Original Contribution/Clinical Investigation

A Comparative Study of Life Tables in an Urban Set-up of North-East of India, since 1986 to 2011

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ABSTRACT

Background: Life tables give life expectancies, death probabilities, the most preferred indicators in demographic and health analysis that used to measure status of good health, education and other valued achievements. Keeping this in mind, this study was conducted in Guwahati city, a major place of North East of India.

Objective: To study the trend and differential of mortality of Guwahati city, Assam for male and female by means of life table for the period 1986 to 2011.

Materials and Methods: Data in this study has been extracted from the Office of Birth and Death Registration, Guwahati Municipal Corporation (GMC) for the years 1986 to 2011 at an interval of five year. Total 24,145 death records were collected from Office of Birth and Death Registration, GMC during 1986 to 2011.

Results: Significant changes of life expectancies at different age was found for both sexes of Guwahati city during 1986-2011. A declining trend of probabilities of death has been found since 1986- 2011 irrespective of sex.

Conclusion: Though healthcare policies in Assam are adequate in addressing the issues of infants, children and mothers, it is required to address the issues regarding survival gain in Guwahati.

Key words : Guwahati, SRS, Life expectancy, death probabilities, temporary life expectancy.

Introduction

One of most important devices used in demography is life table (15). From various literature on mortality investigation and other allied topics it is being found that probably the first rudimentary life table was prepared by a Roman author, Ulpian sometime during the third century (9).

The life table provides a convenient, comprehensive and self-contained summary of mortality conditions prevailing in an actual or hypothetical population(2). A life table combines the mortality experience of a population at different ages into a single statistical model, and describes the life history of that hypothetical population. The relations among its columns and parameters have formed one of the most fruitful traditions of mathematical population research. The actuaries, demographers, public health workers and many others use this statistical device in studies of longevity, fertility, migration, and population growth (21). The method of life table is applicable to the analysis of not only mortality but of many measurable processes involving attrition or accession to aggregate size(12).

Of all the summary measures that can be derived from a life table, the expectation of life (or life expectancy) is perhaps the most well-known, widely-used, widely-cited and widely-studied statistic.

For any age x (most frequently, at age zero or birth) ex reports the mean number of person-years of each person at age x can expect to live, given the mortality rates observed throughout the entire life Table[2]. It gives the cumulative effect of mortality over the remaining life span.

Life expectancy at birth e_0^0 is the most preferred indicator in demographic and health analysis.

As mortality rates decline, life expectancy increases, thus a relationship exists with the change in mortality schedule. There is a complex relationship between actual mortality changes at various age groups and resulting change in life expectancy. This idea was first brought under consideration by Arriaga (1982). He introduced the notion of temporary life expectancy, an index to measure by each age group, the annual relative change in the years to be lived. The gain in expectation of life at birth e_x^0 is attributable to the effects of mortality improvements. Arriaga (1984) Vaupel (1986), Pollard (1988), has given rise to analysis of the e_x^0, that shows how the progress in the mortality schedule would translate into progress in expectation of life at birth(28). While analysing changes in life expectancy at birth or studying differences in life expectancy between two populations, decomposition of a difference

may identify ages at which the difference originates in mortality or ages at which the differences occur.

Different phases of life, namely- infancy, childhood, working life, reproductive life, and elder age are normally adopted in life table concept. This division of life phases help in understanding variations in the age patterns and also facilitates comparison of different reasons for mortality. The level of mortality in these phases of life is measured by temporary life expectancy(10). But temporary life expectancy (TLE) gives only increase or decrease of years of life between particular ages in different time periods without considering the maximum possible reduction in those ages. Therefore, the pace of mortality change during a period of time is treated in relative measures by referring it with the maximum possible change (Arriaga,1984). In this case, the index of Annual Relative Change (ARC) in TLE can be used as a better indicator. Annual Relative Change (ARC), an index of TLE represents the difference in percentage change between two mortality measures in their observed reduction in deaths in relation to the total possible reduction (Arriaga, 1984). In other words, it shows the change in TLE between two periods.

It is seen that, life expectancy at birth for the world population has undergone a significant change from 48 years in '1950- 1955' to 68 years in '2010' according to estimates presented in United Nations (UN Population Prospects, 2010 revision). According to Sample Registration System (SRS) based abridged life table, there has been a significant improvement in life expectancy in India resulting in greater longevity. The life expectancy at birth in India has increased from 50.5 years in 1970-75 to 64.6 years in 2006-10 for males and from 49.0 years in 1970-75 to 67.7 years for females during 2006-10. Whereas in Assam, life expectancy at birth has increased from 52.9 years in 1986-90 to 61 years for males and from life expectancy of 53.6 years in 1986-90 to 63.2 years for females in 2006-10. There is evidence of convergence in mortality decline across the states in India.

Guwahati, the head quarter of Kamrup Metropolitan District and the capital of state Assam of India is a fast growing metropolis with a population of 9.69 Lakhs (Census report, 2011). The city is far the largest and fastest growing commercial, industrial, educational settlement in the North-Eastern region of India. Geographically, it is located in the southern bank of the River Brahmaputra between 26º 05' to 26º 15' N Latitude and 91º 35' to 91 º 55' E Longitude. The decadal population growth rate in Guwahati Metropolitan Area between 1981-91, 1991-2001 and 2001-2011 are 117.27, 38.6 and 26.3 respectively(Census, India). The recent decadal growth rate (2001-2011) of Guwahati city of 26.3 % is higher than the national population growth rate of 17.64%. The municipal limit of the city is 651.12 sq. Km in 2011. The population density of the city has been 2558, 2705, 3741 and 4445 persons per sq.km in 1981, 1991, 2001 and 2011 respectively. Among all other cities in the state, Guwahati is the largest urban centre in Assam with 23.89% of the total urban population of the state and it alone contributes 55% of the combined population of the significant towns within the state (Various issues of the Census, India). This city is now become one of the prime places for Business, Government as well as non Government offices, Educational Institutions, and Health care services in North- East of India.

With increase of number of government, semi government establishments, big to small private business establishments, household units, vehicles during the last 25 years (1986-2011) Guwahati is growing fast and thus making a deficiency of housing. Rural and other migrants have been crowded together in different areas. A rapidly urbanizing city Guwahati leads a well comfortable life for a large section of the people and in contrast, critical lives in slum areas clouded by polluted and unhygienic

conditions. City's drainage system is poor in many areas. These polluted conditions may affect the mortality situation of the city dwellers. All these have tempted us to study the mortality situation of the city in the last 25 years. In this paper, it is attempted to study the changes in the trend and differential of mortality of Guwahati city by means of life table for males and females for the period 1986 to 2011.

Objectives

(i) To study the trend and differential of probability of death and expectation of life at birth and at some selected ages by means of life table for the years 1986, 1991, 1996, 2001, 2006 and 2011 for males and females in Guwahati.
(ii) To study the trend and differential of temporary expectation of life (TLE) and annual relative change (ARC) in TLE at different age group (0,5), (5,15), (15, 50), (15,60) and 60 and above for both sexes for the above mentioned years in Guwahati city.
(iii) To study the age decomposition analysis in life expectancies at birth for the above mentioned years in Guwahati city for males and females.

Data
Data for this study has been extracted from the Birth and Death Registration, Office of the Guwahati Municipal Corporation (GMC) for the years 1986, 1991, 1996, 2001, 2006 and 2011. From large registered data on death in Guwahati since 1986 to 2011, we limit our analysis to a specific year considering every 5 year interval starting from 1986 to 2011. We believe that selection of the years at 5 year intervals will give us possible information about trend and differentials prevailing in death statistics over 25 years.

In this city, deaths are usually registered with specified cause of death certified by medical practitioner. Deaths occurring at health institutions are certified by physicians as many of them are preceded by an illness and attended by medical practitioner and deaths that occur at home or at any other place are reported by their relative to the authority. Further when a person dies his or her body is brought to the cremation ground and the person employed by Guwahati Municipal Corporation (GMC) registers the name, age, sex, address, cause of death and sends that to the higher concerned authority (4). Even when a particular case, cause of death is not known, the medical registrars are able to give the best information on the cause leading to the death after probing from the Post mortem reports.

There were a total of 24,145 deaths in Guwahati Metropolitan city under consideration of every five year interval since 1986 to 2011. The population age and sex structure of Guwahati city is derived from census of India (1991, 2001 and 2011) and the next consecutive years' population are estimated by taking the census population figures.

Method of constructing life table
For construction of life table Greville's method was used. Certain relationships among the functions of life table have been made based on observed relationship between the probability of death ($_nq_x$) and the age specific death rates ($_nM_x$), between age x to x+n.

The function ($_nq_x$) is calculated by,

$$_nq_x = \frac{nMx}{\left(\frac{1}{n}\right)+nMx\left[\left(\frac{1}{2}\right)+\left(\frac{n}{12}\right)(nMx-k)\right]}$$

$_nM_x$ is the observed age specific death rate. k is constant, obtained on the assumption that $_nM_x$ values follow an exponential curve. Here, K = 0.09.

q_0 value for age group 0-1 is calculated by,

$$q_x = \frac{2Mx}{2+Mx}$$

The values of $_nd_x$ are calculated on multiplying $_nq_x$ by l_x. We start with taking l_0 as 100,000. To obtain I_{x+n} we subtract from I_x the corresponding value of $_nd_x$ and the process is repeated.

The values of $_nL_0$ are obtained by -

$$L_0 = 0.276\ l_0 + 0.724\ l_1$$

$$_nL_x = \frac{n^{d_x}}{n^{M_x}}$$

The values of T_0 and e_x^0 are obtained as

$$Tx = {}_nL_x + {}_nL_{x+1} + \ldots\ldots\ldots\ldots + {}_nL_{x+80}$$

and $$e_x^0 = \frac{Tx}{lx}$$

Temporary Expectation of Life (TLE)
The Temporary Life Expectancy (TLE) is the average number of years lived between the ages of x and x + n by a group of lx members, all aged x. It is a good indicator to understand the mortality reduction. TLE can be calculated for various age spans of life defined by

$$_nE_x = \frac{Tx-Tx+n}{lx}$$

where l_x is the radix of the life table,
T_x and T_{x+n} are the numbers of person-years lived after ages x and x+n,

Index of Annual Relative Changes (ARC) in TLE
Change in TLE between two periods or the pace of mortality change during the period of time can be treated in relative measure by referring it with the possible maximum change (Arriaga, 1984). The index of Annual Relative Change (ARC) serves as a good indicator to observe the maximum mortality changes,

$$_nARC_x^i = [1-(1-nRC_x^i)^{\frac{1}{i}}] * 100,$$

i is the width of the study years and nRC_x^i is the observed change in TLE in relation to the maximum possible changes in age intervals x to x+n.

Where, $nRC_x^i = \frac{(n^{E_{x+n}}) - (n^{E_x})}{n - (n^{E_x})}$ (Arriaga,1984)

Decomposing a Difference in Life Expectancies

Mathematically, decomposing a difference in life expectancies is defined as

$$_n\Delta_x = \frac{l_x^1}{l_0^1}\left(\frac{n^{L_x^2}}{l_x^2} - \frac{n^{L_x^1}}{l_x^2}\right) + \frac{T_{x+n}^2}{l_0^1}\left(\frac{l_x^1}{l_x^2} - \frac{l_{x+n}^1}{l_{x+n}^2}\right) =$$

Contribution of mortality difference in age group x to x+n to difference in life expectancy at birth.

$$_\infty\Delta_x = \frac{l_x^1}{l_0^1}\left(\frac{T_x^2}{l_x^2} - \frac{T_x^1}{l_x^1}\right)$$

= Contribution of mortality difference in open ended age group to difference in life expectancy at birth.

Total life expectancy difference

$$e_0^0(2) - e_0^0(1) = \Sigma\ _n\Delta_x$$

Results and Discussion

Comparison of calculated values of expectation of life at birth (for Guwahati with urban, Assam estimates by SRS based Abridged Life table(India), 1986-2011.

In Table 1 a comparison is made between the values of expectation of life at birth for Guwahati city obtained by us and estimated by SRS (India) for urban, Assam for different periods viz 1986-90, 1989-93, 1994-98, 1999-2003, 2004-2008 and 2006-2010. Life tables are available for its major states of India and the country by rural and urban areas, by sex for period of every five years prepared by Census of India based on SRS data. There is a good concordance between the two sources.

It is seen from the table that values of e_0^0 for Guwahati are higher than the values obtained by SRS. This may be due to the fact that people of Guwahati are more aware about their health problems where literacy rate may contribute to this factor. An average male population of Guwahati lives 7.95 years longer in 2011and females live 8.16 years longer in 2011 compared to 25 years earlier.

In 2006-2010, the expectation of life at birth among urban males was lowest in Assam (66.9) in comparison to other states of India i.e, the expectation of life at birth among males were longest in Himachal Pradesh (72.6), Kerala (72.3), Jammu & Kashmir (72.2), Maharashtra (69.6), West Bengal (69.6), Punjab (69.1) and Tamil Nadu (69.0)(15).

When it came to urban females, Kerala (76.4) took the top expectation of life at birth in 2006- 2010, followed by Himachal Pradesh (75.7) , J&K (75.0), Punjab (73.5), Maharashtra (73.2) and urban Assam was at the bottom of the ladder with an average woman expected to live till just 71.1 years. Higher expectation of life at birth has been observed for females for all the study years since 1986-2011. The coverage of mortality conditions by Office of the Birth and Death registration observed higher e_0^0 for average population in the city than overall e_0^0 for urban population of Assam by SRS for both males and females. Though expectation of life at birth in Guwahati city improving over the years it is still behind in development of some aspects of mortality conditions compared to other urban areas of India.

Table 1: Life Expectancy at Birth for male and female, Guwahati, since 1986 to 2011 calculated by us and estimated by SRS of India for urban, Assam

	Proposed values of e_0^0 for Guwahati			Estimated e_0^0 for urban, Assam by SRS(India)	
Period	Male	Female	Period	Male	Female
1986	63.56	64.55	1986-1990	60.6	61.3
1991	64.90	67.58	1989-1993	63.0	64.1
1996	67.13	69.52	1994-1998	65.0	66.1
2001	68.80	70.47	1999-2003	66.3	67.4
2006	70.95	72.40	2004-2008	66.8	70.8
2011	71.51	72.71	2006-2010	66.9	71.1

While observing growth of life expectancy at birth it is seen that life expectancy has increased from 63.56 years to 71.51 years in 1986-2011 for males and from 64.55 to 72.71 years for females. Expectation of life at birth has increased by 1.34 years and 3.03 years for males and females respectively in the period 1986-1991 which became 0.56 years and 0.31 years for males and females respectively in the recent period 2006-2011 in Guwahati. In the three years 2001, 2006 and 2011 respectively, the city witnessed increasing life expectancies at birth from 68.8, 70.9 to 71.5 years respectively for males and 70.5, 72.4, 72.7 years respectively for females. Overall, for the population of Guwahati, expectation of life e_0^0 has shown an increasing trend (Figure 1) with an increase of almost 8 years for males and 8.2 years for females over the last quarter century i.e, 1986-2011. The maximum increase of e_0^0 (male) was observed as 2.22 years during 1991-1996 and the corresponding value for females was observed as 3.03 years. Also as the values of e_0^0 increases with time from 1986-2011 for both males and females, it is observed that e_0^0 for females is greater than those of males in all the years (1986-2011). This may be because deaths are more prevalent in males in the age group 15-50 due to their hard work and consumption of alcohol, cigarettes etc.

Figure 1: Expectation of life at birth for both male and female, Guwahati, 1986 to 2011

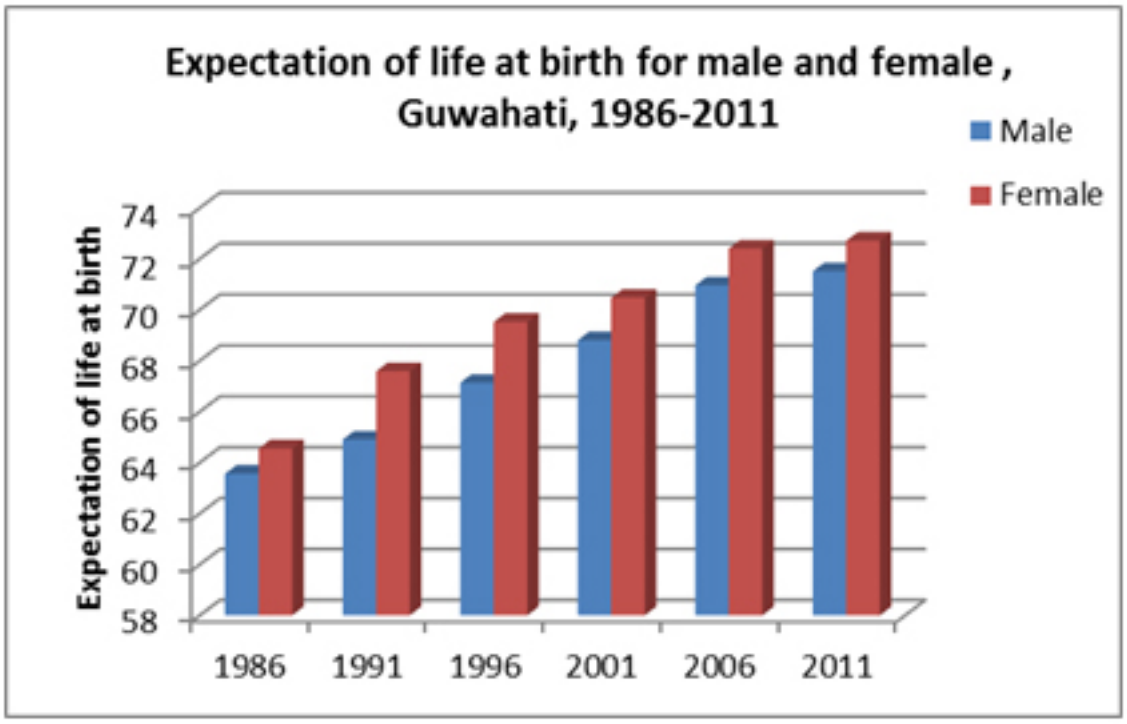


Table 2 : Life expectancy at selected ages for male and female, Guwahati since 1986 to 2011

	e_1^0		e_5^0		e_{15}^0		e_{30}^0		e_{45}^0		e_{60}^0	
	M	F	M	F	M	F	M	F	M	F	M	F
1986	66.9	67.5	63.6	64.8	53.9	55.3	40.0	41.7	27.2	28.4	16.2	17.9
1991	67.4	69.5	64.0	66.6	54.3	56.9	40.3	43.2	27.1	30.0	16.6	18.5
1996	68.9	71.3	65.5	67.9	55.7	58.3	41.6	44.4	28.4	31.1	17.5	19.3
2001	70.3	72.2	66.8	68.8	57.0	59.1	42.7	45.0	29.3	31.5	18.1	19.6
2006	72.5	74.0	69.0	70.5	59.2	60.7	44.8	46.7	31.0	33.1	18.8	20.5
2011	73.1	74.3	69.5	70.8	59.7	61.0	45.4	47.0	31.5	33.4	18.9	20.2

Table 2 (previous page) recorded the expectation of life at selected ages for male and female, Guwahati since 1986 to 2011. It is observed that , in this period there had been remarkable changes of expectation of life at all age groups. Twenty five years back in 1986, the city had expectation of life at age 30 as 40 (41.7) years for male (female), at age 60 it was 16.2 (17.9) years for male (female) which has now in 2011 become 45 (47) years at age 30 to almost 19 (20) years at age 60 for male (female) respectively.

A joint look at the table 1 and 2 reveals that e_x^0 is highest at age 1. This may be possibly due to higher Infant Mortality Rate (IMR).

That is the city is yet to achieve a better IMR like Kerala (Sarma and Choudhury, Canadian studies of population 2014). From 1986 to 2011 it has been observed that life expectancy, e_x^0 was higher for females than their male counterparts. Highest value of e_x^0 occurs at the age 1 and age 5 than all other age groups for both male and female in most of the study years. With the increase of ages, values of e_x^0 decreased over the years under consideration. In the year 1986, the minimum expectancy of life at age 60 was 16.2 years for males whereas for females it was 17.9 years. That is old age longevity is not satisfactory.

In Table 3 results of probabilities of death, ${}_nq_x$ for selected ages viz 0,1,15,30,45,60 since 1986 to 2011 for male and female in Guwahati city are depicted. It is seen from the result that, probability of death at infancy i.e. 0-1 age group is higher than all the age groups except 60 years for both sexes in all the study years. This says the gravity of the situation. Even the death of children in 1-5 years of age is also high. High death in infancy to children under 5 years occurs due to malnutrition, prevalence of infectious diseases, acute respiratory diseases, sanitation, acute diarrhoeal diseases etc(13). While comparing the probabilities of mortality for male and female we found that probabilities of dying ${}_1q_0$ for male in Guwahati had higher values than their female counterparts in almost all study years since 1986 to 2011 except in 200. During 1986-2001 probabilities of dying of female children at age under 5 years were found higher than male but, in recent years 2006-2011 under 5 years male children showed lower survival. Apart from this from the analysis it is observed that values of ${}_5q_{30}$ for females were higher than their male counterparts in all of the study years , but the reverse was observed in ${}_5q_{45}$ and ${}_5q_{60}$ that is, male probability of death was higher in these age groups of (45-60). Females below 40 years of age may have higher death probability due to complications of pregnancy and any other maternal causes during this period of their life. The age group (15-30) belongs to a vulnerable special risk period for females. The risk is due to pregnancy and child bearing or deaths due to complications of pregnancy and child birth during these ages. Thus, reduction of mortality of females in this age group has been an area of concern. High mortality of females may be a reflection of low social, cultural as well as low health status of women in India. Negligence of health care, less care during their reproductive age period, malnutrition, and stress in all aspect of life may be some causes(17). This states the gravity of the situation. Even if a steep decrease of infant mortality resumes in future, importance of female adult-age mortality and health for the

Variations of probabilities of death (nqx) at selected ages, Guwahati, 1986-2011

Table 3 : Values of nqx, at selected ages for male and female of Guwahati, since 1986 to 2011

	${}_1q_0$		${}_4q_1$		${}_5q_{15}$		${}_5q_{30}$		${}_5q_{45}$		${}_5q_{60}$	
	M	F	M	F	M	F	M	F	M	F	M	F
1986	0.0639	0.0574	0.0111	0.0192	0.0076	0.0082	0.0118	0.0136	0.0462	0.0297	0.1633	0.1341
1991	0.0517	0.0422	0.0094	0.0152	0.0064	0.0073	0.0114	0.0135	0.0456	0.0251	0.1329	0.1114
1996	0.0403	0.0394	0.0083	0.0085	0.0051	0.0058	0.0090	0.0130	0.0436	0.0224	0.1257	0.1030
2001	0.0355	0.0385	0.0079	0.0083	0.0035	0.0055	0.0068	0.0092	0.0434	0.0218	0.1225	0.0992
2006	0.0355	0.0354	0.0066	0.0065	0.0030	0.0052	0.0065	0.0077	0.0193	0.0189	0.1060	0.0758
2011	0.0355	0.0354	0.0065	0.0064	0.0029	0.0051	0.0064	0.0102	0.0187	0.0147	0.0863	0.0748

female population of Guwahati city with other parts of the country will have to be improved. Higher probability of death in the age group 15-30 for females may also occur due to the deaths of illiterate females during their pregnancy and child bearing period, specifically in slum areas. Thus female education needs to be improved, also concern needed for nutrition, increase of health services during pregnancy, at the time of delivery, successful implementation of the expanded programmes on immunization, diarrhoeal disease, acute respiratory disease control programmes as well as the control of the other infectious diseases may also contribute to lower the infant mortality(13).

Decreasing trend for values of ${}_1q_0$ has been observed (see Figure 2). It shows that the values of ${}_1q_0$ give a declining trend since 1986 to 1996 for both males and females in Guwahati city. After that the values of ${}_1q_0$ have been stagnant. This may be because mortality has not changed since 1996.

The Temporary Expectation of Life (TLE)

The Temporary Expectation of Life (TLE), under mortality conditions of Guwahati city for male and female along with Annual Relative Change during 1986-2011 is depicted in Table 4. It is observed that high variations in pace of improvements in TLE and ARC existed across the study years, for the age groups, irrespective of sex. Maximum annual relative change (ARC) has been observed during 1986 to 1991 for male in TLE ${}_5E_0$, whereas for female ARC was maximum during 1991 to 1996 in TLE ${}_{10}E_5$. Children below 10 years of age have higher values of ARC compared to Adults and elderly age group irrespective of sex. The relative changes in mortality were considerably low even negative in some of the age group during 1986- 1991, 1996-2001 for male and during 1996-2001, 2001-2006 and 2006-2011 for female. Mostly, smaller changes of ARC have been lower from elderly age group 60+ years to adult age group for both male and female in almost all the study years. This may be due to the fact that adults as well as the elderly persons belong to high risk exposure age group. Therefore low pace of change of fatality reduction has been observed since adulthood for both male and female.

It is observed from Table 4 (next page) that, the values of ${}_5E_0$ for male and female are almost the same in recent years like 2011, though it showed slight higher values for female in previous study years viz 1986, 1991 ,1996 and 2006 respectively, then in 2001 male showed higher ${}_5E_0$ value. This has been depicted in Figure 3. It is seen that, the trend of temporary expectations over the last 25 years is having a wide variation in the age group (5-15) and (15-60) years (see figure 3). The TLE ${}_{10}E_5$ for male, trend is smoothly increasing over the study years. It is interesting to notice that, for the total population female is in a more advantageous position than males with the only exception in age group (5-15) years.

For female ${}_{10}E_5$, the trend shows increasing trend with higher values than their male counterpart, came down slightly from 2006 onwards. For the age group (15-60) i.e. for working age group male and female has wide variation since last 25 years. The TLE ${}_{45}E_{15}$ for males in 2001 had less value than females, but it became higher in 2011. For elderly persons female has been having increasingly higher values of E_{60+} than male counterparts though in recent 2011 both male and female has almost the same TLE values. Kerala's outstanding performance in terms of TLE was observed as this state experienced lower level of child mortality, adult mortality(25).

Higher values of TLE for female are also common in other major places of India like Kerala(24). The study shows higher values of the index of Annual Relative Change (ARC) in early age for both male and female, gives low values in (15-60) and 60+ ages over the years. We observed smaller changes in ARC during (1996-2001) to (2006 to 2011) for age group (5-15) & (15-60). High exposure of ill health may lead to low ARC of mortality by adults and elderly in Guwahat.

Figure 2: The probability of death ${}_1q_0$, for male and female Guwahati during 1986-2011

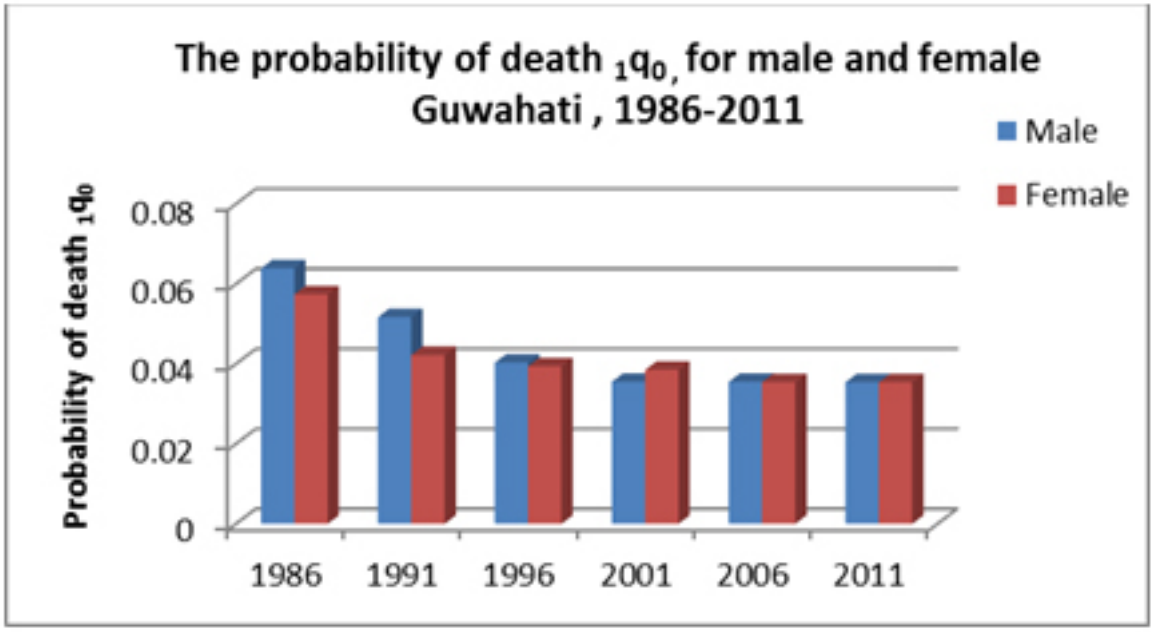


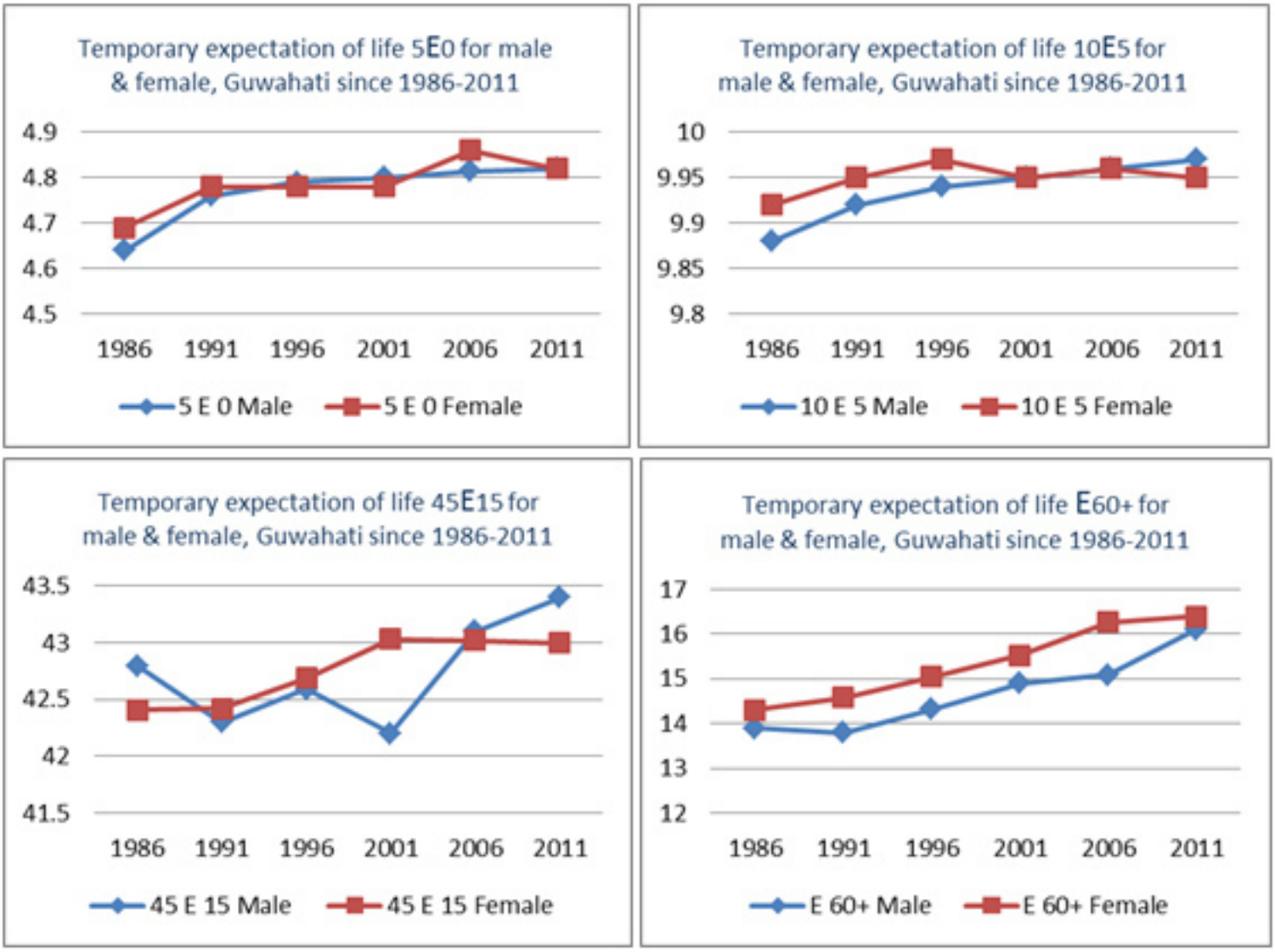
Table 4: Temporary Expectation of life and Annual Relative Changes since 1986-2011, Guwahati city

	Temporary Life Expectancy (TLE)						Annual Relative Change (ARC) in TLE				
Male	1986	1991	1996	2001	2006	2011	1986-1991	1991-1996	1996-2001	2001-2006	2006-2011
${}_5E_0$	4.68	4.74	4.79	4.82	4.819	4.82	7.79	2.64	0.97	2.09	0.55
${}_{10}E_5$	9.98	9.97	9.98	9.99	9.987	9.99	7.79	5.59	3.58	4.36	5.59
${}_{45}E_{15}$	41.9	41.6	42.26	42.6	43.2	43.4	5.03	2.25	-3.05	7.46	3.38
E_{60+}	13.1	13.8	14.06	14.5	14.86	14.9	-0.03	1.74	2.13	0.76	4.50
	Temporary Life Expectancy (TLE)						Annual Relative Change (ARC) in TLE				
Female	1986	1991	1996	2001	2006	2011	1986-1991	1991-1996	1996-2001	2001-2006	2006-2011
${}_5E_0$	4.69	4.77	4.80	4.80	4.82	4.82	6.63	0.00	0.00	8.64	-5.15
${}_{10}E_5$	9.95	9.97	9.98	9.98	9.99	9.98	8.97	9.71	-1.76	4.36	-4.56
${}_{45}E_{15}$	41.84	42.29	42.56	42.88	43.09	43.2	0.07	2.18	3.13	-0.50	-0.20
E_{60+}	14.20	14.45	14.85	15.12	15.87	16.1	1.00	1.76	2.02	3.55	0.76

Table 5: Percentage of ratios of TLE to max possible years in each phase of life of Guwahati, 1986-2011

	Percentage of ratios of TLE to maximum possible years					
Male	1986	1991	1996	2001	2006	2011
0-5	92.8	95.2	95.8	96	96.3	96.4
5-15	98	99.2	99.4	99.5	99.6	99.7
15-50	94.1	94.3	95.6	96.8	97.7	98.5
15-60	95.1	94	94.6	93.8	95.8	96.4
60+	34.5	34.5	35.8	37.3	37.7	40.3
Female	1986	1991	1996	2001	2006	2011
0-5	93.8	95.6	95.6	95.6	97.2	96.4
5-15	99.2	99.5	99.7	99.5	99.6	99.5
15-50	94.40	96.49	95.28	96.22	95.28	96.14
15-60	94.2	94.3	94.9	95.6	95.6	95.6
60+	35.5	36.5	37.6	38.8	40.7	41

Figure 3: Temporary Expectations of life for male and female, Guwahati for different span of life since 1986-2011



The values of percentage of the ratio of TLE at various age groups (Table 5) e.g. children of (0-5) years, children and adolescent of (5-15) years , male and female of (15-50) years and (15-60) years age group oscillate mostly around 95% and 96% over the years under consideration in a city like Guwahati. After 1986 the ratio of TLE of (0-5) has been showing an increasing trend for both male and female (see figure 4.i). The same picture of increasing trend is being observed for (5-15), (15-50) and even for age of 60 years above.

From Table 5, it is observed that as time passes the value of a particular ${}_nE_x$ increases. For example the percentage values for the age group 0-5 for male(female) in 2011 was 96.4(96.4). In 1986 this value for male(female) was 92.8(93.8). The highest value of ${}_5E_0$ is not satisfactory because in the city like Guwahati one expects this value to be 100. Percentage values in the age group 5-15 are almost satisfactory because for this age group values are approximately equal to 100, indicating that in the adolescent period mortality is negligible in the city.

For the age range 15-50, the percentage values are not satisfactory for males and female. From 1996 to 2011 these values are slightly higher for females. This may be due to the death of females during reproductive and child bearing period for malnutrition. Literature from many countries has shown that women in younger age less than 20 and older than 35 years have higher mortality rates(30). Female mortality in age group (15-50) also increases with number of children they carry and birth order (NFHS-3,2005-2006). 6% of teenage mothers aged less 20 years contribute to high mortality of women. The percentage values for males and females for the age group 15-60 are also not satisfactory where for female deaths in the early part of this age range have already been stated and for males this may occur due to hard work, consumption of alcohol, smoking, cigarette etc. For the old age (60+) the percentage values are far from being satisfactory. The highest value among males and females is 41, not even half of maximum possible value i.e, 100. However, in all study years for age above 60 year higher values of ratio of TLE have been seen for females than their male Counterparts (Figure 4.iii).

These values of ratios are expected to lie around 100 and state authorities should take necessary measures to improve this situation in Guwahati to bring the percentage of ratio of TLE for different spans of life to 100.

The decomposition analysis (Table 6) shows, the contribution of different age groups in the increase of life expectancy at birth for male and female. Early childhood mortality i.e. infant mortality is a major contributor to the total change of life expectancy as compared to the higher age group in Guwahati for almost all the age group between 1986-2011. It shows from decomposition analysis that for the total e_0^0 difference (male) as 7.94 early childhood mortality has contribution of 26.43% in contrast to -0.17% at age 80+ and for the total e_0^0 difference (female) as 7.78, early childhood mortality has

Table 6 : Age decomposition of differences in life expectancies (LE) at birth between 1986 and 2011 for male and female separately, Guwahati

Total difference of life expectancy, $e_0^0(2011) - e_0^0(1986) = \sum n\Delta x = 7.9433$ for male

Age Group	MALE $n\Delta x$	% Contribution of age specific death (ASD) to total e_0^0 increase	FEMALE $n\Delta x$	% Contribution of age specific death (ASD) to total e_0^0 increase
0-1	2.09968	26.43%	1.65617	21.28%
1-5	0.29995	3.78%	0.8820	11.33%
5-10	0.0647	0.81%	0.24702	3.17%
10-15	0.09728	1.22%	0.06783	0.87%
15-20	0.24132	3.04%	0.16354	2.10%
20-25	0.20498	2.58%	0.20486	2.63%
25-30	0.09673	1.22%	0.16729	2.15%
30-35	0.20899	2.63%	0.13701	1.76%
35-40	0.14826	1.87%	0.13493	1.73%
40-45	0.79092	9.96%	0.25839	3.32%
45-50	0.68134	8.58%	0.39608	5.09%
50-55	0.32856	4.14%	1.37768	17.70%
55-60	0.77076	9.70%	0.90625	11.64%
60-65	0.83894	10.56%	0.77577	9.97%
65-70	0.85955	10.82%	0.72842	9.36%
70-75	0.06371	0.80%	0.03962	0.51
75-80	0.08439	1.06%	0.08088	1.04%
80+	-0.0136	-0.17%	-0.4410	-5.67%
Total	**7.9433**	**100**	**7.78276**	**100**

Total difference of life expectancy, $e_0^0(2011) - e_0^0(1986) = \sum n\Delta x = 7.7828$ for female

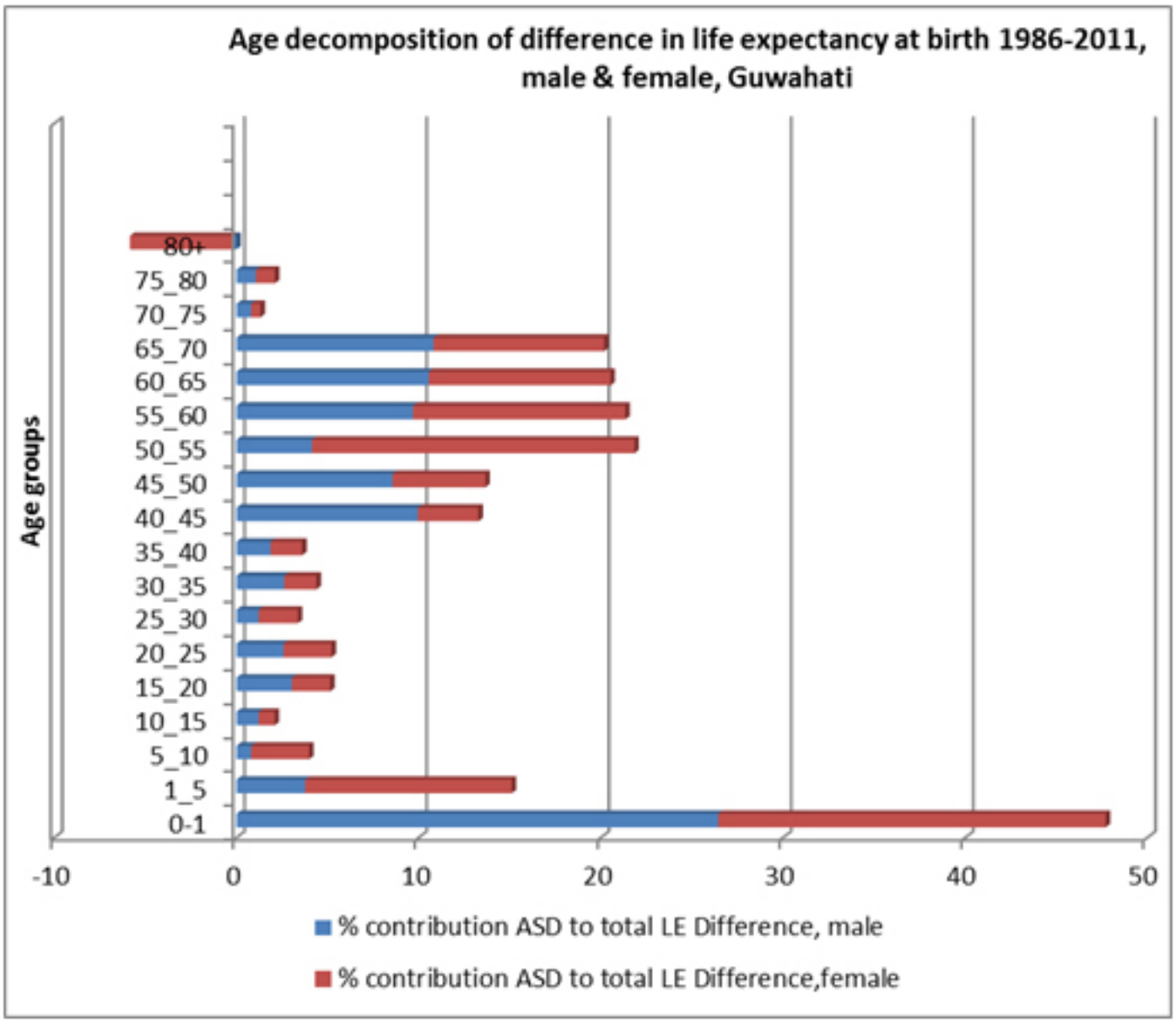
contribution of 21.28% in contrast to -0.44% at age of 80+. Overall the decomposition analysis here produces positive and subsequently negative contribution to the total changes or total differences in expectation of life at birth in the city between 1986-2011. It is the improvement in the process of survival of population in Guwahati that contributes improvement in life expectancy.

It is seen from the above table that there is gain in life expectancy in almost all the age groups for both males and females (expect for males in the age group 80-85 and 85+). At birth, the life expectancy for males is 71.51 years according to the life table, and for females it is 72.71 years. The gain in life expectancy at birth may be due to the improvement in mortality rates for the middle age group.

The objective of this study is to see the trend and differential of mortality of Guwahati city by means of life table. The strength of the study is 25 years of prospectively collected data. Overall, expectation of life at birth has undergone a significant change from 1986 to 2011. Females have recorded accelerated improvements in their life as compared to their male counterparts over the last 25 years. The findings in Guwahati have slight higher values than SRS, Assam urban life table values in most of the study years.

The demonstration of comparative study of life tables of Guwahati, an urban set up of North-East of India since 1986-2011 may be of help to planners and implementers of the State's health development programmes. With its rich natural resources and high business and economic activities, Guwahati is a major place of North-East of India and it has to achieve the desired outcomes of longevity of life. The issues of infants, children and mothers as well as adults need more attention to address the issues regarding overall gain in survival of people in Guwahati city. Future progress should be judged not only in terms of overall gain in life expectancy but also in terms of healthy life of people. The national programmes that are followed for prevention of communicable and non communicable diseases should be sincerely carried out to bring a change in overall longevity of life in this area and it should be the goal which is within our reach.

Figure 5



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