Extended Abstract

Compression and Decompression Patterns of Mortality in India and States

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Introduction:

In the current phase of demographic transition, India's demographic trends are presently transitioning from third to fourth stage of demographic transition. The country has also amidst the second phase of epidemiological transition. Combined effect of decreased fertility and mortality and better survivorship is affecting the level and patterns of mortality and morbidity. In general, the demographic and epidemiological transition in developed countries have resulted in a more skewed distribution and affected the age patterns of mortality and morbidity (Pool *et. al.* 2006).

In India, over the decades, it is observed that age pattern of mortality is heading to a plateau shape from the early U – shape curve. Trends in mortality over times show a steady decline in infant and child mortality rates across the states of India. Adult mortality has also declined steadily and significantly. WHO (2006) estimates show decline by 37 points (per thousand) from 1990 to 2006 in adult mortality, as a result of decline in mortality of younger and adult ages, India's life expectancy has increased up to 65 years. SRS estimates show decline in crude death rate (CDR) from 12.6 to 8.0 during the last three decades. Infant mortality rates have been halved down from 105 to 58 during the same period. As a consequence of this transition, it is expected that age specific mortality pattern is heading to a flattening pattern. According to WHO report (2004) proportion of older population has increased to 7 percent in 2005 and further expected to increase to 22 percent by 2050. At the same time, it is expected that with increase in life expectancy there shall be outward shifts in mortality rates to oldest of older age group probably due to increase or decrease in deceleration or acceleration in mortality rates. At the same time, it is expected that with increase in life expectancy there shall be increase in mortality rates at oldest of older ages (WHO).

Evidence also suggests corresponding epidemiological shifts in morbidity patterns in India and states. The National Sample Survey Organization (NSSO) gives estimates of level of morbidity in broad age groups. According to NSSO (2004), level of morbidity is lowest in 15-29 age group and highest in 60 and above. State variation persists with Kerala having highest percentages of 255 (persons per thousand) and Rajasthan having lowest 60 (persons per thousand). Compared to morbidity level in last ten years, morbidity level has decreased in 0-14 and 15-39 age groups but increased enormously in 60 and above age group. Above observation evidences a pattern of declining morbidity in younger age group and increase in older age group.

Historical Background:

Researchers have investigated the circumstances regarding small pox in India during 19th century and revealed that about 80 percent of India was unprotected against small pox and fatality was

approximately 25 – 30 percent in unprotected population. There has been steady decline in mortality rates during 1950's and 1960's and continued during the later decades. Infectious diseases declined due to increase in vaccination for major states and India during 1969 – 95. The ratio of male to female age specific death rates also declined during the same decade. Studies have also focused on assessing the trends and levels using various indirect methods (Banthia, J. and Dyson, T. 1999; Visaria, L. *et. al.* 2004; Bhat 2004).

Literature Review:

Mortality compression refers to an increasing concentration of ages at death and thus to more rectangularization of survival curve whereas decompression of mortality refers to the spread of ages at death (Wilmoth and Horiuchi, 1998). Therefore, if deaths are occurring at later ages or shifting outward, there is a chance of flattening of mortality curves in younger ages and shifting towards older ages. Consequently, survival curves will be steeper with increasing concentration of deaths in the narrow age range and there will be expansion of mortality curves or increase in distribution of deaths in older age group.

Similar to the concept of mortality compression, morbidity compression refers to the increasing concentration of illness and disability in 'later years of life' (Wilmoth and Horiuchi, 1998). Over period of time the survival curves have assumed an ever more rectangular form.

Fries J. F. (2005) indentified that morbidity compression can occur if average onset of morbidity increases more rapidly than the life expectancy from the same age. Vallin, J. (2004) has identified three major stages contributing majorly to morbidity; overcoming infectious disease, the cardiovascular revolution and disease related to aging. In contrast, Leibson, C.L. *et. al.* (1992) found conflicting evidences for compression of morbidity.

Need for the Study:

Both from theoretical and technical point, the foregoing review suggest the need for investigating the complex age patterns in mortality and morbidity. India's age pattern of mortality (formerly U shape) has been transitioning considerably towards a flattening curve. Morbidity pattern also flattens at younger age group and has been rising at older age group. The change in morbidity pattern is also accompanied by the transition in change in share of different disease in age groups overtime. The study of mortality and morbidity, compression and decompression revolves around the dynamics of changing age pattern and the heterogeneity associated with changes. In this context, it is critical to understand the existing and future course of mortality, morbidity and longevity convergence patterns. However, there have been no such attempts to study the age patterns on the process of compression and decompression of mortality and morbidity.

Some studies have suggested that in state such as Kerala there is possibility that due to longevity increase there may be divergence in mortality rates and morbidity rates at older ages because of better treatment and health facility available to them. This pattern may follow in other states of India or more divergent or convergent pattern may emerge. Regional and geographical variation may bring out new facets of morbidity prevalence patterns and heterogeneity and frailty characterization in time.

From the above background, it is important to study the outcomes of mortality and morbidity transition with particular reference to the following anticipated patterns:

- Age pattern (U – shape) may converge to a flattening curve leading to the process of mortality compression
- Age pattern may result in dynamic and heterogeneous pattern across states and overtime
- Age patterns may further head from previous stage to compression and decompression stages
- Age pattern in morbidity may undergo similar transition from compression to decompression and again to compression stages
- The transitions may follow patterns similar to those developed countries, or may emerge as variants
- The changing pattern may lead to convergence between compressions in mortality and morbidity or may lead to more divergent patterns and corresponding implication for longevity
- Age pattern of mortality and morbidity may reveal sex differentials in terms of compression and decompression and may lead to variant patterns overtime

Mortality related studies are very limited in India and the issues of mortality and morbidity compression have not been addressed. It is therefore critical to examine and understand the changing patterns of mortality and morbidity which have implication for understanding the linkages of mortality, morbidity and longevity.

Objectives of the Study:

The following are specific objectives of the study:

1) To examine the rectangularization of survival curve over period of time
2) To study the patterns of compression and decompression of mortality for India and states
3) To examine the contribution of morbidity in compression and expansion of mortality pattern

Data and methodology:

This proposed study will use the following secondary data sources:

1) Census 1971-2001
2) SRS (1971-2006), SRS Abridged Life Table (1971-2006)
3) NSSO 42nd (1986 – 87), 52nd (1995 – 96) and 60th (2004) rounds

Methods of Analysis

Inter quartile Range (IQR) and Standard Deviation (SD)

Wilmoth and Horiuchi (1999) after measuring ten different measure to calculate the rectangularization and variability in age at death, have proposed IQR method because of its simplicity to calculate and easy interpretation. IQR is the difference between the ages where survival curves crosses 25th percentile and 75th percentile of age at death distribution. In this percentile range

50 percent deaths are concentrated. In summary, it is the distance between the lower and upper quartiles of the distribution of ages at death in life tables. Increase or decrease in variability of age at death can be measured through IQR, as age at death become less variable, this measure decreases.

Mathematically, the IQR at time 't'is given by

$IQR\ (t) = x_{75}\ (t) - x_{25}\ (t)$ where, $x_p\ (t)$ is the p^{th} percentile of the distribution of age at death.

Further, decomposition of IQR is given by

$$\Delta\ IQR\ (t_1, t_2) = \Delta x_{75}\ (t_1, t_2) - \Delta x_{25}\ (t_1, t_2)$$

This decomposition technique can be used for decomposing the change in IQR by age groups which can be measured in terms of differences in lower and upper quintile in the age group. Decomposition of IQR by age group gives positive and negative effect of IQR within two time periods and consequently, establishes the compression and decompression of the distribution of age at death.

Standard Deviation (SD) measures the standard deviation of the distribution of ages at death in a life table. As age at death become less variable, this variation decreases. Decrease in SD overtime will evidence the decreasing variance in age at death.

Contribution of Morbidity

To study the contribution of morbidity, diseases specific prevalence rate and risk ratio is calculated for respiratory diseases, cardiovascular diseases and disabilities due to locomotor, visual including blindness, speech and hearing and other diseases. Crude rate (Rothman, 2002) is calculated assuming sample as the exposed population.

Results and Discussion

Sample Registration System (SRS) gives information on age specific death rates (a.s.d.r) from 1971 to 2006 for India and major states. It is observed that a.s.d.r have decreased over time and thus evidencing flattening of mortality pattern. Analyses show that the mortality pattern is shifting outward after age 45 and above. The mortality pattern tends to be more flattening up to age group 40-44. Over period of time, the variability in age at death is found to be convex in nature. With decrease in variability there is an increase of 5.8 years in mean length of life and variability (SD) has decreased by 2.7 points in third quintile and 0.76 points in first quintile during 1969 to 2005. Compression of mortality is evidenced and in older ages there is expansion of mortality pattern with increase in life expectancy. Expansion is more in case for females. Further, with decline in mortality rates from 208 to 170 deaths per thousand and expanding outward during 1995 to 2005 in oldest age group, mortality patterns may follow sigmoid curve.