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Research Article

ESTIMATION OF LIFE EXPECTANCY FOR ASSAM: A SIMULATION BASE STUDY

Karuna Gogoi and Manash Pratim Barman*

Department of Statistics, Dibrugarh University, Assam, India

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ABSTRACT

Life expectancy is a key characteristic of human longevity and development and different policies are formulated worldwide including India to increase it. Life expectancy at birth and at age sixty plays a pivotal role in policy making and determining human development index and gender development index. In this research paper the researcher estimated the life expectancy of Assam using simulation technique and done an in-depth analysis on it. For comparison purpose the life expectancy of India is also estimated using the same procedure. Chiang method of abridged life table having 85+ open ends with five year age interval is used to estimate the life expectancies. Normality of estimated life expectancies is tested by using Kolmogorov-Smirnov and Shapiro-Wilk test. Life expectancy at birth is found as 68.88 (95% CI from 68.66 to 69.10) years and 71.76 (95% CI from 71.49 to 72.03) years for Assam and India respectively. Life expectancy at age sixty of Assam shows 0.69 years less than national level having 20.85 years and 21.54 years respectively. Although life expectancy of Assam seems to be improved over time but it is less satisfactory in comparison to the national level. High maternal and infant mortality rates, low level of immunization coverage may be the some causes of not up to scratch life expectancy of Assam

INTRODUCTION

Life expectancy is one of the most important indicators for assessing the health of a community or a country. Life expectancy of a country is directly related to the different health care improvements conducted in the country such as new vaccines, new discovery of drugs, change of life style of people etc. It is a synthetic measure of mortality which allows for comparison over time and between different communities and countries eliminating the effect of age structure of the population. Life expectancy is used as a component to estimate different health indicators, viz., Human Development Index, Gender Development Index etc. The expected number of years to be lived by a person or organism on the average at a particular time is termed as life expectancy. It is a Statistical measure, which determines how long the organism will survive, based on different factors like birth year and other demographic factors including gender, socio-economic status etc. The observed expectancy of life at a given age is the sample mean lifetime of an individual's (of age x) exposed to the same mortality conditions until they die. Life expectancy is regard as an unbiased estimate of the corresponding unknown true expectation of life. Mathematically, the average remaining lifetime (in years) for a person, who survive to the beginning of the indicated age interval is the life expectancy. Life expectancy at birth (e_x^0) is the most commonly used measure which can be defined in two ways. First, cohort life expectancy at birth ,which is the mean length of life of an actual birth cohort (all individuals born a given year) and can be computed only for cohorts that were born many decades ago, so that all their members died. Second period life expectancy at birth is the mean length of life of a hypothetical cohort assumed to be exposed since birth until death of all their members to the mortality rates observed at a given year. Life expectancy varies, for different geographical area, sex and other demographic factors. Significantly lowers life expectancy at birth was due to different health and social problems. But for those who survive early hazards, a life expectancy of sixty or seventy would not be uncommon. A widely used indicator of overall development of a country is life expectancy at birth. Improvement of life expectancy can be achieve by socio-economic progress through investing significantly on social sector like health, education, sanitation, environmental management and sustainability and social safety net (Kabir M., 2008). Incidence of poverty, nutrition, adult literacy, access to safe drinking water, burden of disease, level of urbanization and sanitation has direct impact on life expectancy.

A REVIEW OF LITERATURE

Recently many studies have devoted to estimate and project life expectancy at national as well as sub-national level. McCann

Corresponding author:* **Manash Pratim Barman
Department of Statistics Dibrugarh University, Assam, India

C. J. (1976) proposed a method for estimating life expectancy at birth on the basis of crude vital rates. The method was derived from stable population theory and it yielded better estimate than other methods exist. The method is useful for estimating life expectancy for developing countries where good sample registration system is available but age reporting is in poor quality. Swanson (1989) applied regression model for estimating life expectancy for sub-national area. An additional test shows the sensitivity of the model's accuracy to errors on one of its input data elements. The results suggest that the model should be given serious consideration for generating life expectancy estimates for sub-state area. Silcock *et al.* (2001) estimated life expectancy for small area in context of UK by generating computer simulated data. The researchers investigate the sampling distribution and usefulness of expectation of life in comparison of mortality at health district level or below. The researchers developed a computer BASIC program to generate the required data in Monte Carlo simulation method and for the sampling distribution of the estimated life expectancy. Yadava *et al.* (2003) estimated indirectly infant and child mortality rate by using the technique of regression line analysis. Scherbov *et al.* (2011) studied the bias, standard errors and distribution characteristics of life tables for small population. Monte Carlo simulation technique was used to generate the needed data by formulating program in R-software. Stoeldraijer *et al.* (2013) reviewed different methods of mortality forecasting with their assumptions for Europe and assess their impact on projection of future life expectancy for Netherlands. Theoretical considerations and simulations show that statistical efficiency of different methods is affected by population size Sarma *et al.* (2014) estimated the life expectancy indirectly for the major districts of India. They used the data from Coale-Demeney West model life table, United Nations South Asian model life tables and SRS life table of India and its major states for estimating the life expectancy at birth. Kesarwani (2015) estimated the life expectancies for all the major districts of India by using regression method. The researcher extended the open end to 100+ and demonstrated the results in compacts manner. The life expectancy at age 0, 15 and 60 was estimated indirectly by using computer software packages.

Objective

In this research work the researcher attempts to estimate the life expectancy of Assam. For this the researcher generates age-specific mortality data considering prior information from Sample Registration System report, 2012. To estimate the life expectancy life tables are constructed based on the generated data.

METHODOLOGY

For estimating life expectancy one needs to construct life table. The primary information needed for constructing life table is the mortality data. In this paper the age specific mortality count are first generated through simulation process. For the purpose of simulation, a computer program is developed in 'R' (Bank J. *et al.*, 2015; Braun *et al.*, 2007). The simulation process is conducted on the assumption that deaths are binomially distributed (Chiang, 1987). The prior information which facilitates the simulation process is taken for Sample Registration System Report, 2012. The simulation process generates 10,000 death counts for each age group considered for constructing the abridge life table. The simulation process is again repeated 100 times and for each repetition, life expectations are estimated by constructing abridge life table. The abridge life tables are constructed by using Chiang method. The repeated construction of life tables helps us to estimate errors and facilitates the 95% confidence interval. The process of construction of life table is done in MS-Excel. The abridge life tables so constructed is of five year age group having 19 class intervals. The open age interval of the life table is 85 years and above. The same process is repeated for estimating life expectancies for male and female separately. Life expectancies are also constructed at national level for comparison purpose. The normality of the estimated life expectancies is tested by using Kolmogorov-Smirnova and Shapiro-Wilk test.

FINDINGS AND DISCUSSION

Infant Mortality rate is one of the major determinants of life expectancy. The infant and child mortality scenario of Assam is not at a satisfactory level as compared to the National level which is shown in the figure 1.

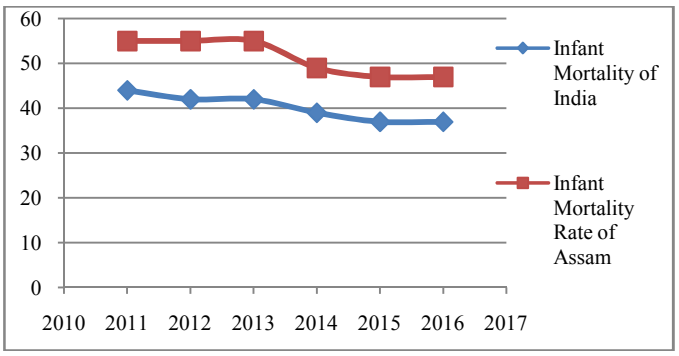

Figure 1 Infant Mortality Rate Trend of Assam and India for the period 2010-2016 (Source: SRS Reports)

Estimated Life expectancy

The mean life expectancy and its 95% confidence interval of Assam for the year 2012 are given in the Table 1.

Table 1 Estimated life expectancy of Assam for the year 2012

age group	life expectancy	variance of L.E.	S.E. of L.E.	95% confidence interval	
				lower limit	upper limit
<1	68.88	0.012	0.113	68.66	69.10
1-4	71.64	0.014	0.119	71.41	71.88
5-9	69.05	0.014	0.121	68.81	69.29
10-14	64.39	0.014	0.122	64.15	64.63
15-19	59.70	0.015	0.123	59.46	59.94
20-24	55.09	0.016	0.128	54.84	55.35
25-29	50.57	0.016	0.129	50.32	50.83
30-34	45.98	0.017	0.130	45.73	46.24
35-39	41.53	0.017	0.132	41.27	41.79
40-44	37.18	0.018	0.134	36.91	37.44
45-49	32.75	0.018	0.137	32.48	33.02
50-54	28.75	0.017	0.132	28.49	29.00
55-59	23.88	0.008	0.089	23.71	24.06
60-64	20.85	0.010	0.100	20.65	21.04
65-69	17.53	0.012	0.113	17.31	17.76
70-74	14.40	0.005	0.073	14.26	14.55
75-79	11.09	0.000	0.000	11.09	11.09
80-84	8.77	0.000	0.000	8.77	8.77
85+	4.65	0.000	0.001	4.65	4.66

From the table 1 it can be observed that the life expectancy at birth of Assam is 68.89 years with 95% confidence interval 68.66 years and 69.10 years. At age one the life expectancy shows higher than the life expectancy at birth having 71.26 years. The life expectancy at infancy period is less due to expose to variety of disease. The life expectancy of Assam at age 60 is 20.85 years with 95% confidence interval 20.65years and 21.04 years. The life expectancy at age 85+is 4.65 years with confidence interval 4.65 years and 4.66 years. The probability of death is higher during the infancy period. Table 1 shows that in the second age group (i.e. 1-4) the life expectancy is higher that the life expectancy at birth. Thereafter, it decreases gradually and at the open end age group (85+) it stops where all people must die. In Figure 2 the values of q_x (probability of death at age x) are plotted for Assam.

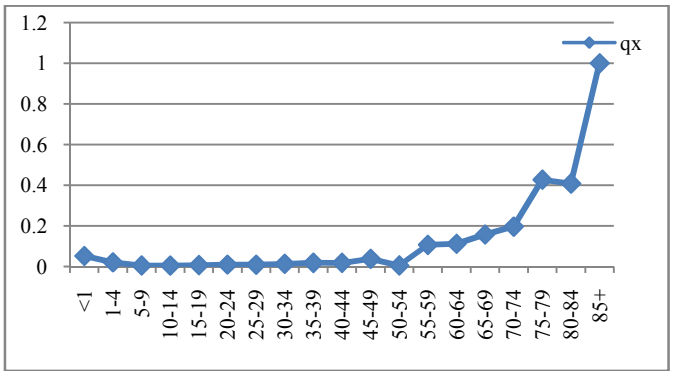

Figure 2 Curve showing probability of death for the population of Assam

The figure shows the probability of death at each age-group (q_x). The pivotal column of life table shows that the probability of deathis rapidly increasing with the increase of the age. At the age 55 the probability of death is drastically change with a high increasing rate. For the open end the probability of death is certain event i.e., it is certain that all the participant of the class interval will die in a finite time interval.

Table 2 Estimated Life Expectancy of Male, Female and Overall population of Assam for the Year 2012

age group	Overall Life Expectancy	life expectancy for female	life expectancy for Male
<1	68.88	70.27	66.29
1-4	71.64	73.08	68.81
5-9	69.05	70.74	65.82
10-14	64.39	66.25	62.54
15-19	59.70	61.37	58.01
20-24	55.09	57.10	53.75
25-29	50.57	52.47	49.35
30-34	45.98	47.83	44.79
35-39	41.53	43.14	40.50
40-44	37.18	38.80	36.11
45-49	32.75	34.07	31.86
50-54	28.75	29.61	28.10
55-59	23.88	25.28	23.62
60-64	20.85	21.84	20.05
65-69	17.53	18.41	16.83
70-74	14.40	14.91	14.03
75-79	11.09	11.74	10.63
80-84	8.77	9.61	8.20
85+	4.65	5.72	3.82

Estimated life expectancy of male and female for the year 2012 is 66.29 years and 70.27 years respectively. The difference between male and female life expectancy at birth is 3.98 years and at age sixty (60) is 1.79 years.

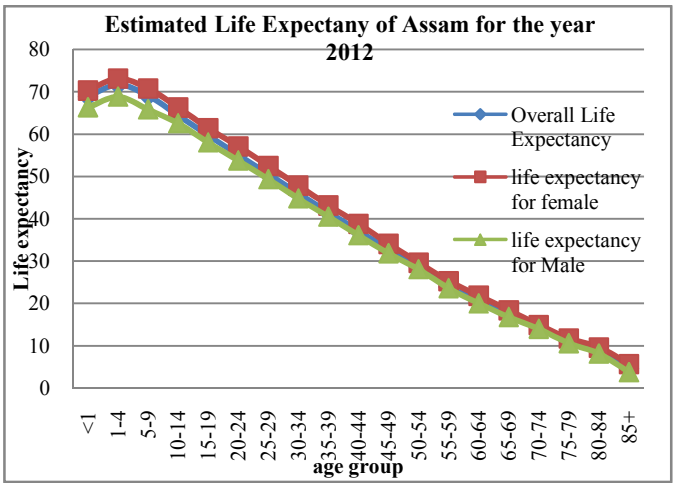

Figure 3 Estimated Life Expectancy of Male, Female and Overall population of Assam for the Year 2012

Table 3 Estimated life expectancies of India for the year 2012

Age group	Expectation of Life (e_x)	var(e_x)	SE(e_x)	95% confidence interval	
				Lower limit	Upper limit
<1	71.76	0.0185	0.136325	71.499	72.034
1-4	73.80	0.0178	0.133791	73.545	74.070
5-9	70.51	0.0159	0.126452	70.269	70.765
10-14	65.83	0.0149	0.122157	65.595	66.074
15-19	61.03	0.0142	0.119557	60.802	61.271
20-24	56.32	0.0134	0.116019	56.102	56.557
25-29	51.77	0.0123	0.110975	51.552	51.987
30-34	47.16	0.0113	0.106663	46.959	47.377
35-39	42.58	0.0104	0.102466	42.383	42.785
40-44	38.07	0.0095	0.097878	37.886	38.270
45-49	33.68	0.0086	0.092789	33.498	33.862
50-54	29.43	0.0075	0.086989	29.268	29.609
55-59	25.33	0.0065	0.080859	25.176	25.493
60-64	21.54	0.0054	0.073557	21.398	21.687
65-69	18.12	0.0042	0.064931	17.994	18.249
70-74	15.03	0.0030	0.054894	14.931	15.147
75-79	12.18	0.0018	0.042664	12.104	12.271
80-84	9.11	0.0007	0.027252	9.066	9.173
85+	5.20	0.00000	--	--	--

Estimated life expectancy of India and Assam shows that (From table 2 and table 3) the national scenario is better than the state. The life expectancy of Assam at birth is 68.88 years whereas for India it is 71.72 years.

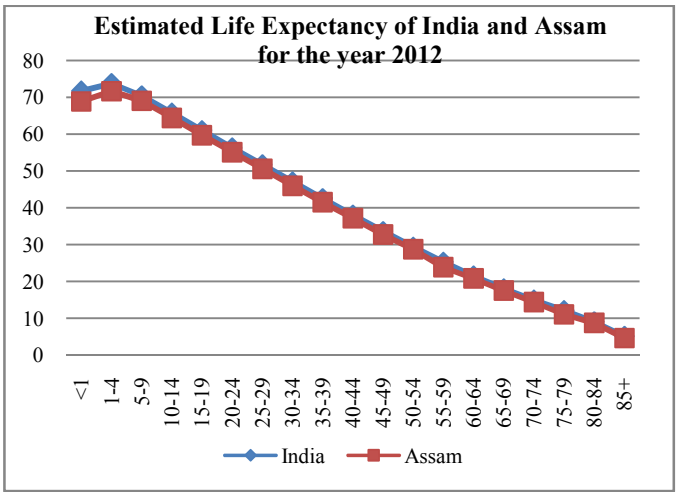

Figure 4 Estimated Life Expectancy for overall population of Assam and India for the Year 2012

Normality of life expectancy

Before going for parametric test using the estimated life expectancies, their normality is tested by using Kolmogorov-Smirnov and Shapiro-Wilk tests. The results are presented in table 4.

Table 4 Normality test of estimated life expectancy of Assam and India

Tests of Normality						
	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	d.f.	*p*-value	Statistic	d.f.	*p*-value
Life expectancy of Assam	0.107	19	0.20	0.935	19	0.221
Male LE of Assam	0.102	19	0.20	0.937	19	0.230
Female LE of Assam	0.104	19	0.20	0.933	19	0.196
Life Expectancy of India	0.099	19	0.20	0.938	19	0.243

From the normality test by both the Kolmogorov-Smirnova and Shapiro-Wilk method, the life expectancies for all the categories are found to be insignificant. The estimated life expectancies follow normal distribution, so we may proceed for parametric test so that inference can be made on the basis of parametric test. This also establishes the claim made by Eayers and colleague (Eayres *et al.*, 2004). In the table 5 the life expectancy of male and female population of Assam for the year 2012 is compared using critical ratio (Chiang, 1984).

may vary between 68.66 years and 69.10 years. Whereas, for India it is 71.72 years with 95% confidence interval 71.49 years and 72.03 years. The life expectancy value of India estimated by Registrar General of India (RGI) for the year 2010-14 is 67.9 years (SRS Bulletin, 2016). Our new method estimates near to the RGI method. For the second age interval, i.e. for age 1 the life expectancy of Assam is 71.70 years whereas for India it is 73.80 years. Another important Life expectancy measure is life expectancy at age sixty which is estimated as 20.83 years for Assam and 21.54 years for India. Life expectancy at birth and at age sixty is important for policy making for old age people. For the open end age interval (85+ years), the life expectancy of Assam is 4.65 years and for India it is 5.20 years. Assam is experiencing a poor level of life expectancy at birth and for all other ages than the national level also may be because of the fact that its poor literature rate, child and mother immunization level, socio-economic condition and high infant and maternal mortality rate.

According to the census commission of India the literacy rate of Assam is 73.18% and for India it is 74.04% for the year 2011 (Census, 2011). Despite the current low level of immunization coverage in Assam, there has been significant improvement in coverage between NFHS-2 and NFHS-3. Full immunization nearly doubled from 17 percent in NFHS-2 to 31 percent in NFHS-3.

Table 5 Expectation of Life and Standard error, females and males, Assam 2012

Age Group	Female		Male		LE difference of Female and Male	S.E.(difference)	Critical Ratio
	Life Expectancy	Standard Error	Life Expectancy	Standard Error			
(1)	(2)	(3)	(4)	(5)	(6)=(2)-(4)	(7)	(8)=(6)÷(7)
<1	70.27	0.147626	66.29	0.1581	3.98	0.216308	18.39971
1-4	73.08	0.146206	68.81	0.1594	4.27	0.216297	19.74134
5-9	70.74	0.130308	65.82	0.1524	4.92	0.200514	24.53692
10-14	66.25	0.123476	62.54	0.1355	3.71	0.183321	20.23773
15-19	61.37	0.121934	58.01	0.1305	3.36	0.178601	18.81293
20-24	57.1	0.112782	53.75	0.1232	3.35	0.167027	20.05664
25-29	52.47	0.108179	49.35	0.1175	3.12	0.159715	19.53477
30-34	47.83	0.103936	44.79	0.1136	3.04	0.153973	19.74373
35-39	43.14	0.100635	40.5	0.1077	2.64	0.1474	17.91048
40-44	38.8	0.093914	36.11	0.1032	2.69	0.139535	19.27829
45-49	34.07	0.091418	31.86	0.0984	2.21	0.134312	16.45418
50-54	29.61	0.087084	28.1	0.0915	1.51	0.126317	11.95409
55-59	25.28	0.082447	23.62	0.084	1.66	0.117701	14.10354
60-64	21.84	0.072949	20.05	0.0723	1.79	0.102708	17.42812
65-69	18.41	0.063422	16.83	0.0628	1.58	0.089254	17.70238
70-74	14.91	0.05463	14.03	0.0505	0.88	0.074395	11.82868
75-79	11.74	0.044928	10.63	0.0399	1.11	0.060088	18.47299
80-84	9.61	0.029272	8.2	0.0236	1.41	0.037601	37.49934
85+	5.72	0	3.82	0	1.9	--------	------

For each of the age group (excluding the age group 85+) the critical ratio far exceeds the critical value of $Z_{0.99}=2.33$ corresponding to $\alpha=0.01$ level of significance. This implies that, according to the mortality experience of Assam for the year 2012, female of any age has a greater expectation of life than male counterparts. For the open end the variance is very small (>0.000), so standard error and critical difference can't be determine using simple calculator.

SUMMARY AND DISCUSSION

The estimated life expectancy at birth of Assam is 68.87 years with confidence interval 68.66 years and 69.10 years. This means new born in Assam will survive on an average about 68 years and there is 95% possibility that the average length of life

For whole India the complete coverage of immunization percentage reported in NFHS-I (1992-93), NFHS-II (1998-99) and NFHS-III (2005-06) are 25%, 42% and 44%. These figures show that the status of Assam in immunization coverage is not satisfactory though it took some improvement in NFHS-III (Lhungdim *et al.*, 2005-06). Assam registered a very high maternal mortality rate (390 per lakhs) in comparison to national level (212 per lakhs). This signifies a very poor health facility for pregnant women available in the state of Assam. Infant mortality rate plays a pivotal role in life expectancy. Infant mortality rate of India in 2010 was 49.13 and 43.19 during the years 2014. For Assam it is 61 for the year 2009 and 55 for 2011. In figure 1 the infant mortality rate of Assam is shown for the year 2009 to 2011. It is a very good sign that

Infant Mortality Rate is decreasing gradually which will impact positively on life expectancy and quality of life.

These figures justifies the results obtain in the present study that life expectancy of Assam is poor than the national average. The human development index (a very important index for studying the overall development of an area) of Assam is 0.444 whereas for India it is 0.609 (Planning Commission of India, 2014). It shows that the overall development of Assam is quite poor than in compression to the national level. Poor human development index of Assam may be because of its low life expectancy at birth as life expectancy at birth is an important component of human development index of an area.

In the previous research work done by Eayres *et al.* (2004) found that the estimated life expectancy in context of UK population follows normal distribution. They also gave a strong argument that for any population size, life expectancy always follows normal distribution. After that, research work done by Scherbov *et al.* (2011) strongly opposes that argument. They gave strong justification that Pearson test is enough to reject the argument. So, in the present study the researcher studied the normality of the estimated life expectancies. The researcher tests the normality by using Kolmogorov-Smirnova and Shapiro-Wilk test. It has been found that the estimated life expectancy follows normal distribution.

CONCLUSION

Although the life expectancy of Assam is found better with respect to time but it is less satisfactory than the national status. In comparison to the developed countries it seems to be quite poor. So, more focus should be given to increase the survival of the people which can be achieved by developing the health and socio-economic condition of the state. Among the different measures of reducing the impact of different diseases in a population, one of the most important ways is to increase the awareness about different communicable and non-communicable diseases among the people. Improvement in health condition and social welfare has significant impact on the increase of life expectancy of Assam. During some past few decades there is no famine, war and major destructive diseases has been reported. Improvement in incidence of poverty, immunization coverage, nutrition, adult literacy, access to safe drinking water, burden of disease and sanitation have positive impact on life expectancy. To increase the awareness among the people the concern authority may initiate different steps such as holding of seminars, awareness programs and increase the level of education. Proper implementation of immunization program of mother and child is also very important in increasing the life span of people. So increase of awareness about immunization among people is also vital to increase the longevity of people.

Although the life expectancy of Assam, especially at birth is less in compression to national level is improving with respect to time. This increase in the level of life expectancy at birth may be because of developments in the health and social sector but a lot achieve which is apparent from the fact that the life expectancy is quite poor in compression to national level.

References

1. Banks J., Carson J.S., Nelson B.L., Nicol D.M (2015). Discrete-Event System Simulation, Dorling Kindersley (India) Pvt. Ltd, Fifth Edition.
2. Braun W.J., Murdoch D.J. (2007). A First Course in Statistical Programming with R, Cambridge University Press.
3. Chiang CL. (1968). The life table and its construction. In: Introduction to stochastic processes in biostatistics. New York: Wiley, pp189-214.
4. Chiang, CL. (1984). The life table and its applications. Malabar, Florida: Robert E. Krieger Publishing Company.
5. Eayres D., Willams E.S. (2004). (Evaluation of Methodologies for small area life Expectancy Estimation), *Journal of Epidemiology and Community Health* (1979-), Vol. 58, No. 3 (March), pp. 243-249
6. Kabir M., (2008). Determinants of Life Expectancy in Developing Countries, *The Journal of Developing Area*, Springer, Vol. 41, No. 2, pp. 185-204.
7. Lahari S., Prakasam C.P, Verma R.K (2008). Life table and Indirect Method of mortality Estimation, IIPS-Mumbai, Department of Extra Mural Studied & Distance Education.
8. Lhungdim H. *et al*. (2008). National Family Health Survey (NFHS-3), India 2005-06, Assam November 2008, IIPS-Mumbai, MOSPI.
9. Nandeesha H.K., Life expectancy as an indicator for HD. Newsletter of UGC-UPE, (University of Mysore) volume-2, February-2014
10. Planning Commission, Government of India, (2014). India Human Development Report 2011 (Towards Social Inclusion) - Summary. IAMR 2014.
11. Sarma R., Choudhury L., (2014). A new model for estimating district life expectancy at birth in India, with special reference to Assam state, Canadian Studies in Population, Vol. 41, No.1-2(Spring-Summer), pp. 180-191.
12. Sergei *et al*. (2011). Significance of Life Table estimates for small populations: Simulation-based study of standard errors. Demographic research (Germany), volume 24, Article 22, pp: 527-550.
13. Siegel S.J., Swanson A. Devid (2008). Methods and Materials of Demography, UK, Second edition; Emerald Group Publishing Limited, Howard House.
14. Silcocks, P.B.S., Jenner, D.A., and Reza, R. (2001). Life expectancy as a summary of mortality in a population: Statistical considerations and suitability for use by health authorities. *Journal of Epidemiology & Community Health* (BMJ) Vol. 55 No. 1 pp: 38-43.
15. SRS Based Abridged Life Tables, 2010-14, Office of the Registrar General and Census Commission, India, Ministry of Home Affairs, GoI, New Delhi.
16. SRS Statistical Report Tables 2012, Registrar General of India, GoI.
17. Toson, B., Baker, A., and the Office of National Statistics (2003). Life expectancy at birth: Methodological options for small populations. National Statistics Methodological Series 2003(33): 1-27.

18. Weisler. Uneméthode simple pour la construction de tables de mortalitéabrégées. World Population Conference, (United Nations), 1954: Vol IV.
19. WHO. (2015). Global Health Observatory Data Repository: Life expectancy -Data by country" (CSV). (Geneva), Switzerland: World Health Statistics 2015, World Health Organization.

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