Life Expectancy at Birth at District level in India (2011)

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ABSTRACT

Life expectancy at birth (LEB) is not only a summary measure of mortality but also an accepted indicator for the development of a country. The estimates of expectation of life at birth are provided by the Sample Registration System (SRS) only at the national level and major states. However, the estimates of LEB at the district level are not available. Due to an insufficiency of vital and demographic data, life expectancy is difficult to estimate in the district. Thus, the technique of indirect estimation is the only way to estimate life expectancy at birth at the district level. Analyzed results revealed that for males (females) 18 (11) % of the districts have LEB below 60 years, 20(27) % between 60-65 years and 30 (62) % above 65 years amongst the 190 districts of the selected states of India. It is believed that the findings of the result will also help the policy makers to formulate various effective programmes in reducing the mortality rates for those districts with less LEB.

Keywords: district, indirect estimation, regression, life expectancy at birth, India.

INTRODUCTION:

Since 1970, both genders have experienced a continuous rise in life expectancy in a developing country like India (Romo and Saikia, 2013). One of the most remarkable achievements of modern societies is the widespread reduction in mortality that has occurred over the past two centuries (Bongaarts, 2014). Changes in mortality levels by age and sex can have a major effect on changes in life expectancy (www.statistics.gov). The summary indicator most widely used to describe the health of a population since 1920's and 1930's is life expectancy at birth (LEB) (Romo and Becker, 2011). LEB is not only a summary measure of mortality but also an accepted indicator for the development of a country (Singh and Ladusingh, 2016). In particular, LEB is the estimated number of years a newborn can be expected to live given the prevailing mortality rates in the population, and it is closely related to biological, environmental and social determinants of health (Zhang and Rasali, 2015). There is massive evidence that life expectancy is distributed very unequally among the countries (Smiths and Monden, 2007). Worldwide, since mid-2000 for the first time in human history, women enjoyed longer LEB than men (Bardford, 2006). Although there are several alternative methods to derive the life expectancy, the most reliable means suggest the construction of life tables (Ranjana, 2015).Construction of life table requires information on age-specific deaths and population age distribution (Sarma and Choudhury, 2014). But the registration of deaths is not satisfactory unfortunately in India and hence the procedure cannot be adopted (Malaker 1986; Bhat 1987). Several international agencies and other demographic centres routinely prepare national mortality estimates or life table compilations as part of their focus on sectoral monitoring (Lopez et.al, 2000). In a developing country like India, the estimates of LEB are provided by the Sample Registration System (SRS). Additionally, SRS also furnishes the LEB estimates for the 16 major states. However, the estimates of LEB at the district level are not available. Due to an insufficiency of vital and demographic data, life expectancy is difficult to estimate in the district. Thus, the technique of indirect estimation is the only way to estimate life expectancy at the district level. In small areas, especially in developing countries, due to non-availability of reliable death registration data, estimation of life expectancy is a challenge for the demographers and public health planners (Barman and Choudhury, 2017). Demographically, India is a very diverse country and there are variations in basic demographic indicators not only across states but also at the districts (Kapoor, 2010). The Government of India and the state governments monitor the progress of implementation of most of the developmental activities at the district level

(Bhalotra, 2007).Therefore, information on district level LEB may be helpful to the state health departments in building the necessary infrastructure and obtaining the required human resources at the district level (Sarma and Choudhury, 2014). The latest estimates of life expectancy at the national and state level are available through SRS reports but estimates of LEB at the district level are very limited. Choudhury and Sarma (2014) provide the LEB estimates for the districts of Assam and some of the selected major states covered by the Annual Health Survey based on the years 2001 and 2010.Since then there has been no attempt to estimate LEB at the district level, hence largely insignificant for development planning and programming.

Various indirect techniques are used for the estimation of life expectancy at birth depending on the source of availability of data. The techniques are namely (1) Stable population concept (2) Biological theories of ageing (3) Age distribution of population (4) Widowhood status and (5) Regression approach (Sarma and Choudhury, 2014).The method of regression is the most suitable amongst all the methods mentioned for the estimation of expectation of life at birth at the district level as it depends upon limited data and the assumptions are not much demanded like other methods (Pathak and Singh, 1992). Swanson (1989) established a regression model for estimating life expectancy based on sub-national level data on crude death rates (CDR) and percentage of the population aged 65 years and above [P(65+)] in the United States. But the data on CDR at the district level published by the Annual Health Survey are not feasible. So, to fulfil the goal of the paper, the method developed by Sarma and Choudhury (2014) is used in the present study. Out of 640 districts based on 2011 census, the LEB for 190 districts of the selected states is estimated in this study.

OBJECTIVES:

In the present study, an attempt has been made

1. To estimate the life expectancy at birth at the district level of the selected states representing various zones of India namely Assam from the North East, Gujarat from the West, Kerala from the South, Rajasthan from the North, Uttar Pradesh from the Central and West Bengal from the East respectively based on the period 2011 for both the sexes.

2. To compare the highest LEB found at the district level of the selected state of India with the LEB for the districts of Sri Lanka for both the sexes for the period 2011.

METHODOLOGY AND DATA:

In a life table, the function $l(x,t)$ describes the number of survivors at age x and at time t then the life expectancy in terms of survival function at age x and at time t is given by

$$e_x(t) = \frac{\int_x^\varpi l(a,t)da}{l(x,t)}$$

where ϖ represents the highest age attained by a member of the population. If the radix of the life table be equal to 1 i.e., $l(0,t)=1$ then

$$e_0(t) = \int_0^\varpi l(a,t)da$$

$$= \int_0^1 l(a,t)da + \int_1^\varpi l(a,t)da$$

where the first term denotes the person years lived between birth and age one and the second term represents the product of life expectancy at age one by the number of survivors at age one respectively.

$$e_0(t) = {}_1L_0 + e_1(t)l_1(t) \tag{1}$$

where $l_1(t) = l(0,t) - {}_1d_0(t) = 1 - q(1)$, since $l(0,t) = l_0 = 1$.

Generally, ${}_1L_0$ is assumed to be a linear function of ${}_1l_0$ i.e.,

$${}_1L_0 = a + bl_1 \text{ where } a = 0.276, b = 0.724$$

Now, by assuming e_1 as a linear function of l_1 we get e_0 to be a quadratic function of l_1 i.e.,

$$e_0 = a + bl_1 + (c + dl_1)l_1$$

$$= a + (b+c)l_1 + dl_1^2$$

The values of l_1 has been calculated by using a Brass method.

The databases used in this study are Census of India and Sample Registration System. For estimation of l_1 necessary data are Children Ever Born (CEB) and Children Surviving (CS) at the district level which is available only in Tables F3 and F5 Census Tables of Census Digital Library. The SRS based Abridged Life Tables covering a period of more than 30 years i.e., from the period 1970-75 to 2009-13 has been used to establish a relationship between e_0 and l_1 by taking e_0 as the independent variable and l_1 as the dependent variable. From the relationship between e_0 and l_1 one can estimate the district-wise estimates of e_0 (Sarma and Choudhury, 2014).

The obtained estimated equations between e_0 and l_1 for the selected states for both the sexes along with R^2 are represented in Table 1.

Table 1: **Estimated equation by the regression method for estimating LEB $\left(e_0^0\right)$**

States	Sex	Equations	R^2
1.Assam	Male	$-957.485-2034.809*l_1-1012.333*l_1^2$	0.952
	Female	$107.291-389.265*l_1+364.840*l_1^2$	0.936
2.Gujarat	Male	$1041.017-2314.856*l_1+1355.650*l_1^2$	0.978
	Female	$2999.638-6601.348*l_1+370.111*l_1^2$	0.901
3.Kerala	Male	$-36.591+109.829*l_1^2$	0.870
	Female	$-72.914+152.836*l_1^2$	0.825
4.Rajasthan	Male	$-176.763+272.578*l_1-14.835*l_1^2$	0.936
	Female	$328.012-893.677*l_1+661.709*l_1^2$	0.930
5.Uttar Pradesh	Male	$108.121-272.689*l_1+239.801*l_1^2$	0.970
	Female	$622.183-1486.593*l_1+954.016*l_1^2$	0.970
6.West Bengal	Male	$-113.550+187.912*l_1$	0.962
	Female	$-200.761+281.550*l_1$	0.979

RESULTS AND DISCUSSION:

The following table (Table 2) presents the estimates of LEB at the district level of the selected states for both the sexes along with the percentages of a number of districts falling under different intervals viz., below 60 years, 60-65 years and over 65 years based on 2011 census data.

Table 2: Sex-wise highest and lowest values of LEB at the district level of the selected states along with the percentage of a number of districts falling under different intervals, 2011.

States	Number of Districts	Sex	Districts with		Percentage of number of districts with		
			Highest	Lowest	<60 years	60-65 years	>65 years
Assam	27	Male	Tinsukia (62.08)	Dhubri (57.97)	33%	66.67%	0
		Female	Kamrup Metropolitan (68.27)	Dhubri (59.05)	11.11%	48.14%	40.74%
Gujarat	26	Male	Surendranagar (66.16)	Dohad (59.29)	7.69%	76.92%	15.38%
		Female	Surendranagar (74.15)	Dohad (64.49)	0	3.85%	96.15%
Kerala	14	Male	Palakkad (68.88)	Alappuzha (66.61)	0	0	100%
		Female	Palakkad (72.04)	Alappuzha (69.96)	0	0	100%
Rajasthan	33	Male	Kota (67.66)	Banswara (54.59)	15.15%	51.51%	33%
		Female	Jaipur (71.03)	Banswara (60.58)	0	3.03%	96.96%
Uttar Pradesh	71	Male	Lalitpur (66.87)	Bara Banki (54.56)	25.76%	73.23%	1.40%
		Female	Jalaun (68.06)	Shrawasti (57.84)	23.94%	52.11%	23.94%
West Bengal	19	Male	Bankura (67.44)	Uttar Dinajpur (63.57)	0	26.31%	73.68%
		Female	Bankura (71.02)	Uttar Dinajpur (65.97)	0	0	100%
Total	190	Male	Palakkad (68.88)	Bara Banki (54.56)	18%	20%	30%
		Female	Palakkad (72.04)	Shrawasti (57.84)	11%	27%%	62%

The above table depicts that out of 27 districts of Assam, highest LEB is found in Tinsukia district with 62.08 years among the males while Kamrup Metropolitan district occurs the

highest position amongst the females with 68.27 years. Lowest LEB is found in Dhubri district for both the sexes with 57.97 years (males) and 59.05 years (females) respectively. In Gujarat amongst the 14 districts, Surendranagar district prevailed the highest position with 66.16 years for males and 74.15 years for females respectively while Dohad district is in the lowest position for both the sexes with 59.29 years (males) and 64.49 years (females).

Amongst the 14 districts of Kerala, Palakkad district prevailed the highest position for both the sexes with 68.88 years for males while in the case of females, the corresponding figure is 72.04 years. The lowest male LEB is found in Alappuzha with 66.61 years .Similar situation is also found amongst the females with 69.96 years. In Rajasthan out of 33 districts, highest male LEB is found in Kota district with 67.66 years and the lowest is seen in Banswara district with 54.59 years. The female LEB is the highest in Jaipur district with 71.03 years and lowest occurred in Banswara district with 60.58 years respectively.

In Uttar Pradesh, out of the 71 districts, Lalitpur district is the highest in terms of male LEB with 66.87 years and in Jalaun district, the highest among the females with 68.06 years. The lowest male LEB is found in Bara Banki district with 54.56 years and female LEB is seen in Shrawasti district with 57.84 years. Finally, amongst the 19 districts of West Bengal, it is found that highest LEB is found in Bankura district for both the sexes with 67.44 years for males and 71.02 years for females while the lowest male LEB is found in Uttar Dinajpur with 63.57 years. The lowest female LEB is also found in the similar district with 65.97 years respectively.

Table 2 also reveals that among the 190 districts of the selected states highest male expectation of life at birth prevailed in Pallakad district of Kerala for both the sexes. The corresponding figures are 68.88 years for males and 72.04 years for females. The lowest LEB occurred in Bara Banki district with 54.56 years for males while in case of females, the lowest figure prevailed in Shrawasti district of Uttar Pradesh with 57.84 years. The above table also depicts that for males Assam has the highest percentage (33%) of the districts whose LEB is below 60 years followed by Uttar Pradesh (26.76%) and West Bengal (18%). But in the case of females, in Uttar Pradesh, the highest percentage of districts falls in this category followed by Assam (11.11%). No district of Kerala has been found in this category for both the sexes. In the range 60-65, Gujarat has the highest percentage (76.92%) of districts amongst the males followed by Uttar Pradesh (73.23%) and Assam (67.76%). Only 20 percent of the districts in West Bengal are found to belong in this category. Amongst the females, districts of Uttar

Pradesh showed the highest percentage belonging to this category. The percentage of districts falling in this category for Gujarat and Rajasthan are very low. In the range of above 65 years, only the districts of Kerala found to be the highest for both the sexes. The lowest percentage of districts falling in this category is found in the districts of Uttar Pradesh with 1.40 % then followed by the districts of West Bengal with 30 % amongst the males. The most salient feature is that none of the districts of Assam has been fallen in this category. Comparing the district -wise estimates of the selected states, only all the districts of Kerala showed an appreciable estimate for both the sexes. Also, most of the districts of Rajasthan had the highest percentage (96.96%) of LEB amongst the females then followed by the districts of Gujarat with 96.15 % in this category. Analyzed results revealed that for males (females) 18 (11) % of the districts have LEB below 60 years, 20(27) % between 60-65 years and 30 (62) % above 65 years amongst the 190 districts of the selected states of India. It is observed that all the districts of Kerala had achieved the average number of survival years above 65 years for both the sexes. The situation is worst among the districts of Uttar Pradesh and Rajasthan as in many districts; survival number of years is less than 60 years.

On the other hand, life expectancy figures for Sri Lanka for both the sexes has increased substantially with the corresponding figures for both less developed countries as well as for South Central Asian region (www.statistics.gov.lk/PopHouSat/Life%20Table%20Report). In India, Kerala is the only state which has achieved demographic characteristics like that of developed countries marked by high life expectancy at birth, low mortality, below replacement level and high literacy (Sarma and Choudhury, 2013).So in the study, the estimates of LEB for the districts of Kerala are compared with the proposed estimates of districts of Sri Lanka to bring out a present scenario prevailing in the districts of India. The figures of LEB for the 14 districts of Kerala and 25 districts of Sri Lanka for both the sexes are given in the following table.

Table 3: **Comparison of LEB between the districts of Kerala (India) and Sri Lanka for the period 2011 for both males and females.**

	Sri Lanka			Kerala		
	LEB $\left(e_0^0\right)$			**LEB** $\left(e_0^0\right)$		
Sl.no	**Districts**	**Male**	**Female**	**Districts**	**Male**	**Female**
1	Colombo	73.0	78.5	Kasaragod	68.01	72.3
2	Gampaha	73.2	79.9	Kannur	68.46	73
3	Kalutara	73.2	79.7	Wayanad	68.25	69.66

4	Kandy	71.9	77.8	Kozhikode	67.43	65.81
5	Matale	71.8	78.5	Malappuram	68.57	72.14
6	Nuwara Eliya	70.2	75.9	Palakkad	68.88	72.04
7	Galle	73.1	79.9	Thrissur	68.88	71.37
8	Matara	73.9	80.2	Ernakulam	68.24	71.89
9	Hambantota	74.2	79.8	Idukki	68.04	70.41
10	Jaffna	69.8	76.8	Kottayam	67.59	70.48
11	Mannar	70.0	77.0	Alappuzha	66.61	69.96
12	Vavuniya	67.8	76.7	.Pathanamthitta	66.58	70.26
13	Mullaitivu	60.9	72.9	Kollam	66.75	70.15
14	Killinochchi	64.5	74.1	Thiruvananthapuram	67.21	69.45
15	Batticaloa	66.8	76.9	NA	----	----
16	Ampara	71.5	81.1	NA	----	----
17	Trincomalee	72.1	78.3	NA	----	----
18	Kurunegala	71.6	78.6	NA	----	----
19	Puttalam	70.7	78.6	NA	----	----
20	Anuradhapura	70.5	77.8	NA	----	----
21	Polonnaruwa	70.0	77.7	NA	----	----
22	Badulla	71.2	77.7	NA	----	----
23	Moneragala	73.7	79.4	NA	----	----
24	Ratnapura	73.7	78.7	NA	----	----
25	Kegalle	72.3	79.5	NA	----	----

Source: *LEB figures for the districts of Sri Lanka for both males and females are taken from Life Tables for Sri Lanka 2011-13 published by Department of Census and Statistics, Ministry of National Policies and Economic Affairs.*

The above table (Table 3) depicts that females have a higher number of survival years as compared to male counterparts in all the districts of Kerala except the district Kozhikode while in Sri Lanka all the districts have higher LEB for females than males. Comparing the district-wise LEB figures amongst the males for Kerala and Sri Lanka, it is found that 12% of the districts of Sri Lanka is less than the district with having less value of LEB in Kerala. But in the case of females, it is noteworthy to mention that all the districts of Sri Lanka have exceeded the LEB figures of the districts of Kerala. In Kerala, the highest LEB occurred in Kannur district with 73 years but the highest figure for districts of Sri Lanka occurred in the district Ampara with 81.1 years. There is also a huge gap (8.1 years) between the two districts. In Sri Lanka, the lowest value occurred in Mullaitivu with 72.9 years. The difference between the highest district of Kerala and lowest district of Sri Lanka is by only 0.1 years. So, although Kerala is the most socially developed state of India but if we compare the district-wise figures of Kerala and Sri

Lanka, Kerala is found to be lagging behind. Figure (a) and Figure (b) shows the LEB values for the districts of Kerala and Sri Lanka by sex.

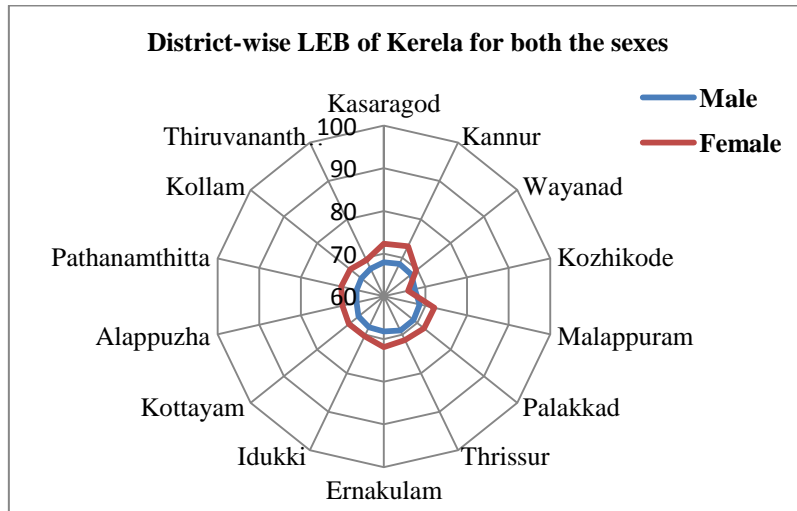**Figure1: Sex-wise Life expectancy at birth for the districts of Kerala (India) and Sri Lanka**
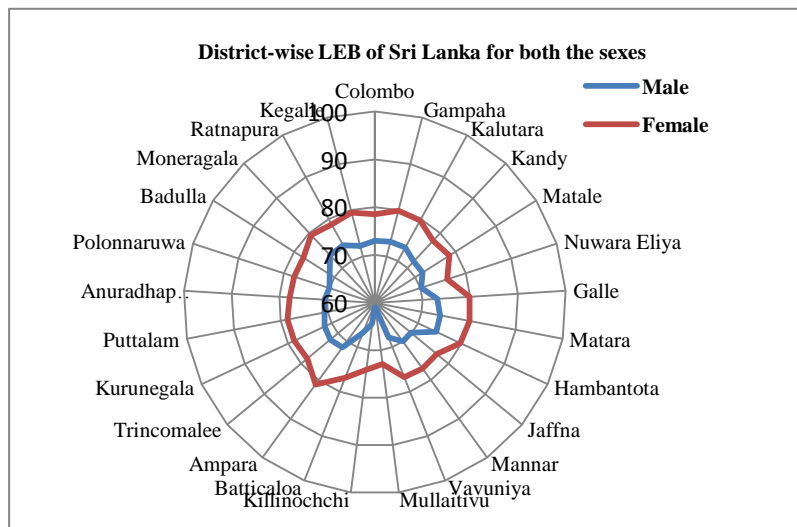

Figure (a): District-wise LEB for Kerala

Figure (b): District-wise LEB for Sri Lanka.

Comparing Figure (a) and Figure (b), the striking feature is that difference between male and female life expectancy is higher in the districts of Sri Lanka as compared to the districts of Kerala. The highest male-female difference occurred in Mullaitivu district with a gap of 12 years and lowest occurred in Ratnapura district with 5 years. On the other hand, in Kerala Ernakulam district showed the highest difference and Wayanad district the least with 3.65 years and 1.41 years respectively.

CONCLUSION:

Due to a scarcity of data, LEB has been estimated by an indirect method. The district-wise estimates showed that most of the LEB figures for the districts of the selected states except Kerala are not at all up to the mark as they are found to be below 60 years. Huge interventions and policies should be highly focussed especially for those districts. The results also showed the disparity prevailing in the districts of India in terms of LEB. It is believed that the findings of the result will also help the policy makers to formulate various effective programmes in reducing the mortality rates for those districts with less LEB.

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