sample registration system for the period 2016–2020 (Government of India, 2022). These estimates suggest that LEB varies from 62.6 years in rural males in Chhattisgarh to 81 years in urban females in Himachal Pradesh (Government of India, 2022). Besides rural males in Chhattisgarh, LEB is estimated to be less than 65 years in rural males in Madhya Pradesh and Uttar Pradesh whereas it has been estimated to be more than 80 years in urban females in Jammu and Kashmir (Government of India, 2022). It is obvious that reducing the inequality in LEB within the country can contribute substantially towards hastening the pace of improvement in LEB in the country.

The inequality in LEB across population groups is the result of both initial differences in LEB across population groups and differences in the gain in LEB over time. The gain in LEB is contingent upon the initial level of LEB as the relationship between initial LEB and the gain in LEB is convex, not linear – the higher the initial LEB the slower the gain in LEB (Preston et al., 1972). At the same time, improvement in LEB has also been found to be influenced by policies that advance income, health, education, sanitation and medicine, with the effects varying over age, period, cohort, place and diversity (Oeppen and Vaupel, 2002). It is therefore crucial in any analysis of the inequality in LEB gain to distinguish between the natural slowing of LEB gains due to biological limits (ceiling effect) and slowdown resulting from policy failures, inefficient healthcare systems or inadequate health technology implementation (Cardona and Bishai, 2018).

Understanding the inequality in LEB gains across population groups is important for determining appropriate health policies and interventions that contribute to reducing the inequalities in LEB gain. An understanding of the inequality in LEB gain also provides insights into disparities in health and mortality across population groups. Gain in LEB reflects cumulative improvement in mortality in different age groups throughout the life span. The relationship between LEB gains and mortality improvements in different ages of the life span is, however, complex (Pollard, 1982). The contribution of mortality decline at various ages to overall LEB gains is not uniform; it depends on the age distribution of those improvements. When mortality reductions are more evenly distributed across the lifespan, their contribution to LEB gains is generally greater than when improvements are concentrated in specific age groups (Glei and Horiuchi, 2007). Therefore, understanding inequality in LEB gains requires analysing how mortality improvements at different ages influence overall life expectancy.

LEB is also universally recognised as an indicator of population health. Inequality in LEB gain across population groups, therefore, reflects the disparity in improvement in population health across population groups, which has implications for the health policy and for the organisation of healthcare delivery services. Understanding the inequality in LEB gains helps in targeting mortality reduction efforts to their maximum efficiency by targeting population groups with poor LEB gains, thereby accelerating improvements in population health. The World Health Organization has recommended LEB as a key indicator for

monitoring health within the framework of the Sustainable Development Goals (WHO, 2023). Improving LEB is also one of the objectives of India's National Health Policy 2017 (Government of India, 2017).

Many studies have analysed disparities in LEB in India (Chaurasia, 1992; 1993a; 1993b; 2010; 2021; 2023; Navaneetham, 1993; Subramanian et al., 2006; Asaria et al., 2019; Silva-Illanes, 2024; Yadav and Yadav, 2024; Kumari and Mohanty, 2020; Jain at al., 2022; Gupta and Sudharsan, 2022; Vyas et al., 2022; Das and Mohanty, 2024) and in other countries (Singh and Siahpush, 2014; Singh and Lee, 2021; Dwyer-Lindgren et al., 2024; Liou et al., 2020; Aksan and Chakraborty, 2023; Kinge et al., 2019; Cardona and Bishai, 2018; Salami et al., 2019; Woolf, 2024; De Ramos et al., 2022; Baker et al., 2018; Dahl et al., 2021; Fuchs and Eggleston, 2018). Most of these studies have focused on the variation in LEB relative to a range of population characteristics such as region, rural-urban, income and education. It has been observed that the age pattern of mortality varied across different regions of India (Chaurasia, 1992). Further, the relative contribution of changes in age-specific survival probabilities to changes in life expectancy at birth (LEB) has also been shown to differ across Indian states (Chaurasia, 2021). There has, however, been little effort to explore the reasons behind uneven gains in LEB within India across population groups. Such an analysis has policy and programme implications as it helps in prioritising health interventions for maximum gains in population health.

This article analyses the inequality in the gain in LEB across sixty mutually exclusive population groups in India during the period 1976–2020 for which life tables are available based on India's official sample registration system. A decomposition model has been used for the analysis which decomposes the gain in LEB in a population group into a state component, which is common to all sub-groups, a sub-group component, which is common to all states, and a residual component which is specific to the population group. The article also analyses how improvement in mortality in different ages of the life span has contributed to the gain in LEB in different population groups. The analysis shows that mortality improvement in India during 1976–2020 has largely been concentrated in younger age groups and has not been dispersed across the entire life span. The concentration of mortality improvement in selected age groups appears to be a reason for the limited impact of mortality improvement on the gain in LEB in the country. Since the inequality in the gain in LEB across population

groups reflects differences in the improvement in population health in different population groups, a decentralised approach to health policy formulation and for planning and programming for the delivery of health care services is needed for accelerated improvement in population health in the country.

The article is divided into six sections. The first section describes the method adopted for the analysis while section two describes the data source. The analysis is based on the life tables constructed using the age-specific mortality rates obtained through the official sample registration system. An overview of the variation in the gain in LEB across sixty mutually exclusive population groups for which life tables are available for the period 1976–2020 is presented in section three, while section four 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 that is common to all population groups. Section five of the article analyses the contribution of the improvement in mortality in different ages to the gain in LEB in the whole country and in different population groups within the country. Section six decomposes the difference in the gain in LEB between two population groups into gain attributed to improvement in mortality in different ages across the life span. The final section of the article summarises the findings of the analysis and discusses their implications from the perspective of the health policy and planning and the health care system.

The Method

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 entire population is divided into n=rxc mutually exclusive population groups. Let e_{ij} denotes the LEB and ∇_{ij} denotes the gain in LEB in sub-group j of the geopolitical unit (state) 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. 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

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

or

$$\frac{\nabla_{ij}}{\nabla_{..}} = m_{i.} \times m_{.j} \times m_{ij} \tag{3}$$

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) can be used to decompose the difference in LEB gain in a population group relative to average gain across all population groups into two components, an average component and a population group-specific component. The average component is determined by the average of the gain in all population sub-groups in a state and is determined by the multiplier m_i, and average of the gain in all states in a population sub-group and is determined by the multiplier $m_{.j}$. The component of the gain in LEB which is specific to the population group 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) which 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,

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

equation (7) can be written as

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

or

$$I = I_r + I_c + I_{rc} \quad (10)$$

where

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

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

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

Equation (3) can be fitted by using the polishing technique first proposed by Tukey (1977). The polishing technique is a non-parametric method that does not require any assumption about the data. The method successively sweeps the polishing function out of rows, then sweeps the polishing function out of columns, then rows, then columns, and so on, 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 in the present analysis. The median is not based on all values in the dataset whereas use of the arithmetic mean is not appropriate when it is uncertain that the underlying data are 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. The use of geometric mean as the polishing function is preferred as it addresses the problems associated with median and arithmetic mean.

Let *g* denotes the geometric mean of the age-specific mortality rates *m*(x). Then the gain in *e* between two points in time t_1 and t_2 ($t_2 > t_1$) may 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

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

Or

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

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

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 (1955), 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

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

Equation (23) is the product-ratio decomposition formula 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 age-specific mortality rates. 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 mortality improvement 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 mortality difference between two populations than the arithmetic difference of the age-specific mortality rates, as the ratio is less sensitive to the level of mortality than the arithmetic difference (Bergeron-Boucher et al., 2018). It may also be noticed that equation (23) also accounts for the difference in age-specific mortality rates between the two populations at time t_1.

Data Source

The analysis is based on the life tables constructed from the age-specific mortality rates available from the official sample registration system (SRS) of India for the period 1976–1980 and 2016–2020 (Government of India, 1985; 2022). The SRS is a large-scale demographic sample survey which is based on the dual record system (Government of India, 2022). The SRS is the only source in India that provides estimates of the age-specific mortality rates for the country and for selected states of the country separately for four mutually exclusive population groups – rural male, rural female, urban male, urban female – on an annual basis. Age-specific mortality rates available from the SRS are, however, known for year-to-year fluctuations of unknown origin. To eliminate the effect of these fluctuations, it is the standard practice to use five-years average mortality rates for the construction of the life tables. An advantage of this practice is that it also augments the sample size (Government of India, 2022).

The present analysis is confined to only those fifteen states of the country for which life tables based on age-specific mortality rates from the SRS are available for the period 1976–1980 and the period 2016–2020. Estimates of age-specific mortality rates are not available for other states and Union Territories of the country either from the SRS or from any other source. Age-specific mortality rates for three states – Andhra Pradesh, Madhya Pradesh and Uttar Pradesh – for the period 1976–1980 and 2016–2020 are, however, not strictly comparable because of changes in administrative boundaries of these states. 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. It is, however, assumed that the difference in the age-specific mortality rates resulting from the change in the administrative boundaries of these three states is only marginal and its impact on the gain in LEB in the three states is negligible. The analysis, therefore, has been carried out for the sixty mutually exclusive population groups – fifteen states and four population sub-groups in each state – rural male, rural female, urban male, urban female.

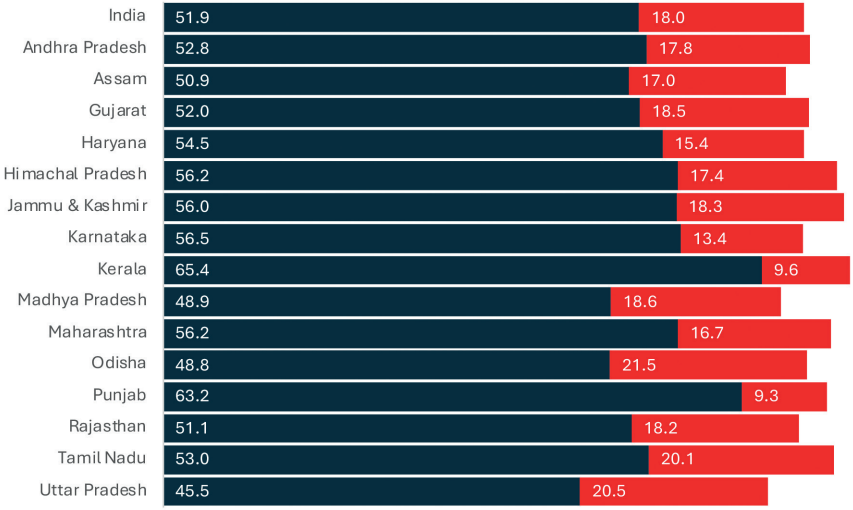
It may also be pointed out that the abridged life tables prepared by the Government of India for the period 1976–1980 are based on a different methodology from that used for the construction of life tables for the period 2016–2020 and, therefore, life tables for 1976–1980 are not comparable with life tables for 2016–2020. Moreover, age-specific death rates for the period 1976–1980 are available up to seventy years of age only whereas data for the period 2016–2020 are available up to 85 years of age. We have, therefore reconstructed the abridged life tables 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 same software has been used for the construction of abridged life tables for the period 2016–2020 by the Government of India.

Gain in LEB in India 1976–2020

Table 1 presents estimates of LEB during 1976–1980 and gain in LEB during 1976–2020 in India and in its fifteen states for total population and for four mutually exclusive population sub-groups. The LEB increased by almost eighteen years in India between 1976–1980 and 2016–2020, which implies an average annual increase of less than 0.5 years per year. Among fifteen states, LEB increased by less than ten years in Punjab and Kerala but more than twenty years in Odisha, Tamil Nadu and Uttar Pradesh, with the gain being the most rapid in Odisha.

Kerala had the highest LEB during 1976–1980 while LEB was the second highest in Punjab. On the other hand, LEB was the lowest in Uttar Pradesh and the second lowest in Odisha during 1976–1980.

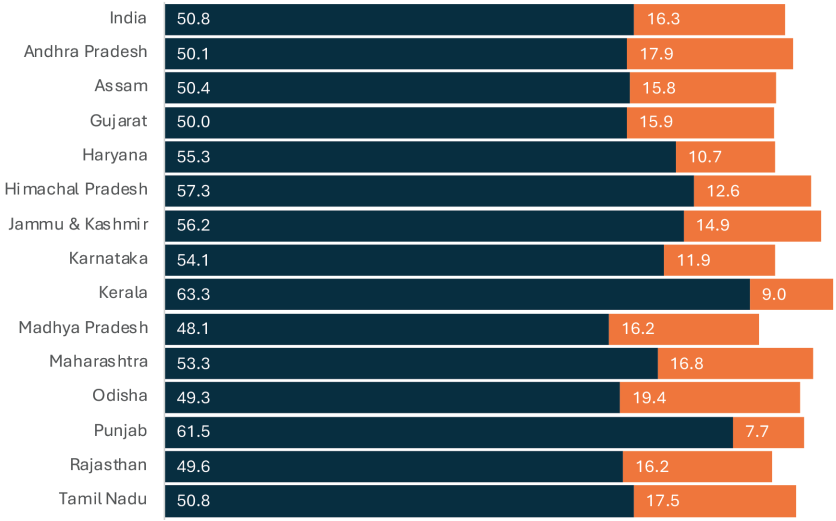
Figure 1. LEB in 1976–1980 and gain in LEB, 1976–2020 – total population



SOURCE: AUTHOR

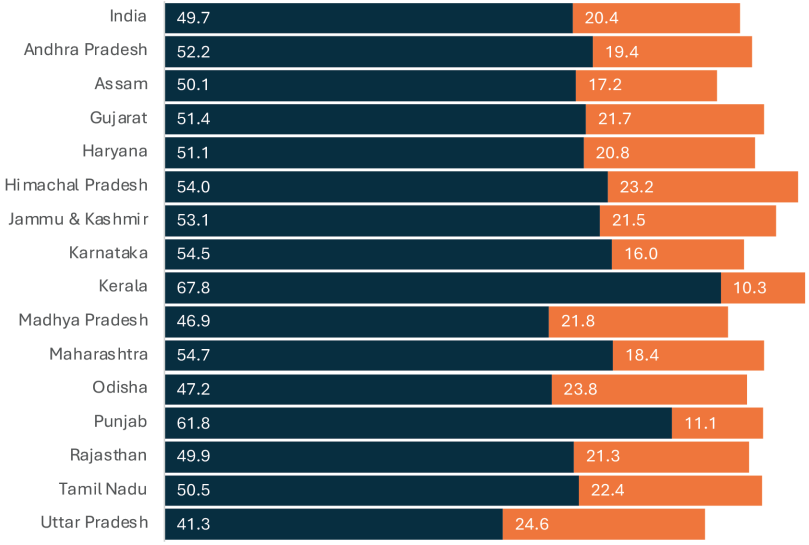
The increase in LEB has also been different in the four population sub-groups – the highest in rural females but the lowest in urban males. The LEB in urban males was almost ten years higher than that in rural females during 1976–1980. This difference reduced to less than two years during 2016–2020. The gain in LEB in urban females has been very slow in Andhra Pradesh, Assam, Karnataka and Madhya Pradesh but very fast in Haryana and Kerala. The gain in LEB in rural females has been the fastest among the four population sub-groups in thirteen of the fifteen states. There is no state where gain in LEB has been the highest in urban males among the four population sub-groups. The gain in LEB in rural females was at least twenty years in nine of the fifteen states but there is no state in which rural males equalled this gain. Similarly, there is no state where the increase in LEB in either rural males or urban males was equal to or greater than twenty years, whereas there is only one state – Haryana – in which urban females recorded an LEB gain exceeding twenty years.

Figure 2. LEB in 1976–1980 and gain in LEB, 1976–2020 – rural male



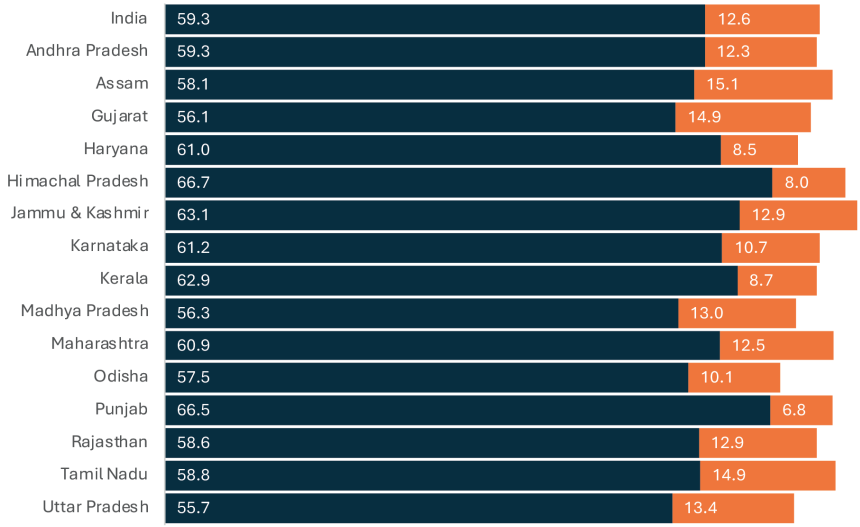
SOURCE: AUTHOR

Figure 3. LEB in 1976_1980 and gain in LEB, 1976–2020 – rural female



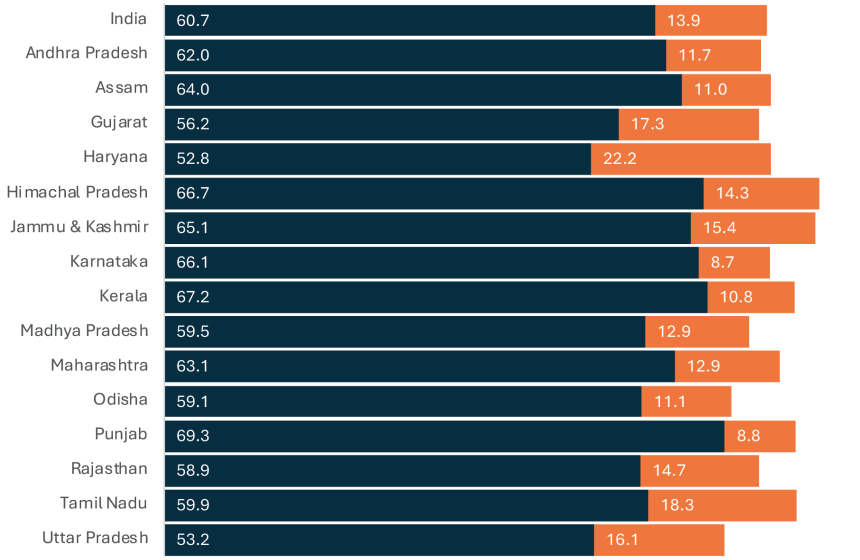
SOURCE: AUTHOR

Figure 4. LEB in 1976–1980 and gain in LEB, 1976–2020 – urban male



SOURCE: AUTHOR

Figure 5 LEB in 1976–1980 and gain in LEB, 1976–2020 – urban female

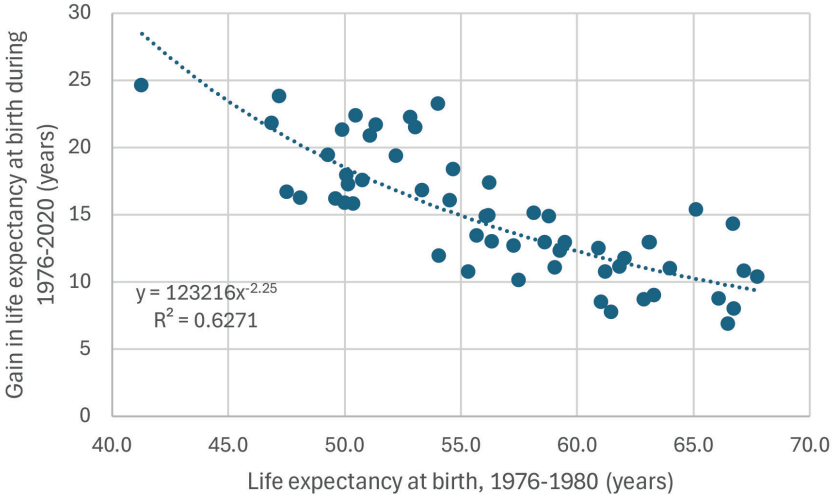


SOURCE: AUTHOR

Among the sixty mutually exclusive population groups, the gain in LEB has been the most rapid in rural females in Uttar Pradesh but the slowest in urban males in Punjab. There are eight population groups in which the gain in LEB has been less than ten years whereas in nine population groups, the gain has been at least twenty years. The within-state inequality in the gain in LEB, measured in terms of the coefficient of variation in LEB gain across four population sub-groups, has been the highest in Haryana followed by Himachal Pradesh and Odisha but the lowest in Kerala. In Haryana, LEB increased by around eight years in urban males but by more than 22 years in urban females, whereas increase in LEB in Kerala ranged between 8.7 to 10.8 years across the four population sub-groups. In many states, gain in LEB has largely been confined to specific population sub-groups only.

The gain in LEB during 1976–2020 across sixty mutually exclusive population groups appears to be associated with the level of LEB during 1976–1980 – the lower the LEB during 1976–1980 the higher the gain in LEB during 1976–2020 and vice versa – but there are notable exceptions. LEB in urban females in Jammu and Kashmir was more than 65 years during 1976–1980, while the gain in LEB has been more than fifteen years during 1976–2020. Similarly, LEB in urban females in Himachal Pradesh was 66.7 years during 1976–1980 while the gain in LEB has been more than fourteen years. LEB in rural females in Himachal Pradesh was around 54 years during 1976–1980 but the gain in LEB was more than 23 years during 1976–2020, making this group an outlier as regards gain in LEB. On the other hand, LEB in rural males in Madhya Pradesh was only around 48 years during 1976–1980 but the gain in LEB was around sixteen years during 1976–2020. Figure 1 suggests that the inequality in the gain in LEB across sixty population groups during 1976–2020 cannot be explained by the variation in LEB in these population groups during 1976–1980 alone. Other factors also appear to have contributed to the uneven distribution of LEB gains during the period 1976–1980 across sixty population groups, although initial levels of LEB have played a role in determining the extent of improvement in LEB during 1976–2020.

Figure 6. Life expectancy at birth, 1976–1980, and gain in life expectancy at birth, 1976–2020, in mutually exclusive population sub-groups in India



SOURCE: AUTHOR, BASED ON TABLE 1.

Table 1. Life expectancy at birth, 1976–1980; gain in life expectancy at birth, 1976–2020; and within-state inequality in gain in life expectancy at birth in India and states

Country/State	Life expectancy at birth 1976–80 (years)					Gain in life expectancy at birth 1976–2020 (years)					Gain inequality
	Total	Rural male	Rural female	Urban male	Urban female	Total	Rural male	Rural female	Urban male	Urban female	
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

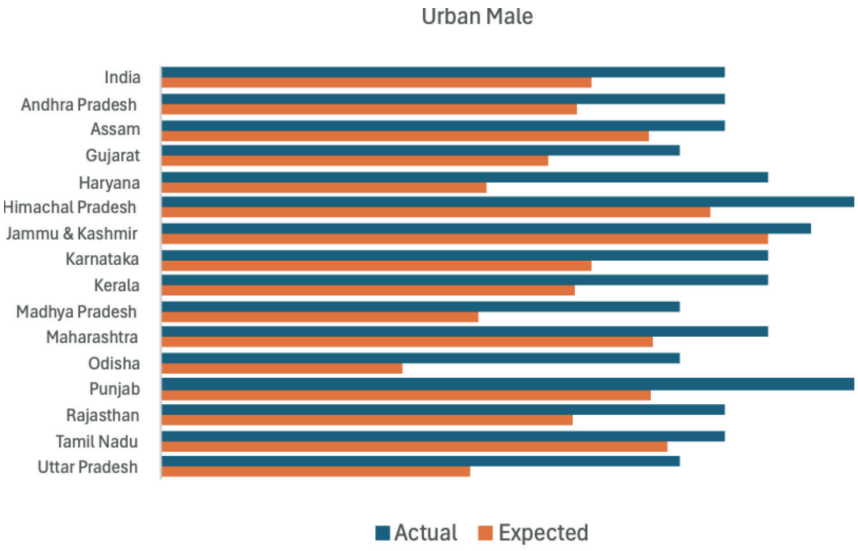
Figure 7a. Actual and expected gain in LEB in rural males

SOURCE: AUTHOR

Figure 7b. Actual and expected gain in LEB in rural females

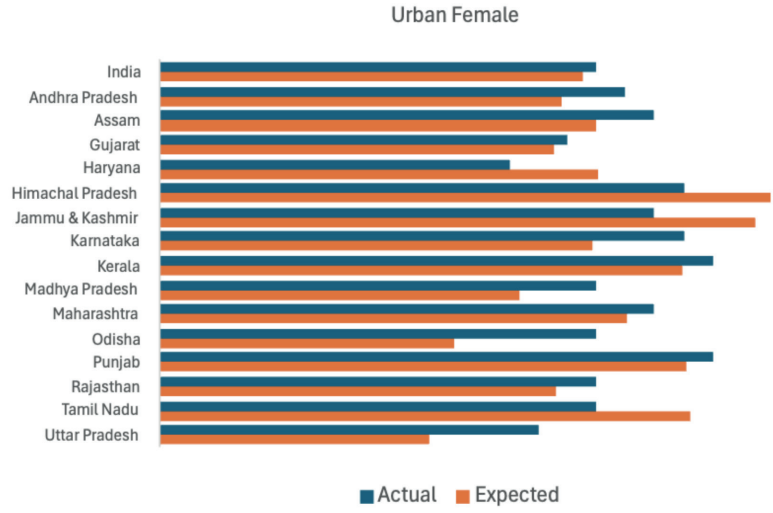
SOURCE: AUTHOR

Figure 7c. Actual and expected gain in LEB in urban males



SOURCE: AUTHOR

Figure 7d. Actual and expected gain in LEB in urban females



SOURCE: AUTHOR

Table 2. Actual and expected LEB in sixty mutually exclusive population groups within India 2016–2020

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 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 (United Nations, 2004). These model mortality improvement trajectories are expressed as annual increments in LEB at a given level of LEB in the beginning of the year but are presented as quinquennial increments labelled as very fast (VF); fast (F); medium (M); slow (S); and very slow (VS) improvement in LEB. A comparison of the gain in LEB in sixty population groups in India with the expected LEB gain based on the United Nations medium (M) mortality improvement trajectory is presented in table 2. In India, actual gain in LEB during 1976–2020 has been less than that expected under United Nations medium mortality improvement trajectory in both urban males and urban females with a substantial shortfall in urban males. In rural males and rural females, on the other hand, the actual gain in LEB has been more than the expected gain, although the difference is marginal. Similarly, the actual gain in LEB has been less than expected in 39 of the sixty mutually exclusive population groups. There is no state where actual gain in LEB in urban males has been more than the expected gain in LEB, whereas actual gain in LEB in rural females has been more than the expected gain in ten of the fifteen states. The actual gain in LEB in rural males has been more than the expected gain in LEB in seven states while actual gain in LEB in urban females has been more than expected in eleven states.

The gain in LEB in a population group can be decomposed into four factors: gain common to all sixty population groups, gain specific to the state common to all sub-groups in the state, gain specific to sub-groups common to all states and the residual gain. Table 3 presents decomposition results. The average gain in LEB across sixty population groups is around 14.2 years. The gain in LEB attributed to states and common to all sub-groups in the state ranges from -5.7 years in Punjab to 3.9 years in Tamil Nadu. Similarly, gain in LEB in different sub-groups but common to all states ranges from -3 years in urban males to 5.1 years in rural females. Finally, gain in LEB which is not explained by the common component, state component and sub-group component ranges from -3.6 years in rural males in Haryana to 8.8 years in urban females again in Haryana. In Himachal Pradesh, Karnataka, Kerala and Punjab, the state factor accounts for a loss rather than gain in LEB. Among the four sub-groups, the gain in LEB is confined to rural female only. In urban males and urban females, there is loss, not gain, in LEB, whereas there is virtually no gain in rural males. On the other hand, in 28 of the

sixty population groups, the residual component results in a loss, rather than gain in LEB. The gain in LEB determined by the grand average and the corresponding state, and sub-group effects may be perceived as the statistically normal gain in LEB for the population group. The deviation from this statistical normal may be attributed to factors that are specific to the population group.

The inequality in the gain in LEB across India's sixty mutually exclusive population groups may be attributed to three factors: inequality in the gain in LEB across states; inequality in the gain in LEB across the four mutually exclusive population sub-groups; and inequality in the residual component of the gain in LEB. The Theil entropy index, which measures the inequality in the gain in LEB relative to the expected gain in LEB, is estimated to be 0.099. This index is zero when the actual gain in LEB is the same as the expected gain in LEB in all sixty population groups and higher the inequality higher the index. Equation (10) suggests that approximately twenty per cent of the inequality in the gain in LEB across sixty population groups may be attributed to variation in the gain in LEB attributed to the residual component, while the remaining eighty per cent of the inequality is almost equally distributed between the variation in the gain in LEB across states and variation in the gain in LEB across the four mutually exclusive population sub-groups. There are twelve population groups in which the gain in LEB has been at least ten per cent higher than the expected gain in LEB due to factors specific to the population group. Similarly, there are eleven population groups in which the gain in LEB has been at least ten per cent lower than the expected gain in LEB due to factors specific to the population group. In the remaining 37 population groups, factors specific to the population group have accounted for less than ±10 per cent of the variation in the actual gain in LEB and the expected gain in LEB.

Table 3. Decomposition of the gain in LEB across sixty population groups, 1976–2020

State	Sub-group	Gain in LEB				
		Common to states and sub-groups	Specific to state	Specific to sub-group	Residual	Total
Andhra Pradesh	Rural Male	14.2	0.8	0.0	3.0	17.9
	Rural Female	14.2	0.8	5.1	-0.7	19.4
	Urban Male	14.2	0.8	-3.0	0.4	12.3
	Urban Female	14.2	0.8	-0.9	-2.3	11.7
Assam	Rural Male	14.2	0.4	0.0	1.2	15.8
	Rural Female	14.2	0.4	5.0	-2.3	17.2
	Urban Male	14.2	0.4	-3.0	3.5	15.1
	Urban Female	14.2	0.4	-0.9	-2.7	11.0
Gujarat	Rural Male	14.2	3.1	0.0	-1.3	15.9
	Rural Female	14.2	3.1	5.9	-1.4	21.7
	Urban Male	14.2	3.1	-3.5	1.1	14.9
	Urban Female	14.2	3.1	-1.1	1.2	17.3
Haryana	Rural Male	14.2	0.1	0.0	-3.6	10.7
	Rural Female	14.2	0.1	4.9	1.6	20.8
	Urban Male	14.2	0.1	-2.9	-2.9	8.5
	Urban Female	14.2	0.1	-0.9	8.8	22.2
Himachal Pradesh	Rural Male	14.2	-0.7	0.0	-0.9	12.6
	Rural Female	14.2	-0.7	4.6	5.1	23.2
	Urban Male	14.2	-0.7	-2.7	-2.8	8.0

State	Sub-group	Gain in LEB				
		Common to states and sub-groups	Specific to state	Specific to sub-group	Residual	Total
	Urban Female	14.2	-0.7	-0.9	1.6	14.3
Jammu & Kashmir	Rural Male	14.2	1.7	0.0	-1.0	14.9
	Rural Female	14.2	1.7	5.4	0.2	21.5
	Urban Male	14.2	1.7	-3.2	0.2	12.9
	Urban Female	14.2	1.7	-1.0	0.5	15.4
Karnataka	Rural Male	14.2	-2.6	0.0	0.4	11.9
	Rural Female	14.2	-2.6	3.9	0.5	16.0
	Urban Male	14.2	-2.6	-2.3	1.5	10.7
	Urban Female	14.2	-2.6	-0.7	-2.1	8.7
Kerala	Rural Male	14.2	-4.5	0.0	-0.7	9.0
	Rural Female	14.2	-4.5	3.3	-2.6	10.3
	Urban Male	14.2	-4.5	-2.3	1.5	8.8
	Urban Female	14.2	-4.5	-0.6	1.7	10.8
Madhya Pradesh	Rural Male	14.2	1.4	0.0	0.6	16.2
	Rural Female	14.2	1.4	5.3	0.9	21.8
	Urban Male	14.2	1.4	-3.2	0.5	13.0
	Urban Female	14.2	1.4	-1.0	-1.7	12.9
Maharashtra	Rural Male	14.2	0.7	0.0	1.9	16.8
	Rural Female	14.2	0.7	5.1	-1.7	18.4
	Urban Male	14.2	0.7	-3.0	0.5	12.5
	Urban Female	14.2	0.7	-0.9	-1.0	12.9

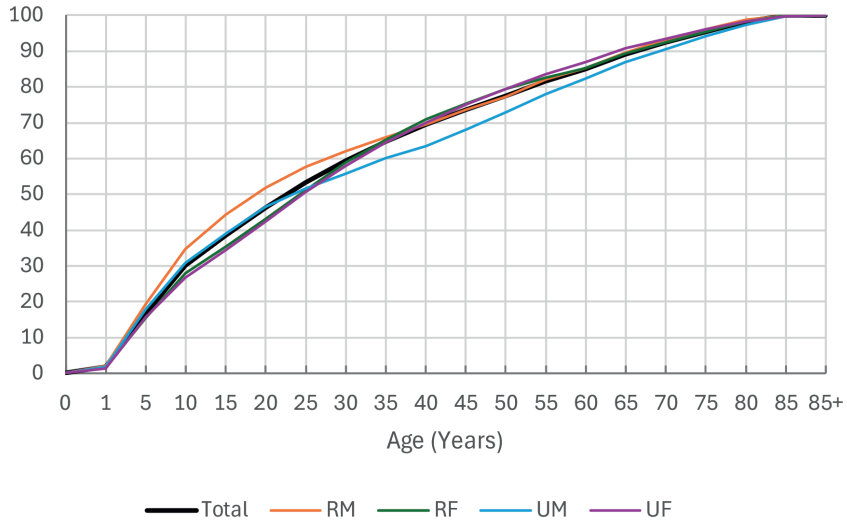
State	Sub-group	Gain in LEB				
		Common to states and sub-groups	Specific to state	Specific to sub-group	Residual	Total
Odisha	Rural Male	14.2	0.9	0.0	4.4	19.4
	Rural Female	14.2	0.9	5.1	3.6	23.8
	Urban Male	14.2	0.9	-3.1	-1.9	10.1
	Urban Female	14.2	0.9	-1.0	-3.1	11.1
Punjab	Rural Male	14.2	-5.7	0.0	-0.7	7.7
	Rural Female	14.2	-5.7	2.9	-0.2	11.1
	Urban Male	14.2	-5.7	-1.7	0.1	6.8
	Urban Female	14.2	-5.7	-0.5	0.8	8.8
Rajasthan	Rural Male	14.2	1.8	0.0	0.2	16.2
	Rural Female	14.2	1.8	5.4	-0.1	21.3
	Urban Male	14.2	1.8	-3.2	0.2	12.9
	Urban Female	14.2	1.8	-1.0	-0.3	14.7
Tamil Nadu	Rural Male	14.2	3.9	0.0	-0.5	17.5
	Rural Female	14.2	3.9	6.2	-1.9	22.4
	Urban Male	14.2	3.9	-3.0	0.4	15.6
	Urban Female	14.2	3.9	-1.1	1.4	18.3
Uttar Pradesh	Rural Male	14.2	3.1	0.0	-0.6	16.7
	Rural Female	14.2	3.1	5.9	1.5	24.6
	Urban Male	14.2	3.1	-3.5	-0.3	13.4
	Urban Female	14.2	3.1	-1.1	-0.1	16.1

SOURCE: AUTHOR

Contribution of Mortality Improvement

Table 4 gives the contribution of the improvement in mortality in different ages of the life span to the gain in LEB in different population groups. In India, mortality improvement in the first year of life accounted for a gain of 0.31 years in LEB gain during the period 1976–2020, whereas average improvement in mortality in the age group 1–4 years accounted for a gain of 0.67 years in LEB gain, which means that mortality improvement in this age group accounted for around 0.67x4=2.7 years of the gain in LEB in the country. Table 4 suggests that almost 39 per cent of the gain in LEB in the country has been the result of the improvement in mortality in the first fifteen years of life, while another 39 per cent has been the result of the improvement in mortality improvement in the age group 15-49 years. By contrast, improvement in mortality in ages seventy years and above during this period has resulted in only about seven per cent of the gain in LEB. As the result, the cumulative distribution of the proportionate contribution of the improvement in mortality in different ages of the life span to the gain in LEB has been convex (Figure 2).

Figure 8. Proportionate (per cent) contribution of the improvement in mortality at different ages to the gain in life expectancy at birth, 1976–2020, in India



SOURCE: AUTHOR

Table 4. Contribution of average mortality improvement (in years) in different age-groups to the gain in life expectancy at birth (years) in India and selected states, 1976–2020

Country/State		Total gain	Age group																		
			< 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	0.31	0.67	0.48	0.30	0.28	0.25	0.22	0.19	0.17	0.15	0.14	0.15	0.12	0.15	0.12	0.11	0.10	0.06	0.02
	RM	16.33	0.33	0.70	0.51	0.32	0.24	0.19	0.14	0.13	0.12	0.13	0.12	0.15	0.10	0.15	0.12	0.09	0.09	0.04	0.00
	RF	20.42	0.31	0.71	0.51	0.30	0.32	0.33	0.32	0.25	0.23	0.18	0.16	0.13	0.11	0.16	0.13	0.12	0.12	0.07	0.02
	UM	12.60	0.23	0.50	0.33	0.21	0.19	0.13	0.10	0.11	0.08	0.12	0.12	0.13	0.11	0.12	0.09	0.09	0.08	0.06	0.03
	UF	13.85	0.19	0.49	0.31	0.22	0.22	0.23	0.20	0.18	0.16	0.14	0.12	0.12	0.09	0.10	0.08	0.08	0.06	0.04	0.02
Andhra Pradesh	All	17.81	0.33	0.61	0.53	0.30	0.29	0.20	0.23	0.18	0.16	0.12	0.10	0.11	0.11	0.13	0.14	0.13	0.12	0.13	0.10
	RM	17.93	0.36	0.60	0.58	0.24	0.26	0.22	0.17	0.14	0.10	0.09	0.09	0.09	0.11	0.14	0.19	0.19	0.19	0.20	0.17
	RF	19.39	0.33	0.67	0.59	0.36	0.31	0.30	0.29	0.24	0.20	0.13	0.10	0.11	0.09	0.12	0.11	0.10	0.09	0.12	0.11
	UM	12.31	0.19	0.38	0.29	0.32	0.19	0.17	0.09	0.12	0.18	0.11	0.11	0.09	0.12	0.13	0.10	0.06	0.07	-0.01	-0.07
	UF	11.74	0.12	0.36	0.22	0.22	0.24	0.28	0.18	0.10	0.20	0.09	0.03	0.08	0.09	0.08	0.07	0.07	0.04	0.04	0.02
Assam	All	17.05	0.24	0.49	0.47	0.28	0.20	0.20	0.20	0.20	0.18	0.15	0.20	0.16	0.16	0.16	0.13	0.12	0.11	0.06	0.01
	RM	15.80	0.23	0.50	0.50	0.29	0.13	0.15	0.18	0.12	0.15	0.10	0.18	0.12	0.12	0.12	0.12	0.16	0.14	0.11	0.07
	RF	17.23	0.19	0.44	0.42	0.27	0.25	0.23	0.24	0.29	0.21	0.22	0.22	0.17	0.15	0.19	0.12	0.05	0.06	-0.02	-0.08
	UM	15.13	0.60	0.79	0.36	0.17	0.07	0.04	0.07	-0.02	0.04	0.14	0.19	0.19	0.20	0.22	0.20	0.15	0.15	0.11	0.06
	UF	10.98	0.33	0.50	0.37	0.01	0.11	0.19	0.27	0.14	0.14	0.14	0.10	0.10	0.10	0.10	0.05	0.02	-0.03	-0.06	-0.08
Gujarat	All	18.52	0.28	0.76	0.47	0.41	0.29	0.24	0.25	0.22	0.18	0.19	0.09	0.15	0.10	0.12	0.10	0.10	0.09	0.04	-0.01
	RM	15.89	0.25	0.77	0.51	0.37	0.22	0.11	0.14	0.14	0.11	0.16	0.09	0.15	0.07	0.13	0.12	0.09	0.09	0.02	-0.03
	RF	21.69	0.28	0.76	0.42	0.42	0.33	0.37	0.35	0.34	0.25	0.18	0.15	0.16	0.11	0.17	0.14	0.11	0.09	0.07	0.02
	UM	14.85	0.23	0.69	0.49	0.35	0.19	0.14	0.16	0.14	0.13	0.18	0.12	0.16	0.11	0.10	0.04	0.08	0.03	-0.03	-0.08
	UF	17.34	0.25	0.69	0.37	0.39	0.35	0.22	0.26	0.21	0.17	0.16	0.00	0.06	0.07	0.06	0.10	0.14	0.14	0.14	0.11
Haryana	All	15.42	0.28	0.65	0.49	0.29	0.26	0.18	0.15	0.12	0.16	0.11	0.06	0.05	0.04	0.05	0.08	0.10	0.17	0.17	0.15
	RM	10.74	0.32	0.67	0.51	0.29	0.15	-0.02	0.01	0.02	0.10	0.07	-0.03	-0.09	-0.11	0.02	0.04	0.10	0.21	0.23	0.24
	RF	20.84	0.27	0.64	0.53	0.29	0.37	0.34	0.27	0.29	0.24	0.24	0.19	0.14	0.10	0.10	0.09	0.11	0.14	0.14	0.11
	UM	8.49	0.12	0.53	0.22	0.20	0.18	0.02	0.00	-0.03	0.04	0.00	0.04	0.09	0.10	0.04	0.07	0.06	0.13	0.09	0.06
	UF	22.22	0.30	0.60	0.46	0.29	0.38	0.43	0.41	0.31	0.35	0.25	0.19	0.15	0.11	0.03	0.14	0.12	0.11	0.16	0.14
Himachal Pradesh	All	17.36	0.31	0.47	0.52	0.35	0.23	0.17	0.20	0.25	0.16	0.13	0.17	0.16	0.12	0.13	0.11	0.10	0.09	0.12	0.11
	RM	12.64	0.25	0.49	0.76	0.21	0.11	-0.01	0.09	0.20	0.10	0.06	0.13	0.06	0.06	0.06	0.04	0.08	0.04	0.09	0.08
	RF	23.24	0.36	0.46	0.40	0.47	0.31	0.32	0.32	0.30	0.26	0.22	0.25	0.27	0.18	0.22	0.19	0.14	0.16	0.18	0.16
	UM	7.95	0.28	0.42	0.06	-0.10	0.08	0.00	0.15	0.19	0.09	0.26	0.10	0.12	0.17	0.10	0.03	0.03	0.03	-0.09	-0.18
	UF	14.29	0.20	0.15	0.20	0.20	0.23	0.36	0.16	0.11	0.17	0.09	0.17	0.30	0.20	0.10	0.08	0.14	0.08	0.09	0.06
Jammu & Kashmir	All	18.30	0.17	0.69	0.34	0.20	0.24	0.28	0.26	0.16	0.19	0.17	0.15	0.15	0.13	0.14	0.16	0.17	0.18	0.15	0.09
	RM	14.90	0.20	0.66	0.39	0.26	0.23	0.14	0.10	0.06	0.08	0.10	0.08	0.12	0.10	0.10	0.14	0.16	0.18	0.14	0.09
	RF	21.52	0.15	0.68	0.31	0.21	0.34	0.40	0.35	0.22	0.25	0.24	0.20	0.18	0.16	0.18	0.17	0.19	0.20	0.14	0.05
	UM	12.90	0.08	0.87	0.22	-0.13	0.10	0.24	0.25	0.03	0.12	0.06	0.11	0.16	0.16	0.09	0.13	0.11	0.10	0.10	0.07
	UF	15.36	0.10	0.56	0.28	0.18	0.12	0.18	0.20	0.26	0.33	0.13	0.18	0.08	0.04	0.13	0.12	0.12	0.12	0.11	0.07
Karnataka	All	13.36	0.25	0.58	0.42	0.30	0.25	0.17	0.17	0.15	0.13	0.09	0.10	0.12	0.08	0.11	0.08	0.00	0.04	-0.03	-0.06
	RM	11.94	0.33	0.65	0.49	0.41	0.28	0.09	0.07	0.03	0.02	0.05	0.03	0.11	0.10	0.09	0.07	-0.02	0.05	-0.05	-0.09
	RF	16.05	0.22	0.59	0.47	0.31	0.22	0.24	0.28	0.27	0.22	0.16	0.13	0.12	0.08	0.14	0.06	0.02	0.05	-0.06	-0.12
	UM	10.72	0.21	0.40	0.21	0.14	0.17	0.02	0.04	0.13	0.12	0.04	0.16	0.16	0.04	0.06	0.14	0.06	0.10	0.15	0.15
	UF	8.74	0.13	0.41	0.24	0.14	0.24	0.18	0.10	0.13	0.11	0.06	0.08	0.04	0.06	0.09	0.02	-0.04	-0.01	-0.03	-0.03
Kerala	All	9.64	0.24	0.36	0.28	0.18	0.11	0.09	0.10	0.14	0.10	0.10	0.08	0.06	0.08	0.07	0.05	0.06	0.06	0.04	0.01
	RM	8.96	0.30	0.38	0.25	0.15	0.09	0.08	0.08	0.09	0.09	0.10	0.08	0.07	0.06	0.06	0.05	0.05	0.06	0.04	0.02
	RF	10.35	0.19	0.37	0.34	0.27	0.12	0.09	0.15	0.09	0.09	0.12	0.08	0.05	0.06	0.07	0.05	0.05	0.07	0.03	0.01

Table 4. Continued

Country/State		Total gain	Age group																	
			< 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	8.67	0.15	0.30	0.30	0.11	0.06	0.09	0.05	0.18	0.10	0.10	0.07	0.07	0.07	0.08	0.04	0.06	0.05	0.03	0.01
	UF	10.78	0.25	0.34	0.11	0.16	0.11	0.10	0.12	0.15	0.17	0.11	0.10	0.08	0.12	0.13	0.09	0.11	0.10	0.07	0.02
Madhya Pradesh	All	18.56	0.30	0.69	0.48	0.33	0.25	0.26	0.24	0.23	0.16	0.19	0.13	0.22	0.09	0.19	0.13	0.12	0.08	0.02	-0.04
	RM	16.23	0.33	0.75	0.54	0.33	0.17	0.19	0.14	0.13	0.04	0.16	0.07	0.30	0.06	0.18	0.11	0.11	0.13	-0.04	-0.16
	RF	21.81	0.29	0.69	0.48	0.34	0.33	0.35	0.33	0.30	0.30	0.29	0.22	0.18	0.09	0.25	0.15	0.12	0.03	-0.01	-0.06
	UM	12.99	0.20	0.60	0.25	0.26	0.09	-0.04	0.00	0.11	0.03	0.07	0.07	0.17	0.12	0.08	0.17	0.20	0.21	0.25	0.24
	UF	12.90	0.16	0.42	0.21	0.30	0.18	0.21	0.23	0.22	0.19	0.16	0.11	0.09	0.06	0.09	0.04	0.07	0.02	0.02	0.01
Maharashtra	All	16.70	0.33	0.62	0.48	0.29	0.24	0.24	0.21	0.17	0.14	0.12	0.12	0.12	0.11	0.13	0.12	0.12	0.10	0.08	0.04
	RM	16.82	0.33	0.62	0.52	0.38	0.24	0.18	0.16	0.11	0.10	0.11	0.12	0.11	0.07	0.13	0.15	0.15	0.14	0.13	0.09
	RF	18.35	0.29	0.61	0.51	0.29	0.29	0.34	0.24	0.25	0.20	0.12	0.10	0.11	0.11	0.15	0.14	0.13	0.10	0.06	0.01
	UM	12.46	0.29	0.57	0.29	0.13	0.24	0.17	0.11	0.14	0.07	0.10	0.13	0.13	0.12	0.10	0.09	0.07	0.05	0.03	0.01
	UF	12.94	0.27	0.56	0.34	0.10	0.14	0.24	0.25	0.15	0.19	0.12	0.11	0.09	0.10	0.08	0.05	0.07	0.04	0.01	-0.02
Odisha	All	21.47	0.35	0.62	0.50	0.29	0.33	0.28	0.24	0.21	0.19	0.15	0.19	0.22	0.21	0.20	0.16	0.19	0.15	0.19	0.17
	RM	19.44	0.33	0.65	0.55	0.27	0.32	0.23	0.12	0.10	0.16	0.12	0.19	0.24	0.21	0.21	0.15	0.15	0.11	0.16	0.14
	RF	23.78	0.35	0.61	0.45	0.32	0.26	0.32	0.37	0.31	0.23	0.16	0.21	0.20	0.21	0.20	0.19	0.24	0.22	0.25	0.21
	UM	10.10	0.30	0.41	0.31	0.20	0.16	0.15	0.11	0.11	0.07	0.16	0.10	0.17	0.18	0.18	0.07	-0.02	-0.11	-0.18	-0.20
	UF	11.05	0.20	0.37	0.43	0.17	0.29	0.22	0.12	0.19	0.15	0.11	0.07	0.13	0.09	0.07	0.02	-0.02	-0.06	-0.09	-0.09
Punjab	All	9.26	0.45	0.79	0.48	0.37	0.22	0.13	0.16	0.09	0.04	-0.03	-0.05	-0.02	-0.12	0.02	-0.07	-0.04	-0.02	-0.04	-0.03
	RM	7.71	0.60	0.98	0.64	0.27	0.21	0.17	0.04	-0.04	-0.06	-0.09	-0.13	-0.18	-0.24	-0.03	-0.07	-0.02	0.06	0.08	0.12
	RF	11.10	0.44	0.84	0.59	0.47	0.21	0.10	0.30	0.21	0.14	0.05	-0.01	-0.06	-0.17	-0.01	-0.10	-0.08	-0.09	-0.10	-0.08
	UM	6.82	0.25	0.39	0.21	0.22	0.28	0.12	0.20	0.02	-0.02	-0.07	-0.06	0.07	0.04	0.02	0.00	-0.01	0.00	-0.02	-0.03
	UF	8.75	0.27	0.47	0.23	0.22	0.00	0.08	0.13	0.15	0.07	0.08	0.07	0.17	0.08	0.10	-0.02	0.01	-0.02	-0.03	-0.05
Rajasthan	All	18.23	0.24	0.64	0.55	0.30	0.31	0.26	0.22	0.19	0.19	0.13	0.14	0.15	0.06	0.12	0.12	0.14	0.12	0.08	0.03
	RM	16.15	0.34	0.89	0.59	0.42	0.29	0.17	0.09	0.10	0.13	0.06	0.14	0.19	0.04	0.11	0.07	0.08	0.04	-0.03	-0.09
	RF	21.28	0.21	0.54	0.60	0.21	0.35	0.35	0.35	0.29	0.29	0.19	0.15	0.14	0.03	0.17	0.18	0.19	0.17	0.11	0.04
	UM	12.91	0.11	0.40	0.39	0.26	0.16	0.07	0.14	0.08	0.12	0.11	0.12	0.07	0.09	0.13	0.10	0.12	0.11	0.14	0.13
	UF	14.69	0.10	0.49	0.37	0.31	0.30	0.15	0.17	0.11	0.13	0.20	0.06	0.09	0.07	0.01	0.07	0.13	0.16	0.18	0.16
Tamil Nadu	All	20.14	0.37	0.77	0.50	0.35	0.29	0.23	0.22	0.19	0.18	0.16	0.15	0.15	0.16	0.18	0.15	0.14	0.13	0.12	0.09
	RM	17.54	0.44	0.85	0.54	0.38	0.29	0.20	0.19	0.16	0.11	0.06	0.10	0.08	0.09	0.13	0.10	0.09	0.11	0.09	0.07
	RF	22.38	0.38	0.75	0.51	0.33	0.34	0.30	0.29	0.21	0.29	0.18	0.22	0.18	0.23	0.20	0.18	0.11	0.13	0.09	0.05
	UM	14.87	0.27	0.68	0.32	0.27	0.15	0.16	0.16	0.12	0.09	0.14	0.08	0.10	0.10	0.16	0.12	0.15	0.13	0.13	0.09
	UF	18.32	0.23	0.54	0.45	0.29	0.25	0.20	0.24	0.18	0.15	0.25	0.16	0.21	0.16	0.17	0.13	0.13	0.10	0.10	0.06
Uttar Pradesh	All	20.51	0.31	0.94	0.61	0.34	0.35	0.33	0.27	0.20	0.15	0.16	0.11	0.11	0.09	0.13	0.13	0.11	0.14	0.05	-0.02
	RM	16.68	0.32	0.94	0.62	0.39	0.32	0.21	0.16	0.08	0.08	0.14	0.10	0.12	0.08	0.11	0.11	0.04	0.05	-0.06	-0.13
	RF	24.61	0.36	1.05	0.64	0.30	0.45	0.40	0.34	0.30	0.20	0.19	0.08	0.06	0.06	0.16	0.17	0.19	0.26	0.17	0.09
	UM	13.44	0.16	0.49	0.54	0.25	0.29	0.13	0.17	0.09	0.04	0.17	0.12	0.12	0.07	0.08	0.03	0.08	0.05	0.03	0.01
	UF	16.08	0.12	0.66	0.39	0.33	0.25	0.25	0.21	0.20	0.20	0.09	0.12	0.07	0.07	0.12	0.11	0.09	0.12	0.04	-0.01

<0	0-0.1	0.1-0.2	0.2-0.3	0.3-0.4	0.4-0.5	≥0.5

SOURCE: AUTHOR

The contribution of the improvement in mortality in different age groups to the gain in LEB has also been different in different population sub-groups. In rural males, almost 45 per cent of the gain in LEB is accounted by mortality improvement in the first fifteen years of life but this proportion is less than 33 per cent in rural females. In urban males, the gain in LEB accounted by the improvement in mortality in the first fifteen years of life is found to be higher than the gain in LEB due to improvement in mortality in urban female but substantially lower than that in female in both rural and urban areas. Gain in LEB attributed to mortality improvement in the age group 50–69 years is found to be higher in males than in females in both rural and urban areas of the country. In the age group seventy years and above, on the other hand, the contribution of the improvement in mortality to the gain in LEB is found to be higher in females in the rural population but in males in the urban population.

The contribution of mortality improvement at different ages to LEB gain has also varied 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 LEB gain is shown in Figure 3. The contribution of mortality improvement in the first five years of life to LEB gain in six states has been higher than the national average, but less than the national average in three states. The contribution of mortality improvement in ages 5–14 years was around 25 per cent in Karnataka, but only eighteen per cent in Odisha. The contribution of mortality improvement in ages 15–49 years was forty per cent in Rajasthan but only 34 per cent in Haryana and Uttar Pradesh. The contribution of mortality improvement in the age group 50–69 years was eighteen per cent in Assam and Odisha, but only seven per cent in Haryana. In the age group seventy years and above, the contribution was thirteen per cent in Odisha, but only five per cent in Madhya Pradesh. In Karnataka, there has been virtually no improvement in mortality in this age group. The male-female difference in the contribution has also been different. The contribution of male mortality improvement in the age-group 1–4 years is higher than that of female mortality in all states except Karnataka, Rajasthan, and Uttar Pradesh. In these states, contribution of urban female mortality improvement to LEB gain 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 Himachal Pradesh where mortality increased, instead of decreased, in urban males. In the 15–49 age group, the contribution of female mortality improvement

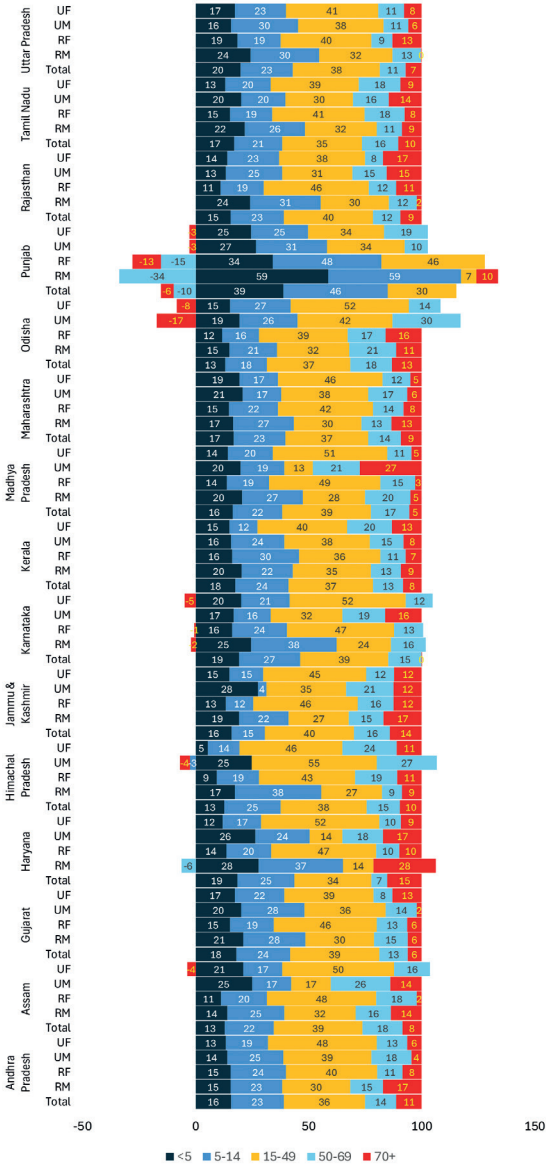
was higher than that of male mortality in all population groups except the urban population of Himachal Pradesh and Punjab. Moreover, in population aged fifty years and above, the contribution of male mortality improvement to LEB gain has, in general, been higher than the contribution of female mortality improvement, but there are important exceptions to this common pattern as may be seen in Figure 3.

Figure 3 also shows that, in some population groups, the improvement in mortality has been inconsistent. The increase in mortality in these population groups has contributed to loss, instead of gain, in LEB. In Punjab, for example, the entire gain in LEB during the reference period has been due to the improvement in mortality in ages below fifty years as mortality increased, instead decreased, in ages fifty years and above. This has particularly been the case with rural females in Punjab, whereas rural males in the age group 50–69 years have seen a marked increase in mortality, although mortality decreased in ages seventy years and above. Similarly, Odisha has seen a marked increase in mortality in ages seventy years and above in both urban males and females while mortality decreased in the state's rural population. In addition to Punjab and Odisha, mortality appears to have increased in urban females aged seventy years and above in Assam, urban males aged seventy years and above in Himachal Pradesh and in rural males and urban females aged seventy years and above in Karnataka. Mortality also increased in the age group 50–69 years in rural males in Haryana and in rural and urban males in Himachal Pradesh. The increase in mortality in these population groups has contributed to a loss, instead of a gain, in LEB. The very slow gain in LEB in Punjab during 1976–2020 can be attributed to the increase in mortality in ages fifty years and above. Similarly, gain in LEB in the urban population of Odisha would have been more rapid if mortality in the population aged seventy years and above had not increased.

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). Results of this decomposition for the four mutually exclusive population groups in India are presented in Table 5, which highlights that contributors to the differences in LEB gains vary across groups. The gain in LEB in rural females in India was 4.1 years higher than the gain in LEB in rural

Figure 9. Proportionate (per cent) contribution of the improvement in age-specific mortality rates to the gain in LEB, 1976–2020, in states of India



SOURCE: AUTHOR

males because of more rapid improvement in mortality in rural females relative to rural males in the age group 35–79 years. In ages younger than 35 years and in ages eighty years and above, mortality improvement in rural males has been more rapid than mortality improvement in rural females. On the other hand, the gain in LEB in urban females has been around 1.3 years higher than the gain in LEB in urban males due to faster improvement in urban female mortality in the age group 1–39 years. In contrast, mortality improvement in the first year of life and in ages forty years and above, has been more rapid in urban males than in urban females. 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 the very elderly), 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 has been found to be around 3.7 years more than that of urban males because mortality improvement in rural males has been more rapid than in urban males in all but four age groups. It is only in the age groups 45–49 years; 55–59 years; and eighty years and above that improvement in female mortality has been more rapid than mortality improvement in rural males. On the other hand, gain in LEB in rural females was around 6.6 years higher than the gain in LEB in urban females because mortality improvement in rural females has been more rapid than mortality improvement in urban females for all ages.

The overall difference in LEB gains between two population groups is the sum of two components: (1) the difference in average mortality improvement between the groups (the product component) and (2) the difference in the ratio of mortality improvement between the groups (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 resulting in a net difference of 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, making the net difference 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 LEB gain between two population groups is around 1.3 years.

Table 5. Decomposition of the difference in the gain in life expectancy at birth 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

Among the sixty mutually exclusive population groups, the gain in LEB during the period 1976–2020 has been the slowest in urban males in Punjab (6.8 years) but the highest in rural females in Uttar Pradesh (24.6 years), a difference of around 17.8 years. Table 6 decomposes the difference in gain in LEB between rural females in Uttar Pradesh and urban males in Punjab. Almost two-thirds of the difference in the gain in LEB between rural females in Uttar Pradesh and urban males in Punjab is attributed to the difference in the ratio component while the product component accounts for around one-third of the difference. Mortality improved in all ages in rural females in Uttar Pradesh during the period 1976–2020, but this has not been the case for urban males in Punjab where mortality increased, instead decreased, in the age groups 35–49 years, 65–74 years, and eighty years and above. The table 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 for all age groups. However, the ratio component of the difference in the gain in LEB contributed to the decrease 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. In other age groups, the ratio component contributed to increase the difference in LEB gain between the two population groups. As the result, the net contribution of the ratio component or the difference in improvement in age-specific mortality rate to the difference in LEB gain between rural females in Uttar Pradesh and urban males in Punjab has been smaller than the net contribution of the product component or the difference in improvement in average mortality in the two population groups.

Discussion and Conclusions

This article has highlighted the unevenness in LEB gain within India, across sixty mutually exclusive population groups. The gain in LEB has varied widely across these mutually exclusive groups, ranging from more than 24 years in rural females in Uttar Pradesh to less than seven years in urban males in Punjab. Reasons for this very marked variation in LEB gain within India are not known at present. A part of the observed unevenness in LEB gain may be attributed to the ceiling effect as LEB varied from around 41 years in rural females in Uttar Pradesh to more than 69 years in Punjab in 1976–1980. If the unevenness in LEB gain attributed to the ceiling effect is controlled, substantial inequality in LEB gain within the country still remains, as is revealed through comparing the observed LEB gain trajectory

in different population groups with the medium model mortality improvement trajectory of the United Nations. This comparison suggests that the difference between the actual gain and the expected gain in LEB has been different in different population groups and, in about two thirds of the population groups, gain in LEB has been slower than expected.

Table 6. Decomposition of the difference between LEB gain in rural females in Uttar Pradesh and urban males in Punjab, 1976–2020 (years)

Age	Difference between LEB gain in rural males in Uttar Pradesh and urban males in Punjab	Components of the difference in LEB gain	
		Ratio component	Product component
<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

Reasons for observed heterogeneity in LEB gain within India are not known at present. A part of this heterogeneity may be due to the variation in LEB gain across states which is common to all population sub-groups within a state. Another part of the observed heterogeneity may be due to variation in the gain across population sub-groups which is common to all states. Finally, heterogeneity in LEB gain may also be due to factors that are specific to specific population groups. The present analysis suggests that around 77 per cent of the variation in LEB gain across sixty population groups may be explained, almost equally, by heterogeneity in gain across states which is common to all population sub-groups within the state and heterogeneity in gain across population sub-groups which is common to all states. Heterogeneity in gain attributed to factors specific to specific population groups accounts for about 23 per cent of the total heterogeneity in LEB gain across sixty population groups. This heterogeneity in LEB gain is not explained by the variation in the gain across states and across population sub-groups.

The variation in LEB gains across states, after accounting for differences across population sub-groups and the residual component, may be attributed to state-level factors that potentially influence life expectancy. A review of the extensive literature on the determinants of life expectancy has identified seven factors: 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, that have a potential impact on LEB (Roffia et al., 2022). Variations in per capita health expenditure and the way health services are organised also contribute to the variation in LEB. Higher public health spending, coupled with efficient health services, is found to accelerate LEB gain whereas inadequate funding and inefficient health services hinder LEB gain. An increase of ten per cent in health spending per capita in real terms is found to be associated with an increase of 3.5 months in LEB gain in OECD countries (OECD, 2019). In Africa, increase in health spending, urbanisation and improved water access are found to be associated with LEB gain (Salami et al., 2019). The impact of increasing per capita public health expenditure on LEB gain is found to be greater than increase in private health expenditure (Raeesi et al., 2018; Novignon et al., 2012). However, these factors do not account for the variation in LEB gains among rural males, rural females, urban males and urban females after controlling for state-level and residual components common to all states. They also fail to explain variation in LEB gains specific to population groups beyond what is attributable to state and sub-group effects.

The gain in LEB summarises mortality improvement in different ages. In general, mortality improved in all ages in the sixty population groups but there are notable exceptions. In Punjab, mortality increased, instead of improving, in ages forty years and above and this increase appears to be the reason behind very slow gain in LEB in the state since 1976–1980. In Odisha, mortality increased in ages seventy years and above in the urban areas but not in the rural areas, which appears to be a factor behind the slow gain in LEB in the urban areas of the state relative to its rural areas. The relatively slow gain in LEB in urban females in Assam and Karnataka, and in urban males in Gujarat and Himachal Pradesh, also appears to be due to the increase in mortality in older ages. There is a need to explore reasons behind the increase in mortality in older population in these population groups. Had mortality not increased in these population groups, the gain in LEB would have been larger and the inequality in LEB gain would have been smaller. In most of the population groups, the gain in LEB has primarily been due to mortality improvement in younger ages, less than fifteen years.

LEB is a universally recognised as the indicator of population health. The inequality in LEB gain, across population groups, therefore, indicates that improvement in population health has been uneven in different population groups. At the policy level, however, there has rarely been any acknowledgement of the inequalities in the improvement in population health as revealed through the inequality in the gain in LEB. The latest health policy of India aims at achieving LEB of seventy years by the year 2025 but is silent about the unevenness in the improvement in population health across different population groups and how to address this inequality (Government of India, 2017). Although the goal set out in the National Health Policy 2017 appears to have been achieved, the present analysis reveals that significant challenges persist due to uneven improvements in population health across the country. Addressing these disparities among population groups is essential for accelerating overall health progress in India.

The health care delivery system in India is a mix of public and private services. A comprehensive review of India's health care delivery system has been carried out elsewhere (Selvaraj et al., 2022). The private health care system is heavily concentrated in big cities and large towns and primarily provides institution-based curative health care at a cost. In contrast, the public health care system provides services either free of cost or at an affordable cost and mainly focuses on health

promotion and preventive treatment, particularly in rural areas. Its presence in urban areas is limited primarily to the delivery of hospital-based curative services. Historically, the public health system in India has been preoccupied with the delivery of maternal and child health care services, as demonstrated by various national level programmes launched from time to time. These programmes appear to have produced substantial improvements in mortality in younger ages, and reduction in female reproductive mortality. However, meeting the health needs of the older population appears to have received only residual attention. The focus on the rural areas in the organisation of public health services is reflected in above average gain in LEB in the rural areas, especially rural females, whereas LEB gain in urban areas has lagged. India launched the National Urban Health Mission in 2013 to address urban health concerns (Government of India, 2013) which has now become a part of the National Health Mission (Government of India, 2016). In 2018, the Ayushman Bharat scheme has been launched to improve health of the population and drastically reduce or eliminate health care-related impoverishment through universal health coverage. The Ayushman Bharat is a publicly financed health insurance scheme for the socioeconomically deprived rural population and selected occupational categories of the urban population (Keshri and Gupta, 2020).

The analysis presented in this article highlights two critical imperatives for India as regards improvement in the health of the people of the country. The first imperative is to explore further the factors, both exogenous and endogenous to the health care delivery system, that are responsible for the inequality in the gain in LEB across mutually exclusive population groups. An understanding of these factors is important since reducing this inequality may contribute to accelerating in the countrywide gain in LEB. Reasons for these disparities are not yet fully understood. In Karnataka, Kerala and Punjab, the gain in LEB has been less than expected in all of the four mutually exclusive population sub-groups, whereas the gain in LEB in Tamil Nadu has been more than that expected. In other states of the country, the gain in LEB has been more than that 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 India must adopt a more nuanced and integrated approach than the existing highly centralised approach. The

present analysis highlights the need for moving towards a decentralised approach to health policy and planning that is sensitive to the marked inequality or disparity in population health that appears to be quite pervasive in India. Setting up separate population health goals for different population groups may be a step in this direction. These goals may be defined in terms of either the gain LEB or in terms of some other appropriate indicator of population health. Estimates of age-specific mortality rates and resulting LEB are currently available for 88 mutually exclusive population groups, cross-classified by 22 states and four mutually exclusive population sub-groups in each state through the official sample registration system. These estimates may serve as the basis for setting up group-specific population health goals. Such an approach may lead to reducing within-country disparities in population health. A reduction in the disparities in population health is an operationally feasible and optimal strategy towards accelerated improvement in population health in India which remains low by international standards.

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