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Analysis of senescent and non-senescent mortality

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Abstract
In the present paper, we calculated the cause-specific deaths and then carried out the analysis for senescent and non-senescent mortality. We observe that the new borns will eventually die from causes combined due to senescent are more as compared to causes combined due to non-senescent mortality. We see the proportion of male/female who survives to age x that will die from cause senescent is more as compared to cause non-senescent. We observe change in the distribution of deaths in non-senescent and senescent by age for male and female populations of India. The deaths in senescent are more compared to non-senescent for both male and female populations.

Keywords: Life table, cause-specific, senescent, survival and mortality

1. Introduction

Over the decades life expectancy in human life has changed and it's been focus of research to understand the human mortality due to aging process and cause of death. The study accounts with an impact of intrinsic and extrinsic factors of mortality. Mainly, the distinction is made between intrinsic cause of death as it is due to biological factors (causes), like non-senescent (Carnes *et al*., 2006) [3] and extrinsic cause of death due to external causes or environmental factors causes deaths, like aging or senescent (Makeham, 1867; Finch, 1994) [9, 5]. The effect of extrinsically imposed mortality on the evolution of senescence has received considerable attention. Population dynamics that are density independent should not be affected by extrinsic mortality is influenced by age if population growth is dependent on density and populations are stable. The possibility of extrinsic mortality leads to increase in senescence rates at all ages, but also leads to decrease in rates at all ages or both at all ages (Abrams, 1993) [1]. The author presented a simple theoretical analysis of how extrinsic mortality should affect the rate of senescence (i.e., the rate at which probability of mortality increases with age) under different evolutionary and population dynamical assumptions.

Intrinsic mortality is due to causes of death arising primarily within an organism, while extrinsic mortality originates from outside (Carnes *et al*., 2006; Caswell, 2007a) [3, 4]. The rate of senescence can be inferred from acceleration by which mortality rates increase over age. Such a senescence rate is generally estimated from parameters of a mathematical model fitted to these mortality rates. According to the fundamental precept of classical theories of senescence, rapid intrinsic deterioration, or aging, is favored by environments with a high mortality risk. This prediction has received mixed empirical support, despite being frequently cited as being largely supported by the data that are currently available. This expectation should only be realized in specific situations, according to recent theory, which could explain the ambiguous empirical results (Williams, *et al*., 2006) [11].

Bongaarts (2009) [2] examined the pattern in two main components of mortality. One is senescent mortality, which is the result of biological ageing; it can be postponed through medical intervention and lifestyle adjustments, but it cannot be avoided because death is inevitable. The other non-senescent deaths unrelated to ageing (e.g., accidents, certain infections), which can be avoided by effective public health medical intervention and taking safety measures. Non-senescent mortality has reached very low levels and nearly all deaths are now due to senescence. Therefore, the key question for forecasters is whether and how rapidly senescent mortality is changing and how these trends affect future life expectancy. Cellular senescence is an underlying mechanism of aging and age-related conditions and also a process in which cells lose the ability to divide and damage neighboring cells by the factors they secrete, collectively referred as the senescence-associated secretory phenotype (SASP). Le Brasseur *et al*. (2015) [7] discussed the concept of cellular senescence, review the evidence that implicates cellular senescence and SASP in age-related deterioration, hyper proliferation, and inflammation, and proposed underlying mechanism of aging which play a fundamental role in the biology of frailty (See also Macieira-Coelho, 2014) [8].

In the present paper we considered the patterns in non-senescent (background) and senescent mortality by means of constructing the columns of life tables based on death rates by cause of death. We compare the survival patterns for each cause of death, non-senescent and senescent deaths using cause of death information. We classify the total deaths (male and female) according to Bongaarts (2009) [2] due to different causes into senescent and non-senescent. Senescent deaths include the deaths due to total cancer, cardio vascular disease (CVD), Lip & oral cavity and tuberculosis (TB), where as non-senescent deaths include deaths due to human immune deficiency virus (HIV), vector borne disease and chronic respiratory disease.

2. Materials and Methods

Constructing a multiple decrement table (cohort or period) involves preparing a basic life table for all causes of decrement combined, and then adding the columns that pertain to decrements from the individual causes. The latter task is simply a matter of recording what has happened. The basic problem is one of converting these observed rates into the probabilities of exiting table from various causes. Thus, we have

$$ {}_n^sq_x^i = \frac{n\cdot {}_n^sm_x^i}{1+(n-{}_n^sa_x){}_n^sm_x} $$

$$ {}_n^sq_x^i = \frac{n\cdot {}_n^sm_x^i}{1+(n-{}_n^sa_x)({}_n^sm_x^i+{}_n^sm_x^{-i})} \tag{1} $$

Where ${}_n^sq_x^i$ is the life table mortality rate for s (male or female) and cause i, the ${}_n^sm_x$ is the age-specific mortality rate for s and is common to write the rate of decrement from causes other than i in the age interval x to $x + n$ as ${}_n^sm_x^{-i}$. Thus ${}_n^sm_x = {}_n^sm_x^i + {}_n^sm_x^{-i}$.

To construct a life table for all causes of decrement combined, we have to compute ${}_n^sm_x = \sum_i {}_n^sm_x^i$. The rate of decrement from all causes combined in the age interval x to $x+n$. The usual procedure consists of assuming for each cause that ${}_n^sM_x^i = {}_n^sm_x^i$ (which also implies ${}_n^sM_x = {}_n^sm_x$, where ${}_n^sM_x^i$ is the observed decrement rate from cause i between ages x to $x+n$ for s.

We compute the probability of exit from cause i in the age interval x to $x+n$ as

$$ {}_n^sq_x^i = {}_n^sq_x \cdot \frac{{}_n^sm_x^i}{{}_n^sm_x} \tag{2} $$

Note that if we have accepted ${}_n^sM_x^i = {}_n^sm_x^i$, then the relationship becomes:

$$ {}_n^sq_x^i = {}_n^sq_x \cdot \frac{{}_n^sM_x^i}{{}_n^sM_x} = {}_n^sq_x \cdot \frac{{}_n^sD_x^i}{{}_n^sD_x} \tag{3} $$

Where ${}_n^sD_x^i$ is the observed number of decrements from cause i between ages x and $x+n$ in the population and ${}_n^sD_x$ is the observed number of decrements from all causes combined in an interval.

Then by using the interrelationships, we compute the number of decrements from cause i in an interval x to $x+n$ as

$$ {}_n^sd_x^i = {}_n^sq_x^i \cdot l_x \tag{4} $$

Compute the number of persons aged x who will eventually leave the table from cause i (survivors) as

$$ l_x^i = \sum_{all\ x}^{\infty} {}_n^sd_x^i \tag{5} $$

To construct the cause-specific death life tables, we have used ${}_n^sa_x$, instead we can use the following formula to calculate

$$ {}_5^sa_x^i = \frac{-\frac{5}{24}{}_5^sd_{x-5}^i+\frac{5}{2}{}_5^sd_x^i+\frac{5}{24}{}_5^sd_{x+5}^i}{{}_5^sd_x^i} \tag{6} $$

Alternative to this is

$$ {}_n^sa_x^i = n + R^i \cdot \frac{{}_n^sq_x}{{}_n^sq_x^i}({}_n^sa_x - n) \tag{7} $$

Where, $R^i = \frac{{}_n^sD_x^i}{{}_n^sD_x}$, $R^i$is the constant of proportionality for decrement i in the age interval. Also, by the assumption of proportionality, the value of R^i, in the age interval is equal the ratio of the observed decrements from cause i to the decrements for all causes combined.

Also

$$ {}_n^sp_x^i = {}_n^sp_x^{\left(\frac{{}_n^sD_x^i}{{}_n^sD_x}\right)} \tag{8} $$

3. Results and Discussion

We have used a single decrement life table for all causes of deaths combined (Rangoli and Talawar, 2023) [10] to construct different columns for each causes of death. In the construction, we have calculated cause-specific deaths and then carried out the analysis for senescent and non-senescent mortality (Source of data: https://vizhub.healthdata.org/gbd-results/). From Table 1 of male population of India, we observe the number of deaths by the cause Malaria (Vector Borne Disease). The highest number of deaths in the population in the age-interval 0-1 i.e., 2316 and lowest number of deaths during the age 85+ i.e., 12 are observed. In the middle age-groups, from 15-20 to 70-75 no much variation of deaths observed. The sudden decline of deaths is noticed after 75+ ages. Similar observations are made in the case female population of India (Table 2).

From Table 6 of male and female population, we observe the number of deaths by the cause cardiovascular disease. The numbers of infant's death for male and female are 505 and 431 respectively. We notice that increase in number of male and female deaths during the age-groups 10-75 and 10-80 for respective populations. Then decline in deaths for both the populations is observed from age 75 and 80. Table 7 gives mortality pattern of non-senescence of male and female population of India for the year 2019. From the table, we observe that the number of infant's death for male and female is 3122 and 3394 respectively. The decrease in number of deaths is observed in the interval 1-5 to 15-20 age-groups for both male and female populations. Then increase in numbers of deaths is observed during the ages 20-80 and 20-85 for respective populations. The decline in deaths for both populations is observed from age 80+ and 85 above. Table 8 gives pattern of senescent mortality of male and female population. We observe from table that number of deaths by the cause senescent mortality and the number of infant's death for male and female population are 2844 and 2687 respectively. We observe that there is an increase in number of deaths from 0-70 and 0-75 age-groups for male and female populations. The decline in number of deaths is observed above the ages 70 and 75 respectively.

Table 1: Life table (cause specific) of male population of India for cause malaria (vector borne disease) for the year 2019

Age x	${}_n^MD_x$ All deaths Male	${}_n^MD_x^i$ Deaths from cause i	${}_n^Mq_x$	${}_n^Mq_x^i$	l_x	${}_n^Md_x^i$	l_x^i
0	369420	2316	0.029996	0.000188	100000	18.80666	171.229
1	53007	2187	0.00429	0.000177	97000.42	17.16643	152.4224
5	38868	2319	0.002956	0.000176	96584.32	17.03741	135.2559
10	37104	1533	0.002652	0.00011	96298.78	10.54903	118.2185
15	55519	429	0.003952	3.05E-05	96043.41	2.929563	107.6695
20	91282	593	0.006811	4.43E-05	95663.84	4.234382	104.7399
25	102893	625	0.008382	5.09E-05	95012.24	4.840114	100.5055
30	132556	551	0.011488	4.77E-05	94215.81	4.497962	95.66543
35	165777	690	0.015826	6.59E-05	93133.47	6.136125	91.16747
40	182082	609	0.020101	6.72E-05	91659.51	6.164014	85.03135
45	232839	654	0.029478	8.28E-05	89817.09	7.439738	78.86733
50	280272	688	0.042636	0.000105	87169.45	9.126521	71.42759
55	373143	941	0.06816	0.000172	83452.86	14.33774	62.30107
60	437850	874	0.094558	0.000189	77764.75	14.68436	47.96333
65	531526	635	0.13845	0.000165	70411.49	11.64734	33.27897
70	559990	645	0.202334	0.000233	60663	14.14637	21.63163
75	525595	160	0.292095	8.87E-05	48388.8	4.291123	7.48526
80	448450	77	0.439822	7.56E-05	34254.7	2.590706	3.194138
85+	384123	12	1	3.14E-05	19188.72	0.603432	0.603432

Table 2: Life table (cause specific) of female population of India for cause malaria (vector borne disease) for the year 2019

Age x	${}_n^FD_x$ All deaths Female	${}_n^FD_x^i$ Deaths from cause i	${}_n^Fq_x$	${}_n^Fq_x^i$	l_x	${}_n^Fd_x^i$	l_x^i
0	358453	2619	0.03196	0.000233	100000	23.34757	196.5383
1	59522	2581	0.005288	0.000229	96804.01	22.195	173.1907
5	38978	1918	0.003245	0.00016	96292.13	15.37553	150.9957
10	34559	1576	0.002712	0.000124	95979.63	11.87395	135.6202
15	57271	488	0.004448	3.79E-05	95719.32	3.628969	123.7462
20	77034	540	0.006126	4.29E-05	95293.54	4.08918	120.1173
25	74987	368	0.006444	3.16E-05	94709.79	2.993711	116.0281
30	79466	372	0.007297	3.42E-05	94099.47	3.215474	113.0344
35	91670	664	0.009202	6.66E-05	93412.83	6.223822	109.8189
40	111187	560	0.01298	6.54E-05	92553.21	6.053339	103.5951
45	131164	490	0.017561	6.56E-05	91351.85	5.997074	97.54174
50	215570	700	0.03374	0.00011	89747.59	9.83743	91.54467
55	251087	814	0.046011	0.000149	86719.47	12.93159	81.70724
60	348737	839	0.073675	0.000177	82729.45	14.65739	68.77565
65	440370	915	0.111405	0.000232	76634.38	17.74614	54.11826
70	495591	838	0.17336	0.000293	68096.94	19.97113	36.37212
75	509070	389	0.254893	0.000195	56291.63	10.96989	16.40099
80	545968	151	0.418479	0.000115	41943.3	4.841125	5.431095
85+	468566	11	1	2.42E-05	24390.92	0.58997	0.58997

Table 3 gives mortality and survival patterns due to chronic respiratory disease for male and female population of India for the year 2019. From the table, we observe that number of deaths by the cause chronic respiratory disease. The numbers of male and female deaths are not observed during an age-interval 0-1. Then from the age- group 5-75 and 5-80, there is a continuous increase in deaths for male and female population. The decline of deaths is noticed after 75+ and 80+ ages for respective populations.

From Table 4 of male and female population of India for the year 2019, we observe that number of deaths by the total cancer, an increase in male and female deaths during the age-group 1-5 to 70-75. Then from age 75+ decline in deaths for both populations is observed.

Table 5 gives mortality and survival pattern of male and female populations due to tuberculosis. We observe the number of infant's death for male and female is 1417 and 1655 respectively. The rise in numbers of male and female deaths is observed during the age-groups 15-55 and 15-70 for respective populations. Then decline in deaths for both populations is observed respectively from 60+ and 75+ ages.

Table 3: Life table of male and female population of India for cause Chronic Respiratory Disease (Airborne disease) for the year 2019

Age x	${}_n^M D_x^i$ Death from cause i	${}_n^M q_x^i$	${}_n^M d_x^i$	l_x^i	${}_n^F D_x^i$ Deaths from cause i	${}_n^F q_x^i$	${}_n^F d_x^i$	l_x^i
0	0	0	0	15894.12	0	0	0	15743.88
1	356	2.88E-05	2.794785	15894.12	237	2.11E-05	2.041159	15743.88
5	141	1.07E-05	1.033123	15891.33	127	1.06E-05	1.018201	15741.83
10	142	1.02E-05	0.978101	15890.3	185	1.45E-05	1.390155	15740.82
15	405	2.88E-05	2.76951	15889.32	593	4.61E-05	4.411674	15739.43
20	873	6.52E-05	6.234476	15886.55	880	7E-05	6.667002	15735.01
25	1209	9.85E-05	9.354621	15880.31	1065	9.15E-05	8.668802	15728.35
30	1961	0.00017	16.01294	15870.96	1709	0.000157	14.7683	15719.68
35	3684	0.000352	32.75713	15854.95	2773	0.000278	26.00293	15704.91
40	5862	0.000647	59.31475	15822.19	4593	0.000536	49.62432	15678.91
45	11128	0.001409	126.5346	15762.88	7648	0.001024	93.54711	15629.28
50	20934	0.003185	277.598	15636.34	16500	0.002582	231.7726	15535.74
55	36604	0.006686	557.9785	15358.74	24337	0.00446	386.7318	15303.96
60	58534	0.012641	983.0232	14800.76	44042	0.009304	769.7415	14917.23
65	87038	0.022671	1596.321	13817.74	64131	0.016224	1243.303	14147.49
70	107417	0.038812	2354.435	12221.42	88313	0.030892	2103.676	12904.19
75	108231	0.060149	2910.515	9866.985	93321	0.046726	2630.277	10800.51
80	99408	0.097496	3339.689	6956.47	116748	0.089486	3753.336	8170.234
85+	72401	0.188485	3616.781	3616.781	84852	0.181088	4416.899	4416.899

Table 4: Life table of male and female population of India for cause Total Cancer for the year 2019

Age x	${}_n^M D_x^i$ Deaths from cause i	${}_n^M q_x^i$	${}_n^M d_x^i$	l_x^i	${}_n^F D_x^i$ Deaths from cause i	${}_n^F q_x^i$	${}_n^F d_x^i$	l_x^i
0	922	7.48E-05	7.484998	9332.202	601	5.35789E-05	5.357892	9315.833
1	1804	0.000146	14.16269	9324.717	1536	0.000136461	13.20999	9310.475
5	2099	0.00016	15.42085	9310.555	1739	0.000144817	13.94475	9297.265
10	2182	0.000156	15.01893	9295.134	1999	0.000156861	15.05545	9283.32
15	2729	0.000194	18.65988	9280.115	2815	0.000218638	20.92785	9268.265
20	4341	0.000324	30.98738	9261.455	4748	0.000377573	35.98032	9247.337
25	5104	0.000416	39.50658	9230.468	6122	0.000526101	49.82694	9211.357
30	7747	0.000671	63.25303	9190.961	9170	0.000842036	79.23513	9161.53
35	12146	0.00116	107.9951	9127.708	14947	0.001500418	140.1583	9082.295
40	17578	0.00194	177.8613	9019.713	23147	0.002702269	250.1036	8942.136
45	27104	0.003431	308.2003	8841.852	30231	0.004047551	369.7513	8692.033
50	36744	0.00559	487.2468	8533.651	46962	0.007350308	659.6724	8322.281
55	50546	0.009233	770.5067	8046.405	48965	0.008972639	778.1025	7662.609
60	59230	0.012791	994.7175	7275.898	55225	0.011666892	965.1955	6884.507
65	66911	0.017429	1227.184	6281.18	57542	0.014556864	1115.556	5919.311
70	62496	0.022581	1369.83	5053.997	54026	0.01889847	1286.928	4803.755
75	51211	0.02846	1377.144	3684.166	44239	0.02215065	1246.896	3516.827
80	35002	0.034329	1175.912	2307.022	35033	0.026852324	1126.275	2269.931
85+	22643	0.058947	1131.11	1131.11	21970	0.046888584	1143.656	1143.656

Table 5: Life table of male and female population of India for cause Tuberculosis (TB) for the year 2019

Age x	${}_n^M D_x^i$ Deaths from cause i	${}_n^M q_x^i$	${}_n^M d_x^i$	l_x^i	${}_n^F D_x^i$ Deaths from cause i	${}_n^F q_x^i$	${}_n^F d_x^i$	l_x^i
0	1417	0.000115	11.50549	4742.828	1655	0.000148	14.75584	2858.629
1	976	7.9E-05	7.660748	4731.322	985	8.75E-05	8.4741	2843.873
5	512	3.89E-05	3.760494	4723.662	750	6.24E-05	6.011939	2835.399
10	801	5.72E-05	5.513015	4719.901	905	7.1E-05	6.815374	2829.387
15	2143	0.000153	14.64995	4714.388	2351	0.000183	17.4798	2822.572
20	4793	0.000358	34.21697	4699.738	4025	0.00032	30.50017	2805.092
25	7943	0.000647	61.48495	4665.521	5148	0.000442	41.89969	2774.592
30	12383	0.001073	101.1076	4604.036	6645	0.00061	57.41901	2732.692
35	16998	0.001623	151.1329	4502.929	7652	0.000768	71.75763	2675.273
40	18951	0.002092	191.7545	4351.796	8918	0.001041	96.35297	2603.515
45	22905	0.0029	260.4572	4160.041	8196	0.001097	100.2456	2507.162
50	24464	0.003722	324.4084	3899.584	13457	0.002106	189.0315	2406.917
55	29223	0.005338	445.4628	3575.176	13293	0.002436	211.2384	2217.885
60	28750	0.006209	482.8278	3129.713	13488	0.00285	235.7396	2006.647
65	28612	0.007453	524.7655	2646.885	14523	0.003674	281.5515	1770.907
70	26601	0.009611	583.0518	2122.12	14893	0.005209	354.751	1489.356
75	20358	0.011314	547.4625	1539.068	13466	0.006742	379.5327	1134.605
80	15943	0.015636	535.6071	991.6053	12757	0.009778	410.1319	755.0721
85+	9128	0.023764	455.9982	455.9982	6627	0.014142	344.9402	344.9402

Table 6: Life table of male and female population of India for cause Cardio Vascular Disease (CVD) for the year 2019

Age x	${}_{n}^{M}D_x^i$ Deaths from cause i	${}_{n}^{M}q_x^i$	${}_{n}^{M}d_x^i$	l_x^i	${}_{n}^{F}D_x^i$ Deaths from cause i	${}_{n}^{F}q_x^i$	${}_{n}^{F}d_x^i$	l_x^i
0	505	4.1E-05	4.100575	31731.3	431	3.84E-05	3.842794	29282.21
1	364	2.94E-05	2.856011	31727.2	407	3.62E-05	3.504094	29278.36
5	312	2.38E-05	2.295661	31724.35	527	4.39E-05	4.225273	29274.86
10	684	4.89E-05	4.709638	31722.05	976	7.66E-05	7.354409	29270.63
15	3071	0.000219	20.9952	31717.34	3433	0.000267	25.52467	29263.28
20	7417	0.000553	52.94643	31696.35	5878	0.000467	44.54304	29237.75
25	10781	0.000878	83.4465	31643.4	7319	0.000629	59.56994	29193.21
30	21049	0.001824	171.8679	31559.95	10729	0.000985	92.705	29133.64
35	33762	0.003223	300.1861	31388.08	15610	0.001567	146.3773	29040.94
40	46399	0.005122	469.4935	31087.9	25526	0.00298	275.8077	28894.56
45	70455	0.00892	801.1589	30618.41	35215	0.004715	430.711	28618.75
50	98644	0.015006	1308.082	29817.25	63582	0.009952	893.1369	28188.04
55	139448	0.025472	2125.722	28509.16	81597	0.014952	1296.646	27294.9
60	161655	0.034911	2714.847	26383.44	116473	0.024606	2035.66	25998.26
65	191726	0.04994	3516.369	23668.6	148729	0.037625	2883.404	23962.6
70	193580	0.069944	4243.004	20152.23	159999	0.055969	3811.284	21079.19
75	177888	0.09886	4783.71	15909.22	167252	0.083743	4714.056	17267.91
80	143789	0.141023	4830.701	11125.51	162177	0.124307	5213.85	12553.85
85+	126011	0.328047	6294.81	6294.81	141006	0.300932	7340.003	7340.003

Table 7: Life table of male and female population of India for Non-senescent Mortality for the year 2019

Age x	${}_{n}^{M}D_x^i$ Deaths from cause i	${}_{n}^{M}q_x^i$	${}_{n}^{M}d_x^i$	l_x^i	${}_{n}^{F}D_x^i$ Deaths from cause i	${}_{n}^{F}q_x^i$	${}_{n}^{F}d_x^i$	l_x^i
0	3122	0.000254	25.35062	16321.14	3394	0.000284	28.40233	15516.54
1	2666	0.000216	20.92909	16295.79	2942	0.000212	20.56735	15488.14
5	2709	0.000206	19.90111	16274.86	2242	0.00017	16.42008	15467.57
10	1899	0.000136	13.07155	16254.96	1949	0.00015	14.40316	15451.15
15	1400	9.97E-05	9.573853	16241.89	1814	0.000125	12.02316	15436.75
20	2294	0.000171	16.37422	16232.32	2683	0.000237	22.69502	15424.72
25	3800	0.00031	29.4119	16215.94	3849	0.00043	40.88319	15402.03
30	6119	0.00053	49.95901	16186.53	5499	0.000795	74.89347	15361.15
35	8657	0.000826	76.96942	16136.57	6862	0.001185	110.3381	15286.25
40	10572	0.001167	106.9708	16059.6	8171	0.001477	135.3901	15175.91
45	15320	0.00194	174.2085	15952.63	10457	0.00235	211.0839	15040.52
50	24072	0.003662	319.2097	15778.42	19026	0.003763	328.0156	14829.44
55	38786	0.007085	591.246	15459.21	25968	0.007049	588.2847	14501.42
60	60052	0.012969	1008.515	14867.97	45323	0.012289	955.6555	13913.14
65	87964	0.022913	1613.309	13859.45	65252	0.020515	1444.483	12957.48
70	108163	0.039081	2370.779	12246.14	89214	0.036423	2209.54	11513
75	108420	0.060253	2915.583	9875.366	93724	0.053777	2602.204	9303.461
80	99488	0.097574	3342.353	6959.783	116901	0.094174	3225.887	6701.257
85+	72414	0.188519	3617.43	3617.43	84864	0.181115	3475.37	3475.37

Table 8: Life table of male and female population of India for Senescent Mortality for the year 2019

Age x	${}_{n}^{M}D_x^i$ Deaths from cause i	${}_{n}^{M}q_x^i$	${}_{n}^{M}d_x^i$	l_x^i	${}_{n}^{F}D_x^i$ Deaths from cause i	${}_{n}^{F}q_x^i$	${}_{n}^{F}d_x^i$	l_x^i
0	2844	0.000231	23.09106	46566.36	2687	0.000218	21.81681	40467.43
1	3144	0.000254	24.67945	46543.27	2929	0.000237	22.99205	40445.62
5	2938	0.000223	21.5828	46518.59	3034	0.000231	22.29037	40422.62
10	3695	0.000264	25.43438	46497.01	3919	0.00028	26.97368	40400.33
15	8041	0.000572	54.97422	46471.58	8674	0.000617	59.30261	40373.36
20	16759	0.001251	119.6292	46416.6	14817	0.001106	105.7714	40314.06
25	24221	0.001973	187.477	46296.97	18797	0.001531	145.4934	40208.29
30	41969	0.003637	342.6806	46109.5	26918	0.002333	219.7854	40062.79
35	64490	0.006157	573.3903	45766.82	38726	0.003697	344.3171	39843.01
40	85319	0.009419	863.3127	45193.42	58590	0.006468	592.8454	39498.69
45	123897	0.015686	1408.855	44330.11	75102	0.009508	854.0021	38905.85
50	164436	0.025015	2180.525	42921.26	126204	0.019199	1673.548	38051.84
55	224747	0.041053	3426.002	40740.73	146358	0.026734	2231.047	36378.29
60	255378	0.055151	4288.826	37314.73	188399	0.040687	3163.985	34147.25
65	292956	0.076308	5372.974	33025.9	223946	0.058333	4107.294	30983.26
70	287110	0.103738	6293.039	27652.93	231690	0.083714	5078.316	26875.97
75	252743	0.14046	6796.675	21359.89	227434	0.126395	6116.079	21797.65
80	196644	0.192861	6606.39	14563.22	211979	0.207901	7121.572	15681.57
85+	159281	0.414662	7956.826	7956.826	171356	0.446096	8560.002	8560.002

Table 9: Proportion of decrement $i$in the age interval for Non-senescent and Senescent mortality

Age x	${}^{M}_{NS}R^{i}_{x}$	${}^{M}_{S}R^{i}_{x}$	${}^{F}_{NS}R^{i}_{x}$	${}^{F}_{S}R^{i}_{x}$
0	0.008451	0.007698	0.009469	0.007273
1	0.050298	0.059311	0.049429	0.055256
5	0.069698	0.075587	0.057507	0.078066
10	0.051185	0.099595	0.0564	0.105623
15	0.025223	0.144834	0.031676	0.156238
20	0.025129	0.183593	0.03483	0.162326
25	0.03693	0.235396	0.051333	0.182682
30	0.046158	0.316611	0.069196	0.203065
35	0.05222	0.389014	0.074858	0.233601
40	0.05806	0.468576	0.073485	0.321776
45	0.065797	0.532116	0.079725	0.322551
50	0.085888	0.586701	0.088257	0.450292
55	0.103944	0.602309	0.103423	0.39223
60	0.137152	0.583255	0.129963	0.430283
65	0.165493	0.55116	0.148175	0.421326
70	0.193151	0.512705	0.180015	0.413739
75	0.20628	0.48087	0.184108	0.432718
80	0.221848	0.438497	0.214117	0.472692
85+	0.188519	0.414662	0.181115	0.446096

Table 9 shows proportion of decrement for non-senescent and senescent mortality of male and female population. Highest proportion of decrement is observed in age 80 whereas lowest is observed in infants for both populations. The lowest proportion of decrement is observed in infants of non-senescent mortality. In case of senescent highest proportion is observed in age 55 for males and age 80 for females.

Figure 1 gives the proportion of male and female population aged x die from various causes. We observe that newborns will eventually die from causes combined due to non-senescent for males are more as compared to causes combined due to that for females. Figure 2 gives the proportion of male and female population aged x die from various causes. Thus the proportion of male/female who survives to age x will die from cause senescent for males are more as compared to cause senescent for females. From tables 1 to 6, we have the state of interest is being alive and decrements from that state are attributed to cause i and all other causes of death. Figure 3 and Figure 4 gives change in the distribution of deaths in non-senescent and senescent by age for male and female populations respectively. The deaths in senescent are more compared to non-senescent for both male and female populations. Figure 5 and Figure 6 give the non-senescent and senescent mortality for male and female population. In both cases senescent mortality is more compared to non-senescent mortality.

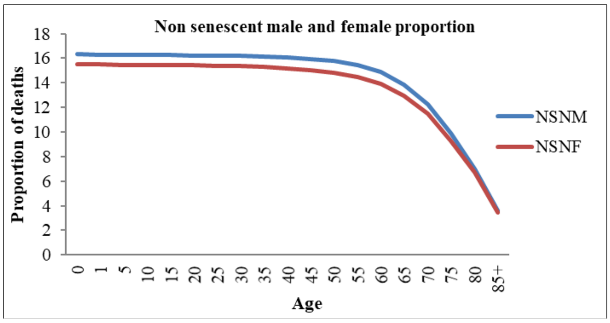

Fig 1: Proportion of male and female population aged x die from various causes

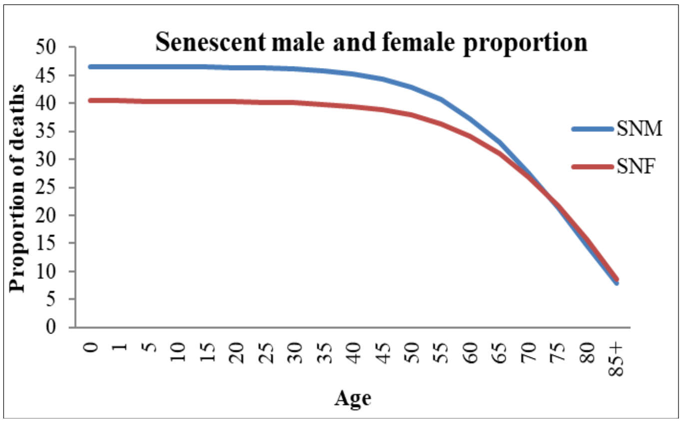

Fig 2: Proportion of female population aged x die from various causes

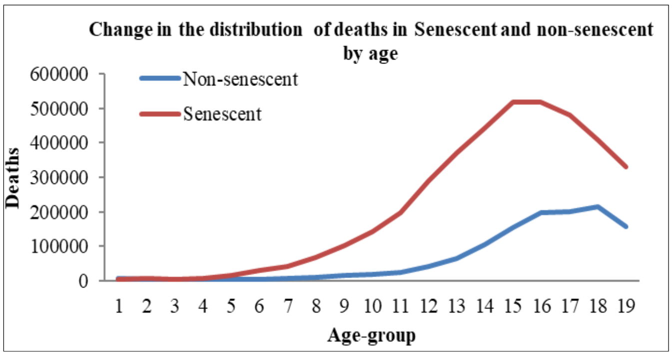

Fig 3: Number of deaths in non-senescent and senescent for male population.

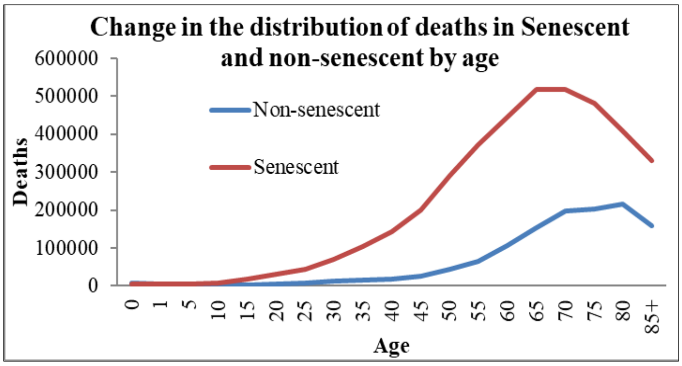

Fig 4: Number of deaths in non-senescent and senescent for female population.

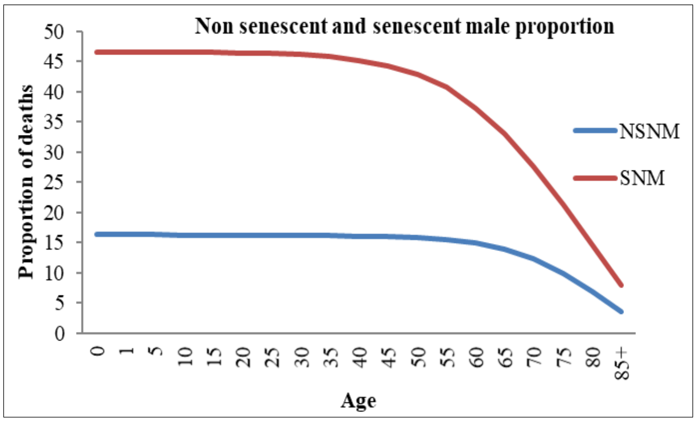

Fig 5: Proportion of male population aged x die from various causes

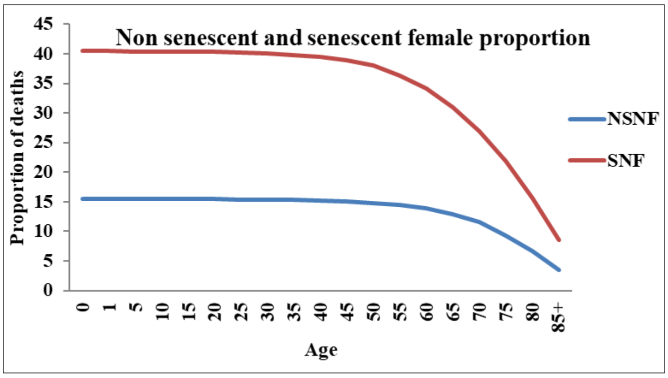

Fig 6: Proportion of female population aged x die from various causes

4. Conclusion

The cause-specific deaths are determined and are used for the analysis of senescent and non-senescent mortality. The senescent mortality highly observed in the age 65 and 70, least for infants for male and female population. In case of non-senescent mortality, deaths are more in the age 75 and 80, least is noticed in the age 15 for both populations. We observe change in the distribution of deaths in non-senescent and senescent by age and the proportion of deaths in senescent is more as compared to that of non-senescent for male and female populations of India.

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