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A demographic approach to competing risks analysis

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Abstract
The analysis of competing risk data is very important to understand the change in the effect of one cause over another. Here, we are considering competing risks analyses using life table methods. Initially, we have constructed an abridged life table for the year 2019, Indian male and female population. And observed that females have a longer life expectancy than males. Also, we have constructed multiple decrement and cause-eliminated life tables for the different causes (malaria, chronic respiratory disease, total cancers, lip and oral cavity cancer, tuberculosis, HIV, and CVD). If we eliminate CVD as a cause of death, then one can get an additional 4.9 years of life. We have also estimated crude, net, and partial crude probabilities. Here we have observed that malaria affects more infants and children's, whereas HIV affects more to adults, and chronic respiratory disease and CVD affects older peoples. For malaria, the crude probability of dying is 0.000188, and the net probability of dying is 0.029811. From this, we can say that in the absence of competing risks, the net probability is high. Hence, it is necessary to study the competing risk approach to understand the effect of one cause in the presence or absence of competing risks. And the gain in life expectancy is also estimated; from that, we can say that the contribution of life expectancy at birth for malaria is from infants and children's, and for total cancers, chronic respiratory disease, and CVD, it is from older ages.

Keywords: Life table, competing risks, multiple decrements, life expectancy, cause elimination, crude and net probability

1. Introduction

Let us consider any subject, whether it is mechanical or biological; it will fail at last. Now the concept is that, though the subject may fail due to one cause, it may be affected by many causes, which are risks. This terminology is said to have competing risks. As causes competing with each other to fail the subject. Here we are considering only the biological aspect, that is, the deaths of humans. More specifically, one can reasonably assume that in the human biosystem, right from the day when a person is born, all the risks that are capable of taking the life of an individual start competing with each other, and a particular risk ultimately succeeds in taking away the life of an individual either in the presence of a subset of the set of risks, depending upon the individual's setup. Now consider the deaths of individuals and the construction of the life table. The life table is a statistical tool that is very helpful to many fields like actuaries, economists, etc. Generally, we have two types of life tables: cohort and current life tables. The construction of the cohort life table is time-consuming, and we also do not get all the data. The use of the current life table nearly gives us the same result as the cohort (Dublin and Spiegelman, 1941) [12], so it has become quite common to use the current life table, which considers the current mortality pattern to calculate the life table.

Many authors worked on the construction of the life table with different methods, like King (1914) [16], Reed and Merrel (1939)[17], Greville (1943) [13], Keyfitz (1966) [15], and Chiang (1968) [6]. Choosing the method is based on the availability of data and the conditions. Using a life table, we can construct multiple-decrement (MD) and associated single-decrement (ASD) life tables, as MD life table provides the probability of dying from a certain cause of death in the presence of other causes and ASD life table answers the questions concerning what would be the life expectancy if certain causes were eliminated (Sharma and Choudhury, 2023) [18]. So, the concept of multiple decrements is nothing but the competing risks where more than two causes act. Also, using life tables, one can construct cause eliminated life tables, and from that, we can see the effect of a change in life expectancy or a gain in life expectancy.Here we are considering causes acts independently.

Many authors (Cornfield, 1957; Chiang, 1960, 1961, 1972, 1978 and 1991; Keyfitz, 1966; Wong, 1977; Arias, and Tejada-Vera, 2023) [11, 4-5, 7-9, 15, 20, 1] also worked on the competing risks using the life table approach with the elimination of some causes. Here we were considering the construction of a life table, a multiple-decrement life table, and competing risks with different probabilities (crude, net, and partial crude).

As cause eliminated life tables are used to assess the change in life expectancy in which a particular cause of death has been hypothetically elimination. Many causes (cardiovascular disease (CVD), cancer, tuberculosis (TB), malaria, chronic respiratory disease, the human immunodeficiency virus and acquired immune deficiency syndrome (HIV/AIDS), etc.) play a major role in human life. In this paper, we are considering these causes as cause of deaths and calculating the overall life expectancy and life expectancy when a specific cause is eliminated, and also the crude, net, and partial crude probabilities of dying.

Description about life expectancy

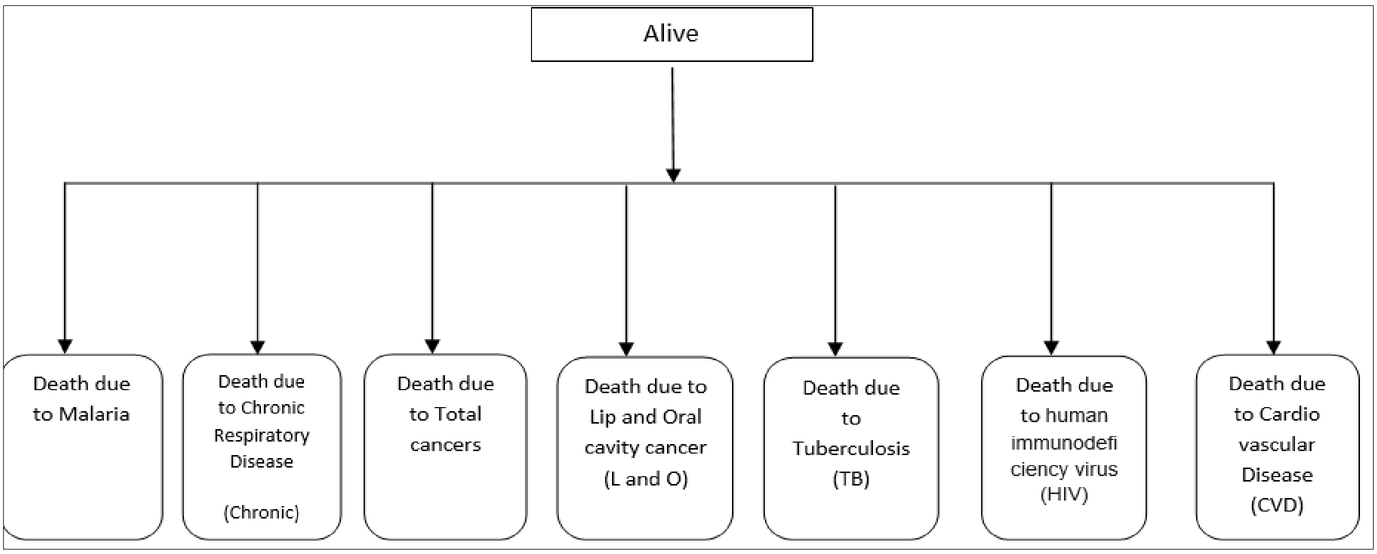
In India life expectancy at birth is about 50.5 and 49 years for male and female respectively in 1970-74. And in 2010, the life expectancy being increasing with 65.4 and 68.8 for male and female respectively and in 2018, 68.8 and 71.4 for male and female respectively (Sample registration survey report 2018). Now we are going to considering 2019 population and deaths.

Description about decrement

Generally, in survival studies of human population, decrement refers as lost. In construction of ordinary life table we are going to consider the loss of an individual is due to death, where we are not considering cause of death. While in construction of decrement life tables we are considering the cause of death of an individual and constructing multiple decrement life table.

Description about elimination

Generally, we see, what is the probability that a person dying from a specific cause. Now the concept of elimination, if we eliminate a specific cause then we can be able to see what will be the life expectancy, either it may be increasing or decreasing. From this we can be able to see how much this cause is affecting the human beings. Below is the flowchart for the causes we were considered.



2. Methods and Materials

The data for the study was collected from IHME, Global Burden, 2019 for India. This dataset contains age and sex wise deaths and populations, and we have considered causes of death such as malaria (m), chronic respiratory disease (CH), tuberculosis (TB), total cancers (TC), lip and oral cavity cancer (LO), HIV/AIDS, and cardiovascular disease (CVD). Now, age-specific and age-cause-specific death rates have to be calculated using the given data. First, we construct an abridged life table using the current life table method for population 2019. Several authors (King, 1914; Reed and Merrell, 1939; Greville, 1943; Sirken, 1964; Keyfitz, 1966; Chiang, 1968; and Coale and Demeny, 1983)[16, 17, 13, 19, 15, 6, 10] derived the formula for calculating the probability of dying through the observed death rate at each age.

2.1 Columns of Life table

1. ${}_nm_x$:Age Specific death rate

$$ {}_nm_x = \frac{{}_nD_x}{{}_nP_x} \quad (1) $$

Where ${}_nD_x$ is the observed number of deaths in the age group $(x, x+n)$ and ${}_nP_x$ is the observed mid-year population.

2. ${}_nq_x$: The probability of dying between the age group $(x, x+n)$

$$ {}_nq_x = \frac{n\,{}_nm_x}{1+(n-{}_na_x)\,{}_nm_x} \quad (2) $$

Where n is the length of the interval,

${}_na_x$: Fraction of years lived by l_x individuals in age group $(x, x+n)$

For the conversion of ${}_nm_x$ into ${}_nq_x$ we use the (2) equation, now the concept is to calculate the ${}_na_x$ values, in literature we have lot of methods to calculate the ${}_na_x$values *viz*, Reed and Merrel (1939) [17], Chiang (1968) [6], etc, here we are using Keyfitz (1966) [15] method that is (3).

$$_na_x = \frac{-\frac{n}{24}{_nd_{x-n}}+\frac{n}{2}{_nd_x}+\frac{n}{24}{_nd_{x+n}}}{_nd_x} \quad (3)$$

This method is applicable if we have equal width of interval 5. For less than 5 year age group Coale and Demeny (1983) [10] had given the standard values for calculation of $_na_x$.
In equation (3), $_nd_x$ is the number of people died in the cohort of age group $(x, x+n)$ which can be calculated using $_nq_x$. So to solve this circulatory problem, iteration procedure must use. Initially $_na_x$ is taken as $n/2$, to calculate $_nq_x$ through $_nm_x$, then one can get first set of $_nd_x$. Using these $_nd_x$ set, new set of $_na_x$ can be calculated using equation (3). This process is repeated until a stable $_na_x$ and $_nd_x$ values are obtained. Two to three iterations are sufficient to get stable values. For $_1a_0$ and $_4a_1$ adopted Coale and Demeny (1983) [10] formulas given below,

$_na_x$	$_nm_x$	Male	Female
$_1a_0$	$If\ _1m_0 \geq 0.107$	0.33	0.35
$_1a_0$	$If\ _1m_0 < 0.107$	$0.045 + 2.684\ _1m_0$	$0.053 + 2.8\ _1m_0$
$_4a_1$	$If\ _1m_0 \geq 0.107$	1.352	1.361
$_4a_1$	$If\ _1m_0 \geq 0.107$	$1.651 - 2.816\ _1m_0$	$1.522 - 1.518\ _1m_0$

3. $_np_x$: The probability that a person survive in the age group $(x, x+n)$

$$_np_x = 1 - {_nq_x} \quad (4)$$

4. l_x : Number of persons surviving in a cohort with age $(x, x+n)$ Initially l_0 is the radix of the life table, taken as 100000.

5. $_nd_x$: Number of persons died in the age interval $(x, x+n)$ of the cohort

$$_nd_x = {_nq_x}\ l_x \quad (5)$$

6. $_nL_x$: The average number of persons-years lived by l_x individuals in the age interval (x, x+n)

$$_nL_x = n(l_x - {_nd_x}) + {_na_x}{_nd_x} \quad (6)$$

For the open interval

$$_wL_x = \frac{_wd_x}{_wm_x} \quad (7)$$

where w is the maximum age attained by an individual.

And also $_wq_x = 1,\ _wp_x = 0$ (8)

7. Total number of persons-years lived after the age x i,e, total number of years lived by the cohort after age x.

$$T_x = \sum_{a=x}^{w} {_nL_a} \quad (9)$$

8. e_x : the number of years can be expected to live by the person aged x

$$e_x = \frac{T_x}{l_x} \text{ and} \quad (10)$$

$$e_w \cong \frac{1}{_wm_x} \quad (11)$$

$$_wL_x = T_w = l_w e_w \quad (12)$$

Using these equations we can construct ordinary life table for males and females.

2.2 Multiple Decrement life table

Now we can consider the probability of dying for a specific cause i in the age group $(x, x+n)$ given by,

$$_nq_x^i = {_nq_x}\frac{_nD_x^i}{_nD_x} \quad (13)$$

Where $_nD_x^i$ is the observed number of deaths in the age group $(x, x+n)$ from cause i.

$_nm_x^i$: is the age cause specific death rate given by,

$$_nm_x^i = \frac{_nD_x^i}{_nP_x} \quad (14)$$

$_nd_x^i$: is the number of deaths in the age group $(x, x+n)$ in a given cohort

$$_nd_x^i = {_nd_x}\frac{_nD_x^i}{_nD_x} \quad (15)$$

l_x^i : Number of persons reaching age x which will eventually die from the specific cause i.

$$l_x^i = \sum_{a=x}^{w} {_nd_a^i} \quad (16)$$

2.3 Cause Elimination life table

Here we are eliminating certain diseases, and checking the change in life expectancy. This table considers mortality experience due a specific cause (s) i,e, people have been exited from the cohort by a specific cause (s).
In constructing the associated single decrement life table, the constant of proportionality for decrement other than specific cause in the age group $(x, x+n)$, $_nR_x^{-i}$ is computed using below formula, here $-i$ refers as this cause is eliminated.

$$_nR_x^{-i} = 1 - \frac{_nD_x^i}{_nD_x} \quad (17)$$

The probability of surviving between the age group $(x, x+n)$ in absence of specific cause i can be estimated using following formula (Chiang 1978) [8]

$$_np_x^{-i} = (_np_x)^{_nR_x^{-i}} \quad (18)$$

And probability of dying between the age group $(x, x+n)$ in absence of specific cause i is given by,

$$_nq_x^{-i} = 1 - {_np_x^{-i}} \quad (19)$$

Now fraction of years lived by l_x individuals when cause i is eliminated is given by $_na_x^{-i}$,

Age	$_na_x^{-i}$
For age 0-10	$_na_x^{-i} = n + {_nR_x^{-i}}\frac{_nq_x}{_nq_x^{-i}}(_na_x - n)$
For age > 10	$_5a_x^{-i} = \frac{-\frac{5}{24}{_5d_{x-5}^{-i}} + \frac{5}{2}{_5d_x^{-i}} + \frac{5}{24}{_5d_{x+5}^{-i}}}{_5d_x^{-i}}$

And the remaining columns of life table can be calculated using below formulas,

$${}_nd_x^{-i} = {}_nq_x^{-i}l_x^{-i} \quad (20)$$

$${}_nL_x^{-i} = n(l_x^{-i} - {}_nd_x^{-i}) + {}_na_x^{-i}{}_nd_x^{-i} \quad (21)$$

$$e_w^{-i} = \frac{e_w}{{}_wR_x^{-i}} \quad (22)$$

$$T_x^{-i} = \sum_{a=x}^{w} {}_nL_a^{-i} \quad (23)$$

$$e_w^{-i} = \frac{T_x^{-i}}{l_x^{-i}} \quad (24)$$

$$T_w^{-i} = {}_wL_x^{-i} = e_w^{-i} * l_w^{-i}$$

2.4 Competing risk approach

Generally competing risks means their exist more than two causes of failure. Here we can see the effect of one cause in presence and absence of the other causes (Chiang, 1960) [4]. The study of survival and the applications of life table methodology requires understanding of these below probabilities.

a) **The Crude Probability:** The probability of deaths from a specific cause in presence of all other risks acting in a population. $Q_{x\delta} = p$(an individual alive at time $x$will die in the interval $(x, x+n)$ from cause δ in the presence of all other risks in the population)

$$Q_{x\delta} = \frac{d_{x\delta}}{l_x} \qquad \delta = 1,2,\dots,r \quad (25)$$

$$Q_{x1} + Q_{x2} + \cdots + Q_{xr} = q_x \quad (26)$$

b) **The Net Probability:** The probability of death if a specific risk is the only risk in effect in the population or conversely, the probability of death if a specific risk is eliminated from the population.

$q_{x\delta} = p$ (an individual alive at $x$will die in the interval $(x, x+n)$ if δ is the only risk acting on the population);
$q_{x.\delta} = p$ (an individual alive at $x$will die in the interval $(x, x+n)$ if δ is eliminated as a risk death)

$$q_{x\delta} = 1 - p_x^{\frac{Q_{x\delta}}{q_x}} \quad (27)$$

$$q_{x.\delta} = 1 - p_x^{1-\frac{Q_{x\delta}}{x}} \quad (28)$$

c) **The partial crude probability:** The probability of death from a specific cause when another risk (risks) is eliminated from the population.

$Q_{x\delta.1} = p$ (an individual alive at x will die in the interval $(x, x+n)$ from δ if cause 1 is eliminated from the population)
$Q_{x\delta.12} = p$ (an individual alive at x will die in the interval $(x, x+n)$ from δ if cause 1 and cause 2 is eliminated from the population)

$$Q_{x\delta.1} = \frac{Q_{x\delta}}{q_x - Q_{x1}} q_{x.1} \quad (29)$$

$$Q_{x\delta.1} = \frac{Q_{x\delta}}{q_x - Q_{x1}}\left(1 - p_x^{1-\frac{Q_{x1}}{q_x}}\right) \quad (30)$$

$$\sum_{\delta=2}^{r} Q_{x\delta.1} = q_{x.1} \quad (31)$$

$$Q_{x\delta.12} = \frac{Q_{x\delta}}{q_x - Q_{x1} - Q_{x2}}\left(1 - p_x^{\frac{q_x - Q_{x1} - Q_{x2}}{q_x}}\right) \quad (32)$$

Note
1. Generally$q_{x\delta} > Q_{x\delta}$, Because of the absence of the competing risks, net probability is always greater than the corresponding crude probability.
2. If two risk 1 and 2 are such that $Q_{x1} > Q_{x2}$. Then $q_{x1} > q_{x2}$ and $q_{x.1} < q_{x.2}$.

From these concepts we can be able to see the effect of one cause in presence and absence of other causes.

2.5 Decomposition of life expectancy (DLE) at birth difference

When a specific cause is eliminated from the decrement process, there has been change in the mortality in the all age groups that can be lead to gain or loss in the life expectancy. The difference in the life expectancy at birth with the presence and absence of the specific cause i.e. gain at birth can be decomposed into specific age groups to determine which age groups probably most contributed to the total gain using the procedure proposed by Arriaga, 1984 [2].

$${}_nDLE_x = \frac{l_x}{l_0}\left(\frac{{}_nL_x^{-i}}{l_x^{-i}} - \frac{{}_nL_x}{l_x}\right) + \frac{T_{x+n}^{-i}}{l_0}\left(\frac{l_x}{l_x^{-i}} - \frac{l_{x+n}}{l_{x+n}^{-i}}\right) \quad (33)$$

The first term at the right side of the equation refers to the direct effect of a change in mortality rates between ages $x$and $x + n$ that consequence to change in the life years within the specific age group, whereas the second term refers to the sum of both the indirect and interaction effects of contributions resulting from the number of person-years to be added because of additional survivors at age $x + n$exposed to the new mortality conditions. The equation used for the open-ended interval is as follows

$${}_wDLE_x = \frac{l_x}{l_0}\left(\frac{T_x^{-i}}{l_x^{-i}} - \frac{T_x}{l_x}\right) \quad (34)$$

2.6 Gain in Life expectancy

The gain in life expectancy (Chiang 1991)[9] is given by

$$Gain = \frac{\widehat{e_{x.J}} - \widehat{e_x}}{\widehat{e_x}} * 100 \quad (35)$$

Where $\widehat{e_x}$ is total life expectancy at age $(x, x+n)$
$\widehat{e_{x.J}}$ is the life expectancy at age $(x, x+n)$ after eliminating cause J.

3. Results and Discussions

As we have estimated life expectancy for male and female. And also calculated crude, net and partial crude probability, which can be given in below.

Table 1 explains the abridged life table for the 2019 male population. We considered deaths and population for the year 2019 and calculated an age-specific death rate. Now the important aspect is the calculation of the fraction of years lived by l_x individuals i,e, ${}_na_x$. We have used the Keyfitz (1966) [15] method for the calculation of the ${}_na_x$ which can be calculated using current population and deaths, and we compared it with Chiang (1968, 1972) [6-7] constants; they are similar. And for the infant and child, we have used Coale and Demeny (1983) [10] values. From Table 1, we can say the life expectancy at birth is 69.63 years for the 2019 male population. Table 2 explains the life expectancy of males and females, in which we can see that females have a higher life expectancy as compared to males, as shown in Figure 1. The life expectancy of a female at birth is 72.24 years, whereas that of a male is 69.63 years; hence, we can say females have a higher life expectancy than males.

Figures 2 and 3 show the life expectancy of males and females in total, and after eliminating the specified causes, here we can observe that if we eliminate all seven causes, we have a high life expectancy compared to the rest.

Table 3 explains life expectancy after eliminating the specified causes. Here, we can say the life expectancy at birth for males is 69.63. After eliminating the causes of malaria, chronic respiratory diseases, total cancers, lip and oral cavity cancer, tuberculosis (TB), HIV, and CVD, the life expectancy becomes 69.7, 71.45, 71, 69.8, 70.5, 69.6, and 74.6, respectively. From this, we can say that if we eliminate CVD as a cause of death, then the person will live 4.9 additional years. And if we eliminate malaria, lip and oral cavity cancer, and HIV, we can see there is not much difference in life expectancy. Similarly, Table 4 explains the life expectancy for females in that if we eliminate diseases like chronic respiratory disease and CVD, then they will get an additional 1.8 and 4.31 years. From this, we can say CVD affects more male than female populations. And if we eliminate all seven selected causes, the male population will have an additional 14.7 years of life, while females will have 12.4 additional years of life. From this, we can say these selected causes affect more males than females.

Table 5 explains the competing risks approach. Here, we can say the crude probability of dying for the specific cause of malaria is 0.000188, which is acting in the presence of all causes. And for people aged 50 and older, we can see that CVD and chronic respiratory diseases have a high impact. From this, we can say that older people are more affected by CVD and chronic respiratory diseases.

From Table 6, we can see the net probability when a specified cause was eliminated. The probability of dying at birth is 0.0299996. When we eliminate malaria and TB, we can see a slight decrease in the probability of dying, i.e., 0.029811 and 0.029882, respectively. And at age 50, the probability of dying in the presence of all causes is 0.042636, and in the absence of chronic respiratory disease, total cancers, TB, and CVD is 0.039516, 0.037152, 0.038988, and 0.027842. From this, we can say that for people aged 50 and older, these causes were affecting them more. Similarly, at age 80, the probability of dying is 0.439822, and in the absence of chronic respiratory disease and CVD, it is 0.363036 and 0.325438. From this, we can say these two causes were affecting more people aged 80 and older. Here, we can say that in the absence of competing risks, the effect changes.

Table 7 explains the partial crude probability when malaria and chronic respiratory disease are eliminated. This table considers the probability of dying for different causes when malaria is eliminated. Here we see that if we eliminate malaria as a risk of death, then it will not be affected by the rest of the selected causes. This can be seen in Figure 4. Similarly, if we eliminate chronic respiratory disease, we can see that at ages 80 and older, the probability of dying increases for the rest of the selected causes. And similarly, tables 8, 9, and 10 explain the probability of dying in the absence of total cancer, CVD, chronic respiratory disease, lip and oral cavity cancer, TB, HIV, and CVD, respectively. If we eliminate these causes, we cannot see much change in younger and middle-aged people, i.e., people aged 0–75; only those people get affected by these causes whose age is 80+.

Figure 4 explains the crude and partial crude probabilities of dying with respect to the specified causes. Here we can say, as earlier explained, that the probability of dying is changing after 80+ years.

Similarly, figure 5 explains the effect on specified causes when each of the causes is eliminated separately and compared with the crude probability of the respective specific cause. This figure can be used to show the effect on a specified cause when the rest of the causes are eliminated separately. From this figure, we can say that in the absence of CVD, the probability of dying for the causes of chronic respiratory disease, total cancers, lip and oral cavity cancer, and TB, i.e., plots (b), (c), (d), and (e), has increased after age 80+. From this, we can say that the contribution of CVD causes is greater at older ages.

From tables 5 and 6, for malaria, the crude probability of dying is 0.000188, and the net probability of dying is 0.029811. From this, we can say that in the absence of competing risks, the net probability is high.

Table 11 explains the decomposition of life expectancy at birth. The gain in life expectancy at birth when CVD is eliminated is 4.9 years, which means a person gains 4.9 years more life if they were not affected by CVD. This gain in life expectancy can be decomposed using the equation (33). And after decomposition, we can see that the majority of the gain is from older people, which means older people get affected more. Similarly, when we consider malaria, infants and children's lives contribute more to life expectancy; from this, we can say this cause has a high impact on these ages.

Table 12 explains the percentage gain in life expectancy when the specific causes are eliminated. In the absence of CVD, there will be a 10.7% increase in life expectancy when compared with the presence of CVD at age 25. Similarly, in the absence of chronic respiratory disease at age 80+, life expectancy increases by 21.4% as compared to the presence of the disease.

Table 1: Abridged Life table for the 2019 Male population

Life table for the year 2019 male population												
Age	**Deaths**	**Population**	${}_n m_x$	**n**	${}_n a_x$	${}_n q_x$	${}_n p_x$	l_x	${}_n d_x$	${}_n L_x$	T_x	e_x
0	369420	11993458	0.030802	1	0.127672	0.029996	0.970004	100000	2999.581	97383.38	6963748	69.63748
1	53007	49297885	0.001075	4	1.564262	0.00429	0.99571	97000.42	416.1023	386988.2	6866364	70.78695
5	38868	65635178	0.000592	5	2.382731	0.002956	0.997044	96584.32	285.5342	482174.3	6479376	67.08518
10	37104	69866695	0.000531	5	2.57671	0.002652	0.997348	96298.78	255.3774	480875.1	5997202	62.27703
15	55519	70114405	0.000792	5	2.717475	0.003952	0.996048	96043.41	379.5669	479350.7	5516327	57.43577
20	91282	66791032	0.001367	5	2.633283	0.006811	0.993189	95663.84	651.5998	476777	5036976	52.65287
25	102893	61128585	0.001683	5	2.612674	0.008382	0.991618	95012.24	796.432	473159.9	4560199	47.99591
30	132556	57379910	0.00231	5	2.630413	0.011488	0.988512	94215.81	1082.339	468514.3	4087039	43.37955

35	165777	51977488	0.003189	5	2.607432	0.015826	0.984174	93133.47	1473.956	462140.8	3618525	38.85311
40	182082	44861492	0.004059	5	2.632716	0.020101	0.979899	91659.51	1842.418	453936	3156384	34.43597
45	232839	38945612	0.005979	5	2.647471	0.029478	0.970522	89817.09	2647.647	442856.8	2702448	30.08835
50	280272	32214831	0.0087	5	2.670434	0.042636	0.957364	87169.45	3716.583	427189.2	2259591	25.92183
55	373143	26489551	0.014086	5	2.633197	0.06816	0.93184	83452.86	5688.115	403801.7	1832402	21.95733
60	437850	22108242	0.019805	5	2.615039	0.094558	0.905442	77764.75	7353.264	371286.5	1428600	18.3708
65	531526	17922640	0.029657	5	2.605164	0.13845	0.86155	70411.49	9748.488	328711.4	1057314	15.01621
70	559990	12479957	0.044871	5	2.574439	0.202334	0.797666	60663	12274.2	273543.2	728602.4	12.01066
75	525595	7704638	0.068218	5	2.541149	0.292095	0.707905	48388.8	14134.11	207190.3	455059.2	9.404226
80	448450	4008303	0.11188	5	2.569896	0.439822	0.560178	34254.7	15065.97	134661.6	247868.9	7.236056
85+	384123	2266204	0.169501	-		1	0	19188.72	19188.72	113207.3	113207.3	5.89968

Table 2: Life Expectancy of Male and Female population in year 2019

Life Expectancy of Male and Female for year 2019		
Age	**Male Life Expectancy**	**Female Life Expectancy**
0	69.6375	72.24591
1	70.787	73.62689
5	67.0852	70.0104
10	62.277	65.23075
15	57.4358	60.4011
20	52.6529	55.6591
25	47.9959	50.98634
30	43.3795	46.30059
35	38.8531	41.622
40	34.436	36.9842
45	30.0883	32.436
50	25.9218	27.96687
55	21.9573	23.85041
60	18.3708	19.87241
65	15.0162	16.24175
70	12.0107	12.94711
75	9.40423	10.11654
80	7.23606	7.693529
85+	5.89968	6.345157

Table 3: Life expectancy of male population after eliminating the causes.

Life expectancy after eliminating the causes										
Age	**Total**	**Malaria**	**Chronic respiratory diseases**	**Total cancers**	**Lip and oral cavity cancer**	**TB**	**HIV**	**CVD**	**Rest**	**Combined 7**
0	69.63748	69.70538	71.45478	70.99805	69.75514	70.4465	69.7222	74.58158	78.65059	84.33417
1	70.78695	70.84326	72.66045	72.18405	70.90825	71.61252	70.86953	75.88075	77.68921	85.89542
5	67.08518	67.12939	68.96469	68.47791	67.207	67.90873	67.16741	72.19872	73.72509	82.21884
10	62.27703	62.30989	64.16139	63.66329	62.39914	63.10046	62.35827	67.40406	68.75578	77.42112
15	57.43577	57.46215	59.32452	58.81615	57.55808	58.25791	57.51627	62.57326	63.78228	72.59009
20	52.65287	52.67766	54.54748	54.02776	52.77529	53.46979	52.73147	57.79764	58.82335	67.82016
25	47.99591	48.01863	49.9001	49.36342	48.11839	48.80012	48.07194	53.14519	53.90342	63.1738
30	43.37955	43.40011	45.29513	44.73895	43.5016	44.16036	43.44888	48.52759	49.02082	58.54619
35	38.85311	38.87193	40.7836	40.19962	38.97374	39.59773	38.91027	43.9761	44.21524	53.95981
40	34.43597	34.45264	36.38381	35.75964	34.55293	35.13115	34.47883	39.5053	39.50857	49.42013
45	30.08835	30.10315	32.05376	31.37315	30.19904	30.72773	30.11717	35.06789	34.90424	44.87269
50	25.92183	25.93469	27.90392	27.14291	26.02338	26.49543	25.93857	30.75208	30.48545	40.38464
55	21.95733	21.96816	23.94249	23.08723	22.046	22.46173	21.96543	26.5567	26.31147	35.92725
60	18.3708	18.37872	20.34406	19.37422	18.44408	18.79428	18.37452	22.63774	22.52085	31.62501
65	15.01621	15.02147	16.93811	15.87654	15.07424	15.36691	15.01772	18.931	18.99637	27.4411
70	12.01066	12.01415	13.84072	12.72096	12.05459	12.29826	12.01119	15.55952	15.84213	23.50951
75	9.404226	9.405452	11.09725	9.973981	9.437645	9.632722	9.404388	12.62302	13.13392	19.94231
80	7.236056	7.236671	8.790054	7.685499	7.261591	7.422463	7.236083	10.19604	10.96235	16.9117
85+	5.89968	5.899865	7.269956	6.26923	5.922801	6.043292	5.899694	8.779905	9.780957	14.8674

Table 4: Life expectancy of female population after eliminating the causes.

Life expectancy total and after eliminating causes for female population										
Age	**Total**	**Malaria**	**Chronic respiratory diseases**	**Total cancers**	**Lip and oral cavity cancer**	**TB**	**HIV**	**CVD**	**Rest**	**Combined 7**
0	72.24591	72.32481	74.04450262	73.77462	72.32041	72.74421	72.32881	76.55207	82.34393	84.6676
1	73.62689	73.69071	75.4848722	75.20194	73.70386	74.1304	73.7073	78.07215	81.38924	86.41058
5	70.0104	70.05786	71.87668054	71.58367	70.08777	70.51017	70.09043	74.47649	77.43103	82.8174
10	65.23075	65.26751	67.10237244	66.79907	65.30828	65.72788	65.30993	69.7082	72.46408	78.04393
15	60.4011	60.43017	62.27687157	61.96357	60.47864	60.89508	60.47956	64.88556	67.4963	73.21424
20	55.6591	55.68607	57.54048849	57.21551	55.73665	56.1446	55.7346	60.14693	62.5492	68.47171
25	50.98634	51.01117	52.87545095	52.53156	51.06366	51.45756	51.05695	55.47472	57.63284	63.78557
30	46.30059	46.32404	48.1973186	47.82936	46.37755	46.75306	46.36152	50.78456	52.74026	59.06284
35	41.622	41.64411	43.52545271	43.12363	41.698	42.05057	41.66949	46.09104	47.89003	54.30862

40	36.9842	37.00387	38.89383091	38.4384	37.05886	37.38604	37.01848	41.42595	43.0982	49.54978
45	32.436	32.45363	34.35100303	33.81093	32.50757	32.80617	32.45832	36.81868	38.41651	44.79574
50	27.96687	27.98281	29.88304144	29.23742	28.03374	28.30973	27.98003	32.26353	33.83091	40.05587
55	23.85041	23.86397	25.7598072	24.96011	23.91039	24.14831	23.85632	27.98883	29.55967	35.47709
60	19.87241	19.88322	21.76408821	20.82098	19.9248	20.12823	19.87512	23.8072	25.44335	30.96514
65	16.24175	16.24998	18.08590383	17.02814	16.28509	16.46178	16.24283	19.91279	21.64247	26.68764
70	12.94711	12.95257	14.72657698	13.58202	12.98276	13.13381	12.94745	16.31613	18.17409	22.68054
75	10.11654	10.11903	11.77868744	10.60835	10.14611	10.26895	10.11663	13.19917	15.21423	19.06907
80	7.693529	7.694468	9.271528389	8.074895	7.718333	7.816415	7.693558	10.50507	12.78235	15.94568
85+	6.345157	6.345311	7.74827554	6.657309	6.368975	6.436179	6.345177	9.076592	11.60379	14.00133

Table 5: Crude probability of dying for the specific causes.

Crude probability Q_x							
Age	**Malaria**	**Chronic respiratory diseases**	**Total cancers**	**Lip and oral cavity cancer**	**TB**	**HIV**	**CVD**
0	0.000188	0	7.48E-05	0	0.000115	6.54E-05	4.1E-05
1	0.000177	2.88E-05	0.000146	0	7.9E-05	9.98E-06	2.94E-05
5	0.000176	1.07E-05	0.00016	1.1E-06	3.89E-05	1.9E-05	2.38E-05
10	0.00011	1.02E-05	0.000156	2E-06	5.72E-05	1.6E-05	4.89E-05
15	3.05E-05	2.88E-05	0.000194	6.97E-06	0.000153	4.03E-05	0.000219
20	4.43E-05	6.52E-05	0.000324	1.55E-05	0.000358	6.17E-05	0.000553
25	5.09E-05	9.85E-05	0.000416	3.2E-05	0.000647	0.00016	0.000878
30	4.77E-05	0.00017	0.000671	6.85E-05	0.001073	0.000313	0.001824
35	6.59E-05	0.000352	0.00116	0.000151	0.001623	0.000409	0.003223
40	6.72E-05	0.000647	0.00194	0.000264	0.002092	0.000453	0.005122
45	8.28E-05	0.001409	0.003431	0.000435	0.0029	0.000448	0.00892
50	0.000105	0.003185	0.00559	0.000697	0.003722	0.000373	0.015006
55	0.000172	0.006686	0.009233	0.00101	0.005338	0.000227	0.025472
60	0.000189	0.012641	0.012791	0.00124	0.006209	0.000139	0.034911
65	0.000165	0.022671	0.017429	0.001486	0.007453	7.59E-05	0.04994
70	0.000233	0.038812	0.022581	0.001602	0.009611	3.62E-05	0.069944
75	8.87E-05	0.060149	0.02846	0.001826	0.011314	1.6E-05	0.09886
80	7.56E-05	0.097496	0.034329	0.001873	0.015636	2.14E-06	0.141023
85+	3.14E-05	0.188485	0.058947	0.003904	0.023764	2.38E-06	0.328047

Table 6: Net Probability of dying when these causes are eliminated

Net Probability when these causes are eliminated $q_{x.i}$							
Age	**Malaria**	**Chronic respiratory diseases**	**Total cancers**	**Lip and oral cavity cancer**	**TB**	**HIV**	**CVD**
0	0.029811	0.029996	0.029922	0.029996	0.029882	0.029931	0.029955
1	0.004113	0.004261	0.004144	0.00429	0.004211	0.00428	0.00426
5	0.00278	0.002946	0.002797	0.002955	0.002917	0.002937	0.002933
10	0.002543	0.002642	0.002496	0.00265	0.002595	0.002636	0.002603
15	0.003922	0.003923	0.003758	0.003945	0.0038	0.003912	0.003734
20	0.006767	0.006746	0.006488	0.006796	0.006455	0.00675	0.00626
25	0.008332	0.008284	0.007968	0.008351	0.007738	0.008223	0.007507
30	0.01144	0.011319	0.01082	0.01142	0.01042	0.011177	0.009673
35	0.015761	0.015477	0.014675	0.015676	0.014215	0.015421	0.012624
40	0.020034	0.01946	0.018178	0.019839	0.018028	0.019652	0.015017
45	0.029397	0.028089	0.026092	0.02905	0.026617	0.029037	0.020651
50	0.042534	0.039516	0.037152	0.041954	0.038988	0.042272	0.027842
55	0.067994	0.061684	0.059206	0.067184	0.062994	0.067941	0.043249
60	0.094378	0.082454	0.082309	0.093378	0.088633	0.094426	0.060736
65	0.138297	0.117168	0.122135	0.137071	0.131511	0.13838	0.090871
70	0.202126	0.166983	0.181953	0.200906	0.193722	0.202302	0.137498
75	0.29202	0.239904	0.267862	0.290564	0.282559	0.292081	0.204296
80	0.439766	0.363036	0.413903	0.438438	0.428162	0.439821	0.325438
85+	1	1	1	1	1	1	1

Table 7: Partial Crude Probability when Malaria and chronic respiratory diseases is eliminated

Partial crude Probability Malaria cause eliminated $q_{x.m}$							**Partial crude Probability Chronic cause eliminated $q_{x.CH}$**					
Age	**Chronic respiratory diseases**	**Total cancers**	**Lip and oralcavity cancer**	**TB**	**HIV**	**CVD**	**Malaria**	**Total cancers**	**Lip and oral cavity cancer**	**TB**	**HIV**	**CVD**
0	0	7.48571E-05	0	0.000115	6.54458E-05	4.12089E-05	0.000188	7.48E-05	0	0.000115	6.53E-05	4.1E-05
1	2.88E-05	0.000146019	0	7.9E-05	9.97892E-06	3.04999E-05	0.000177	0.000146	0	7.9E-05	1E-05	2.94E-05
5	1.07E-05	0.000159676	1.1E-06	3.89E-05	1.89548E-05	2.50738E-05	0.000176	0.00016	1.1E-06	3.89E-05	1.89E-05	2.37E-05
10	1.02E-05	0.00015597	2E-06	5.73E-05	1.60387E-05	5.00742E-05	0.00011	0.000156	2.01E-06	5.72E-05	1.6E-05	4.82E-05
15	2.88E-05	0.000194289	6.97E-06	0.000153	4.03447E-05	0.000208139	3.05E-05	0.000194	7.01E-06	0.000153	4.02E-05	0.000208
20	6.52E-05	0.000323927	1.55E-05	0.000358	6.17317E-05	0.000511959	4.43E-05	0.000324	1.56E-05	0.000358	6.18E-05	0.000514
25	9.85E-05	0.000415816	3.2E-05	0.000647	0.000160164	0.000791406	5.09E-05	0.000416	3.22E-05	0.000647	0.000159	0.000796
30	0.00017	0.000671379	6.85E-05	0.001073	0.000312568	0.00154234	4.77E-05	0.000671	6.91E-05	0.001073	0.000309	0.001559

35	0.000352	0.001159611	0.000151	0.001623	0.000408848	0.002581659	6.59E-05	0.00116	0.000153	0.001623	0.000407	0.002629
40	0.000647	0.001940522	0.000264	0.002092	0.000452691	0.003839603	6.73E-05	0.001941	0.000269	0.002093	0.000457	0.003954
45	0.001409	0.003431565	0.000435	0.0029	0.000447975	0.006266512	8.29E-05	0.003434	0.00045	0.002902	0.000463	0.006563
50	0.003185	0.005589948	0.000697	0.003722	0.000372687	0.009823168	0.000105	0.005599	0.000742	0.003728	0.000399	0.01059
55	0.006687	0.009233649	0.00101	0.005338	0.000226852	0.016203494	0.000172	0.009265	0.001104	0.005356	0.000251	0.017921
60	0.012642	0.012792616	0.00124	0.006209	0.000138983	0.022468622	0.00019	0.012875	0.001414	0.00625	0.00016	0.025884
65	0.022673	0.017430254	0.001486	0.007453	7.58599E-05	0.032817352	0.000167	0.017638	0.00176	0.007542	9.07E-05	0.039197
70	0.038817	0.022583819	0.001602	0.009613	3.62237E-05	0.047585903	0.000238	0.023059	0.001968	0.009815	4.48E-05	0.058812
75	0.060151	0.028461379	0.001826	0.011314	1.60498E-05	0.069165416	9.17E-05	0.029436	0.002287	0.011702	2.02E-05	0.087075
80	0.097501	0.034330051	0.001873	0.015637	2.14166E-06	0.10436528	8.02E-05	0.036405	0.002399	0.016582	2.75E-06	0.134066
85+	0.188491	0.058948458	0.003904	0.023765	2.37654E-06	0.32805772	3.88E-05	0.072638	0.00481	0.029283	2.93E-06	0.404241

Table 8: Partial Crude Probability when Total cancers and CVD & chronic causes are eliminated

Partial Crude Probability when total cancer eliminated $q_{x.TC}$							Partial crude Probability when CVD and Chronic causes are eliminated $q_{x.CVD\&CH}$				
Age	Malaria	Chronic respiratory diseases	Lip and oral cavity cancer	TB	HIV	CVD	Malaria	Total cancers	Lip and oral cavity cancer	TB	HIV
0	0.000188	0	0	0.000115	6.54E-05	4.1E-05	0.000188	2.28E-06	0	3.5E-06	1.99E-06
1	0.000177	2.88E-05	0	7.9E-05	9.98E-06	2.94E-05	0.000177	6.28E-07	0	3.4E-07	4.29E-08
5	0.000176	1.07E-05	1.1E-06	3.89E-05	1.9E-05	2.38E-05	0.000176	4.73E-07	3.24E-09	1.15E-07	5.61E-08
10	0.00011	1.02E-05	2E-06	5.73E-05	1.6E-05	4.89E-05	0.00011	4.14E-07	5.32E-09	1.52E-07	4.26E-08
15	3.05E-05	2.88E-05	6.97E-06	0.000153	4.03E-05	0.000219	3.05E-05	7.69E-07	2.76E-08	6.04E-07	1.6E-07
20	4.43E-05	6.52E-05	1.55E-05	0.000358	6.17E-05	0.000554	4.43E-05	2.21E-06	1.06E-07	2.44E-06	4.22E-07
25	5.1E-05	9.85E-05	3.2E-05	0.000647	0.00016	0.000878	5.1E-05	3.5E-06	2.69E-07	5.45E-06	1.35E-06
30	4.78E-05	0.00017	6.85E-05	0.001074	0.000313	0.001825	4.78E-05	7.76E-06	7.91E-07	1.24E-05	3.61E-06
35	6.59E-05	0.000352	0.000151	0.001624	0.000409	0.003225	6.6E-05	1.85E-05	2.41E-06	2.59E-05	6.52E-06
40	6.73E-05	0.000648	0.000264	0.002094	0.000453	0.005127	6.74E-05	3.94E-05	5.36E-06	4.25E-05	9.19E-06
45	8.3E-05	0.001411	0.000435	0.002905	0.000449	0.008935	8.33E-05	0.000103	1.3E-05	8.67E-05	1.34E-05
50	0.000105	0.003194	0.000699	0.003732	0.000374	0.015049	0.000106	0.000243	3.04E-05	0.000162	1.62E-05
55	0.000173	0.006718	0.001015	0.005363	0.000228	0.025593	0.000175	0.000651	7.12E-05	0.000376	1.6E-05
60	0.00019	0.012725	0.001248	0.00625	0.00014	0.035143	0.000194	0.001268	0.000123	0.000615	1.38E-05
65	0.000167	0.02288	0.0015	0.007521	7.66E-05	0.0504	0.000172	0.002585	0.00022	0.001105	1.12E-05
70	0.000236	0.039287	0.001621	0.009729	3.67E-05	0.0708	0.000247	0.005051	0.000358	0.00215	8.1E-06
75	9.01E-05	0.061113	0.001855	0.011495	1.63E-05	0.100445	9.7E-05	0.009609	0.000617	0.00382	5.42E-06
80	7.72E-05	0.099518	0.001912	0.01596	2.19E-06	0.143948	8.75E-05	0.018777	0.001025	0.008553	1.17E-06
85+	3.34E-05	0.200291	0.004148	0.025252	2.53E-06	0.348596	6.5E-05	0.121925	0.008075	0.049153	4.92E-06

Table 9: Partial crude probability when lip and oral cavity cancer and TB causes are eliminated

Partial Crude Probability when Lip and Oral (LO) cavity cancer is eliminated $q_{x.LO}$							Partial Crude Probability when TB is eliminated $q_{x.TB}$					
Age	Malaria	Chronic respiratory diseases	Total cancers	TB	HIV	CVD	Malaria	Chronic respiratory diseases	cancers	Lip and oral cavity cancer	HIV	CVD
0	0.000188	0	7.48E-05	0.000115	6.54E-05	4.1E-05	0.000188	0	7.49E-05	0	6.54E-05	4.1E-05
1	0.000177	2.88E-05	0.000146	7.9E-05	9.98E-06	2.94E-05	0.000177	2.88E-05	0.000146	0	9.98E-06	2.94E-05
5	0.000176	1.07E-05	0.00016	3.89E-05	1.9E-05	2.38E-05	0.000176	1.07E-05	0.00016	1.1E-06	1.9E-05	2.38E-05
10	0.00011	1.02E-05	0.000156	5.72E-05	1.6E-05	4.89E-05	0.00011	1.02E-05	0.000156	2E-06	1.6E-05	4.89E-05
15	3.05E-05	2.88E-05	0.000194	0.000153	4.03E-05	0.000219	3.05E-05	2.88E-05	0.000194	6.97E-06	4.03E-05	0.000219
20	4.43E-05	6.52E-05	0.000324	0.000358	6.17E-05	0.000553	4.43E-05	6.52E-05	0.000324	1.55E-05	6.17E-05	0.000554
25	5.09E-05	9.85E-05	0.000416	0.000647	0.00016	0.000878	5.1E-05	9.85E-05	0.000416	3.2E-05	0.00016	0.000879
30	4.77E-05	0.00017	0.000671	0.001073	0.000313	0.001824	4.78E-05	0.00017	0.000672	6.85E-05	0.000313	0.001825
35	6.59E-05	0.000352	0.00116	0.001623	0.000409	0.003223	6.59E-05	0.000352	0.001161	0.000151	0.000409	0.003226
40	6.73E-05	0.000647	0.001941	0.002092	0.000453	0.005123	6.73E-05	0.000648	0.001943	0.000264	0.000453	0.005128
45	8.29E-05	0.001409	0.003432	0.0029	0.000448	0.008922	8.3E-05	0.001411	0.003436	0.000435	0.000449	0.008933
50	0.000105	0.003186	0.005592	0.003723	0.000373	0.015012	0.000105	0.003191	0.0056	0.000699	0.000373	0.015035
55	0.000172	0.00669	0.009238	0.005341	0.000227	0.025485	0.000172	0.006704	0.009258	0.001013	0.000227	0.025542
60	0.000189	0.012649	0.0128	0.006213	0.000139	0.034933	0.000189	0.012682	0.012832	0.001244	0.000139	0.035023
65	0.000166	0.022689	0.017442	0.007459	7.59E-05	0.049979	0.000166	0.02276	0.017497	0.001492	7.62E-05	0.050136
70	0.000233	0.038845	0.0226	0.00962	3.63E-05	0.070004	0.000234	0.039013	0.022698	0.00161	3.64E-05	0.070307
75	8.88E-05	0.06021	0.028489	0.011325	1.61E-05	0.098961	8.92E-05	0.060529	0.02864	0.001838	1.62E-05	0.099486
80	7.57E-05	0.097605	0.034367	0.015653	2.14E-06	0.14118	7.63E-05	0.09841	0.03465	0.001891	2.16E-06	0.142345
85+	3.16E-05	0.189223	0.059178	0.023857	2.39E-06	0.329333	3.22E-05	0.193073	0.060382	0.003999	2.43E-06	0.336033

Table 10: Partial Crude Probability when HIV and CVD causes are eliminated

Partial Crude Probability when HIV are eliminated $q_{x.HIV}$							Partial Crude Probability when CVD are eliminated $q_{x.CVD}$					
Age	Malaria	Chronic respiratory diseases	Total cancers	Lip and oral cavity cancer	TB	CVD	Malaria	Chronic respiratory diseases	Total cancers	Lip and oral cavity cancer	TB	HIV
0	0.000188	0	7.49E-05	0	0.000115	4.1E-05	0.000188	0	7.49E-05	0	0.000115	6.54E-05
1	0.000177	2.88E-05	0.000146	0	7.9E-05	2.94E-05	0.000177	2.88E-05	0.000146	0	7.9E-05	9.98E-06
5	0.000176	1.07E-05	0.00016	1.1E-06	3.89E-05	2.38E-05	0.000176	1.07E-05	0.00016	1.1E-06	3.89E-05	1.9E-05
10	0.00011	1.02E-05	0.000156	2E-06	5.72E-05	4.89E-05	0.00011	1.02E-05	0.000156	2E-06	5.73E-05	1.6E-05
15	3.05E-05	2.88E-05	0.000194	6.97E-06	0.000153	0.000219	3.05E-05	2.88E-05	0.000194	6.97E-06	0.000153	4.03E-05
20	4.43E-05	6.52E-05	0.000324	1.55E-05	0.000358	0.000553	4.43E-05	6.52E-05	0.000324	1.55E-05	0.000358	6.17E-05
25	5.09E-05	9.85E-05	0.000416	3.2E-05	0.000647	0.000878	5.1E-05	9.85E-05	0.000416	3.2E-05	0.000647	0.00016

30	4.77E-05	0.00017	0.000671	6.85E-05	0.001073	0.001824	4.78E-05	0.00017	0.000672	6.85E-05	0.001074	0.000313
35	6.59E-05	0.000352	0.00116	0.000151	0.001623	0.003224	6.6E-05	0.000352	0.001161	0.000151	0.001625	0.000409
40	6.73E-05	0.000647	0.001941	0.000264	0.002093	0.005123	6.74E-05	0.000649	0.001945	0.000265	0.002097	0.000454
45	8.29E-05	0.001409	0.003432	0.000435	0.002901	0.008922	8.32E-05	0.001415	0.003447	0.000437	0.002913	0.00045
50	0.000105	0.003185	0.005591	0.000697	0.003722	0.015009	0.000105	0.003209	0.005632	0.000703	0.00375	0.000376
55	0.000172	0.006687	0.009234	0.00101	0.005339	0.025475	0.000174	0.006774	0.009354	0.001024	0.005408	0.00023
60	0.000189	0.012642	0.012792	0.00124	0.006209	0.034914	0.000192	0.012872	0.013025	0.001263	0.006322	0.000142
65	0.000165	0.022672	0.017429	0.001486	0.007453	0.049942	0.00017	0.023276	0.017894	0.001526	0.007652	7.79E-05
70	0.000233	0.038812	0.022581	0.001602	0.009612	0.069945	0.000242	0.040309	0.023452	0.001663	0.009982	3.76E-05
75	8.87E-05	0.060149	0.02846	0.001826	0.011314	0.098861	9.38E-05	0.063592	0.030089	0.001931	0.011961	1.7E-05
80	7.56E-05	0.097496	0.034329	0.001873	0.015636	0.141023	8.24E-05	0.106188	0.037389	0.00204	0.01703	2.33E-06
85+	3.14E-05	0.188485	0.058947	0.003904	0.023764	0.328048	4.68E-05	0.280503	0.087724	0.00581	0.035365	3.54E-06

Table 11: Decomposition of Life Expectancy at birth

Decomposition of life expectancy at birth							
Age	**Malaria**	**Chronic respiratory diseases**	**Total cancers**	**Lip and oral cavity cancer**	**TB**	**HIV**	**CVD**
0	0.013287	0	0.005387	0	0.008215	0.004625	0.0031
1	0.011918	0.001991376	0.010023	0	0.005378	0.000672	0.002127
5	0.011047	0.000688928	0.010207	6.8687E-05	0.002468	0.001188	0.001605
10	0.00631	0.000603189	0.009186	0.0001155	0.003341	0.000925	0.003057
15	0.001627	0.001565967	0.010495	0.0003665	0.008125	0.002127	0.012536
20	0.002128	0.003242307	0.015976	0.0007409	0.0174	0.002953	0.029241
25	0.002212	0.004432563	0.018523	0.0013819	0.028441	0.006915	0.042176
30	0.001848	0.006843972	0.026723	0.002638	0.04216	0.01208	0.079047
35	0.002246	0.012550638	0.040783	0.0051388	0.056288	0.013949	0.124693
40	0.001987	0.020107066	0.059299	0.0077861	0.06293	0.013399	0.174044
45	0.002079	0.037494215	0.089558	0.0109022	0.074268	0.011299	0.261973
50	0.002173	0.071109794	0.121479	0.0145246	0.079071	0.007829	0.372203
55	0.002882	0.122167658	0.162622	0.017005	0.091612	0.003865	0.520129
60	0.00246	0.181267697	0.174543	0.0161359	0.082388	0.001834	0.561719
65	0.001578	0.243063004	0.174874	0.0142078	0.072465	0.00074	0.603611
70	0.001527	0.29093788	0.155196	0.010478	0.063903	0.000245	0.59531
75	0.000382	0.286918185	0.121742	0.0074237	0.046713	6.91E-05	0.543603
80	0.000175	0.269378809	0.083043	0.0043103	0.036296	6.49E-06	0.461255
85+	3.56E-05	0.262938375	0.070912	0.0044367	0.027557	2.69E-06	0.552678
Total	0.067903	1.817301624	1.360572	0.1176607	0.80902	0.084723	4.944108

Table 12: Percentage of Gain in Life Expectancy

Percentage of Gain In Life Expectancy with age							
Age	**Malaria**	**Chronic respiratory diseases**	**Total cancers**	**Lip and oral cavity cancer**	**TB**	**HIV**	**CVD**
0	0.097509	2.60966	1.953793	0.168962	1.161759	0.121663	7.099781
1	0.079542	2.646672	1.973658	0.171358	1.166271	0.116654	7.19596
5	0.065898	2.801674	2.076067	0.181593	1.227628	0.122583	7.622464
10	0.052776	3.02578	2.225963	0.196078	1.322214	0.130458	8.232633
15	0.045939	3.288453	2.403354	0.212962	1.431419	0.140155	8.944754
20	0.047081	3.598294	2.611235	0.232501	1.551512	0.14927	9.771106
25	0.047337	3.967392	2.84921	0.255184	1.675569	0.158401	10.72857
30	0.047405	4.415855	3.133746	0.281346	1.799962	0.15982	11.86743
35	0.048437	4.968691	3.465641	0.310483	1.916503	0.147129	13.18553
40	0.048411	5.656418	3.843853	0.339662	2.018775	0.124479	14.72104
45	0.049189	6.532135	4.270087	0.367905	2.12501	0.095805	16.54974
50	0.049629	7.646434	4.710635	0.391761	2.212814	0.064578	18.63394
55	0.049339	9.040983	5.145881	0.403828	2.297173	0.036909	20.94685
60	0.043109	10.74131	5.462064	0.398939	2.305211	0.020284	23.22676
65	0.034981	12.79881	5.729304	0.386418	2.335491	0.010059	26.07038
70	0.029101	15.23702	5.913972	0.365752	2.394576	0.004435	29.54761
75	0.01303	18.00283	6.058499	0.355354	2.429714	0.00172	34.2271
80	0.008501	21.47576	6.211153	0.352887	2.576076	0.000371	40.90601
85+	0.003145	23.22627	6.263896	0.391907	2.434233	0.000238	48.82002

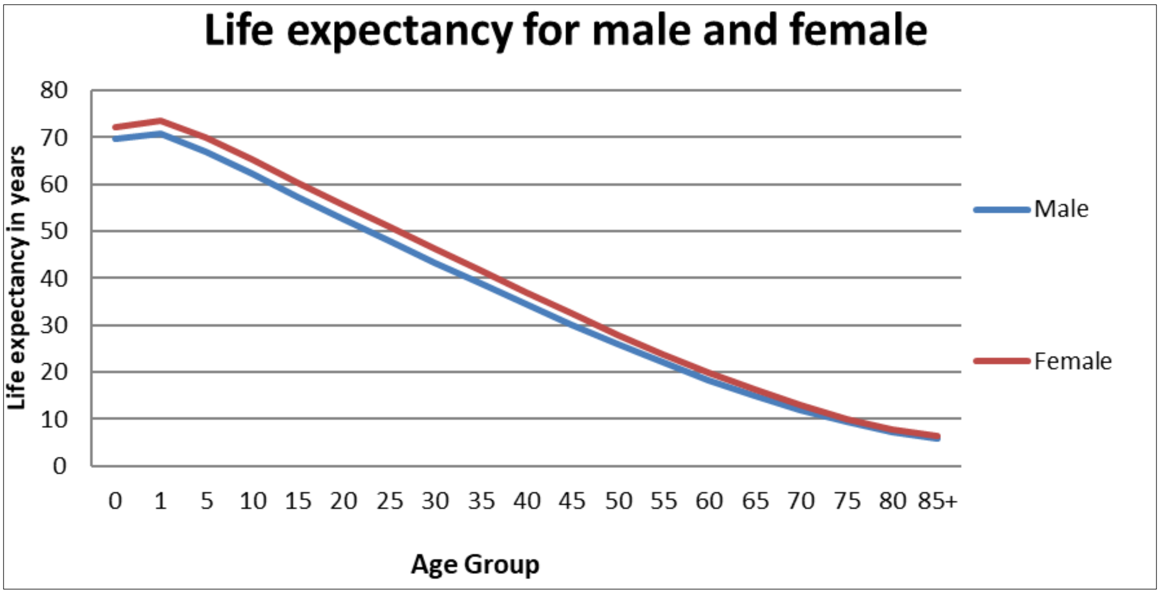


Fig 1: Life Expectancy of Male and Female for year 2019

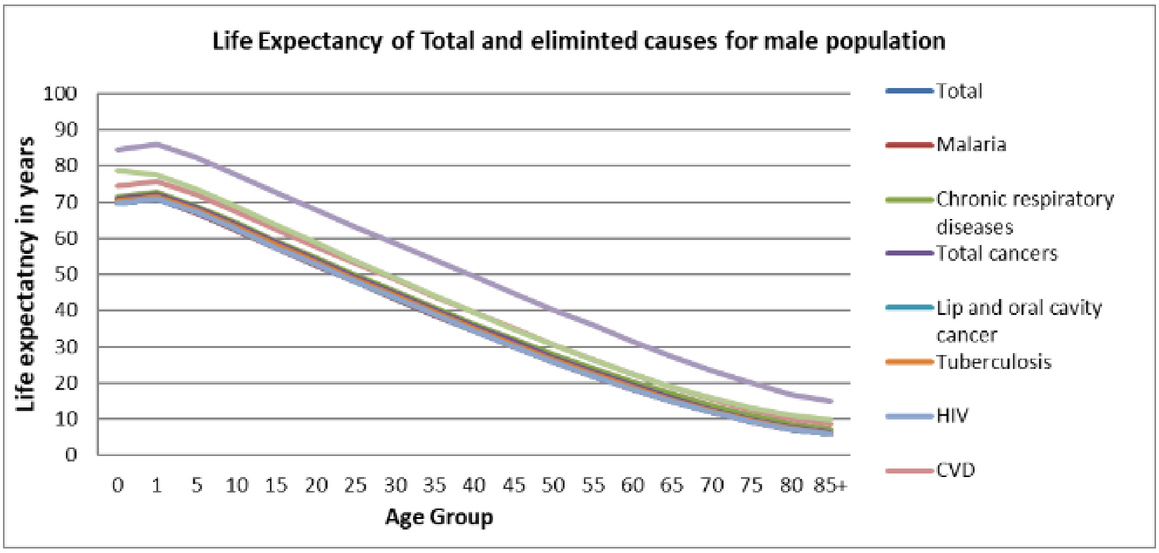


Fig 2: Life expectancy (Total and after eliminating the causes) for male population

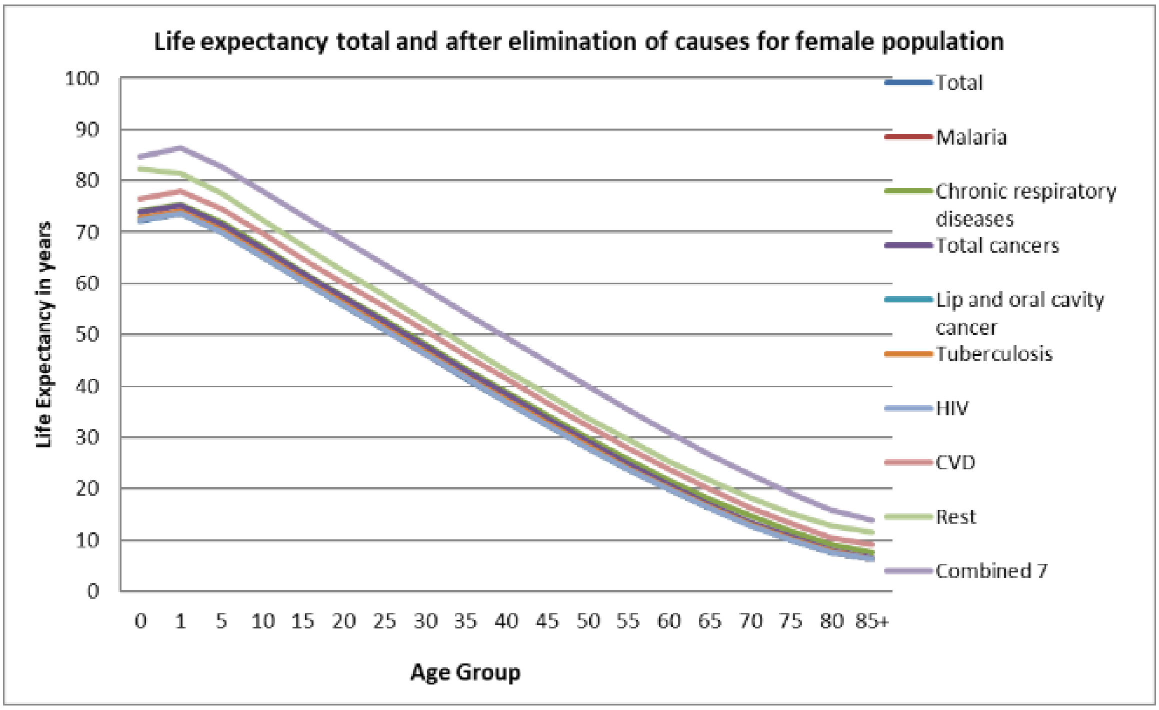


Fig 3: Life expectancy (Total and after eliminating the causes) for female population

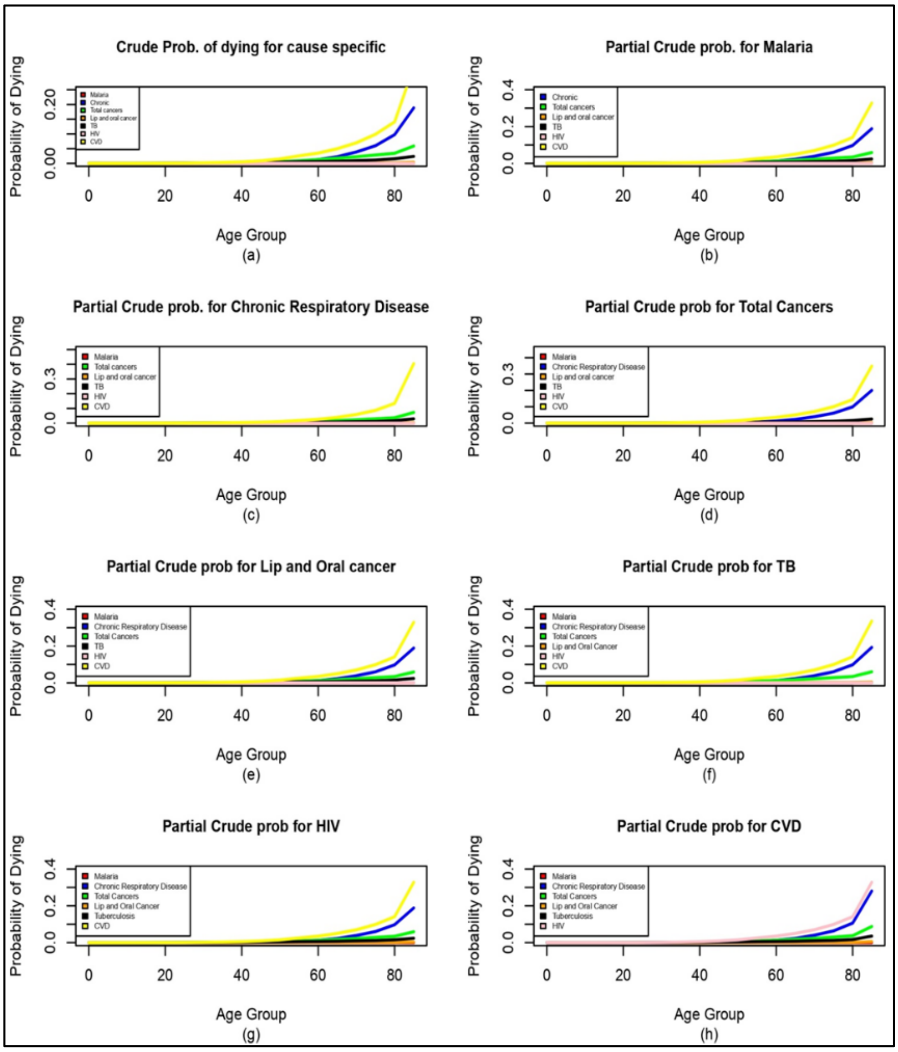


Fig4: Crude and Partial crude probability for specified causes

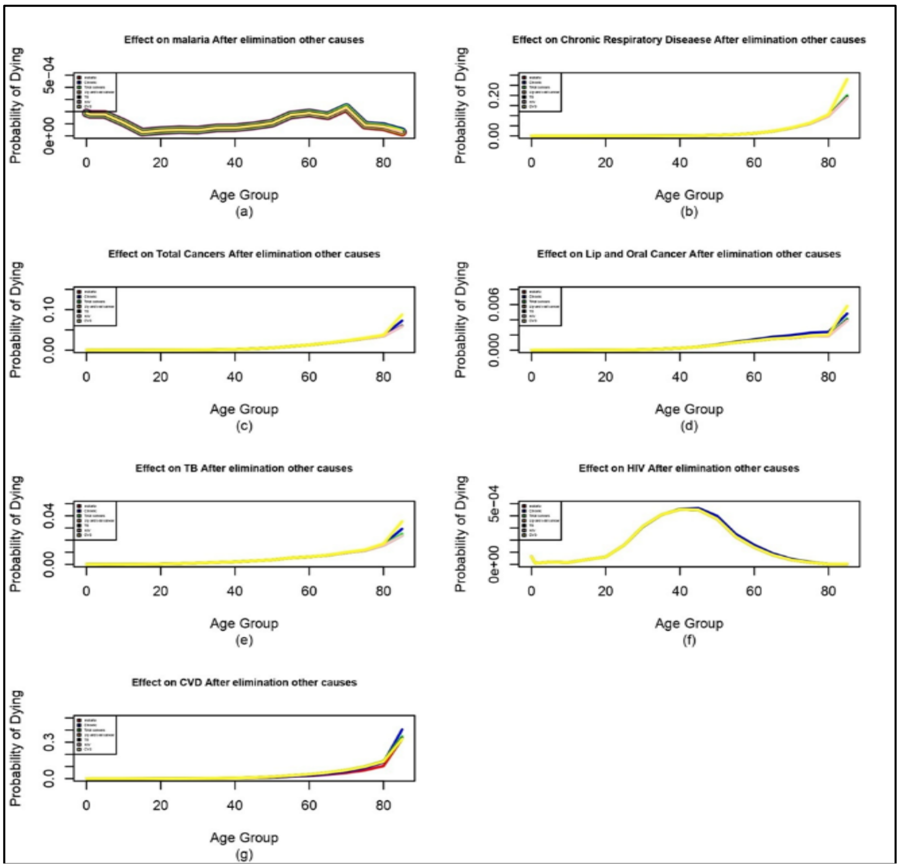


Fig 5: Effect on specified causes when all causes eliminated separately

4. Conclusions

From the above analysis, we can say that females have a longer life expectancy as compared to males. Elimination of chronic and CVD causes gave more life expectancy as compared to the rest of the selected causes. Malaria is affecting more infants and children's, while total cancers, CVD, and HIV are affecting more older people, and for adult people, HIV is affecting more. If we eliminate all these 7 causes together, we can see that males have a longer life expectancy as compared to females. From this, we can say these causes affect more male populations. In the absence of CVD, the probability of dying for the causes of chronic respiratory disease, total cancers, lip and oral cavity cancer, and TB has increased after age 80+. From this, we can say that the contribution of CVD causes is greater at older ages. In the absence of CVD, there will be a 10% increase in life expectancy when compared with the presence of CVD at age 25. Similarly, in the absence of chronic respiratory disease at age 80+, there are 21.4% increases in life expectancy as compared to the presence of the disease. From tables 5 and 6, for malaria, the crude probability of dying is 0.000188, and the net probability of dying is 0.029811. From this, we can say that in the absence of competing risks, the net probability is high. Hence, it is necessary to study the competing risk approach to understand the effect of one cause in the presence or absence of competing risks.

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6. References

1. Arias E, Tejada-Vera B. Differential impact of the COVID-19 pandemic on excess mortality and life expectancy loss within the Hispanic population.DemographicResearch. 2023;48:339-352.
2. Arriaga E. Measuring and explaining the change in life expectancy. Demography. 1984;21:83–96.
3. Census of India. Sample Registration Survey report; c2018.
4. Chiang CL. A stochastic study of the life table and its applications: I. Probability distributions of the biometric functions. Biometrics. 1960;16(4):618-635.
5. Chiang CL. A stochastic study of the life table and its applications. III. The follow-up study with the consideration of competing risks. Biometrics. 1961;17(1):57-78.
6. Chiang CL. Introduction to Stochastic Processes in Biostatistics, New York: John Wiley and Sons, Inc; c1968.
7. Chiang CL. On constructing current life tables. Journal of the American Statistical Association. 1972;67(339):538-541.
8. Chiang CL. Life table and mortality analysis. WHO**; c**1978.
9. Chiang CL. Competing risks in mortality analysis. Annual review of public health. 1991;12(1):281-307.
10. Coale AJ, Demeny P, Vaughan B. Regional Life Tables and Stable Populations second edition. academic press; c1983.
11. Cornfield J. Estimation of the probability of developing a disease in the presence of competing risks. American Journal of Public Health and the Nations Health. 1957;47(5):601-607.
12. Dublin LI, Spiegelman M. Current versus generation life tables. Human Biology. 1941;13(4):439-458.
13. Greville TNE. Short Methods of Constructing Abridged Life Tables, Record of American Institute of Actuaries. 1943;32(65):29-43.
14. Institute for Health Metrics and Evaluation (IHME). Institute for Health Metrics and Evaluation (IHME); c2019. https://vizhub.healthdata.org/gbd-results/.
15. Keyfitz N. A life table that agrees with the data. Journal of the American Statistical Association. 1966;61(314):305-312.
16. King G. On a short method of constructing an abridged mortality table. Journal of the Institute of Actuaries. 1914;48(3):294-303.
17. Reed LJ, Merrell M. A Short Method for Constructing an Abridged Life Table. American Journal of Hygiene. 1939;30:33-62.
18. Sharma M, Choudhury L. Partial Elimination of Cause of Death under Dynamic Set Up and Its Applications. Thailand Statistician. 2023;21(1):137-147.
19. Sirken MG. Comparisons of Two Methods of Constructing Abridged Life Tables by reference to a “standard” table. Vital and Health statistics. Ser. 1, Programs and Collection Procedures. 1964;4(2):1-11.
20. Wong O. A competing-risk model based on the life table procedure in epidemiological studies. International Journal of Epidemiology. 1977;6(2):153-159.