Examination of The Gaps of Life Expectancy at Birth in India: A Decomposition Study

Background

Globally the pace of life expectancy is very rapid but not uniform across the countries because large differentials in the pace of mortality decline exist between regions and within countries. The most popular measure of life expectancy is life expectancy at birth (LEB) which is often used as a tool which can measure the level and change in mortality of a population. It is also used for assessing trends in differentials of mortality. India, which is a diverse country in its own social and economic prospects, its previous pattern of improvement in mortality decline results in longevity that is more significant. The LEB in India increased from 49.7 years in 1970–1975 (RGI, 1984) to 66.1 years in 2006–2010 (RGI, 2012). This increase was more enjoyed by females than males. The LEB of males was higher in the 1970s and 1980s but LEB for females became higher in late 1990s in most of the states of India whereas (Dyson, 1984). In spite of the fact that the existence of higher child mortality and maternal mortality the Indian females surpassed males in expected life years at birth. This pace of increase in LEB was more prominent in rural than urban India (Singh, A., & Ladusingh, L., 2016). The pace of increase also differs in different Indian states since large dispersion exist in the pace and level of mortality (Bhat, 1987; Saikia, Jasilionis, Ram *et al*., 2011). These results and facts signifies that India is also diverse in its prevailing mortality conditions. Previous studies which examine the mortality conditions of India most of them discuss the differences in life expectancy between different subpopulations such as gender and rural-urban differences (James and Syamala 2010; Saikia et al. 2011; Sauvaget et al. 2011). But there are few studies which actually tried to analyze the contribution of improvement in age specific mortality to the change in the life expectancy (decomposition of the change) which is another way to examining and comparing the mortality conditions Saikia et al. 2011; Singh and Ram 2003; Singh and Ladusingh 2010). There are studies which attempted to decompose the sex differential in life expectancy and their results which are also cited in different studies but still they are few in numbers. Studies which decomposed the rural-urban residence differential in life expectancy are also rare. This study tried to fill those analytical gaps.

Research Question-

This study tried to address that how much changes does in age specific mortality contributes to the overall changes in LEB for various sub-groups of the population such gender and residence for India in selected years?

Data and Methods

The Sample Registration System (SRS), under the aegis of the Office of the Registrar General of India (RGI), which is considered the most reliable source of death statistics is the primary and continuous source of data on mortality and life tables in India. Starting in 1970, the SRS provides age-specific death rates (ASDR) and abridged life tables. Data on age-specific death rates, for the year 1991, 2001 and 2011 were used in this study. The SRS is a dual record system that maintains a continuous recording of vital events from a nationally representative sample of villages and urban blocks. An independent six-monthly survey by a senior supervisor helps to update vital events and demographic particulars of the sample population. Since appropriate literature is available which explains issues by using SRS life tables directly into the analysis which is also faced in the preliminary phase of our analysis. Hence, according to our research

question of this study we have reconstructed the life tables for the year 1991, 2001 and 2011 respectively for Indian men and women and rural-urban residence data, using ASDRs for the broad age groups (from 0–1, and 1–4 to 70 years and above extracted from SRS compendium (1971-2013). The rationale behind using SRS compendium is, since from the very start SRS provides mortality database (viz. ASDR and life tables) with the upper bound of age "*70 years and above"*, but from mid-nineties SRS changes its pattern and now currently it gives information with upper limit of age *"85 years and above"*. Contrary to this SRS compendium for the period (1971-2013) gives mortality data uniformly with upper limit of age *"70 years and above"* with five-year interval, which helped us to make our analysis in a synchronized order. The description of different methodologies with have been used for our analysis is discussed below.

Construction of life table-

For reconstruction of life tables for the required years we have used Chiang method (Chiang, C. L., 1979) which is a popular and frequently used method for this purpose. Under which $\boldsymbol{a}_{(x,x+n)}$ values are chosen *e.g.* for the age group 0-1, it equals to 0.3, for age group 1-4 it is taken as 0.4 and 0.5 for all other age groups. (Chiang, 1968; Rowland, 2003; Preston *et al*., 2001).

Decomposition of LEB difference-

To estimate the contribution of a change in mortality at each age group to the total change in (LEB) for the different population groups a decomposition method has been used given by Eduardo E. Arriaga (Arriaga, 1984) which is also known as Arriaga decomposition method. In Arriaga method, the gap produced in the LEB or any other age is explained by three effects:

1. ***Direct effect (DE)***

   The direct effect on life expectancy is due to the change in life years within a particular age group as a consequence of the mortality change in that age group

2. ***Indirect effect (IE)***

   The indirect effect consists of the number of life years added to a given life expectancy because the mortality change within (and only within) a specific age group will produce a change in the number of survivors at the end of the age interval. The difference in survivors (between those surviving before and after the mortality change) will be added to or subtracted from "years lived" (if the difference is positive or negative, respectively) as they pass through successive ages, assuming that mortality has not changed and remains at the same level.

   Addition of above two effects gives total effect that a change in mortality specifically only to that age group produces in the life expectancy.

3. ***Interaction effect (I)-***

   Both previous effects take into account only the mortality change at each age group, independent of the change in other ages. Since mortality changes simultaneously in all ages, a small part of the life expectancy change is due to the fact that the difference in the number of survivors at the end of the age interval (those responsible for the indirect effect) will not experience an unchanged mortality. The difference in mortality levels (unchanged and actual) applied to the difference in survivors (at the end of the group age interval) produces the interaction effect. This is the effect of the overall mortality change on life expectancy that cannot be explained by or assigned to particular age groups.

Preliminary Findings-

The contribution of mortality gender differentials at different age groups to the total gender differential in the LEB in 1991, 2001 and 2011

The results in table 1 showing the contribution of each age group the total gap in the LEB between males and females. In 1991 the total sex differential in LEB was almost equal to 1.44 years in which 50-69 age group is contributing the highest share to the sex differential in LEB which is, which approximately equal to 1.5 years. However, the age groups 1-4 and 5-14 try to reduce the gap of the gap in the LEB by 0.9 years. In 2001, the total sex differential in LEB is almost equal to 3.08 in which the age group with the highest contribution of 1.7 years approx. is again 50-69 age group as seen in 1991. The age groups 0-1, 1-4, and 5-14 were trying to reduce the sex differential in LEB by almost 0.6 years. In 2011, the total sex differential in LEB is approx. 4.8 years in which the highest contribution is again given by 50-69 age group with approx. 2.2 years. The age groups, which try to reduce the gap of LEB between males and females in 2011, are infant and child age groups with almost 0.6 years. This set of findings suggest the sex differential in LEB has increased over time and regardless of the time the age group less than 5 years of age trying to reduce the sex differential in LEB. Therefore, we can infer that females in India are still deprived in these age groups in comparison to males. At these ages where the prejudice against the female children is common and well documented in literature (Basu, Alka M. 1989). The adult age groups contribute more significantly the LEB differential in sex; it signifies that in Indian females are advantaged in adult ages in comparison to males (Singh, A., & Ladusingh, L., 2016).

The contribution of the rural-urban mortality differential at each age groups to the total rural-urban differential in the LEB in 1991, 2001, 2011

The results in table 2 showing the contribution of each age group the total gap between rural-urban LEB. In 1991 the total rural-urban differential in LEB was 5.8 years, and infant age group is contributed the highest share with almost 2.3 years. In 2001, the total rural-urban differential in LEB is almost 5.5 year, and the same pattern of contribution is there as seen in 1991, but the contribution is shifted slightly in later ages. The infant age group contributes the most with almost 2.1 years. In 2011 the similar pattern was apparent, but in 2011 the shifting of the contribution in total rural-urban differential to the later ages is more prominent than 2001. This set of findings suggest that the total differential in LEB by residence contributed mostly by mortality differential in 0-4 age group, however this contribution is slightly shifted to adult ages over the years and overall each age group is contributing positively. This result confirms with the finding that where the mortality is high, the reduction in child mortality can increase the life expectancy (Shkolnikov et al., 2011; Saikia et al., 2011).

Table 1: LEB for different population groups for selected years

GROUPS	Year			Gradient per year from 1991-2001	Gradient per year from 2001-2011
	1991	2001	2011		
Gender					
Male	59.17	62.78	66.49	0.36	0.37
Female	60.61	65.86	71.32	0.53	0.55
Residence					
Rural	59.05	63.04	67.44	0.40	0.44
Urban	64.84	68.52	72.75	0.37	0.42
Total Persons	59.82	64.21	68.7	0.44	0.45

Table 2: Contribution of mortality sex differential at different age groups to the total gap in LEB

Age	Direct Effect	Indirect+ Interaction effect	Total Effect	Percent of Total
		Year: 1991		
0-1	0.000	0.045	0.046	3
1-4	-0.028	-0.749	-0.777	-54
5-14	-0.012	-0.120	-0.132	-9
15-49	-0.072	0.370	0.298	21
50-69	0.731	0.776	1.507	105
70+	0.495	0.000	0.495	34
Total	**1.115**	**0.322**	**1.437**	**100**
		Year: 2001		
0-1	-0.003	-0.279	-0.281	-9
1-4	-0.010	-0.277	-0.287	-9
5-14	-0.007	-0.031	-0.038	-1
15-49	0.085	0.693	0.778	25
50-69	0.674	1.036	1.710	56
70+	1.196	0.000	1.196	39
Total	**1.935**	**1.143**	**3.078**	**100**
		Year: 2011		
0-1	-0.002	-0.234	-0.236	-4.89
1-4	-0.011	-0.327	-0.338	-6.99
5-14	0.000	0.014	0.014	0.30
15-49	0.400	1.283	1.683	34.82
50-69	0.835	1.362	2.197	45.46
70+	1.512	0.000	1.512	31.29
Total	**2.734**	**2.099**	**4.833**	**100**

Table 3: Contribution of different age groups to the total change in LEB by residence

Age	Direct Effect	Indirect+ Interaction effect	Total Effect	Percent of Total
		Year: 1991		
0-1	0.024	2.287	2.310	40
1-4	0.034	0.912	0.945	16
5-14	0.055	0.508	0.564	10
15-49	0.466	0.646	1.112	19
50-69	0.118	0.214	0.331	6
70+	0.526	0.000	0.526	9
Total	**1.223**	**4.566**	**5.789**	**100**
		Year: 2001		
0-1	0.021	2.115	2.136	39
1-4	0.03	0.848	0.879	16
5-14	0.038	0.374	0.412	8
15-49	0.515	0.723	1.238	23
50-69	0.134	0.248	0.382	7
70+	0.437	0.000	0.437	8
Total	**1.174**	**4.309**	**5.483**	**100**
		Year: 2011		
0-1	0.013	1.406	1.419	27
1-4	0.016	0.468	0.484	9
5-14	0.026	0.282	0.308	6
15-49	0.311	0.595	0.906	17
50-69	0.356	0.836	1.191	22
70+	1.004	0.000	1.004	19
Total	**1.725**	**3.586**	**5.312**	**100**

References-

Office of the Registrar General (ORG). (1984). *SRS based abridged life tables 1970–1975, Census of India 1981*, occasional papers No. 1 of 1984. New Delhi, India: Office of the Registrar General

Registrar General of India (RGI). (2012). *SRS based abridged life tables 2003–2007 to 2006–2010*. New Delhi, India: Office of the Registrar General

Dyson T. (1984). Excess male mortality in India. *Economic and Political Weekly*, 19(10): 422–426.

Singh, A., & Ladusingh, L. (2016). Measuring early life disparity in India. *Journal of biosocial science*, *48*(4), 457-471

Bhat PNM. (1987). *Mortality in India: levels, trends and patterns* (Thesis). University of Pennsylvania.

Saikia N, Jasilionis D, Ram F, *et al*. (2011). Trends and geographic differentials in mortality under age 60 in India. *Population Studies*, 65(1): 73–89.

James, K. S., & Syamala, T. S. (2010). Income, income inequality and mortality: an empirical investigation of the relationship in India, 1971-2003. The institute for social and economic change, working paper (p. 249).

Sauvaget, C., Ramadas, K., Fayette, J.-M., Thomas, G., Thara, S., & Sankaranarayanan, R. (2011). Socio-economic factors & longevity in a cohort of Kerala State, India. Indian Journal of Medical Research, 133(5), 479–486.

Singh, A., & Ladusingh, L. (2010). Increasing life expectancy and convergence of age at death in India. Genus, 69(1), 83–99.

Singh, A., & Ram, F. (2003). Gender differentials in mortality in India. Demography India, 32(2), 275–291

Chiang CL (1968). An Introduction to Stochastic Processes in Biostatistics. New York: Wiley.

Chiang, C. L., & World Health Organization. (1979). Life table and mortality analysis.

Rowland D (2003). Demographic methods and concepts. Chapter 8. Oxford University Press.

Preston S, Heuveline P and Guillot M (2001). Demography: Measuring and Modeling Population Processes. Chapter 3. Wiley-Blackwell

Arriaga, E. E. (1984). Measuring and explaining the change in life expectancies. *Demography*, *21*(1), 83-96.

Basu, A. M. (1989). Is discrimination in food really necessary for explaining sex differentials in childhood mortality? *Population studies*, *43*(2), 193-210