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Effect of Elimination of Cardiovascular Diseases on Life Expectancy and Disability- Free Life Expectancy in India

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Abstract

Cardiovascular disease (CVD) significantly affects elderly individuals globally due to ageing and lifestyle factors. The World Health Organization (WHO) estimated that, due to the burden of CVDs, India had lost 237 billion dollars over ten years (2005-2015) (Gupta,2019). Eliminating CVD could notably enhance total life expectancy and disability-free life expectancy (DFLE) among older adults particularly those aged 50 and above. This study intends to determine the gains in life expectancy and DFLE in India after eliminating CVD. The prevalence of CVD was obtained from the Longitudinal Ageing Survey of India (LASI) 2018-19, while the number of deaths and mid-year 2019 population estimates were obtained from the data of Global Burden of Disease (GBD) 2019. Life expectancy gains followed Shuji Hashimoto's methodology, while DFLE computations used Sullivan's method following Alain Colvez and Madeleine Blanchet's approach. After the elimination of CVD, life expectancies for males and females at birth rose to 70.04 and 72.92 years from 68.94 and 72.10 years and at the age of 50, the life expectancy for males and females rose to 25.39 and 27.13 years from 24.19 and 26.29 years, but no improvement was observed at age 70 irrespective of their sexes. However, DFLE for males in India at the age of 50 is 19.95 and for females it is 17.46 and after the elimination it rose to 22.29 for males and 20.73 for females. Substantial DFLE gains were evident in Northern and Southern states at both ages of 50 and 70 years, outperforming those in Central and Eastern regions. Reducing the burden of CVD, especially through delayed onset, can significantly enhance DFLE among older adults in India

Keywords

Cardiovascular disease, disability-free life expectancy, elderly, life expectancy,Global Burden of Disease, LASI.

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Introduction

The epidemiological transition from communicable to non-communicable diseases is occurring in many developing nations, including India. This transition was characterized by an increase in the rate of morbidity, where non-communicable diseases became a predominant health problem. Among the non-communicable diseases, cardiovascular disease (CVD) is a group of disorders that affect the heart and blood vessels and remains a major contributor to deaths in India. More than 80 per cent of CVD deaths are due to heart attacks and strokes and one-third of these deaths occur in people below 70 years of age. According to Global Burden of Disease, the state age-standardized CVD death rate in India is 272 per 100000 population is much higher than the global average of 235. CVDs strike Indians a decade earlier than the western population (Prabhakaran,2016).

India is a country having the highest number of young people and ageing is rapidly progressing. According to UNFPA, the current elderly population of 153 million (aged 60 and above) is expected to reach 347 million by 2050. Aging can cause changes in the heart and blood vessels which results in the increased risk of CVD, but these risks are also due to some factors including frailty, obesity, and diabetes. Nearly 52% of CVD deaths occur before the age of 70 years, compared to 23% in developed countries (Ghaffar et al., 2004).

As the cardiovascular risk among older adults is high, eliminating CVD in this age group has become essential (Hanna, 2024). CVD is a significant cause of disability in those aged 75 and above, with coronary heart disease alone contributing considerably to these cases (Ian, 2019). While age is an immutable risk factor, it remains a powerful predictor of CVD, highlighting the need for preventive measures from middle age onward. Such actions could foster healthier ageing and enhance the quality of life for the elderly (Marianna, 2020). CVD not only reduces life quality but also imposes considerable healthcare costs. Thus, targeting CVD prevention and better management can lead to longer lives and improved disability-free life expectancy (DFLE) in India (Reddy K. S.,2009; Sharma Meenakshi et al.,2017; Gupta Rajeev,2018).

Some studies in India have analysed the impact of eliminating specific diseases on life expectancy and only a few studies (Gulati, 2013; Kulkarni, 2004) have estimated the potential gain in life expectancy after the elimination of CVD. However, no study to date has calculated the potential increase in DFLE if CVD were eliminated. Thus, this study aims to provide this information by calculating both life expectancy and DFLE gains in India and its states after eliminating CVD among older adults.

Data

The data on age-specific death rates for India and its constituent states were taken from the Sample Registration System Statistical Report 2019 released by the Office of the Registrar General and Census Commissioner of India (ORGI, 2022). The prevalence of disability among older individuals is calculated using the IADL and ADL information obtained from the Longitudinal Ageing Survey of India (LASI) 2017-18. The older person, either having IADL or ADL, is identified as having a disability for the present study. The prevalence of the same is used to calculate the disability-free life expectancy (DFLE) using the Sullivans method.

The required age-sex-wise cause of death data for the calculation of gain in life expectancy has been obtained from the Global Burden of Diseases data 2019. Similarly, for the calculation of gain in DFLE, the prevalence of CVD has been obtained from the self-reported data of LASI. For the present study, 65,562 samples (age 45+) were taken, out of which 30,479 are males and 35,083 are females.

Methods

In this study, the prevalence of CVD is estimated by considering the self-reported status of chronic heart diseases and hypertension.

An abridged life table is constructed using the age-specific death rate obtained from the Sample Registration System – Statistical Report (2019) and the prevalence of disability is calculated from LASI Main Wave 1(2017-18). In the LASI, Activities of Daily Living (ADL) is a term used for routine daily self-care activities, including getting out of bed, changing position from sitting to standing, feeding oneself, bathing, dressing, grooming, and personal hygiene. To evaluate ADL limitation, LASI respondents were asked whether they had any of the following limitations and were expected to have the limitation for more than three months. Instrumental Activities of Daily Living (IADL) are those that are not necessarily related to the fundamental functioning of a person but which allow an individual to live independently in a community, such as preparing a hot meal, shopping for groceries, making a telephone call, taking medications, doing work around the house or garden, managing money (such as paying bills and keeping track of expenses), and getting around or finding an address in unfamiliar places.

To identify IADL limitations, respondents were asked if any problems would last for more than three months. In this study, the percentage of older adults who are limited in any three ADL limitations will be counted as having ADL and the percentage of older adults with any three IADL limitations will be considered as having IADL. Thus, disability is considered if any respondent has limitations in ADL or IADL.

Global Burden of Disease

Deaths due to CVD are calculated from Global Burden of Disease Study (GBD) data, which is the most comprehensive observational epidemiological study in the world, providing data on mortality and morbidity at regional, national and global levels from the year 1990 to the present (Kyu et al., 2018). The main goal of GBD is to collect all the available data on mortality and morbidity from various sources including vital registrations, censuses, surveys, and published studies. A coherent measurement framework and standardized estimation techniques are adopted by the GBD to achieve comparability of data across countries/territories and years (Chen et al., 2019).

The estimated data for India were extracted from the website Global Health Data Exchange (GHDX) "VizHub - GBD Results." https://vizhub.healthdata.org/gbd-results/ and the data for the states were extracted from "VizHub - GBD Compare." https://vizhub.healthdata.org/gbd-compare/india, which was completely accessible online.

Multiple Decrement Life Table

Multiple-decrement life tables are based on the idea that the life table cohort can be decreased by attrition from more than one cause of death. A life table with more than

one source of decrement is called a Multiple decrement life table. The decrement function from the multiple-decrement, ${}_nd_{x,\alpha}$ is used in the calculation of the cause elimination life table, ${}_nd_{x,\alpha}$ is the number of life table deaths due to the C_α cause of death.

Here, the data for number of deaths due to CVD and the total number of deaths were obtained from GBD data 2019. The mid-year population was estimated from GBD 2019 Population Estimates 1950-2019.

The multiple-decrement life tables are constructed by following the steps proposed by Namboodiri and Suchindran:

Cause-of-Death Ratios

The cause-of-death ratio for cause C_α for an age group is defined as the proportion of the number of deaths from cause C_α in that age group to the total number of deaths in that age group. For [x, x +n) the cause-of-death ratios are calculated as follows.

Cause of death ratios = ${}_nD_{x,\alpha}$ / ${}_nD_{x+}$

Distribution of Life Table Deaths by Cause of Death

Multiplying the total number of deaths at age (x, x+n) with the corresponding death ratios gives the life table death by cause.

${}_nd_{x,\alpha}$ = / ${}_nd_{x+}$ * (${}_nD_{x,\alpha}$ / ${}_nD_{x+}$)

Cause-Specific Probability of Dying

The probability of dying for cause Cα, after having survived to age 'x' but before the age of 'x+n' (for all causes being in effect), can be computed by taking the ratio of ${}_nd_{x,\alpha}$ divided by l_x. These are often called the "Crude probabilities of death" from specified causes.

${}_nq_{x,\alpha}$ = ${}_nd_{x,\alpha}$ / l_x.

Cause-Specific Density Function

The ratio of the number of deaths due to a particular cause in the age interval (x, x +n) to the number of survivors at the age zero with the particular cause.

The graph obtained by plotting ($l_{x,\alpha} - l_{x+n,\alpha}$) / ${}_nl_{o,\alpha}$ against the midpoint of [x, x+n) is called the curve of death from cause C_α.

Calculation of Gain in Life expectancy

A life table that eliminated deaths caused by disease was constructed using data on the number of deaths and life tables without disease elimination.

The gain in life expectancy was calculated following the article "Gains in Disability-Free Life Expectancy from The Elimination of Diseases and Injuries" by Shuji Hashimoto et al (2012).

The probability of survival in the age group x with the disease eliminated (p_x^e) was expressed using the probability without disease elimination (p_x) obtained from the abridged life table whereas the number of deaths from the disease (D_x) from all diseases and injuries and the number of deaths from the disease (D_x^e) which was obtained from GBD 2019. The relationship between these variables was used to express the probability of survival in the age group with the disease removed.

ln (p_x^e) = (1- D_x^e / D_x) * ln (p_x), where ln is the natural logarithm function.

Using Chiang's life table method as mentioned above, calculate the number of survivors (l_x^e), ${}_nL_x^e$, T_x^e and the new life expectancy called the gain in life expectancy (e_x^e).

Calculation of Gain in disability-free life expectancy

Disability-free life expectancy, calculated by Sullivan's method, is the number of

remaining years, at a particular age, at which an individual can expect to live in a healthy state. The data required are the age-specific prevalence (proportions) of the population with and without disability and disease. Here only the age-specific prevalence of CVD and disability at the ages of 50 and 70 is calculated.

DFLE cause elimination is done by following the article "Potential Gains in Life Expectancy Free of Disability: A Tool for Health Planning." by Alain Colvez and Madeleine Blanchet.

For the calculation of disability-free life expectancy, first calculate the age-specific prevalence of disability (πx) at the age of 50 and 70 years obtained from the Longitudinal Ageing Study in India (LASI) Main wave 1, (2017-18).

Using that proportion, calculate (1- πx) * L_x, Where L_x is the stationary population obtained from the abridged life table and (1- πx) * L_x is treated as L_x itself. Using Chiang's life table Method calculate the T_x.

Then, DFLE= T_x / l_x, where l_x is the number of survivors obtained from the abridged life table.

Similarly, calculate the age-specific prevalence of disability after the elimination of CVD and the disability at the age of 50 and 70

Then Using the life table obtain the new T_x^e and DFLE after elimination ($DFLE^e$) is given as
$DFLE^e = T_x^e / l_x$.

Results

Cause-of-Death Ratios

The cause-of-death ratios for CVD in India for both males and females in 2019 are shown in Table 1. In children, (0-14 years), the cause-of-death ratio is relatively low for both genders. However, as individuals progress into adolescence and young adulthood (15-29 years), the cause-of-death ratios due to CVD start to increase.

Table 1 Age and Sex-Specific Cause-of-Death Ratios due to CVD

Age	Cause-of-death ratios due to CVD	
	Males	Females
<1	0.0095	0.0072
1-4	0.0094	0.0104
5-9	0.0084	0.0152
10-14	0.0123	0.0170
15-19	0.0336	0.0446
20-24	0.0721	0.0784
25-29	0.0813	0.0915
30-34	0.1270	0.1170
35-39	0.1854	0.1404
40-44	0.1993	0.1946
45-49	0.2514	0.1634
50-54	0.2644	0.2532
55-59	0.3185	0.2340
60-64	0.3041	0.2645
65-69	0.3424	0.3001
70-74	0.3683	0.3143
75-79	0.4815	0.4666
80-84	0.3206	0.2970
85+	0.3280	0.3009

Source: Author's calculation based on data obtained from GBD, 2019

Distribution of Life table deaths by cause of deaths

The distribution of life table deaths by cause of death is presented in Table 2. The life table deaths steadily with age except among infants (age<1). For males, the deaths due to CVD increase from the age of 25 onwards. The highest number of deaths due to this cause was observed among the oldest age group (85+). While for females, in the age group below 1 year, there were 26 deaths attributed to CVD. As females enter older age groups (from the age of 70), the mortality rates due to CVD increase substantially.

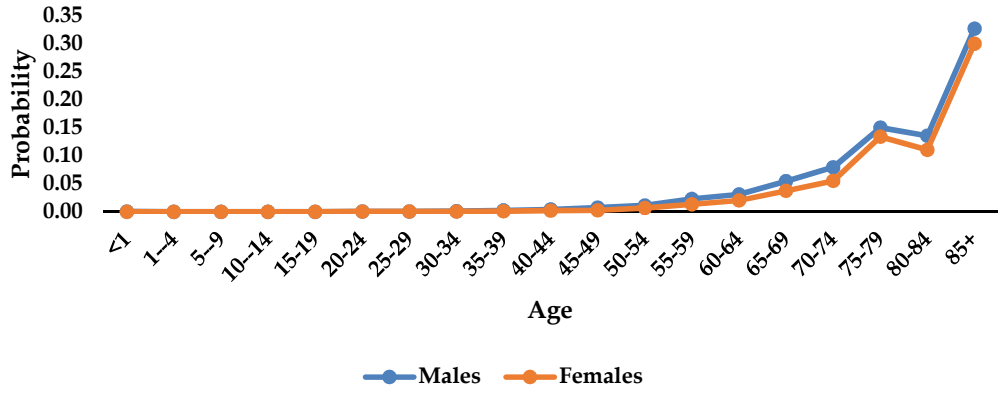
Table 2 Ordinary life table and the distribution of life table deaths by CVD for males and females

Age	Male				Female			
	$_nq_x$	l_x	$_nd_x$	Distribution of life table deaths by CVD	$_nq_x$	l_x	$_nd_x$	Distribution of life table deaths by CVD
<1	0.03407	100000	3407	32	0.03569	100000	3569	26
1-4	0.00518	96593	501	5	0.00479	96431	461	5
5-9	0.00250	96092	240	2	0.00200	95969	192	3
10-14	0.00250	95852	239	3	0.00250	95778	239	4
15-19	0.00349	95613	334	11	0.00300	95538	286	13
20-24	0.00598	95279	570	41	0.00399	95252	380	30
25-29	0.00698	94709	661	54	0.00549	94872	520	48
30-34	0.00995	94048	936	119	0.00549	94351	518	61
35-39	0.01391	93112	1295	240	0.00747	93834	701	98
40-44	0.02030	91817	1864	371	0.01094	93133	1019	198
45-49	0.02910	89953	2617	658	0.01785	92113	1644	269
50-54	0.04264	87335	3724	985	0.02716	90469	2457	622
55-59	0.07339	83611	6136	1954	0.05649	88012	4972	1163
60-64	0.10319	77475	7995	2431	0.07755	83040	6440	1703
65-69	0.16098	69481	11185	3830	0.12554	76600	9616	2886
70-74	0.21640	58295	12615	4646	0.17587	66983	11781	3703
75-79	0.31320	45680	14307	6889	0.28836	55203	15918	7427
80-84	0.42455	31373	13319	4270	0.37308	39285	14656	4353
85+	1	18054	18054	5922	1	24628	24628	7411

Source: Author's calculation based on data obtained from SRS and GBD 2019

Cause-Specific Probability of Dying

Figure 1 shows that the probability of males dying due to CVD in the age group below one year is 32 deaths per 100,000 live births, and for females, it is only 26 deaths per 100,000 live births. The probabilities of dying due to CVD among children (from age 1 to 14) for both genders in the age group are very low. At the age of 35-39 years, the probability that males will die due to CVD is 0.002578 (257.8 deaths per 100,000), while females have a probability of 0.001044 (104.4 deaths per 100,000). Nonetheless, there is an increase in the likelihood of dying for both genders from the age of 50 and 55. In the oldest age group (85+ years), the probability that the males will die due to CVD is 0.328016 (32,801.6 deaths per 100,000) and for females, it is 0.300918 (30,091.8 deaths per 100,000**).**

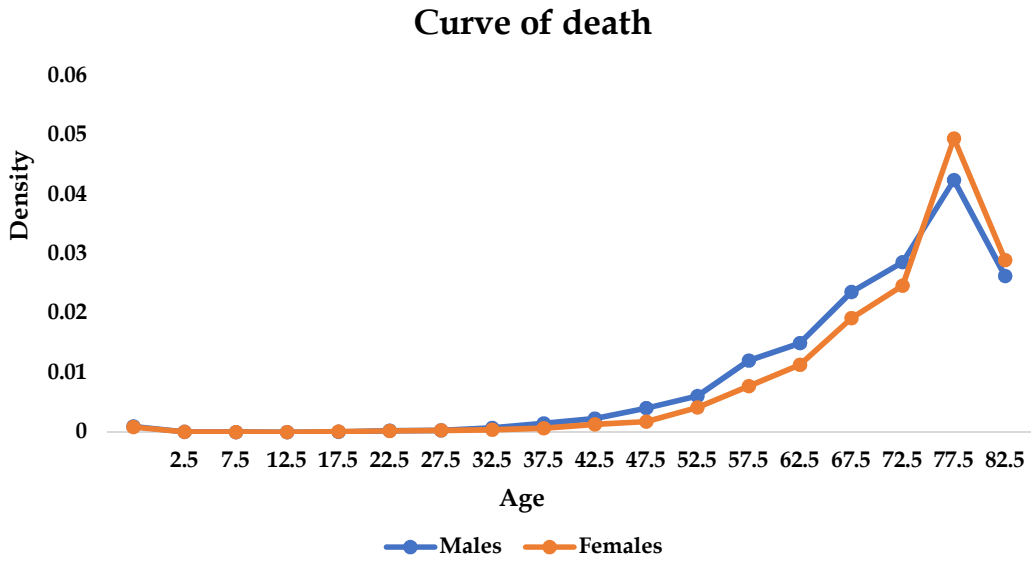


Source: Author's calculation based on data obtained from SRS and GBD 2019

Figure 1 Cause-specific probability of dying due to CVD by age and sex

Cause-Specific Density Function

The curve of death due to CVD for both males and females is shown in Figure 2. From the curve, it can be inferred that among males, childhood deaths due to CVD declined till the age of 35 years and after that slowly increased up to the age of 55 years and then reached the maximum in older ages (75-79). CVD is found to be the least affected cause of death among children and the most severe for the older age groups. From the curves of death it is noted that for females, the deaths due to CVD increases after the age of 40 years and then sharply reaches a maximum in older ages.



Source: Author's calculation based on data obtained from SRS and GBD 2019

Figure 2 Cause-specific density function of deaths due to CVD by age and sex

Gain in life expectancy due to the elimination of CVD.

The data presented in Tables 3 and 4 reveals the impact of CVD on the life expectancy of both genders. For males, the average life expectancy at birth is 68.94 years and for females it is 72.10 years, After the elimination of CVD, the life expectancy further rose to 70.04 for males and 72.92 for females.

Regionally, both genders display distinct patterns. Northern states like Punjab, Haryana and Jammu and Kashmir consistently reveal higher life expectancies, while states in the Central and Eastern regions have only lower life expectancies for both males and females. Additionally, states which have already higher initial life expectancies such as Delhi, Jammu and Kashmir, Punjab, and Maharashtra experience more significant gains in life expectancy after eliminating CVD irrespective of the sexes. However, these gains are also observed in states with lower initial life expectancies, though their life expectancies still remain comparatively lower. CVD seem to exert a more pronounced impact on life expectancy till the age of 50.

Table 3 Life expectancy before and after elimination of CVD for males across India.

States	Age 0		Age 50		Age 70	
	LE	LE^e	LE	LE^e	LE	LE^e
India	68.94	70.04	24.19	25.39	11.26	11.26
North						
Delhi	74.36	76.32	26.72	28.32	11.52	11.52
Haryana	66.33	69.83	22.45	26.18	10.72	10.72
Himachal Pradesh	69.67	72.31	24.53	26.63	11.60	11.60
Jammu and Kashmir	73.47	76.66	27.62	30.41	15.87	15.87
Punjab	69.79	74.28	25.34	28.6	13.08	13.08
Rajasthan	66.96	69.27	22.74	24.72	10.83	10.83
Uttarakhand	66.86	69.72	22.13	24.43	11.19	11.19
Central						
Chhattisgarh	63.98	66.75	21.09	23.49	8.93	8.93
Madhya Pradesh	65.98	68.62	23.41	25.65	11.01	11.01
Uttar Pradesh	65.90	67.83	22.71	24.98	10.09	10.09
East						
Bihar	70.37	72.48	23.81	25.60	9.25	9.25
Jharkhand	70.18	72.00	24.38	25.99	10.88	10.88
Odisha	69.17	71.29	25.34	27.18	12.88	12.88
West Bengal	71.11	74.41	24.98	27.82	12.11	12.11
Northeast						
Assam	67.57	69.95	23.1	25.13	10.62	10.62
West						
Gujarat	68.54	71.59	23.92	26.44	11.07	11.07
Maharashtra	71.65	74.72	25.50	28.11	12.55	12.55
South						
Andhra Pradesh	70.37	73.70	25.51	28.22	12.52	12.52
Karnataka	70.37	73.70	25.51	28.22	12.52	12.52
Kerala	71.27	74.25	23.93	26.37	10.43	10.43
Tamil Nadu	71.64	75.22	26.26	29.03	13.34	13.34
Telangana	68.92	72.24	24.06	26.69	10.68	10.68

Source: Author's calculation based on data obtained from SRS and GBD 2019

Table 4 Life expectancy before and after elimination of CVD for females across India

States	Age 0		Age 50		Age 70	
	LE	LE^e	LE	LE^e	LE	LE^e
India	72.10	72.92	26.29	27.13	12	12
North						
Delhi	79.03	80.71	30.87	32.25	15.34	15.34
Haryana	74.07	75.93	27.83	29.49	13.55	13.55
Himachal Pradesh	75.79	77.39	28.42	29.77	13.44	13.44
Jammu and Kashmir	80.33	82.94	33.73	35.97	20.4	20.4
Punjab	74	77.17	27.23	29.81	13.81	13.81
Rajasthan	72.31	73.73	27.43	28.73	13.07	13.07
Uttarakhand	73.73	75.22	26.97	28.22	12.48	12.48
Central						
Chhattisgarh	67.97	70.25	22.87	24.89	9.79	9.79
Madhya Pradesh	69.93	71.76	25.24	26.88	11.06	11.06
Uttar Pradesh	67.64	69.08	24.56	25.86	10.95	10.95
East						
Bihar	69.83	71.81	23.20	24.95	9.53	9.53
Jharkhand	69.46	71.36	23.37	25.04	9.79	9.79
Odisha	71.95	74.07	26.52	28.42	13.99	13.99
West Bengal	74.71	77.22	27.59	29.81	13.01	13.01
Northeast						
Assam	67.24	69.57	22.91	24.91	10.58	10.58
West						
Gujarat	74.12	76.07	28.22	29.92	13.55	13.55
Maharashtra	75.27	77.3	28.2	29.91	13.31	13.31
South						
Andhra Pradesh	72.92	75.22	26.39	28.37	12.38	12.38
Karnataka	72.89	75.04	26.43	28.26	11.81	11.81
Kerala	77.48	79.44	28.85	30.52	13.63	13.63
Tamil Nadu	76.8	78.65	29.13	30.69	13.73	13.73
Telangana	71.94	74.28	26.06	27.99	11.83	11.83

Source: Author's calculation based on data obtained from SRS and GBD 2019

Gain in Disability-free Life Expectancy due to the elimination of CVD.

Table 5 highlights the differences in Disability-Free Life Expectancy (DFLE) and Disability-Free Life Expectancy after elimination ($DFLE^e$) across genders in the various Indian states. The DFLE for men is 19.95 years at age 50, and it noticeably increases to 22.29 years once fatalities from CVD are eliminated. Similarly, in females, the DFLE of 17.46 years at the age of 50, rises significantly to 20.73 years after eliminating CVD-related mortality. Regionally, both genders display distinct patterns. In the Northern region, Delhi has the highest disability-free life expectancy gain, followed by Haryana and Punjab. Whereas states like Jammu and Kashmir and Uttarakhand have comparatively lower DFLE and $DFLE^e$. In the central region, Madhya Pradesh shows the highest values, while Chhattisgarh and Uttar Pradesh report lower DFLE and $DFLE^e$. In the eastern region, Odisha shows the highest DFLE and $DFLE^e$, whereas Bihar records the lowest at age 0 and age 50. In the West, Gujarat and Maharashtra show only less gains, and Kerala leads in the Southern region, with Tamil Nadu and Andhra Pradesh also showing relatively higher DFLE and $DFLE^e$. Regional disparities in disability-free life expectancy exist for both genders, with states in the South, West, and North generally having higher values than those in the Central and Eastern region.

Table 5 DFLE before and after elimination of CVD by sex across India

States	Males				Females			
	Age 50		Age 70		Age 50		Age 70	
	DFLE	DFLE^e	DFLE	DFLE^e	DFLE	DFLE^e	DFLE	DFLE^e
India	19.95	22.29	7.71	9.39	17.46	20.73	5.70	7.72
North								
Delhi	22.46	25.75	7.62	9.82	21.03	25.87	8.19	11.24
Haryana	18.99	23.42	7.00	10.31	21.23	26.00	8.56	11.87
Himachal Pradesh	21.40	25.16	8.57	11.77	18.64	22.84	5.00	7.86
Jammu and Kashmir	19.97	25.09	8.35	12.62	13.67	21.38	4.88	10.1
Punjab	22.85	28.49	11.16	15.28	21.20	27.00	8.63	13.08
Rajasthan	20.63	23.26	8.34	10.47	20.95	23.94	7.79	9.99
Uttarakhand	19.69	22.86	9.27	12.09	17.95	20.54	6.41	7.46
Central								
Chhattisgarh	18.55	21.69	6.14	8.45	17.79	20.58	5.09	6.91
Madhya Pradesh	18.77	22.02	6.56	8.83	17.99	21.00	5.70	7.47
Uttar Pradesh	19.48	21.75	7.43	8.90	16.84	19.11	5.20	6.44
East								
Bihar	18.61	21.85	5.06	7.34	14.33	17.63	3.84	5.37
Jharkhand	20.14	22.64	7.33	9.13	15.42	18.26	4.41	6.02
Odisha	22.77	25.44	10.03	12.23	22.42	25.53	10.51	13.06
West Bengal	19.09	23.61	7.07	10.38	16.25	20.89	4.72	7.75
Northeast								
Assam	19.26	22.76	6.82	9.73	15.75	19.97	4.77	7.79
West								
Gujarat	20.98	24.24	8.36	10.65	21.47	25.41	7.83	11.06
Maharashtra	21.48	25.42	9.76	12.72	18.63	22.97	6.64	9.50
South								
Andhra Pradesh	20.17	25.26	7.66	11.52	17.39	22.60	5.77	9.30
Karnataka	18.68	22.23	6.93	8.59	13.48	19.85	3.42	7.08
Kerala	21.46	25.57	8.18	11.53	20.93	26.52	6.93	10.78
Tamil Nadu	21.08	25.5	8.95	11.94	18.29	22.01	6.15	8.35
Telangana	19.62	23.7	7.47	10.05	18.51	23.40	5.79	9.40

Source: Author's calculation based on data obtained from LASI (2017-18), SRS and GBD 2019

Discussion

The study was carried out to estimate the gain in life expectancy and DFLE due to the elimination of CVD, which is one of the most prominent causes of death in India. The data on age-specific CVD deaths are obtained from GBD, a comprehensive data that quantifies health outcomes and their causes worldwide. Multiple decrement life tables and cause elimination techniques were used for the analysis to find the impact of the elimination of CVD on disability-free life expectancies among older adults in India. The study revealed that the life expectancy at birth for males in India is 68.94 years and for females it is 72.10 years. After the elimination of CVD deaths, the life expectancy rose to 70.04 years among males and 72.92 years among females. At the age of 70, there was no gain in life expectancy irrespective of sex. DFLE for males in India at the age of 50 rose from 19.95 to 22.29 and for females, it increased from 17.46 to 20.73. Unlike life expectancy, there was a considerable gain in DFLE at the age of 70. Regionally, states in the Northern and Southern regions have higher gains in life expectancy and disability-free life expectancy compared to states in the Central and Eastern regions. Thus, the elimination of deaths due to CVD leads to a notable

increase in life expectancy and disability-free life expectancy for both males and females. This means that by addressing and effectively managing CVD, the older population in India can expect to live longer and enjoy more years free from disabilities associated with such conditions.

The results presented here indicate that the proportion of healthy years in a person's life has remained relatively stable, suggesting that the additional years gained are generally characterized by poor health. If individuals can enjoy these additional years in good health, and if they are supported by a suitable environment then their ability to engage in activities, they prefer may not be different from that of younger individuals. However, if these additional years are primarily marked by physical and mental decline, it has more negative implications for both older individuals and society as a whole (Jena Diptismita,2023).

DFLE in India has always been a topic of concern, with studies indicating a decline in quality of life despite improvements in life expectancy (M, Benson,2014). Research shows that India has the lowest DFLE among the countries studied, with high rates of moderate and severe disability, particularly affecting older individuals, females, and urban populations (Witness,2017). The burden of diseases, mortality, and morbidity in India has been assessed to understand the age and sex patterns of disability, highlighting the need for effective interventions to improve healthy ageing policies (Ajit,2020). Factors such as chronic diseases and degenerative conditions significantly impact DFLE, emphasizing the importance of addressing health issues to enhance the overall quality of life in India.

Eliminating CVD from disability-free life expectancy in India is crucial due to its significant impact on the population's health and economy. Studies have shown that CVD is a leading cause of disability-adjusted life years, with a high prevalence in India and a substantial burden on the younger population (Gaurav,2023). Research indicates that eliminating diabetes, stroke, hypertension, or arthritis could compress disability and increase DFLE, emphasizing the importance of addressing these conditions. Previous studies have consistently shown that CVD is a leading cause of mortality and morbidity globally, and our results in the Indian context corroborate this pattern. For instance, Kulkarni, M.S., et al. (2004) sought to estimate potential gains in life expectancy for the Goa population by eradicating all CVD that existed in 1991 and a similar study done by Shuji Hashimoto (2011) examined the gains in disability-free life expectancy in Japan by eliminating selected diseases and injuries. However, studies calculating DFLE after eliminating CVD among older adults in India are not available to the best of our knowledge. Therefore, this study tried to fill the gap by determining the gain in life expectancy and disability-free life expectancy after eliminating CVD among older adults in India. In conclusion, these findings of the study underscore the importance of adopting a holistic approach to reduce the CVD rate in India which is a major public health concern. Relevant policies may be adopted that focus on the demographically vulnerable group of older adults in specific regions of India where the incidence of CVD is high. Through such efforts, it is possible to extend the disability-free years, enhancing the overall well-being and quality of life of both males and females in India.

Strengths and Limitations of the study

This study represents a significant advancement in public health research as it calculates the gains in DFLE following the elimination of CVD in India, addressing a critical gap in the existing literature. However, certain limitations should be acknowledged. The analysis considers only chronic heart disease and hypertension in the estimation of the prevalence of CVD. Additionally, the reliance on cross-sectional data restricts the ability to infer causal relationships or capture long-term trends, potentially limiting the depth of insights into the broader implications of CVD elimination.

Declaration of Competing Interests

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