Population Health and Burden of Disease Profile of Women in India: 1990 to 2015

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Research article

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Population health and burden of disease profile of women in India: 1990 to 2015

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Abstract

Background: India has taken a step in the right direction with its latest national health policy highlighting the importance of the sustainable development goals (SDGs). However, SDG 5, which addresses gender equality is not clearly outlined in the policy. In India, gender equality has been linked to equal access to healthcare services for men and women. To understand India's progress toward equal healthcare opportunities for men and women, we describe trends in population health indicators, and burden of non-communicable diseases (NCDs); communicable, maternal, neonatal, nutritional diseases (CMNNDs), and injuries in women from India between 1990 to 2015; and compare these rates to the burden of disease in men.

Methods: This cross-sectional study used secondary data from the Institute of Health Metrics & Evaluation (IHME). We measured population health according to World Health Organization standards, using disability adjusted life years (DALYs), years of life lost (YLLs), years lived with disability (YLDs) and age specific death rate (ASD). Using these metrics, we measured trends in the relative importance of NCDs, CMNNDs and injuries amongst women and men.

Results: Between 1990 and 2015, the main cause of death in women from India escalated from CMNNDs to NCDs. From 1990 to 2015, DALYs attributed to CMNNDs declined by 10.7%, while DALYs attributed to NCDs increased by 10.8%. From 1990 to 2015, DALYs due to injuries decreased slightly (0.1%). In women, the main cause of

DALYs and YLLs was cardiovascular disease, whereas musculoskeletal disorders was the main cause of YLDs. Over the years, age specific mortality rates declined with increasing age for women when compared to men.

Conclusion: In 2015, NCDs were the leading cause of disability and deaths amongst women in India.

Key words: Burden of disease, women, India, health system, sustainable development goals

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Background

As one of the G8+5 countries, India is a key signatory to the 2030 Agenda for Sustainable Development. The sustainable development goals (SDGs) followed on from the millennium development goals (MDGs) which were established in 2000. Even though India made significant progress towards the MDGs, it did not meet most of its targets.^[7,10,32] In terms of health, India attained four of the MDGs, namely reducing HIV incidence by 57%, reducing TB mortality to 50%, increasing access to safe drinking water and increasing the number of child births attended by skilled health personnel.^[10,32] Prior to the formulation of the SDGs, India had not improved women's literacy (MDG3), maternal mortality (MDG4) and infant mortality (MDG5), these areas were still unsatisfactory.^[32] In a bid to address the unmet MDGs and newly formulated SDGs, India developed a National Health Policy in 2017, that directly aims to achieve these goals.^[11] The success of the policy towards achieving these goals, should be measured regularly to adjust and realign interventions, and using multiple indicators to confirm and reaffirm findings would help to validate findings.

One set of possible indicators includes the Global Burden of Disease (GBD) and Injuries and Risk factor study.^[1] The GBD study provides relevant information pertaining to death and mortality rates for various countries regarding disease, risk factors and injuries that

result in premature death, health loss and disabilities.^[1,3] The GBD study portrays various population health and disease trends, and provides comparisons between countries, providing valuable information regarding changes in healthcare needs and the progress of national healthcare systems.^[1,3,36] Importantly, the GBD study provides data comparing health outcomes for people of different ages and sexes, at a specific point in time in a specific place, and when analyzed over a 15 year time period, sheds light on the trends of the relative importance of different diseases and conditions towards mortality and morbidity. The GBD study has also been used to highlight gender disparities in health outcomes.^[1,37]

Globally, the disability adjust life years (DALYs) for women and men vary according to different risk factors. Men are more prone to lifestyle risks, such as diet, high blood pressure, tobacco smoke and alcohol use, with men carrying a higher risk when compared to women in these areas.^[2,37] While women also carry a high burden of DALYs due to diet and high blood pressure; when compared to men, women are more at risk of child and maternal malnutrition, and negative health outcomes due to unsafe sex.^[2,37] The most recent GBD study for India, described similar patterns, with women at risk of DALYs due to child and maternal malnutrition, followed by air pollution; whilst in men risk of DALYs is attributed to maternal malnutrition, followed by dietary risk factors.^[3] Importantly, in India, 17.6% of the total DALYs are carried by children younger than five years old, which contributes to the high risk for child and maternal malnutrition for both sexes.^[3] As the population ages, the relative contribution of non-communicable diseases (NCDs) to DALYs increases, overtaking the burden of disease due to communicable, maternal, neonatal and nutritional (CMNN) diseases.

The high burden of CMNN diseases in India, especially in children under five, draws attention to existing health inequalities.^[2, 3] In India, gender inequality is closely linked to health inequality. Women earn 27% less than men, usually because they do not have access to the same schooling and education.^[8] In India, only 39% of women attain secondary education compared to 63.5% of men, as a result, women comprise only 27.2% of the total labor force, whilst men comprise 78.8% of the labor force.^[8, 16,18] Due

to a lack of education, women in India have lower literacy rates^[6] and do not have the finances or enough knowledge to take responsibility for their health. This problem is exacerbated by the absence of a functioning public healthcare system, especially in rural areas, where almost 70% of the Indian population live.^[7] If India is to attain SDG 5, gender equality for women and girls, women will have to be able to access health care services.

Recent estimates of disease burden in India have identified a growing burden of NCDs, whilst the burden of CMNNDs remains high.^[3] Lalit et al. also identified that some states are experiencing health transition, whilst some states are experiencing little to no health transition.^[3] While this study reports changes in disease burden for both sexes combined, we investigate the changes in disease burden for men and women separately. We also investigate changes in disease burden of men and women older than 14 years. By investigating health transition for men and women, separately, we may be able to identify if women's access to healthcare has changed, especially when considering risk factors such as malnutrition and unsafe sex practices. This study thus describes epidemiological trends in population health and burden of NCDs, communicable, maternal, neonatal, nutritional diseases (CMNNDs), and injuries of women in India from 1990 to 2015 and compared these rates to the male burden of disease.

Methods

This cross sectional study used data from the Institute of Health Metrics and Evaluation database (<http://www.healthdata.org>).^[1] Data describing the burden of disease of women and men from India, older than 14 years, were extracted for the period 1990 to 2015.^[1]

Using the GBD analytical framework, we extracted data for three categories of health outcomes, namely, communicable, maternal, neonatal and nutritional (CMNN) conditions, non-communicable diseases (NCDs) and injuries.^[1, 3] For each category, we extracted death rates^[1, 3, 18], as well as disability-adjusted life years (DALYs), years of life lost (YLLs), years lived with disability (YLDs) and age standardized death rates (ASD), as per WHO guidelines.^[18] From the GBD framework, we extracted the important risk factors for DALYs.^[18] For each category, we expressed the above variables for different age groups and sexes.

Data were analyzed using SAS 9.4 software. We performed a trend analysis to quantify the degree of change in DALYs for health outcomes and risk factors associated with those DALYs.^[3, 18] We analyzed data in 5-year intervals and reported rate measures as rates per 100 000 population. This study was approved by the Research Ethics Committee, Faculty of Health Sciences, University of Pretoria (Ethics number: 288/2018).

Results

Health transition (DALY, YLLs and YLDs)

Burden of disease expressed as DALYs, YLLs and YLDs, from 1990-2015, is shown in Table 1. Health transition patterns were similar for men and women (Table 1). Over the time period, men (41.31%, 95% CI [39.06 - 42.27]) had more DALYs due to NCDs, compared to women (39.45%, 95% CI [37.24 - 41.62]). Women (52.78%, 95% CI [50.69 - 55.32]) had more DALYs due to CMMN disorders, compared to men (47.50%, 95% CI [45.62-50.04]). DALYs caused by CMMNs declined by -45.7% and -42% for women and men, respectively, between 1990 and 2015. The DALYs caused by NCDs, declined from 1990 to 2005, but increased from 2010 to 2015 for both men and women, by 2.5% and 1.1%, respectively. DALYs caused by injuries declined from 1990 to 2015. Men had more DALYs due to injuries than women.

YLLs and YLDs caused by CMMN conditions showed different trends. Loss of life (CMMN: YLLs) dropped by -54.7% (women) and -46.9% (men) from 1990 to 2015, whereas long term and short-term disability (CMMN: YLDs) increased by 0.2% for women (2000-2005) and 1.4% for men (2000-2015). YLLs and YLDs due to NCDs increased from 2010 to 2015, by 2.6% (NCD: YLLs) for women and 3.8% (NCD: YLDs) for men. YLDs caused by NCDs increased by 2% from 1990 to 2015 for women. YLDs caused by injuries increased by 5.1% and 11.5%, for women and men respectively, from 1990 to 2015.

Table 1 DALYs, YLLs and YLDs due to CMNNs, NCDs and Injuries for men and women, older than 14, from India (1990 to 2015)

	Male (DALY)						
CBD Cluster	1990	1995	2000	2005	2010	2015	Trendline
CMNN	58,04	54,82	50,77	46,99	40,26	34,14	
NCD	32,31	35,11	38,31	41,42	47,05	53,64	
Injuries	9,65	10,07	10,92	11,59	12,69	12,22	
	Female (DALY)						
CBD Cluster	1990	1995	2000	2005	2010	2015	Trendline
CMNN	62,90	59,96	56,30	52,39	46,37	38,77	
NCD	30,02	32,70	35,85	39,74	45,40	53,02	
Injuries	7,08	7,34	7,85	7,87	8,23	8,21	
	Male (YLL)						
CBD Cluster	1990	1995	2000	2005	2010	2015	Trendline
CMNN	64,13	61,25	57,05	53,66	46,06	39,43	
NCD	25,35	27,60	30,68	33,09	39,25	46,14	
Injuries	10,52	11,15	12,27	13,24	14,69	14,43	
	Female (YLL)						
CBD Cluster	1990	1995	2000	2005	2010	2015	Trendline
CMNN	70,59	68,32	64,82	61,98	55,72	46,71	
NCD	21,58	23,39	26,07	28,65	34,28	43,16	
Injuries	7,84	8,29	9,11	9,38	9,99	10,13	
	Male (YLD)						
CBD Cluster	1990	1995	2000	2005	2010	2015	Trendline
CMNN	27,47	26,52	25,87	24,42	22,13	20,32	
NCD	67,26	68,15	68,56	69,58	71,43	73,24	
Injuries	5,26	5,33	5,57	6,00	6,43	6,45	
	Female (YLD)						
CBD Cluster	1990	1995	2000	2005	2010	2015	Trendline
CMNN	31,61	30,49	29,84	28,16	25,83	23,67	
NCD	64,35	65,50	66,19	67,74	69,80	71,76	
Injuries	4,04	4,01	3,98	4,10	4,37	4,57	

Mortality by age and sex

Mortality rate increased with age for women and men (Table 2). However, when we compared the age specific mortality rate across 5-year intervals, mortality rate declined with increasing age for women and men from 1990 to 2015. Women had a lower average mortality rate across the 25-year period compared to men for all age groups except the 15 to 24 year age group where men had a 13.5% lower mortality rate than women (Table 2). Mortality rate for men was 62% and 53.9% higher than women in the 35 to 44 and 45 to 54-year age groups, respectively.

Table 2 Mortality rate (per 100 000) of men and women from India (1990 – 2015).

	Death Rate 1990		Death Rate 1995		Death Rate 2000	
Age Groups	Female	Male	Female	Male	Female	Male
15 to 24	281.92	217.28	258.35	206.90	238.92	200.74
25 to 34	322.59	346.64	295.51	338.60	278.17	349.05
35 to 44	422.93	587.17	390.81	571.06	369.76	581.49
45 to 54	864.03	1 201.96	792.47	1 136.70	720.09	1 088.67
55 to 64	2 060.89	2 648.36	1 911.44	2 538.69	1 783.25	2 409.73
65 to 74	5 068.69	5 771.96	4 656.51	5 523.59	4 384.56	5 304.22
75 Plus	9 384.80	10 204.72	8 661.53	9 815.20	8 175.45	9 431.30
	Death Rate 2005		Death Rate 2010		Death Rate 2015	
Age Groups	Female	Male	Female	Male	Female	Male
15 to 24	208.08	185.35	170.03	165.60	143.64	146.46
25 to 34	250.47	341.91	213.25	305.43	180.61	266.26
35 to 44	332.66	577.93	293.34	538.19	263.29	480.67
45 to 54	638.05	1 041.20	591.33	989.40	564.17	913.21
55 to 64	1 590.66	2 183.68	1 453.44	2 045.05	1 384.88	1 950.82
65 to 74	4 104.72	4 911.94	3 821.26	4 688.32	3 563.21	4 349.85
75 Plus	7 609.00	8 797.45	7 081.85	8 523.83	6 673.66	8 075.12

Leading causes of YLLs

From 1990 to 2015, NCDs accounted for 53.9% (women) and 51.3% (men), CMNNs accounted for 27.1% (women) and 35.1% (men) and injuries accounted for 19% (women) and 13.7% (men) of the total YLLs. Cardiovascular diseases ranked as the leading cause of death for both sexes (Table 3). The other top 4 leading causes for YLLs in women and men was diarrhea, lower respiratory and other common infectious diseases, chronic respiratory diseases, HIV/AIDS and tuberculosis and neoplasms. When compared, the top five causes of YLLs for women and men were the same disease categories but with different rankings.

Table 3 Top 10 causes of YLLs for men and women from India older than 14 years (1990 – 2015).

	YLL FEMALE Rate (per 100 000)						Rank						
Cause	1990	1995	2000	2005	2010	2015	1990	1995	2000	2005	2010	2015	Avg Rank
Cardiovascular diseases	5 582,90	5 373,08	5 151,27	4 982,83	5 167,03	5 348,88	1	1	1	1	1	1	1,00
Diarrhea, lower respiratory, and other common infectious diseases	5 020,14	4 664,47	4 375,07	3 896,80	3 313,34	2 856,75	4	2	2	4	2	2	2,00
Chronic respiratory diseases	3 070,71	2 921,89	2 770,55	2 228,12	2 072,43	2 046,26	4	3	4	4	4	4	3,83
HIV/AIDS and tuberculosis	3 456,15	2 914,49	2 823,76	2 564,05	2 010,18	1 456,39	3	4	3	3	5	5	3,83
Neoplasms	2 197,84	2 179,95	2 204,05	2 205,24	2 225,85	2 327,62	6	6	5	5	3	3	4,67
Self-harm and interpersonal violence	1 863,42	1 879,39	1 729,64	1 585,23	1 290,88	1 211,97	7	7	7	6	7	7	6,83
Maternal disorders	2 855,41	2 281,97	1 735,35	1 362,65	970,01	654,91	5	5	6	7	9	9	6,83
Unintentional injuries	1 532,74	1 456,79	1 427,52	1 337,31	1 243,27	1 185,09	8	8	8	8	8	8	8,00
Diabetes, urogenital, blood, and endocrine diseases	1 189,96	1 192,48	1 250,87	1 275,51	1 347,72	1 429,01	9	9	9	9	6	6	8,00
Digestive diseases	815,25	781,88	761,87	708,17	624,03	579,36	10	10	10	10	10	10	10,00
	YLL MALE Rate (per 100 000)						Rank						
Cause	1990	1995	2000	2005	2010	2015	1990	1995	2000	2005	2010	2015	Avg Rank
Cardiovascular diseases	7 127,33	7 119,06	7 140,46	7 173,60	7 592,54	7 725,56	1	1	1	1	1	1	1,00
HIV/AIDS and tuberculosis	5 218,73	4 754,07	4 754,43	4 430,98	3 448,29	2 503,32	4	2	2	4	2	2	2,00
Diarrhea, lower respiratory, and other common infectious diseases	4 260,21	3 970,57	3 677,08	3 264,49	2 815,80	2 430,84	3	3	3	3	3	3	3,00
Chronic respiratory diseases	3 699,55	3 542,40	3 360,46	2 666,15	2 511,82	2 410,19	4	4	4	4	4	4	4,00
Neoplasms	1 962,49	1 983,26	2 038,05	2 129,85	2 230,41	2 332,18	6	7	5	5	5	5	5,50
Transport injuries	1 895,98	1 984,69	2 034,83	2 103,29	2 192,62	2 087,67	8	6	6	6	6	6	6,33
Unintentional injuries	2 123,46	2 030,92	1 974,93	1 886,51	1 761,76	1 635,42	5	5	7	7	7	9	6,67
Self-harm and interpersonal violence	1 924,43	1 890,28	1 888,67	1 866,05	1 757,37	1 678,80	7	8	8	8	8	7	7,67
Diabetes, urogenital, blood, and endocrine diseases	1 339,18	1 356,32	1 426,48	1 492,25	1 599,97	1 645,37	9	9	9	9	9	8	8,83
Cirrhosis and other chronic liver diseases	953,63	961,60	1 015,07	1 063,37	1 110,04	1 121,43	10	10	10	10	10	10	10,00

Leading causes of YLDs

From 1990 to 2015, NCDs accounted for 75.3% (women) and 77.8% (men) of the total YLDs. CMNNs accounted for 18.4% (women) and 13.1% (men) YLDs, while injuries caused 6.3% (women) and 9.1% (men) of YLDs (Table 4). For women, the top five causes of YLDs included various NCDs such as muscular skeletal disorders, other non - communicable diseases, mental disorders, nutritional deficiencies and neurological disorders. Muscular skeletal disorders had the highest average ranking, followed by other NCDs and mental disorders (Table 4). For men, the leading cause of YLDs were mental disorders, followed by other NCDs and muscular skeletal disorders (Table 4).

Table 4 Top 10 causes of YLDs for men and women from India older than 14 years (1990 – 2015).

	YLD FEMALE Rate (per 100 000)						Rank						
Cause	1990	1995	2000	2005	2010	2015	1990	1995	2000	2005	2010	2015	Avg Rank
Musculoskeletal disorders	2 585,80	2 625,43	2 406,93	2 398,67	2 410,47	2 535,13	1	1	1	3	2	1	1,50
Other non-communicable diseases	2 336,33	2 387,25	2 399,72	2 434,66	2 478,80	2 502,22	3	3	2	1	1	2	2,00
Mental disorders	2 395,95	2 397,85	2 393,38	2 401,06	2 278,94	2 287,03	2	2	3	2	3	3	2,50
Nutritional deficiencies	1 881,34	1 807,16	1 777,48	1 770,72	1 721,59	1 698,65	4	4	4	4	4	4	4,00
Neurological disorders	1 523,92	1 522,10	1 514,97	1 507,52	1 513,11	1 509,96	5	5	5	5	5	5	5,00
Diabetes, urogenital, blood, and endocrine diseases	1 061,33	1 115,90	1 174,85	1 254,96	1 148,26	1 156,06	6	6	6	6	6	6	6,00
Unintentional injuries	722,54	697,74	681,61	651,05	682,96	738,50	7	7	7	7	7	7	7,00
Chronic respiratory diseases	615,38	615,49	600,18	591,52	628,68	686,39	8	8	8	8	8	8	8,00
Diarrhea, lower respiratory, and other common infectious diseases	410,86	393,35	379,94	359,20	344,46	332,77	9	9	9	9	9	10	9,17
Cardiovascular diseases	274,76	283,35	292,84	307,05	325,03	344,51	10	10	10	10	10	9	9,83
	YLD MALE Rate (per 100 000)						Rank						
Cause	1990	1995	2000	2005	2010	2015	1990	1995	2000	2005	2010	2015	Avg Rank
Mental disorders	2 460,72	2 473,79	2 488,20	2 503,83	2 399,88	2 382,87	1	1	1	1	1	1	1,00
Other non-communicable diseases	2 127,92	2 150,69	2 150,69	2 169,11	2 204,62	2 232,19	2	2	2	2	2	2	2,00
Musculoskeletal disorders	1840,18	1962,93	2036,90	1951,82	1736,15	1869,49	3	3	3	3	3	3	3,00
Neurological disorders	992,25	989,15	977,66	973,78	979,19	974,72	4	4	4	4	4	4	4,00
Chronic respiratory diseases	835,69	837,90	817,14	801,61	860,67	910,57	5	5	6	6	5	5	5,33
Diabetes, urogenital, blood, and endocrine diseases	711,05	766,99	868,76	924,73	858,10	892,79	7	6	5	5	6	6	5,83
Unintentional injuries	784,86	761,38	728,05	699,20	725,92	791,62	6	7	7	7	7	7	6,83
Nutritional deficiencies	609,22	567,35	555,71	508,81	499,22	479,49	8	8	8	8	8	8	8,00
Diarrhea, lower respiratory, and other common infectious diseases	394,50	375,26	358,38	336,86	320,71	311,42	9	9	9	9	10	10	9,33
Transport injuries	237,85	247,59	276,69	299,70	345,43	356,74	11	11	10	10	9	9	10,00

Leading causes of DALYs

NCDs accounted for 60.1% (women) and 60.7% (men) of the total DALYs. CMNNs caused 28.9% (women) and 23.1% (men) of DALYs, whilst injuries caused 11% (women) and 16.2% (men) of DALYs (Table 5). For both men and women, cardiovascular disease ranked first and chronic respiratory diseases ranked third (Table 5). For women, diarrhea, lower respiratory and other common infections ranked second, whilst HIV/AIDS and tuberculosis were the second most important cause of DALYs for men. For women, HIV/AIDS and tuberculosis were ranked fourth in 1990 but dropped to the twelfth position in 2015.

Table 5 Top 10 causes of DALYs for men and women from India older than 14 years (1990 – 2015).

	DALY FEMALE Rate (per 100 000)						Rank						
Cause	1990	1995	2000	2005	2010	2015	1990	1995	2000	2005	2010	2015	Avg Rank
Cardiovascular diseases	5 857,66	5 656,43	5 444,10	5 289,87	5 492,07	5 694,36	1	1	1	1	1	1	1,00
Diarrhea, lower respiratory, and other common infectious diseases	5 431,00	5 057,82	4 755,01	4 256,00	3 657,80	3 185,50	2	2	2	2	2	2	2,00
Chronic respiratory diseases	3 686,09	3 537,38	3 370,73	2 819,64	2 701,10	2 732,49	3	3	3	3	3	3	3,00
Other non-communicable diseases	2 441,07	2 490,80	2 506,11	2 543,38	2 585,28	2 608,91	7	6	5	5	4	4	5,17
HIV/AIDS and tuberculosis	3 542,36	2 995,69	2 916,21	2 657,79	2 101,09	1 531,19	4	4	4	4	9	12	6,17
Musculoskeletal disorders	2 604,60	2 644,52	2 427,16	2 419,40	2 432,40	2 559,17	6	5	7	8	6	6	6,33
Diabetes, urogenital, blood, and endocrine diseases	2 251,29	2 308,38	2 425,71	2 530,47	2 495,99	2 585,01	10	9	8	6	5	5	7,17
Mental disorders	2 437,35	2 440,85	2 438,73	2 444,70	2 317,77	2 326,72	8	7	6	7	7	8	7,17
Neoplasms	2 235,68	2 217,31	2 241,09	2 242,02	2 263,62	2 368,41	11	10	9	9	8	7	9,00
Unintentional injuries	2 255,28	2 154,53	2 109,13	1 988,36	1 926,23	1 923,77	9	11	10	10	10	9	9,83
	DALY MALE Rate (per 100 000)						Rank						
Cause	1990	1995	2000	2005	2010	2015	1990	1995	2000	2005	2010	2015	Avg Rank
Cardiovascular diseases	7 364,21	7 359,87	7 385,26	7 430,63	7 867,24	8 018,42	1	1	1	1	1	1	1,00
HIV/AIDS and tuberculosis	5 404,48	4 937,95	4 972,71	4 643,47	3 653,18	2 677,79	2	2	2	2	2	4	2,33
Chronic respiratory diseases	4 535,25	4 380,30	4 177,60	3 467,76	3 372,48	3 320,80	4	3	3	4	3	2	3,17
Diarrhea, lower respiratory, and other common infectious diseases	4 654,71	4 345,82	4 035,46	3 601,34	3 136,51	2 740,12	3	4	4	3	4	3	3,50
Mental disorders	2 685,12	2 707,37	2 735,57	2 761,23	2 658,17	2 643,84	6	6	5	5	5	5	5,33
Unintentional injuries	2 908,32	2 792,30	2 702,98	2 585,71	2 487,68	2 427,24	5	5	6	6	7	8	6,17
Transport injuries	2 133,83	2 232,28	2 311,52	2 403,00	2 538,06	2 445,12	8	8	7	8	6	7	7,33
Diabetes, urogenital, blood, and endocrine diseases	2 050,23	2 123,31	2 295,25	2 416,98	2 458,08	2 537,88	9	9	8	7	8	6	7,83
Other non-communicable diseases	2 238,53	2 262,06	2 265,35	2 288,88	2 320,57	2 348,26	7	7	9	9	9	10	8,50
Neoplasms	1 989,48	2 010,36	2 065,36	2 157,78	2 260,13	2 364,28	11	10	10	10	10	9	10,00

Risk factors for DALYs

Data on the attributable risks of DALYs were only available from 2005 to 2016 during the

period of the study (Table 6, IHME). We included 2016 data as it approximates 2015 data. The same risk factors were associated with DALYs in women from India in 2005 and 2016. Five risk factors were metabolic, three risks factors were behavioral, and two risk factors were environmental or occupational. In 2016, the top five risk factors for females were high systolic blood pressure, air pollution, dietary risks, high fasting plasma glucose, and child and maternal malnutrition.

Table 6 Top 10 risks contributing to DALYs for women from India, older than 14 years from 2005-2016. % Change indicates the relative change in DALYs associated with the risk factor between 2005 and 2016.

Risk	2005 Ranking		2016 Ranking		% Change 2005-2016
Air pollution	1		1	High systolic blood pressure	32.51
High systolic blood pressure	2		2	Air pollution	14.99
Dietary risks	3		3	Dietary risks	30.67
Unsafe water, sanitation, and handwashing	4		4	High fasting plasma glucose	15.79
High fasting plasma glucose	5		5	Child and maternal malnutrition	16.50
Child and maternal malnutrition	6		6	Unsafe water, sanitation, and handwashing	-20.59
High total cholesterol	7		7	High body-mass index	64.31
Tobacco	8		8	High total cholesterol	45.97
High body-mass index	9		9	Tobacco	26.83
Impaired kidney function	10		10	Impaired kidney function	32.26
		Behavioral risks			
		Environmental/occupational risk			
		Metabolic risk			

Discussion

This study outlines the burden of disease profile of women older than 14 years in India. Previous studies have shown that India is experiencing a rapid epidemiological transition portraying increased life expectancy with decreased mortality.^[3] Our results support evidence for this transition, since we observed a decline in CMMNs with an increase in NCDs which is associated with aging populations.^[3] For men and women, older than 14 years, total DALYs decreased by 11% and 19.78%, respectively, over the time period. This decrease is mostly due to a substantial drop in the number of DALYs due to CMMNs. This decline in total DALYs may not persist into the future, as DALYs attributed to NCDs are currently increasing. In India, cardiovascular disease is the most important cause of DALYs for both men and women from 1990 to 2015, which is supported by the increasing importance of high systolic blood pressure as a risk factor (Table 6). For women, the importance of HIV infection and tuberculosis as a cause of DALYs dropped from fourth to twelfth position,

indicating a possible improvement in access to health care.

Studies from various countries show significant associations between life expectancy, risk factors contributing to burden of disease and socio-economic status.^[19] Worldwide, the life expectancy of women and men has improved, with women living longer than men ^[2], similar to our findings. We found that mortality rate increased with age for women and men, but that mortality rate decreased over the 25-year period. On average, men had a higher mortality rate than women, implying that women live longer than men in India. Usually, aging women are prone to higher disability (YLDs)^[21,31], which are usually the greatest contributor to DALYs in women of this age group. Our results indicate that mortality (YLLs) amongst women are the greatest contributor to DALYs, with most of this mortality attributed to NCDs and, in particular, cardiovascular disease.

To address the burden of NCDs, the government of India launched a National program for prevention and control of cancer, diabetes, cardiovascular disease and stroke (NPCDCS).^[23] Even though this program was launched in 2010, our findings show an increase in DALYs, YLDs and YLLs due to NCDs between 2010 and 2015. Nine years later, NCDs are still the highest burden of disease in India. Our results indicate that the high burden of NCDs are comprised of cardiovascular disease, respiratory disease, and other NCDs. These causes were very similar for men and women, but for men, respiratory disease escalated from fourth position in 1990 to second position in 2015. This could be attributed to the environmental exposure of at work for men who have better job outcomes than women.^[19]

DALYs caused by CMMNs in adult women and men, are lower than for children younger than five^[3], but still contributes to the health burden of adult women and men. Leading CMMN causes for DALYs include diarrhea, lower respiratory, and other common infectious diseases, HIV/AIDS and tuberculosis. Diarrhea, lower respiratory, and other common infectious diseases was ranked higher for women than men. In contrast, the ranked importance of HIV infection and tuberculosis as a cause of DALYs dropped for women but increased for men. Cultural beliefs in India, where women are married off to older men in early adolescence, could also have contributed to high rates of HIV infection amongst women in the 1990s.^[8] Since then, relevant educational campaigns may have contributed to

a decline in the rate of HIV/AIDS in India.^[23] Current rate of infection may be due to husbands living away from wives due to work commitments and engaging in extra-marital sexual activity.^[8] In India, a woman's chastity is of utmost importance whereas men are allowed multiple sexual and marriage partners.^[8]

The leading causes of disability were muscular skeletal disorders for women and mental disorders for men. Global statistics indicate that muscular skeletal disorders are a major cause of morbidity and the second most common cause of disability and occurs in 40% of individuals older than sixty years.^[25] Our findings that women live longer than men, could be associated with the higher prevalence of muscular skeletal disorders amongst women in India. The WHO stipulates that mental disorders such as depression may be the second largest contributor to the burden of disease by 2020.^[26] Mental disorders ranked first for men and third for women in our findings. Our results may be an under-estimate, because, according to Basu, women are likely to suffer silently with mental disorders and not seek medical help due to the social stigma of being classified as 'witches'.^[26,28] In 2016, deaths resulting from suicide in India accounted for 36.6% of deaths in women and 24.3% of deaths in men.^[3,32] The highest suicide deaths in India can be accounted to married women.^[3,32] High suicide rates in women could be attributed to early marriage, inability to cope with domestic violence, poverty and minimal care to seek medical help for mental disorders.^[3,32] In 2017, the Indian Mental Health Care Act emphasized the reduction of suicide deaths and suicide attempts, however progress in the implementation of the mental health program has been slow.^[3,32]

In the GBD study, DALYs can be attributed to certain risk factors. For example, DALYs due to respiratory disease could be attributed to air pollution, which was an important risk factor for DALYs between 2005 and 2016 (Table 6) and was associated with a 14.99% rise in DALYs. In our study, nutritional deficiencies ranked fourth for women and eighth for men, as a cause of disability in 2015, thus showing that in India, nutritional deficiencies cause more disability for women than men. In Indian homes, men are given meals first and women eat what's left, predisposing women to hunger especially in households where there is scarcity of food.^[28] In our study, maternal and child malnutrition increased in importance as an attributable risk factor for DALYs, along with dietary risks. These risk factors are two sides

of the same coin and may contribute to a variety of negative health outcomes. Dietary risks could be associated with high systolic blood pressure, high body mass index, high total cholesterol and high fasting plasma glucose.^[3] In most homes, women decide on dietary behaviors and lifestyle practices of their children.^[28] A study conducted in 2012 by Tilakavati et al, on dietary health behaviors revealed that 70% of Indian diets needed improvement. ^[29] Given the rise of diet related NCDs such as hypertension, diabetes, cardiovascular diseases; women play a crucial role in curbing this burden of disease regardless of gender.^[29]

This study was cross sectional, hence findings must be perceived as associative and not causative. Secondly, secondary data were used from the IHME website, hence there is possibility of subjective and information bias in accuracy of data obtained. Data on risk factors were only extracted for women. Thirdly, GBD data obtained from the IHME website is a sample of the population hence the actual prevalence or incidence of disease cannot be determined but can only be estimated. Fourthly, data category tools on the IHME website aren't comprehensive. Data on literacy rate and social economic status are not included. Lastly, the study analyzed data during the time frame of 1990-2015, however state level data including the year 2017 is now available for use on the IHME website.

Recommendations

This study outlines the overlap between gender and age, and its significant role in curbing the burden of disease in India of which NCDs are most prevalent.^[2,3,6,11] We found that DALYs due to CMNNDs are decreasing steadily for women and men in India, but DALYs due to NCDs are showing a rising trend. The increase in DALYs due to NCDs may soon negate the positive impact of public health programs that have been so effective in reducing CMNNDs. Our findings suggest that high systolic blood pressure and exposure to air pollution are important risk factors for DALYs in adult women. Health programs should focus on important drivers or determinant of these risk factors.

Conclusion

To conclude, this study on the epidemiological trend and burden of disease of women in India from 1990 to 2015 is the first to attempt to understand the burden of disease profile from a

gender related perspective. India has made progress towards reducing mortality and increasing life-expectancy.^[3] However, increased life expectancy leads to increased burden of disease of which the women are most affected because they live longer.^[25] Current programs aimed to reduce the high burden of non-communicable diseases in the country have not resulted in a decline of NCDs.^[3] This study, therefore suggests that gender equity must be considered when formulating policy and addressing program interventions to reduce mortality and morbidity resulting from NCDs in India.^[3,18]

Additional File

This file includes 7 additional figures and additional results. Fig 1 to fig 4 depicts DALY, YLLs, YLDs and causes of death trend patterns from 1990 to 2015 for females and males. Fig 5 depicts the age specific death rate by sex and Fig 6 & Fig7 depicts the death rate ranks of males and females respectively from 1990 to 2015.

Abbreviations

AIDS: Acquired immune deficiency syndrome, ASD: Age Standardized Death , BRICS: Brazil, Russia, India, China, South Africa, CHE: Catastrophic Health Expenditure, CMNNs: Communicable, maternal, neonatal and nutritional, DALY: Disability Adjusted Life Years, GBD: Global Burden of Diseases, GDP: Gross Domestic Product, HIV: Human Immunodeficiency Virus, IHME: Institute for Health Metrics and Evaluation, MDGs: Millennium Development Goals, NCD: Non-Communicable Disease, OOP: Out of Pocket , SDGs: Sustainable Development Goals, TB: Tuberculosis, UNDP: United Nations Development Program, WHO: World Health Organization, YLL: Years of Life Lost, YLD: Years Lived with Disability.

Declaration**Ethical Approval and consent to participate**

Not applicable. All data we used are publicly available

Consent for publication

Not applicable because the article does not include details, images or videos relating to individual participants.

Availability of data and materials

The dataset supporting the results and discussion of this article is within the article, in additional file 1 and is available from the school of Health System & Public Health website at the University of Pretoria.

Competing interest

The authors declare that they have no competing interests.

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Authors Contribution

KM: Study design, data interpretation and analysis of results, drafting the manuscript, accountable for all aspects of the work. FS: Critically revising the manuscript, final approval of the version to be published. Agreement to be accountable for all aspects of the work. TC: Data extraction and statistical analysis of the data captured from the web- based application that was used as data source. Agreement to be accountable for all aspects of the work. All authors have read and approved the manuscript.

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