

Estimation of disease specific age pattern of mortality and life expectancy in India

Akansha Singh¹, Laishram Ladusingh²

¹Ph.D. student, International Institute for Population Sciences, Govandi Station Road, Deonar, Mumbai-400088

²Professor, Department of Mathematical Demography and Statistics, International Institute for Population Sciences, Govandi Station Road, Deonar, Mumbai-400088

Introduction

Out of every 10 deaths in the world 6 are attributed to non-communicable diseases and 4 are attributed to other communicable causes and injuries. Non-communicable diseases such as cardiovascular diseases, cancers are the leading cause of death in the world (WHO, 2008). In India communicable diseases was the major cause of mortality in early 1900s however with significant mortality and epidemiological transition mortality and disease burden is slowly shifting towards non-communicable diseases. In India non-communicable diseases mortality accounts for the large share of the mortality burden and the share of deaths due to other diseases has declined. The RGI (2003) report shows that the non-communicable diseases accounts for the 42 percent of deaths and other communicable causes and injuries accounts for the 58 percent of deaths. Similarly increasing longevity and changing cause of death structure would significantly effects age pattern of mortality (Gutterman & Handerhoof, 1998) Since different diseases has different age pattern it is expected that such changes would be observed in age pattern of mortality. The cause specific mortality analysis for selected developed countries shows that mortality in ages below 15 shifted from communicable disease to non-communicable and other diseases during 1950s to 1990s time period. In the middle aged adults, similar pattern is observed with differences by sex. The cause specific mortality above age 50 was mainly dominated by non-communicable diseases (Solomon & Murray, 2002)

To gain insight of burden of diseases it is always required to have estimates of incidence, prevalence and mortality burden of diseases (Baan et al. 1999). The disease mortality estimation in India is difficult because of lack of good cause of death statistics. Valid estimates of disease mortality by age cannot be derived from cause-of-death statistics because of poor coverage and data quality. Further role of disease mortality on life expectancy cannot be estimated using cause of death information in India. Therefore indirect estimation of disease mortality becomes important (Barendregt et al., 2000; Barendregt et al., 2003; Kruijshaar et al., 2003). Such estimates combine data from epidemiologic or health care studies on the prevalence of diseases and the relative risk of mortality with mortality information collected from the vital registration system.

In the view of current and future scenario of disease burden in India our major focus would be on mortality due to non-communicable diseases This study would basically focus on estimation of mortality by two broad groups of diseases; one is non-communicable diseases and others which includes communicable and injuries groups. Though, it is known that which cause of death group is contributing most towards total mortality burden little is known about the age pattern of mortality according to broad disease group and change in age pattern of disease mortality over time. This main objective of this paper is to estimate and study the change in the age pattern of mortality by broad disease group and further assess the effect of this mortality pattern on life expectancy in the last two decades in India.

Data and Methodology

Data for diseases were extracted from the two rounds of National Sample Survey Organisation surveys on Morbidity and Health care conducted in 1995-96 and 2004. In both surveys questions were asked on all the spells of ailments suffered by each and every member in the

household. Different type of communicable, non-communicable diseases and injuries suffered by the members of the households were asked (NSSO, 1998; NSSO 2008). Age specific death rates information was extracted from the Sample Registration System reports for the year 1995, 96 and 2004 (RGI, 1995;1996; 2004). Sample registration system is the most reliable data source of mortality in India.

Estimating differences in mortality rates for the persons with disease is usually done with observational studies requiring long periods of follow-up. Another way to estimate the mortality associated with a disease is to exploit the interrelatedness of epidemiological parameters such as, prevalence, relative risk of disease and overall mortality, which can be expressed mathematically. This method has been used by Baan et al. (1999) to estimate disease specific mortality in Netherlands.

We estimated sex- and age-specific mortality rates for the disease conditions (non-communicable and other disease conditions using:

$$M = pM_0 + (1 - p)M_1 \quad (1)$$

$$\text{and: } M_1 = M_0R \quad (2)$$

Where: M is the average total mortality rate of the population;

M_1 is the total mortality rate for non-communicable disease population;

M_0 is the total mortality rate for other disease population;

p is the prevalence of disease; R is the relative risk for total mortality, given exposure to disease. Age indexes are suppressed.

Substituting 2 into 1 yields the mortality of the other disease subjects:

$$M_0 = \frac{M}{pR+(1-p)} \quad (3)$$

Age specific prevalence of non-communicable disease was estimated separately for males and females using generalised linear model with logit link function and adjusted for place (urban/rural) and income quintiles (based on monthly per capita expenditure).

Relative risk of mortality requires information for longitudinal cohort data or clinical studies which have estimated the risk of dying due to any diseases. In India, it is difficult to have such type of information. Hence in this study relative risk of having that disease is assumed to be similar to the relative risk of dying due to that disease. This risk was estimated using logistic regression analysis. Separate models were used for each age group for male and female separately. The dependant variable was individual suffering from non-communicable diseases as 1 and suffering from other diseases as 0. The independent variables were age, sector (urban/rural), and income quintiles (five categories). For each model age was categorised differently. For example, for estimation of relative risk for males in the age group 0-4, male in the age group 0-4 was coded as 1 and other age groups were coded as 0.

We calculated life tables for the non-communicable disease population and other disease population for males and females. The life expectancy of the non-communicable disease population can be interpreted as the life expectancy among non-communicable disease

population. The gain in life expectancy due to elimination of non-communicable diseases is the difference between the life expectancies of the total population (overall) and other disease population.

Results

Before mortality estimation, it was important to see the prevalence of non-communicable diseases and relative risk of non-communicable diseases in India and study their change from 1995-96 to 2004. Table 1 show that the adjusted age specific prevalence of non-communicable diseases increases linearly with age. The burden of non-communicable diseases is most experienced by the elderly age groups. Male-female gap in prevalence of non-communicable diseases has increased manifolds in India in these ten years. Females are at higher risk of suffering from non-communicable diseases than males.

Table 1: Prevalence of non-communicable disease by sex and age group in India

Age group	Males		Females	
	1995-96	2004	1995-96	2004
0-4	0.0035	0.0294	0.0030	0.0195
5-9	0.0027	0.0150	0.0032	0.0113
10-14	0.0032	0.0130	0.0031	0.0122
15-19	0.0041	0.0147	0.0034	0.0192
20-24	0.0052	0.0137	0.0057	0.0194
25-29	0.0049	0.0174	0.0069	0.0293
30-34	0.0061	0.0185	0.0089	0.0352
35-39	0.0070	0.0283	0.0120	0.0475
40-44	0.0123	0.0406	0.0178	0.0689
45-49	0.0114	0.0530	0.0203	0.0809
50-54	0.0165	0.0736	0.0220	0.0951
55-59	0.0231	0.0992	0.0251	0.0984
60-64	0.0554	0.2116	0.0697	0.2203
65-69	0.0636	0.2574	0.0618	0.2524
70-74	0.0754	0.2984	0.0672	0.3367
75-79	0.0716	0.3643	0.1300	0.3524
80-84	0.0808	0.3642	0.1079	0.3208
85+	0.0807	0.3291	0.1070	0.3839

Relative risk of suffering from the non-communicable diseases as compared to the other diseases is estimated from the logistic regression analysis using separate models for each age group by sex. The results show that the relative risk of suffering from non-communicable diseases is much higher in the age group 40-44 onwards than the younger age group. The relative risk of less than 1 signifies that the other diseases (communicable diseases and other diseases) have higher chance of occurrence in the younger age group. The magnitude of relative risk is more than 3 times in elderly age group 60 and above in 2004 irrespective of sex. This shows that the severity of non-communicable diseases is much higher in elderly age group. The risk rises to peak for age group 70-74 for males in 1995-96 (3.10) and age group 80-84 in 2004

(4.99). For females relative risk was higher in oldest old age groups of 75-79 in both time periods (1995-96: 4.31; 2004: 4.43). Over time the relative risk of suffering from non-communicable diseases than other diseases has increased after 65+ in females and among males from 45-49 age group this increase is observed. Over time this risk has increases both among males and females. Though the prevalence of non-communicable diseases has increased at a faster rate in females than males, rate of increase in relative risk is more for the males in higher age groups. In 1995-96 risk of having non-communicable diseases was much higher among females than males.

Table 2: Relative risk of having non-communicable disease as compared to other diseases

	Male		Female	
	1995-96	2004	1995-96	2004
0-4	0.19	0.25	0.16	0.17
5-9	0.34	0.32	0.34	0.26
10-14	0.43	0.39	0.37	0.41
15-19	0.62	0.52	0.40	0.63
20-24	0.81	0.54	0.62	0.55
25-29	0.87	0.70	0.69	0.68
30-34	0.86	0.57	0.79	0.80
35-39	0.96	0.80	0.89	0.91
40-44	1.44	1.05	1.34	1.32
45-49	1.09	1.32	1.38	1.42
50-54	1.53	1.73	1.45	1.33
55-59	1.87	2.07	1.68	1.65
60-64	2.50	3.33	3.05	2.94
65-69	2.99	4.19	2.46	3.57
70-74	3.10	3.66	2.83	3.96
75-79	2.55	4.30	4.31	4.43
80-84	2.41	4.99	4.00	3.05
85+	2.43	3.44	3.90	3.99

Table 3 provides the estimates of death rates for mortality due to other diseases (M_0) and mortality due to non-communicable diseases (M_1). Even when suitable sources to estimate disease risk and mortality are available, the estimates obtained from them will be subject to uncertainty. Uncertainty surrounding point estimates of disease risk and mortality may be due to limitations of sample sizes, differences in diagnostic criteria, and methods of case finding. Therefore we have provided the 95 percent confidence intervals for the estimates of the death rates.

In 1995-96, the death rate due to other diseases is higher in the age group 0-4 to 35-39. The death rate due to non-communicable diseases surpasses the death rate due to other diseases from the age group 40-44 and above. In the age group 0-4 the mortality due to other diseases (0.0228) is more than five times higher than the non-communicable diseases (0.0042). This suggests large burden of communicable diseases mortality in the younger age group. Relative of other diseases, death rate among non-communicable disease group is four to five times higher in the elderly age groups. These figures increased significantly from 1995-96 to 2004. This suggests that the mortality burden due of non-communicable diseases has increased significantly in India

from 1995-96 to 2004. Contrary to death rates due to non-communicable diseases, mortality due to other diseases has declined over time. The gap between death rates of two groups has increased over time. The rate of decline in death rate for those suffering from the other diseases is much faster than the decline in death rate for the non-communicable diseases.

The death rate due to other disease among females in the age group 0-4 is around six times higher than non-communicable diseases death (Table 4). These figures decline to approx three times in the next two age groups. These ratios remain more or less similar in both the time period. The death rate in elderly age group for non-communicable diseases is 3 to 4 times of death rate due to other diseases. These figures increased significantly for each and every elderly age group among females. As compared to males, increase is observed only in elderly age groups in females. Similar to males, rate of decline in death rate due to non-communicable diseases is lower than other diseases. The rate of decline in death rate due to other diseases or non-communicable diseases is much higher among females than males.

Table 3: Estimates of death rates for other diseases (M_0) and non-communicable diseases (M_1) and 95% percent confidence intervals, males

Age group	1995-96						2004					
	M_0	95% CI		M_1	95% CI		M_0	95% CI		M_1	95% CI	
0-4	0.0228	0.0228	0.0228	0.0042	0.0029	0.0062	0.0170	0.0170	0.0170	0.0043	0.0037	0.0050
5-9	0.0021	0.0021	0.0021	0.0007	0.0005	0.0010	0.0015	0.0015	0.0015	0.0005	0.0004	0.0006
10-14	0.0013	0.0013	0.0013	0.0005	0.0004	0.0008	0.0010	0.0010	0.0010	0.0004	0.0003	0.0005
15-19	0.0016	0.0016	0.0016	0.0010	0.0007	0.0014	0.0015	0.0015	0.0015	0.0008	0.0006	0.0010
20-24	0.0021	0.0021	0.0020	0.0017	0.0012	0.0024	0.0019	0.0019	0.0019	0.0010	0.0008	0.0014
25-29	0.0026	0.0026	0.0025	0.0022	0.0016	0.0030	0.0025	0.0025	0.0025	0.0018	0.0013	0.0023
30-34	0.0030	0.0030	0.0030	0.0026	0.0019	0.0035	0.0032	0.0032	0.0032	0.0019	0.0015	0.0023
35-39	0.0038	0.0038	0.0038	0.0037	0.0028	0.0047	0.0038	0.0038	0.0038	0.0030	0.0023	0.0039
40-44	0.0056	0.0056	0.0055	0.0080	0.0061	0.0107	0.0053	0.0053	0.0052	0.0055	0.0045	0.0068
45-49	0.0080	0.0080	0.0080	0.0087	0.0067	0.0113	0.0066	0.0067	0.0065	0.0087	0.0072	0.0105
50-54	0.0122	0.0123	0.0121	0.0187	0.0140	0.0249	0.0095	0.0097	0.0092	0.0164	0.0133	0.0201
55-59	0.0173	0.0175	0.0171	0.0325	0.0253	0.0417	0.0124	0.0129	0.0118	0.0257	0.0214	0.0305
60-64	0.0266	0.0274	0.0257	0.0666	0.0538	0.0820	0.0165	0.0177	0.0152	0.0548	0.0502	0.0595
65-69	0.0369	0.0385	0.0349	0.1103	0.0866	0.1388	0.0192	0.0211	0.0174	0.0805	0.0752	0.0857
70-74	0.0563	0.0594	0.0527	0.1747	0.1373	0.2192	0.0309	0.0346	0.0274	0.1133	0.1046	0.1215
75-79	0.0819	0.0864	0.0762	0.2091	0.1511	0.2838	0.0363	0.0438	0.0297	0.1562	0.1432	0.1678
80-84	0.1145	0.1228	0.1030	0.2763	0.1815	0.4064	0.0473	0.0607	0.0360	0.2360	0.2126	0.2557
85+	0.1849	0.2017	0.1597	0.4492	0.2577	0.7374	0.1075	0.1332	0.0842	0.3699	0.3176	0.4176

Table 4: Estimates of death rates for other diseases (M_0) and non-communicable diseases (M_1) and 95% percent confidence intervals, females

	1995-96						2004					
	M_0	95% CI		M_1	95% CI		M_0	95% CI		M_1	95% CI	
0-4	0.0255	0.0255	0.0255	0.0041	0.0030	0.0057	0.0178	0.0178	0.0178	0.0030	0.0025	0.0036
5-9	0.0027	0.0027	0.0027	0.0009	0.0006	0.0014	0.0015	0.0015	0.0015	0.0004	0.0003	0.0005
10-14	0.0014	0.0014	0.0014	0.0005	0.0004	0.0008	0.0009	0.0009	0.0009	0.0004	0.0003	0.0005
15-19	0.0020	0.0020	0.0020	0.0008	0.0006	0.0011	0.0017	0.0017	0.0017	0.0011	0.0008	0.0014
20-24	0.0027	0.0027	0.0027	0.0017	0.0012	0.0024	0.0021	0.0021	0.0021	0.0012	0.0009	0.0014
25-29	0.0026	0.0026	0.0026	0.0018	0.0014	0.0023	0.0020	0.0020	0.0020	0.0014	0.0011	0.0017
30-34	0.0028	0.0028	0.0027	0.0022	0.0017	0.0029	0.0024	0.0024	0.0024	0.0019	0.0016	0.0023
35-39	0.0030	0.0030	0.0029	0.0026	0.0021	0.0033	0.0023	0.0023	0.0023	0.0021	0.0017	0.0026
40-44	0.0038	0.0038	0.0038	0.0051	0.0039	0.0067	0.0029	0.0030	0.0029	0.0039	0.0033	0.0046
45-49	0.0052	0.0052	0.0052	0.0072	0.0056	0.0091	0.0046	0.0047	0.0045	0.0066	0.0055	0.0078
50-54	0.0087	0.0087	0.0086	0.0126	0.0097	0.0161	0.0055	0.0057	0.0054	0.0074	0.0061	0.0088
55-59	0.0125	0.0126	0.0124	0.0210	0.0169	0.0261	0.0102	0.0105	0.0100	0.0169	0.0146	0.0194
60-64	0.0198	0.0207	0.0188	0.0604	0.0485	0.0744	0.0121	0.0129	0.0112	0.0354	0.0326	0.0383
65-69	0.0288	0.0298	0.0277	0.0710	0.0571	0.0877	0.0155	0.0168	0.0141	0.0552	0.0511	0.0593
70-74	0.0476	0.0498	0.0451	0.1347	0.1052	0.1705	0.0222	0.0250	0.0195	0.0879	0.0823	0.0931
75-79	0.0541	0.0629	0.0444	0.2334	0.1743	0.2983	0.0282	0.0344	0.0228	0.1252	0.1139	0.1352
80-84	0.0853	0.0967	0.0720	0.3414	0.2469	0.4516	0.0609	0.0726	0.0499	0.1856	0.1608	0.2090
85+	0.1414	0.1630	0.1154	0.5519	0.3722	0.7694	0.0817	0.1077	0.0599	0.3260	0.2843	0.3611

Table 5, 6 7 and 8 provides the life table columns for the mortality due to other diseases and non-communicable diseases among males and females in 1995-96 and 2004. The probability of dying due to other diseases is higher in the initial age groups and non-communicable diseases in the higher age groups. The percent of deaths in the non-communicable disease population in the age group below 60 is higher among males than females. In 1995-96, 35 percent of deaths among males occurred in the age group below 60 and 27 percent among females. This proportion declines to 30 percent and 22 percent in 2004 (Estimated from Table 5-8). Number of deaths due to other diseases is higher till age 30-34 or 35-39, after these age groups death due to non-communicable diseases was higher. Life expectancy at birth is higher among non-communicable disease population than other disease population. Life expectancy at age 5 and above is higher for the other disease population. Comparison of Table 5 and 7 shows that in 1995-96, life expectancy at birth was higher for non-communicable disease population and in 2004 for the other disease population. Similar phenomena were not observed among females in India (Table 6 and 8). The increase in life expectancy for the non-communicable disease population from 1995-96 to 2004 is not significant. As compared to female population with non-communicable disease, increase is much lower among males. For the other disease population, increase in life expectancy do not varies much by sex of the person.

Table 5: Life table columns for the other disease and non-communicable disease male population in India, 1995-96

	Other disease				Non-communicable disease			
	${}_nq_x$	l_x	d_x	e_x	${}_nq_x$	l_x	d_x	e_x
0- 5	0.1065	100000	10651	60.8	0.0311	100000	3110	62.7
5-10	0.0105	89349	935	62.8	0.0036	96890	348	57.2
10-15	0.0062	88414	552	58.5	0.0027	96542	257	52.4
15-20	0.0077	87862	679	53.8	0.0048	96285	464	47.5
20-25	0.0102	87183	890	49.2	0.0083	95820	793	42.7
25-30	0.0127	86293	1094	44.7	0.0110	95027	1044	38.1
30-35	0.0149	85199	1270	40.3	0.0128	93983	1200	33.5
35-40	0.0188	83929	1580	35.8	0.0181	92783	1680	28.9
40-45	0.0275	82349	2262	31.5	0.0394	91103	3593	24.3
45-50	0.0392	80088	3137	27.3	0.0425	87511	3720	20.2
50-55	0.0594	76950	4569	23.3	0.0894	83791	7487	16.0
55-60	0.0831	72381	6014	19.6	0.1500	76304	11443	12.4
60-65	0.1247	66367	8275	16.2	0.2834	64861	18379	9.1
65-70	0.1684	58092	9784	13.1	0.4237	46482	19696	6.8
70-75	0.2454	48308	11855	10.3	0.5823	26786	15596	5.1
75-80	0.3361	36453	12253	7.9	0.6478	11190	7249	4.2
80-85	0.4358	24199	10545	5.6	0.7469	3941	2943	3.2
85+	0.6030	13654	8233	3.3	0.8831	997	881	2.0

Table 6: Life table columns for the other disease and non-communicable disease female population in India, 1995-96

	Other disease				Non-communicable disease			
	${}_nq_x$	l_x	d_x	e_x	${}_nq_x$	l_x	d_x	e_x
0- 5	0.1177	100000	11766	62.3	0.0299	100000	2988	65.1
5-10	0.0134	88234	1186	65.4	0.0046	97012	450	59.6
10-15	0.0070	87048	608	61.2	0.0026	96562	249	54.9
15-20	0.0097	86440	840	56.6	0.0039	96313	376	50.0
20-25	0.0134	85599	1150	52.2	0.0084	95937	805	45.2
25-30	0.0127	84449	1072	47.9	0.0088	95131	837	40.6
30-35	0.0137	83377	1141	43.4	0.0109	94295	1026	35.9
35-40	0.0147	82236	1206	39.0	0.0130	93269	1212	31.3
40-45	0.0190	81031	1536	34.6	0.0252	92057	2323	26.7
45-50	0.0257	79495	2044	30.2	0.0352	89735	3162	22.3
50-55	0.0424	77451	3284	25.9	0.0609	86572	5270	18.0
55-60	0.0605	74167	4489	21.9	0.0998	81302	8117	14.0
60-65	0.0944	69678	6575	18.2	0.2606	73185	19074	10.3
65-70	0.1343	63103	8475	14.8	0.2989	54111	16173	8.1
70-75	0.2120	54628	11580	11.8	0.4900	37938	18590	5.6
75-80	0.2370	43048	10201	9.3	0.6877	19348	13305	3.8
80-85	0.3472	32847	11406	6.4	0.8142	6043	4920	2.7
85+	0.5069	21441	10868	3.6	0.9155	1122	1028	1.7

Table 7: Life table columns for the other disease and non-communicable disease male population in India, 2004

	Other disease				Non-communicable disease			
	${}_nq_x$	l_x	d_x	e_x	${}_nq_x$	l_x	d_x	e_x
0- 5	0.0836	100000	8357	66.8	0.0313	100000	3130	65.1
5-10	0.0075	91643	692	67.5	0.0024	96870	232	59.7
10-15	0.0050	90951	457	63.0	0.0020	96638	191	54.8
15-20	0.0075	90494	681	58.3	0.0039	96447	376	49.9
20-25	0.0095	89813	855	53.8	0.0052	96071	497	45.1
25-30	0.0125	88958	1111	49.3	0.0087	95574	835	40.3
30-35	0.0160	87847	1405	44.9	0.0092	94739	873	35.7
35-40	0.0189	86442	1636	40.5	0.0151	93866	1418	31.0
40-45	0.0261	84806	2214	36.3	0.0273	92448	2526	26.4
45-50	0.0324	82592	2676	32.2	0.0427	89922	3837	22.1
50-55	0.0464	79916	3705	28.2	0.0787	86084	6771	18.0
55-60	0.0600	76212	4575	24.4	0.1204	79314	9549	14.3
60-65	0.0791	71636	5668	20.8	0.2398	69764	16729	10.9
65-70	0.0916	65968	6044	17.4	0.3314	53035	17577	8.6
70-75	0.1433	59924	8587	13.9	0.4323	35458	15329	6.7
75-80	0.1661	51337	8526	10.8	0.5419	20129	10908	5.1
80-85	0.2106	42811	9015	7.5	0.6916	9222	6378	3.6
85+	0.4159	33796	14055	3.9	0.8370	2844	2380	2.3

Table 8: Life table columns for the other disease and non-communicable disease female population in India, 2004

	Other disease				Non-communicable disease			
	nq_x	l_x	d_x	e_x	nq_x	l_x	d_x	e_x
0- 5	0.08690	100000	8690	69.2	0.0249	100000	2485	70.0
5-10	0.00754	91310	688	70.4	0.0019	97515	189	63.2
10-15	0.00452	90622	410	65.9	0.0019	97325	181	58.3
15-20	0.00852	90212	769	61.2	0.0053	97145	519	53.4
20-25	0.01054	89443	943	56.7	0.0058	96625	557	48.7
25-30	0.01004	88501	889	52.3	0.0068	96069	656	44.0
30-35	0.01201	87612	1052	47.8	0.0096	95412	916	39.3
35-40	0.01149	86559	994	43.3	0.0104	94496	983	34.6
40-45	0.01457	85565	1246	38.8	0.0192	93513	1797	30.0
45-50	0.02294	84319	1934	34.4	0.0324	91716	2975	25.5
50-55	0.02725	82384	2245	30.1	0.0362	88741	3209	21.3
55-60	0.04995	80139	4003	25.9	0.0809	85533	6923	17.0
60-65	0.05849	76137	4453	22.1	0.1623	78610	12757	13.3
65-70	0.07438	71684	5331	18.3	0.2413	65852	15892	10.4
70-75	0.10501	66352	6968	14.6	0.3555	49960	17761	7.9
75-80	0.13171	59385	7822	11.0	0.4651	32199	14977	6.0
80-85	0.26253	51563	13537	7.3	0.6042	17222	10406	4.2
85+	0.33537	38026	12753	4.1	0.8004	6817	5456	2.5

Table 9 clearly shows that eliminating non-communicable disease mortality at different age group can significantly increases the life expectancy at different ages. Eliminating mortality due to non-communicable diseases increases life expectancy at birth by 0.57 years among males and 0.92 years among females in 1995-96. In 2004, elimination of non-communicable disease mortality increased life expectancy at birth by 3.16 years in males and 2.88 years in females. Gain in life expectancy is much higher in 2004 than 1995-96. Gain in life expectancy in terms of number of years is highest at age 60 than at other ages irrespective of time and sex. In 2004 eliminating non-communicable disease mortality increased the life expectancy at age 60 by 4.40 years for elderly males and 3.80 years for elderly females. In 1995-96, this gain was very low for males than females. Life expectancy at age 60 was 0.84 for males and 1.32 years for females in 1995-96. This shows significant change in contribution of non-communicable disease mortality in India. In 1995-95 gain in life expectancy was higher among females than males. This scenario changed completely in 2004 with higher gain in life expectancy among males than females. Comparison of males and females suggest that the change in gain of life expectancy is much higher for males than females.

Table 9: Gain in life years after eliminating non-communicable disease mortality

Age group	Male		Female	
	1995-96	2004	1995-96	2004
0-4	0.57	3.16	0.92	2.88
5-9	0.66	3.58	1.07	3.25
10-14	0.66	3.61	1.08	3.28
15-19	0.67	3.63	1.09	3.30
20-24	0.68	3.66	1.10	3.33
25-29	0.68	3.70	1.12	3.37
30-34	0.69	3.75	1.13	3.41
35-39	0.70	3.81	1.15	3.45
40-44	0.72	3.89	1.17	3.49
45-49	0.73	3.99	1.19	3.54
50-54	0.76	4.11	1.21	3.60
55-59	0.80	4.25	1.26	3.67
60-64	0.84	4.40	1.32	3.80
65-69	0.79	4.15	1.23	3.60
70-74	0.67	3.59	1.25	3.20
75-79	0.44	2.97	1.27	2.39
80-84	0.30	1.92	0.74	1.40
85+	0.14	0.67	0.33	0.78

Discussion and Conclusion

In this study an attempt has been made to associate age specific disease burden, mortality and its effect on life expectancy. With the increase in age, prevalence and relative risk of non-communicable diseases increases significantly. There has been a significant increase in non-communicable disease burden from 1995-96 to 2004. Relative risk of non-communicable diseases increases from middle aged adults to elderly population among males. For females, relative risk for having non-communicable diseases was significantly higher among elderly females. Death rate estimates show that death rate due to other diseases is five to six times of non-communicable diseases in the child age group of 0-4 years. Majority of deaths in the child age group is due to communicable causes as found in several other studies (Murray & Lopez, 1990; RGI, 2003). With the increase in age, there is gradual shift in this relation with more number of deaths due to non-communicable diseases in higher age groups. Premature deaths in age below 60 due to non-communicable diseases are higher among males than females. The socio-economic impact of premature death due to non-communicable diseases is enormous since these deaths often affect the main income earner in the household and those who rear those children (Quigley, 2006). The rate of decline in age specific death rate due to other diseases is much faster than the decline in death rate due to non-communicable diseases. This can be attributed to the rising burden of non-communicable diseases in India.

Life expectancy with non-communicable diseases is significantly lower than the life expectancy with other diseases. Over time, life expectancy at different ages increases in both disease groups. The increase is more significant in other diseases group than non-communicable diseases group. Life expectancy among males with non-communicable disease has not increased much than females. Eliminating non-communicable disease mortality significantly increases life

expectancy in India. This gain in life expectancy increases with increasing prevalence and relative risk of non-communicable. Non-communicable disease mortality affects most the elderly life expectancy rather than life expectancy at birth. Life expectancy at age 60 can increase by 4.4 years among males and 3.8 years among females in 2004 eliminating non-communicable disease mortality. Several other studies show that the non-communicable diseases and mortality burden in India would increase in the near future (MoHFW, 2005). Further improvement in life expectancy in India in the near future would heavily depend on burden of non-communicable diseases. Gain in life expectancy estimates suggest that preventing deaths from non-communicable diseases would significantly improve life expectancy in India. Increasing significance of non-communicable disease mortality also suggests the need for serious intervention strategies to prevent non-communicable disease burden. The basic challenge would be to implement appropriate prevention strategies in order to halt the growing trend in non-communicable diseases against a background of infectious diseases which remain out of control.

Limitations of this study

The risk of suffering and dying from non-communicable diseases than other diseases is assumed to be similar. For this purpose, relative risk estimates from any longitudinal and cohort type of studies would have given better estimates of mortality and life expectancy.

References

- Baan, C. A., Nusselder, W. J., Barendregt, J. J., Ruwaard, D., Bonneux, L., & Feskens, E. J. M. (1999). The Burden of Mortality of Diabetes Mellitus in The Netherlands. *Epidemiology*, 10(2), 184-187.
- Barendregt, J.J., Baan, C.A., & Bonneux, L. (2000). An indirect estimate of the incidence of non-insulin dependent diabetes mellitus. *Epidemiology*, 11(3), 274–279.
- Barendregt, J. J., Van Oortmarssen, G. J., Vos, T., & Murray, C.J. (2003). A generic model for the assessment of disease epidemiology: the computational basis of DisMod II. *Population Health Metrics*, 1-4.
- Guterman, S., & Vanderhoof, I.T. (1998). Forecasting changes in mortality: A search for a law of causes and effects. *North American Actuarial Journal*, 2(4), 135-138.
- Kruijshaar, M. E., Barendregt, J. J., & Van De Poll-Franse, L. V. (2003). Estimating the prevalence of breast cancer using a disease model: data problems and trends. *Population Health Metrics*, 1, 5. doi:10.1186/1478-7954-1-5
- Ministry of Health & Family Welfare, Government of India. (2005). *National Commission on Macroeconomics and Health Background Papers—Burden of Disease in India*. New Delhi: Ministry of Health & Family Welfare, Government of India.
- Murray, C. J. L., & Lopez, A. D. (1994). Global and regional cause-of-death patterns in 1990. *Bulletin of the World Health Organization*, 72 (3), 447-480.
- National Sample Survey Organisation, Department of Statistics, Government of India. (1998). *Morbidity and Treatment of Ailments, NSS Fifty-second Round, July 1995 – June 1996, Report No. 441(52/25.0/1)*. New Delhi: National Sample Survey Organisation.
- National Sample Survey Organisation, Ministry of Statistics and Programme Implementation, Government of India. (2006). *Morbidity, Health Care and the Condition of the Aged NSS 60th round (January – June 2004) Report No. 507 (60/25.0/1)*. New Delhi: National Sample Survey Organisation.
- November 1998
- Quigley, M A. (2006). Commentary: Shifting burden of disease— epidemiological transition in India. *International Journal of Epidemiology*, 35, 1530–1531.

Registrar General of India (RGI). (1995-1996, 2004). *Sample Registration System Statistical Reports*. New Delhi: Office of the Registrar General.

Registrar General of India. (2009). *Report on Causes of Death in India, 2001-03*. New Delhi: Office of the Registrar General.

Salomon, J.A. & Murray, C. J. L. (2002). The Epidemiologic Transition Revisited: Compositional Models for Causes of Death by Age and Sex. *Population and Development Review*, 28(2), 205-228.