Original Article

The Most Prevalent Causes of Deaths, DALYs, and Geriatric Syndromes in Iranian Elderly People Between 1990 and 2010: findings from the Global Burden of Disease study 2010

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Abstract

Background: The substantial increase in life expectancy during recent decades has left all countries with a high number of elderly people that have particular health needs. Health policy-makers must be aware of the most prevalent causes of deaths and DALYs in this age group, as well as geriatric syndromes, in order to provide appropriate care and allocate resources in an equitable manner.

Methods: The Global Burden of Disease study 2010 (the GBD study 2010), conducted by the Institute for Health Metrics and Evaluation team, estimated the worldwide burden of diseases from 1990 to 2010. Its estimations were conducted on the basis of the proportion of deaths, the duration of symptoms and disability weights for sequelae, years lived with disability (YLDs), years of life lost (YLLs), and disability adjusted life years (DALYs) attributable to different diseases. In the present study, we extracted the data regarding the top five most prevalent causes of deaths, DALYs, and geriatric syndromes in the elderly based on the aforementioned the GBD study 2010, discussed the results using some tables and figures, reviewed the results, described the limitations of the GBD study 2010, and finally provided some recommendations as potential solutions.

Results: According to the GBD study 2010, the total number of deaths in Iran in 1990 was 321,627, of which 116,100 were in elderly people (those aged 60 years and above), meaning that 36.10% of all deaths occurred in the elderly. Among all diseases in this year, the first to third ranked causes of death were ischemic heart disease (IHD; 29.44%), neoplasms (13.52%), and stroke (7.24%). In comparison, the total number of deaths in Iran increased to 351,814 in 2010, with 213,116 of these occurring in the elderly (60.58% of deaths), but the most prevalent causes of death remained the same as in 1990. The highest 1990 DALYs rates were the result of IHD (21.56%), neoplasms (10.70%), and stroke (4.85%). IHD (22.77%), neoplasms (9.48%), and low back pain (LBP; 5.72%) were the most prevalent causes of DALYs in older Iranian adults in 2010. The fourth and fifth ranked causes of deaths and DALYs in both 1990 and 2010, both in Iran and globally, were different diseases and geriatric syndromes in the elderly Iranian population.

Conclusion: The aged population of Iran is growing steadily, and there is a need for health policy-makers to create appropriate programs to meet the health needs of elderly people. Although the GBD study results are useful in providing burden estimations at regional and national levels, each individual country should estimate its burden of diseases, injuries, and risk factors at a sub-national level to obtain further details regarding the health status of its people. As no comprehensive study regarding elderly people in Iran has previously been conducted, our study will be a major source for identifying the important causes of deaths, DALYs, and geriatric syndromes among this population.

Keywords: Geriatric Syndromes, Global Burden of Disease, Iran, Burden

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Introduction

The remarkable increase in life expectancy that occurred during the 20th century has been one of the world's greatest health achievements,[1] and its explicit consequence is an increase in the number of older people. Thus, population aging is an unavoidable phenomenon in the modern era.[2]

Although there is no standard criterion for defining older people, the United Nations generally refers to those aged 60 years and above as elderly. It is estimated that the worldwide number of people aged 60 years and above will increase from 605 million in 2000 to approximately two billion people in 2050.[3] In contrast, estimations indicate that people in the oldest age group (those aged ≥85 years) have the fastest growth rate among the elderly population. Therefore, the worldwide number of people aged 85 years and above will increase by 351% between 2010 and 2050, with corresponding increases of 188% for those aged 65 years and above, and 22% for those aged under 65 years.[1]

In Iran, the number of older people has continuously increased from 1986 to 2011.[3] On the basis of the 2011 census of that nation, the percentage the population aged ≥60 years was 8.2%,[4] and worldwide estimates indicate that this figure will reach 10.5% in 2025 and 21.7% in 2050.[5]

According to the GBD study 2010 estimates, 23% of the total burden of diseases is attributed to diseases and disorders in people aged ≥60 years.[6] It is notable that the disability adjusted life years (DALYs) *per capita* is 40% higher among older people who live in low-income and middle income than among those who live in high-income countries.[5] Chronic illnesses usually affect older people more often than younger adults because of several changes in vital capacities and psychosocial status that occur as a result of aging.[7] Moreover, elderly populations utilize a huge proportion of global health resources.[8] Although the prevalence of chronic diseases and the high economic cost of care have risen in this age group, very few studies have addressed the prevalence and incidence of chronic diseases and their outcomes among older people at national and regional levels in Ira.[9–11] Therefore, we conducted a relatively comprehensive review of the most common causes of deaths and DALYs, as well as geriatric syndromes, of elderly people in Iran, using the GBD study 2010 results.

Materials and Methods

The Institute for Health Metrics and Evaluation conducted the GBD study 2010 to investigate the worldwide burden of diseases. Comprehensive and systematic, the GBD study 2010 estimated the burden of diseases across 187 countries, 20 age groups and both genders, using a common framework of data collection, statistical methods, and estimation processes that have been described elsewhere.[12–19] The results were released in 2013. The GBD study 2010 used the proportion of deaths, the mean duration of symptoms, and the disability weights of sequelae for estimating the years lived with disability (YLDs), the years of life lost (YLLs) due to premature mortality, and the disability adjusted life years (DALYs) attributable to different diseases between 1990 and 2010. The data were derived from epidemiologic surveys, and the registration systems of countries. In the event of no epidemic studies, or lack of data, the GBD study 2010 team used a statistical model (DisMod-MR) to extrapolate and interpolate gender-age-groups prevalence and to estimate the burden of diseases and risk factors.

In the present study, we extracted the data relating to the top five causes of deaths and DALYs, as well as geriatric syndromes, in the elderly in Iran according to the GBD study 2010. In order to improve our analysis, similar to the GBD, our age groups included five categories: 60–64, 65–69, 70–74, 75–79, and 80+ years. Since the number of people in the 80+ age group was relatively small, and an accurate calculation of DALYs was not possible, the GBD study 2010 did not thoroughly estimate the burden of diseases in this subpopulation. Moreover, the rates, trends, and types of diseases differed between genders, so it was necessary for the GBD study 2010 to estimate separately the burden of diseases for women and men.[20] We followed this protocol, and our results are separated according to gender. The entire measures have been reported with a 95% Uncertainty Interval (UI).

After extracting the data regarding the most prevalent causes of deaths and DALYs in the elderly, as well as geriatric syndromes, we discuss and review the results, using some tables and figures, and describe the limitations of the GBD study 2010. Finally, we provide some recommendations for potential solutions.

Results

According to the GBD study 2010, the total number of deaths in Iran was 321,627 in 1990, and 116,100 of these were in the elderly (aged 60 years and above).This means that 36.10% of deaths occurred in the elderly. Ischemic heart disease (IHD; 29.44%), neoplasms (13.52%), and stroke (7.24%) were the leading causes of mortality in that year. In comparison, the total number of deaths in Iran increased to 351,814 in 2010, with 213,116 of these occurring in the elderly (60.58% of deaths). However, the top-ranked causes of deaths in elderly Iranians in 2010 had not changed compared to 1990; IHD was the most prevalent cause of death (32.75%), followed by neoplasms (12.05%), and stroke (8.46%).

In contrast, the DALYs rate in Iran was 21.714.100 years in 1990, of which 2.748.791 years (12.66%) were lost in the elderly. The most prevalent causes of DALYs in the elderly were IHD (21.56%), neoplasms (10.70%), and stroke (4.85%). These proportions were a little different in 2010, with IHD (22.77%), neoplasms (9.48%), and LBP (5.72%) being the most prevalent causes of DALYs in this sub-population (Table 1).

By extracting the GBD study 2010 results, we drew Tables 2 to 6, which show the five leading causes of deaths and DALYs in older age groups in Iran and worldwide in 1990 and 2010, based on gender and age. These tables indicate that the main cause of deaths and DALYs was IHD. Deaths and DALYs due to IHD per 100,000 population increased in all ages and both genders in the first 10 years of the study, and then the rate decreased from 2000 to 2010. IHD was also the main cause of deaths and DALYs in the elderly at a global level during these years. IHD and ischemic stroke were second-ranked among the main causes of deaths and DALYs in the elderly in both Iran and worldwide in 1990 and 2010. In a majority of older adults at global level, the third-ranked most prevalent cause of deaths and DALYs was chronic obstructive pulmonary disease (COPD), both in 1990 and in 2010. The top-ranked most prevalent causes of deaths and DALYs in the Iranian elderly during 1990 and 2010 were cardiovascular diseases (CVDs), LBP, Alzheimer's disease and other dementias, road injury, and natural accidents. The same could be said of the fourth and the fifth ranked prevalent diseases in both Iran and the globe, which were occupied by different diseases and geriatric syndromes in the two different years. However, the rate of deaths and DALYs due to a number of diseases and geriatric syndromes increased between 1990 and 2010, as a result of aging.

Based on the total number of deaths in 2010, the most changes among elderly diseases in Iranian males who aged 60 to 64, 65 to 69, 70 to 74 and 75 to 79 years old and Iranian females who aged 70 to 74 and 75 to 79 years old belonged to falls. The most changes for the other age groups and both sexes belonged to diabetes mellitus. Moreover, the least changes among elderly diseases in all elderly age groups of Iranian males and females belonged to ischemic stroke (Table 7).

The total number of DALYs showed that the most and least changes among elderly diseases in Iranian males and females in all elderly age groups belonged to Alzheimer's disease and other dementias and ischemic stroke respectively except for females who were in 60 to 64 and over 80 years in which the most changes shifted to diabetes mellitus (Table 7).

Table 1. The percentages of the most prevalent diseases of Iranian elders in the years 1990 and 2010.

Metric	Year	Total Number	Total in Elderly	Percentage in Elderly group	Disease	Percentage for each disease
Death	1990	321,627	116,100	36.10	IHD	29.44
					Stroke	7.24
					Neoplasms	13.52
					Diabetes Mellitus	1.80
					COPD	1.78
					Falls	0.21
					Alzheimer	0.37
					Others	45.64
	2010	351,814	213,116	60.58	IHD	32.75
					Stroke	8.46
					Neoplasms	12.05
					Diabetes Mellitus	2.73
					COPD	2.26
					Falls	0.39
					Alzheimer	1.53
					Others	39.83
DALY	1990	21,714,100	2,748,791	12.66	IHD	21.56
					Stroke	4.85
					Low Back Pain	4.82
					Neoplasms	10.70
					Diabetes Mellitus	2.73
					COPD	2.51
					Falls	1.57
					Alzheimer	0.72
					Others	50.54
	2010	19,401,400	4,225,434	21.78	IHD	22.77
					Stroke	5.36
					Low Back Pain	5.72
					Neoplasms	9.48
					Diabetes Mellitus	4.30
					COPD	2.93
					Falls	1.89
					Alzheimer	1.73
					Others	45.82

Alzheimer's Disease & Other Dementias
Chronic Obstructive Pulmonary Disease
Cirrhosis of the Liver
Diabetes Mellitus
Falls
Forces of Nature
Hypertensive Heart Disease
Ischemic Heart Disease
Ischemic Stroke
Low Back Pain
Lower Respiratory Infections
Trachea, Bronchus, and Lung Cancers
Osteoarthritis
Other Cardiovascular & Circulatory Diseases
Road Injury
Stomach Cancer
Tuberculosis

Table 2. The first rank of leading causes of deaths and DALYs in Iran and globe based on sex and age groups in 1990 and 2010.

Rank	Sex	Year	Age	Deaths (95% UI)		DALYs (95% UI)	
				Location		Location	
				Iran	Globe	Iran	Globe
1	Female	1990	60 to 64	386.8 (288.4-507.9)	61.7 (53.8-75.2)	10267.9 (7740.79-13320.6)	1683.2 (1481.1-2036.9)
			65 to 69	624.3 (477.9-800.3)	124.3 (111.5-144.1)	13623.7 (10590.8-17272.3)	7758.2 (7254.1-8847.6)
			70 to 74	1079.0 (841.6-1359.6)	292.9 (257.8-342.6)	18709.3 (14786.5-23322.5)	5184.7 (4590.1-6019.9)
			75 to 79	1831.2 (1472.8-2267.8)	669.1 (609.7-750.1)	24248.4 (19631-29781.5)	9041.8 (8284.6-10093.6)
			80 plus	3896.6 (3169.4-4617.7)	3149.6 (2995.3-3439.4)	30259.3 (24596.5-35782.7)	21965.2 (21034.3-23905)
		2010	60 to 64	250.1 (160.1-338.3)	145.4 (121.9-167.2)	6750.04 (4453.9-9019.7)	4094.8 (3468.4-4679.1)
			65 to 69	440.4 (294.9-567.1)	257.6 (225.1-290.9)	9716.5 (6666.59-12426.9)	5894.0 (5177.8-6599.9)
			70 to 74	778.8 (537.9-1008.3)	499.6 (442.9-551.7)	13604.0 (9552.08-17457.6)	8974.9 (8027.4-9888.2)
			75 to 79	1381.7 (985.1-1729.3)	449.4 (404.6-509.5)	18362.0 (13275.4-22871.6)	6271.9 (5676.1-7076.4)
			80 plus	3436.3 (2651.9-4137.4)	2519.9 (2371.4-2803.8)	24974.2 (19496.6-30043)	16969.8 (15914.9-18501.8)
	Male	1990	60 to 64	682.6 (533.2-874.8)	401.9 (373.5-456.7)	17931.0 (14095.3-22874.3)	10783.6 (10058.8-12172.7)
			65 to 69	1066.1 (859.1-1339.8)	606.4 (565.5-687.8)	23103.5 (18719-28911.9)	13434.4 (12609-15239)
			70 to 74	1613.9 (1306.7-2020.6)	897.6 (842.3-1028.8)	27945.1 (22780.5-34753.2)	15896.4 (15017.3-18136.2)
			75 to 79	2457.1 (2013.9-2931.2)	1524.8 (1442.0-1692.4)	32606.9 (26733.5-38633.5)	20655.3 (19669.5-22719.7)
			80 plus	4470.9 (3664.3-5252.2)	3279.7 (3119.4-3583.2)	35993.1 (29703.1-42033.4)	24893.4 (23655.6-27043.9)
		2010	60 to 64	555.9 (392.5-740.7)	315.9 (267.9-350.0)	14670.8 (10454.2-19385.2)	8558.8 (7392.0-9463.5)
			65 to 69	874.6 (627.6-1112.5)	482.3 (417.2-535.8)	19018.4 (13797.4-24060)	10778.7 (9476.7-11905.4)
			70 to 74	1347.7 (1003.7-1705.2)	776.1 (690.8-851.0)	23392.6 (17565.5-29260.2)	13830.1 (12435.2-15089.2)
			75 to 79	2149.6 (1639.4-2680.8)	1186.7 (1078.5-1291.8)	28529.8 (21930.2-35322.4)	16219 (14793.3-17601.8)
			80 plus	4314.0 (3474.9-5210.7)	2639.4 (2475.4-2869.0)	32222.6 (26131.2-38680.6)	19574.6 (18396.8-21160.5)

Table 3. The second rank of leading causes of deaths and DALYs in Iran and globe based on sex and age groups in 1990 and 2010.

Rank	Sex	Year	Age	Deaths (95% UI)		DALYs (95% UI)	
				Location		Location	
				Iran	Globe	Iran	Globe
2	Female	1990	60 to 64	86.4 (58.4-121.5)	192.2 (176.0-228.0)	2268.9 (1559.5-3178.5)	5332.3 (4876.7-6243.0)
			65 to 69	150.2 (105.8-206.8)	343.3 (321.5-395.8)	3264.1 (2339.8-4452.6)	2797.7 (2525.1-3209.6)
			70 to 74	298.1 (208.2-403.9)	605.0 (569.8-697.3)	5152.3 (3617.4-6911.6)	10798.5 (10098.6-12281.8)
			75 to 79	625.4 (449.6-804.2)	1157.4 (1103.2-1291.7)	8278.1 (6076.6-10611.9)	15663.1 (14930-17436.4)
			80 plus	1382.3 (1020.3-1808.5)	2025.0 (1892.5-2187.4)	10747.1 (7995.9-14054.8)	14412.4 (13466.1-15555.1)
		2010	60 to 64	54.1 (31.5-81.6)	40.3 (35.3-48.3)	3562.9 (2346.7-4871.2)	1149.1 (1015.1-1348.9)
			65 to 69	92.8 (56.1-133.3)	84.4 (76.3-97.7)	2077.6 (1290.8-2937.4)	1979.7 (1799.2-2265.5)
			70 to 74	188.3 (116.4-264.2)	216.6 (195.3-244.7)	3330.1 (2065.9-4604.2)	3935.9 (3562.9-4418.6)
			75 to 79	426.7 (277.1-576.2)	848.8 (766.6-928.4)	5742.7 (3845.6-7665.6)	11601.1 (10612.6-12782.8)
			80 plus	1159.8 (778.7-1515.5)	1472.3 (1362.7-1618.5)	8522.2 (5820.4-11095.6)	10219.7 (9458.3-11141.2)
	Male	1990	60 to 64	289.4 (137.4-679.8)	102.6 (83.6-134.9)	7425.2 (3552.6-17370.3)	2761.4 (2278.5-3585.6)
			65 to 69	194.0 (136.5-264.9)	182.3 (150.7-237.3)	4218.5 (2979.1-5697.9)	4076.0 (3414.6-5240.3)
			70 to 74	342.8 (237.2-478.8)	352.9 (286.0-467.7)	5952.1 (4147.8-8229.5)	14275.5 (12678.9-16297.7)
			75 to 79	650.1 (437.1-939.1)	714.3 (612.3-875.0)	8670.9 (5920.7-12385.4)	9752.8 (8455.3-11807.5)
			80 plus	1336.9 (930.8-1833.5)	1791.2 (1580.5-2051.9)	10806.7 (7671.6-14732)	13857.9 (12264.1-15786.6)
		2010	60 to 64	72.5 (43.3-115.5)	75.3 (63.7-102.2)	4315.1 (2862.3-5947.2)	2081.2 (1775.0-2768.6)
			65 to 69	146.1 (99.1-203.1)	140.1 (117.8-189.1)	3232.2 (2239.4-4434.3)	3213.6 (2737.9-4280.4)
			70 to 74	273.5 (177.2-394.2)	290.7 (250.6-380.0)	4814.5 (3170.2-6847.3)	5273.0 (4586.7-6776.4)
			75 to 79	539.4 (339.9-772.9)	529.5 (453.8-686.7)	7276.6 (4665.5-10309.2)	7440.4 (6462.4-9490.7)
			80 plus	1273.1 (848.4-1716.7)	1343.6 (1187.8-1680.5)	9631.3 (6510.2-12870.1)	10310.4 (9203.6-12635.7)

Table 4. The third rank of leading causes of deaths and DALYs in Iran and globe based on sex and age groups in 1990 and 2010.

Rank	Sex	Year	Age	Deaths (95% UI)		DALYs (95% UI)	
				Location		Location	
				Iran	Globe	Iran	Globe
3	Female	1990	60 to 64	169.4 (78.8-387.1)	157.8 (140.1-176.2)	4351.9 (2042.1-9879.6)	5017.8 (4421.6-5604.3)
			65 to 69	214.7 (100.3-479.0)	267.5 (240.5-293.8)	4551.3 (2148.1-10108.0)	6774.3 (6086.1-7463.4)
			70 to 74	256.9 (120.7-560.3)	483.1 (436.5-529.3)	4148.7 (2750.4-5850.7)	9433.1 (8610.6-10291.7)
			75 to 79	405.6 (233.5-636.4)	661.1 (610.7-711.7)	5235.8 (3022.4-8211.9)	9917.2 (9113.1-10741.3)
			80 plus	820.8 (539.7-1203.2)	1260.5 (1178.3-1344.0)	6245.0 (4106.4-9142.3)	10334.4 (9592.5-11123.4)
		2010	60 to 64	54.6 (29.7-95.6)	71.6 (58.6-86.4)	1460.3 (878.8-2189.5)	2800.9 (2311.2-3316.0)
			65 to 69	86.3 (47.1-137.8)	138.4 (116.6-164.4)	3778.7 (2462.5-5219.3)	4061.8 (3463.6-4742.5)
			70 to 74	161.4 (80.8-275.8)	234.1 (198.4-276.8)	4065.8 (2741.0-5668.2)	5199.3 (4496.0-6035.2)
			75 to 79	279.0 (165.9-454.7)	366.0 (320.5-419.4)	4320.9 (2923.8-6053.8)	6081.2 (5300.8-6916.8)
			80 plus	668.1 (442.8-962.5)	774.3 (706.4-848.5)	5172.9 (3045.0-8251.8)	6473.2 (5869.0-7157.9)
	Male	1990	60 to 64	101.1 (66.3-144.3)	239.1 (203.2-282.1)	1949.2 (1215.6-3029.3)	7205.1 (6221.4-8319.4)
			65 to 69	329.4 (157.6-762.2)	423.5 (365.6-495.9)	6988.6 (3366.0-16105.5)	10216.2 (8840.3-11768.8)
			70 to 74	318.7 (187.7-510.3)	760.0 (667.9-878.3)	5385.9 (3172.5-8614.5)	6275.3 (5138.9-8211.1)
			75 to 79	489.4 (272.0-814.4)	1125.2 (995.0-1288.8)	6349.3 (3531.3-10554.5)	16107.5 (14363.8-18292)
			80 plus	944.4 (593.0-1483.1)	1977.6 (1757.8-2249.7)	7434.5 (4675.2-11663.2)	16173.8 (14427.9-18232)
		2010	60 to 64	126.9 (73.8-221.2)	132.2 (89.4-165.3)	2662.6 (1776.6-3749.4)	4124.1 (3357.7-5214.1)
			65 to 69	160.2 (79.4-285.6)	238.9 (195.3-302.4)	4591.0 (3059.7-6367.5)	6299.8 (5231.3-7732.5)
			70 to 74	258.9 (147.9-416.1)	421.5 (350.5-521.0)	4974.8 (3359.8-6900.9)	8488.2 (7197.6-10256.3)
			75 to 79	396.3 (225.3-648.0)	695.2 (593.6-844.1)	5323.1 (3609.4-7419.0)	10465.3 (9003.8-12487.2)
			80 plus	809.1 (508.1-1241.3)	1364.7 (1180.7-1629.9)	5923.6 (3726.3-9068.7)	11064.5 (9642.3-12921)

Table 5. The fourth rank of leading causes of deaths and DALYs in Iran and globe based on sex and age groups in 1990 and 2010.

Rank	Sex	Year	Age	Deaths (95% UI)		DALYs (95% UI)	
				Location		Location	
				Iran	Globe	Iran	Globe
4	Female	1990	60 to 64	78.7 (42.0-134.3)	60.9 (49.2-75.5)	3696.5 (2403.1-5255.4)	2169.5 (1853.2-2598.9)
			65 to 69	121.1 (68.4-191.5)	79.9 (71.9-93.3)	3904.6 (2501.7-5559.7)	2659.9 (2285.5-3194.8)
			70 to 74	224.1 (143.7-334.1)	142.3 (118.9-163.1)	4343.2 (2064.4-9439.7)	3038.7 (2640.2-3616.7)
			75 to 79	369.3 (211.3-589.4)	235.5 (202.0-279.0)	4781.7 (2743.5-7609.5)	3188.6 (2753.6-3796.2)
			80 plus	799.7 (524.8-1163.6)	756.0 (647.9-889.5)	6091.2 (4019.5-8855.0)	5330.4 (4627.8-6228.5)
		2010	60 to 64	39.5 (21.9-61.2)	53.7 (42.8-60.0)	2547.8 (1597.4-3739.9)	2252.6 (1867.7-2678.1)
			65 to 69	74.5 (39.8-127.7)	93.0 (70.3-104.9)	3090.8 (2335.7-4073.5)	2976.1 (2442.5-3453.5)
			70 to 74	140.2 (87.9-210.3)	134.7 (99.7-149.4)	3426.8 (2588.7-4419.8)	2424.8 (1676.0-3261.9)
			75 to 79	269.5 (158.2-428.6)	197.6 (153.4-232.9)	4043.7 (3000.2-5253.0)	3634.1 (3001.5-4223.9)
			80 plus	653.4 (427.3-975.3)	694.9 (554.7-796.5)	4788.3 (3178.5-6873.4)	5766.4 (4257.4-7189.0)
	Male	1990	60 to 64	143.0 (80.4-234.3)	170.7 (123.8-220.1)	4474.7 (2955.2-6372.8)	4387.8 (3201.3-5654.6)
			65 to 69	198.2 (101.5-353.2)	235.1 (173.1-314.9)	4712.2 (3113.0-6690.2)	5000.2 (3698.4-6666.9)
			70 to 74	337.9 (164.2-799.8)	287.8 (215.3-403.6)	5729.4 (2803.6-13520.2)	4902.8 (3663.6-6850.8)
			75 to 79	403.7 (234.2-634.9)	352.5 (274.0-441.0)	5247.5 (3509.9-7331.1)	4694.1 (3694.8-5866.8)
			80 plus	741.4 (453.6-1134.5)	1008.8 (821.6-1236.7)	5833.8 (3576.8-8917.5)	7574.5 (6202.5-9266.1)
		2010	60 to 64	108.1 (59.4-186.8)	119.1 (94.3-157.2)	3671.6 (2280.2-6016.5)	3398.1 (2306.1-4233.5)
			65 to 69	151.5 (88.0-281.4)	192.1 (131.5-235.3)	3613.0 (2286.6-6312.6)	4087.4 (2813.8-4999.1)
			70 to 74	187.5 (99.7-279.0)	268.5 (173.1-325.2)	4383.7 (2516.2-7028.0)	4572.8 (2957.5-5516.6)
			75 to 79	306.9 (191.9-468.0)	345.9 (209.6-414.1)	5154.5 (2960.6-8392.5)	4518.1 (2750.1-5388.3)
			80 plus	645.8 (431.7-925.6)	886.9 (685.5-1064.3)	5380.0 (3619.7-7536.4)	6343.7 (4942.7-7600.4)

Table 6. The fifth rank of leading causes of deaths and DALYs in Iran and globe based on sex and age groups in 1990 and 2010.

Rank	Sex	Year	Age	Deaths (95% UI)		DALYs (95% UI)	
				Location		Location	
				Iran	Globe	Iran	Globe
5	Female	1990	60 to 64	68.1 (41.8-110.3)	51.4 (45.9-61.2)	2539.8 (1624.2-3742.7)	2210.1 (1531.1-2975.2)
			65 to 69	120.5 (66.6-201.8)	75.9 (61.7-89.1)	2573.8 (1632.9-3776.8)	2352.4 (1646.2-3149.3)
			70 to 74	224.6 (114.9-378.8)	115.8 (106.5-141.2)	3772.0 (2421.0-5620.0)	2492.5 (2095.3-2828.1)
			75 to 79	259.8 (125.8-547.0)	153.8 (139.1-184.8)	4375.9 (2855.4-6120.2)	3162.8 (2730.2-3729.9)
			80 plus	331.1 (203.0-497.4)	363.6 (247.8-523.6)	4400.8 (2901.6-6250.1)	4475.6 (3369.9-5704.8)
		2010	60 to 64	37.6 (23.6-53.4)	44.5 (25.0-59.2)	2449.6 (1825.0-3265.1)	2126.7 (1460.6-2856.7)
			65 to 69	65.7 (41.7-99.9)	68.1 (48.3-84.0)	2584.0 (1640.5-3801.5)	2253.8 (1556.7-3022.1)
			70 to 74	90.6 (62.2-127.4)	113.1 (83.0-139.0)	2765.9 (1426.8-4695.8)	1994.2 (1485.6-2434.2)
			75 to 79	153.7 (100.7-224.7)	184.1 (139.0-203.4)	3645.8 (2194.2-5893.8)	2666.1 (2109.2-3122.2)
			80 plus	302.8 (176.5-476.1)	383.8 (173.1-518.3)	4663.4 (3059.7-6940.5)	4541.9 (3633.6-5215.4)
	Male	1990	60 to 64	113.7 (69.0-198.9)	132.8 (104.5-176.3)	3650.7 (2054.4-5977.6)	3592.5 (2897.3-4691.8)
			65 to 69	166.6 (104.0-261.2)	160.6 (128.0-211.6)	4188.1 (2148.2-7449.8)	3660.3 (2945.7-4759.6)
			70 to 74	243.6 (153.4-371.8)	199.4 (152.6-248.1)	4987.3 (3368.2-6920.5)	3467.2 (2673.9-4296.1)
			75 to 79	314.1 (177.4-449.1)	352.6 (262.9-499.2)	5228.4 (3040.1-8216.7)	4615.2 (3447.5-6501.2)
			80 plus	442.2 (248.8-681.0)	363.8 (271.9-514.2)	5283.2 (3539.5-7478.6)	3455.9 (2706.2-4440.4)
		2010	60 to 64	67.3 (29.7-102.4)	73.1 (53.9-88.8)	2767.8 (1531.5-4768.5)	2533.3 (1745.7-3441.1)
			65 to 69	115.6 (68.1-181.1)	91.6 (65.7-106.0)	3395.9 (1696.2-6031.3)	2959.8 (2398.5-3465.2)
			70 to 74	186.9 (107.3-337.9)	160.4 (113.7-195.7)	3712.7 (2703.9-4910.5)	3401.5 (2772.6-3946.9)
			75 to 79	227.7 (126.2-347.6)	290.2 (219.5-352.8)	4223.4 (3037.9-5693.5)	3881.0 (2952.3-4681.0)
			80 plus	417.2 (245.5-697.2)	404.7 (243.9-470.8)	4718.8 (3159.6-6737.3)	4679.5 (3588.8-5780.8)

Table 7. The median % change of deaths and DALYs per 100000 population based on sex and age groups in 2010.

Disease	Sex	Age	Median % change of Deaths (95% UI)	Median % change of DALY (95% UI)
Ischemic Heart Disease	Female	60 to 64	-1% (-37 to 56)	1% (-34 to 55)
		65 to 69	1% (-34 to 46)	2% (-32 to 44)
		70 to 74	55% (2 to 119)	55% (5 to 116)
		75 to 79	131% (56 to 210)	132% (59 to 208)
		80 plus	231% (147 to 334)	210% (134 to 303)
	Male	60 to 64	7% (-27 to 57)	7% (-26 to 56)
		65 to 69	-1% (-28 to 36)	0% (-28 to 35)
		70 to 74	77% (26 to 144)	77% (28 to 142)
		75 to 79	190% (114 to 288)	191% (116 to 285)
		80 plus	347% (250 to 479)	315% (227 to 433)
Ischemic Stroke	Female	60 to 64	-2% (-39 to 59)	0% (-36 to 61)
		65 to 69	-10% (-38 to 35)	-8% (-36 to 35)
		70 to 74	37% (-5 to 99)	39% (-3 to 101)
		75 to 79	108% (47 to 187)	111% (51 to 190)
		80 plus	212% (138 to 306)	193% (127 to 281)
	Male	60 to 64	-13% (-43 to 38)	-12% (-42 to 39)
		65 to 69	-13% (-37 to 21)	-12% (-36 to 22)
		70 to 74	60% (11 to 128)	61% (13 to 131)
		75 to 79	164% (78 to 268)	167% (82 to 270)
		80 plus	319% (197 to 483)	292% (181 to 441)
Chronic Obstructive Pulmonary Disease	Female	60 to 64	10% (-37 to 90)	28% (-19 to 103)
		65 to 69	3% (-40 to 78)	18% (-23 to 87)
		70 to 74	72% (-5 to 202)	81% (22 to 188)
		75 to 79	168% (45 to 367)	168% (76 to 316)
		80 plus	275% (126 to 490)	239% (128 to 403)
	Male	60 to 64	-11% (-39 to 89)	7% (-28 to 73)
		65 to 69	1% (-35 to 73)	8% (-28 to 63)
		70 to 74	86% (26 to 218)	93% (35 to 191)
		75 to 79	205% (111 to 412)	208% (122 to 351)
		80 plus	405% (258 to 645)	360% (229 to 557)
Alzheimer's Disease & Other Dementias	Female	60 to 64	282% (-40 to 1677)	82% (-6 to 260)
		65 to 69	280% (-17 to 1326)	84% (-2 to 247)
		70 to 74	366% (4 to 1640)	165% (34 to 423)
		75 to 79	596% (80 to 2959)	297% (105 to 684)
		80 plus	799% (145 to 3297)	371% (147 to 881)
	Male	60 to 64	182% (-34 to 1111)	72% (-14 to 251)
		65 to 69	177% (-22 to 990)	70% (-14 to 253)
		70 to 74	392% (32 to 1962)	214% (64 to 524)
		75 to 79	662% (102 to 2721)	396% (142 to 914)
		80 plus	1033% (218 to 4217)	567% (246 to 1178)
Diabetes Mellitus	Female	60 to 64	87% (1 to 203)	99% (48 to 166)
		65 to 69	62% (-9 to 170)	78% (25 to 141)
		70 to 74	100% (25 to 218)	140% (83 to 220)
		75 to 79	230% (99 to 429)	265% (172 to 393)
		80 plus	414% (217 to 745)	377% (259 to 558)
	Male	60 to 64	57% (-14 to 179)	64% (17 to 124)
		65 to 69	44% (-20 to 140)	54% (10 to 112)
		70 to 74	149% (40 to 332)	169% (96 to 283)
		75 to 79	305% (133 to 565)	332% (206 to 510)
		80 plus	604% (296 to 1075)	542% (354 to 772)

Falls	**Female**	**60 to 64**	55% (-41 to 405)	33% (5 to 69)
		65 to 69	46% (-44 to 414)	23% (-2 to 55)
		70 to 74	121% (-6 to 660)	86% (49 to 131)
		75 to 79	248% (17 to 1235)	168% (114 to 242)
		80 plus	335% (47 to 1399)	235% (166 to 337)
	Male	**60 to 64**	67% (-45 to 411)	27% (-2 to 69)
		65 to 69	84% (-50 to 451)	16% (-10 to 52)
		70 to 74	179% (-11 to 956)	100% (53 to 166)
		75 to 79	308% (26 to 1028)	204% (139 to 284)
		80 plus	521% (135 to 1664)	329% (239 to 449)
Low Back Pain	**Female**	**60 to 64**	-	49% (11 to 92)
		65 to 69	-	39% (4 to 80)
		70 to 74	-	109% (64 to 159)
		75 to 79	-	202% (136 to 285)
		80 plus	-	274% (190 to 381)
	Male	**60 to 64**	-	26% (-1 to 68)
		65 to 69	-	18% (-8 to 59)
		70 to 74	-	111% (70 to 166)
		75 to 79	-	238% (164 to 327)
		80 plus	-	372% (265 to 512)

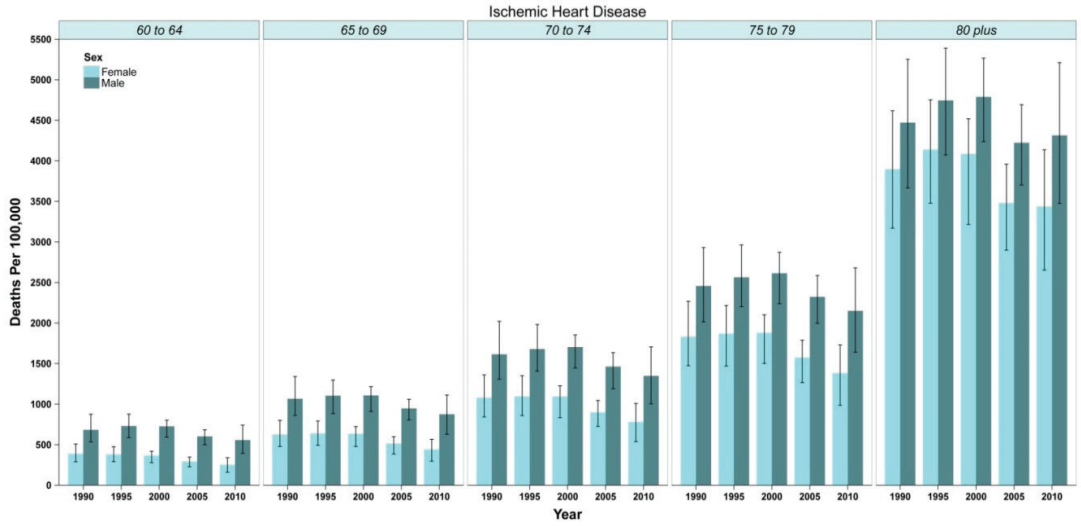

Figure 1. Ischemic Heart Disease Deaths per 100000 population based on sex and age groups between 1990 and 2010.

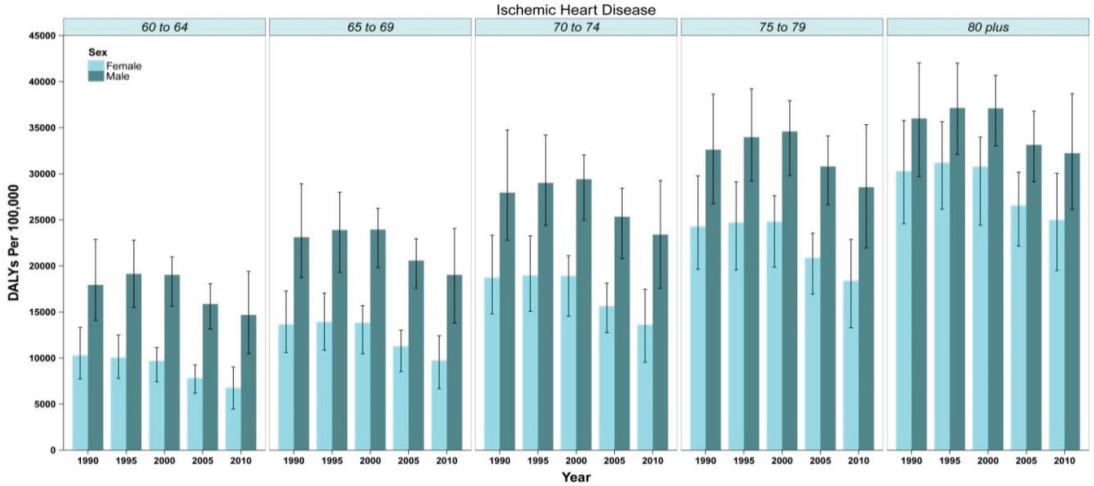

Figure 2. Ischemic Heart Disease DALYs per 100000 population based on sex and age groups between 1990 and 2010.

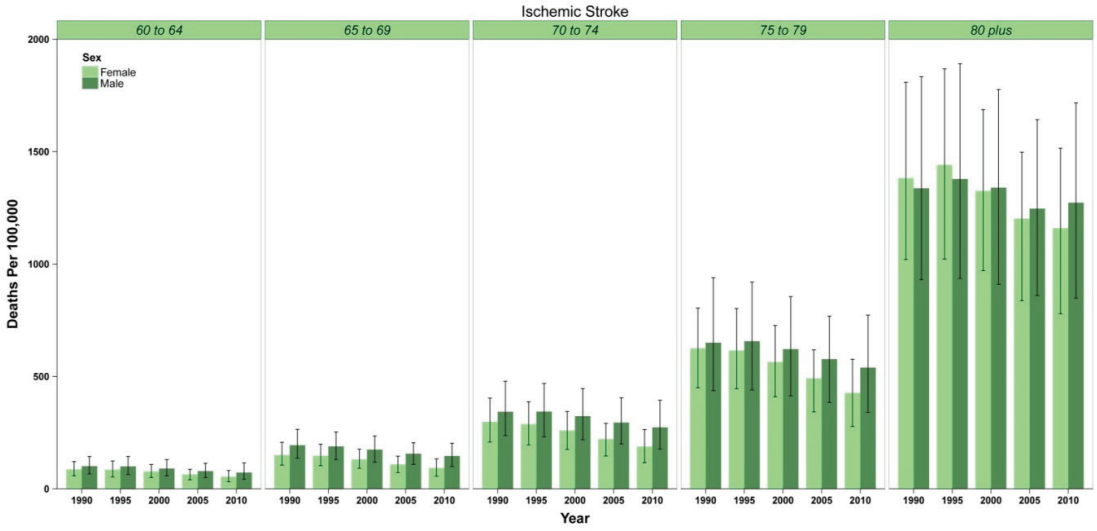

Figure 3. Ischemic Stroke Deaths per 100000 population based on sex and age groups between 1990 and 2010.

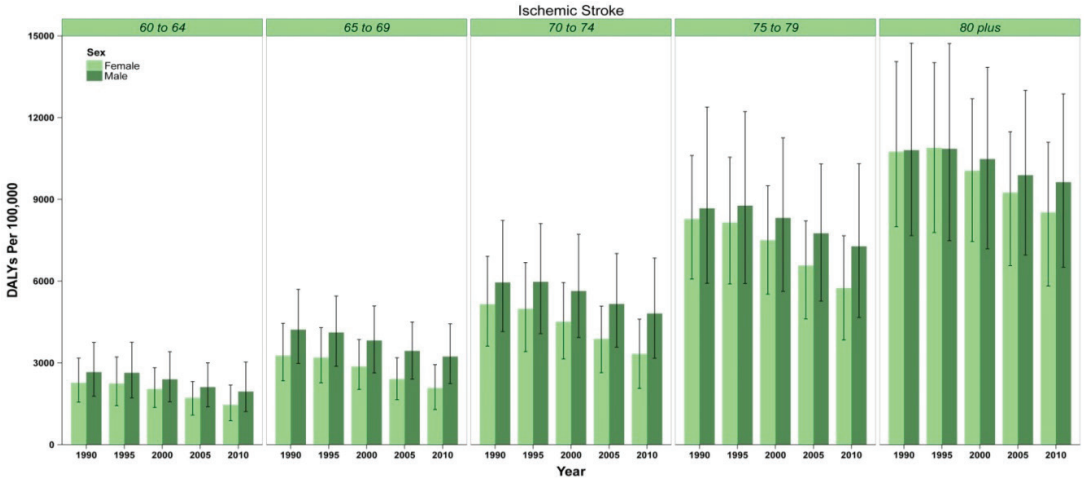

Figure 4. Ischemic Stroke DALYs per 100000 population based on sex and age groups between 1990 and 2010.

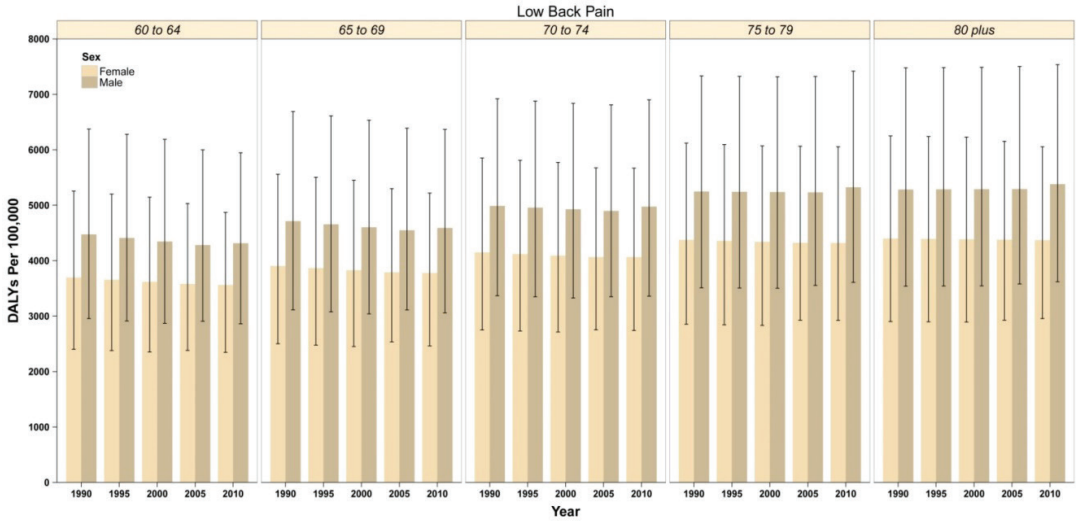

Figure 5. Low Back Pain DALYs per 100000 population based on sex and age groups between 1990 and 2010.

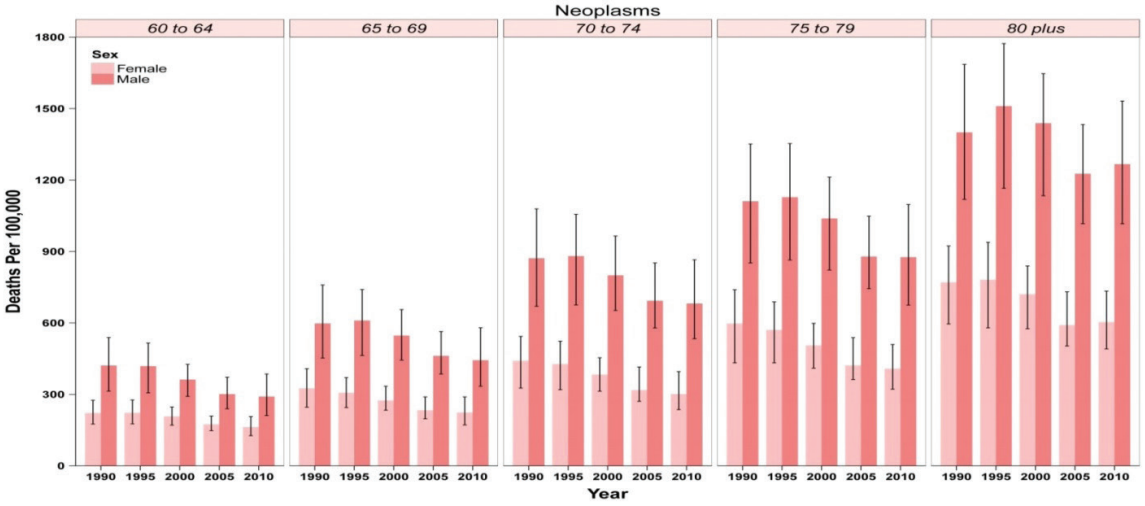

Figure 6. Neoplasms Deaths per 100000 population based on sex and age groups between 1990 and 2010.

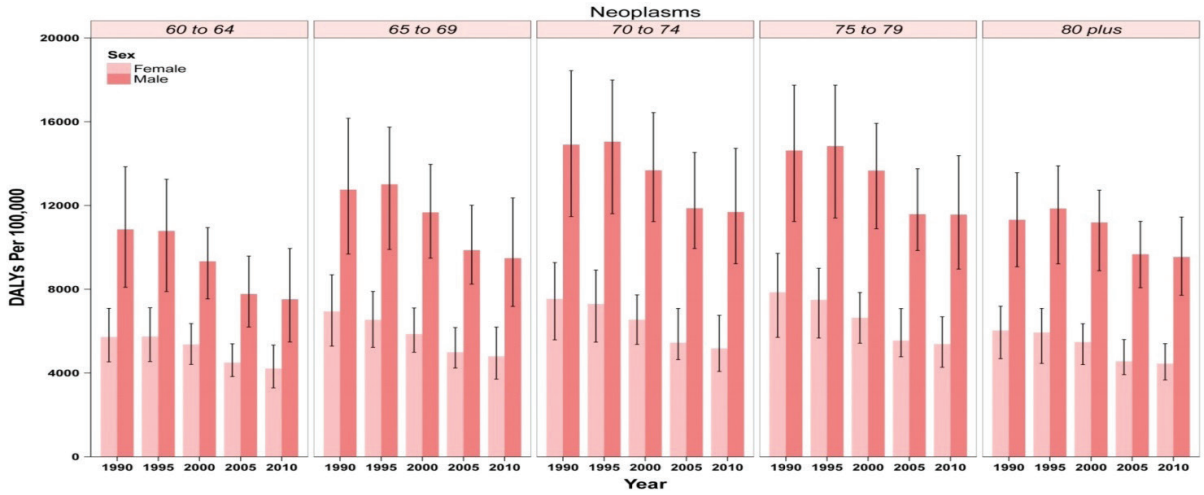

Figure 7. Neoplasms DALYs per 100000 population based on sex and age groups between 1990 and 2010.

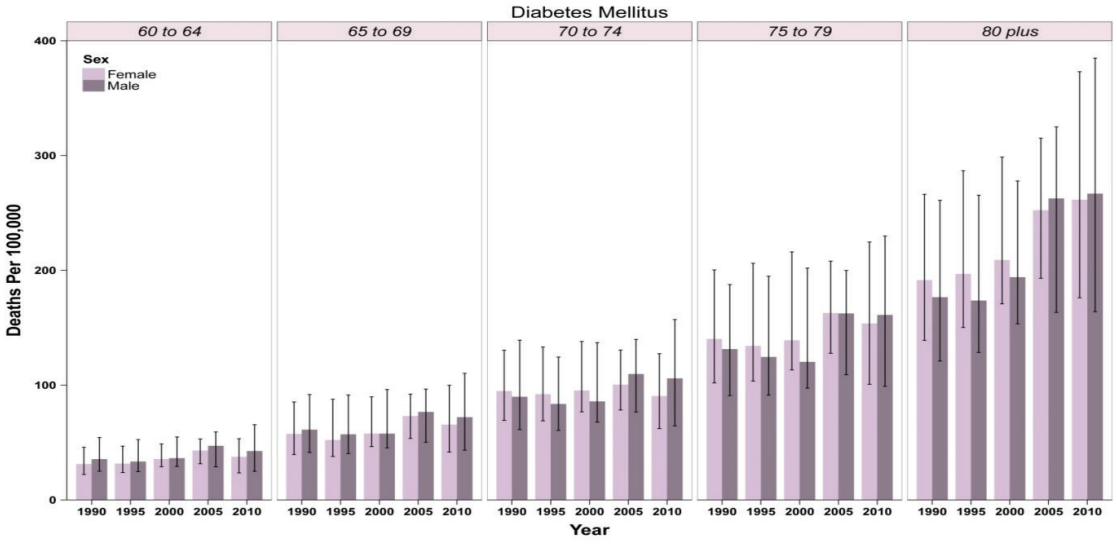

Figure 8. Diabetes Mellitus Deaths per 100000 population based on sex and age groups between 1990 and 2010.

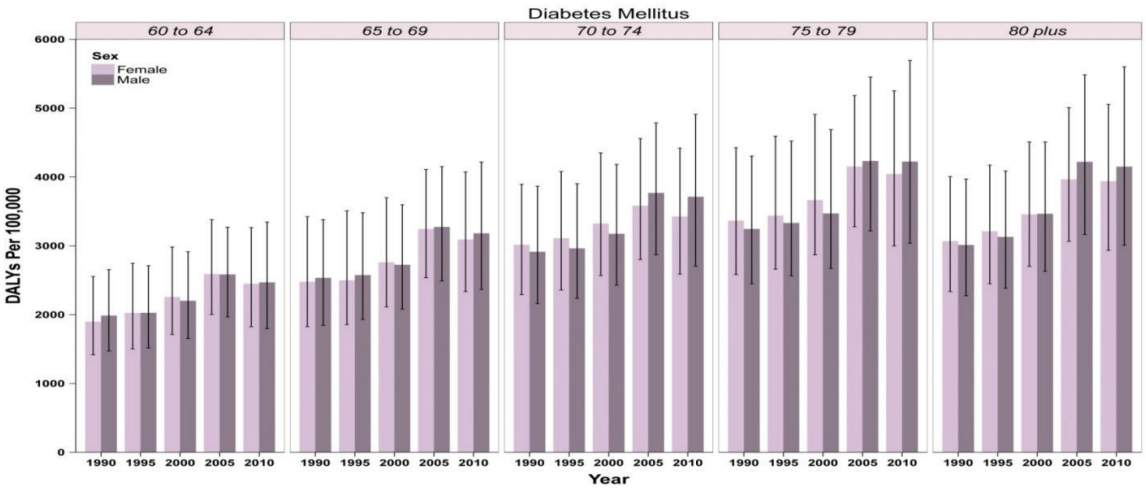

Figure 9. Diabetes Mellitus DALYs per 100000 population based on sex and age groups between 1990 and 2010.

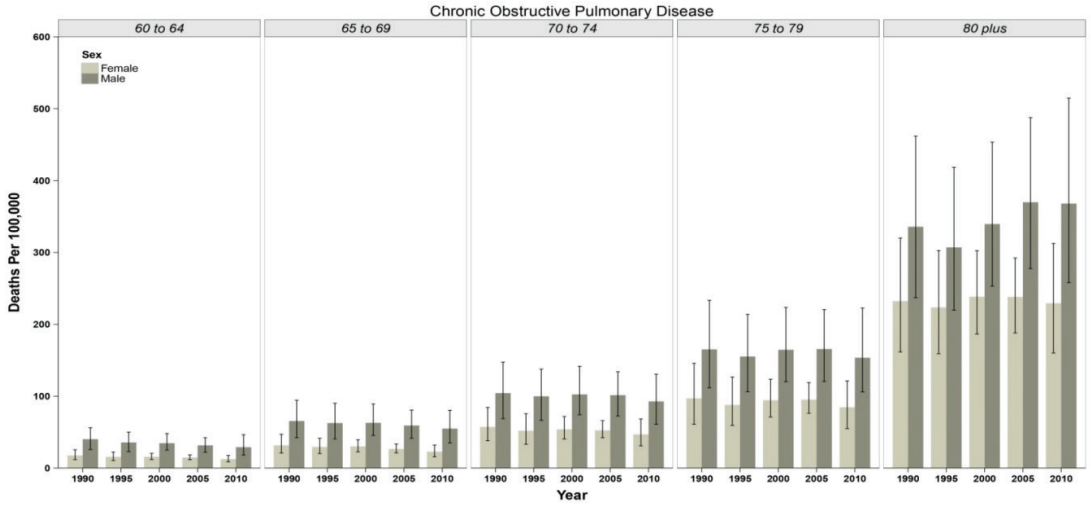

Figure 10. Chronic Obstructive Pulmonary Disease Deaths per 100000 population based on sex and age groups between 1990 and 2010.

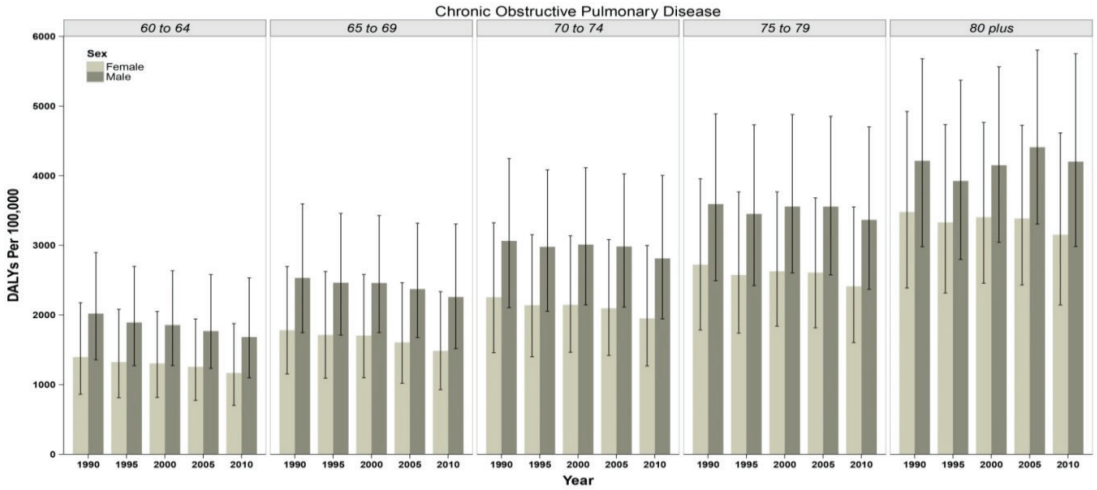

Figure 11. Chronic Obstructive Pulmonary Disease DALYs per 100000 population based on sex and age groups between 1990 and 2010.

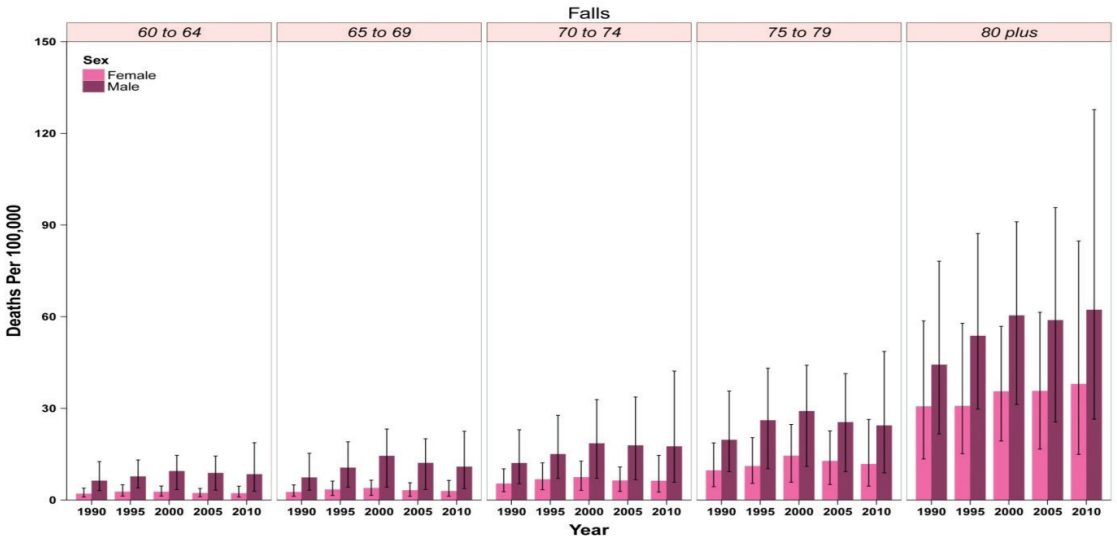

Figure 12. Falls Deaths per 100000 population based on sex and age groups between 1990 and 2010.

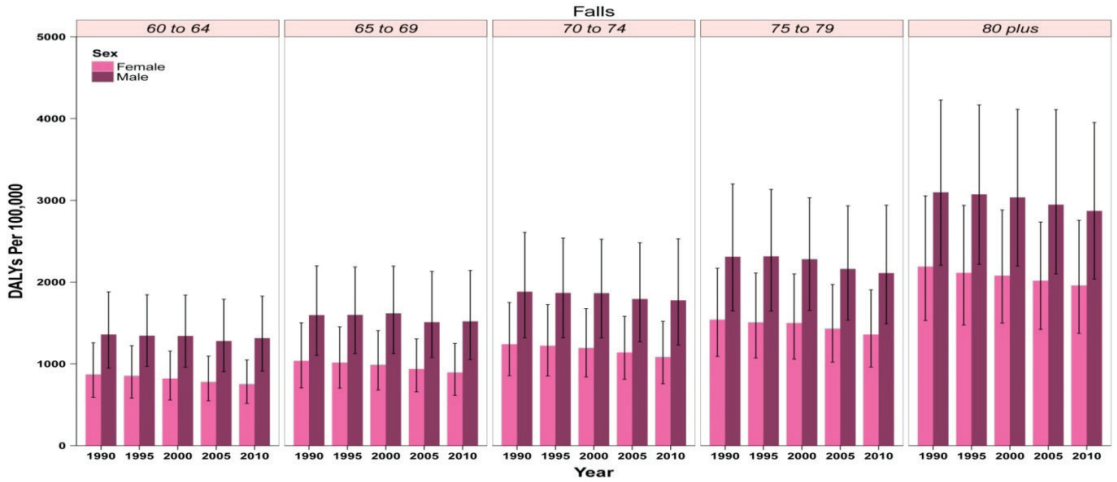

Figure 13. Falls DALYs per 100000 population based on sex and age groups between 1990 and 2010.

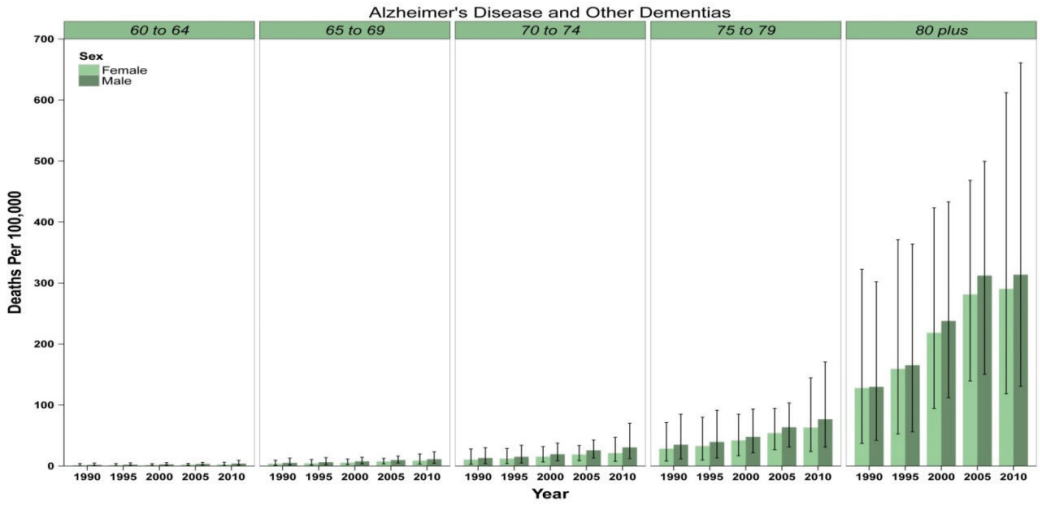

Figure 14. Alzheimer's Disease and other Dementias Deaths per 100000 population based on sex and age groups between 1990 and 2010.

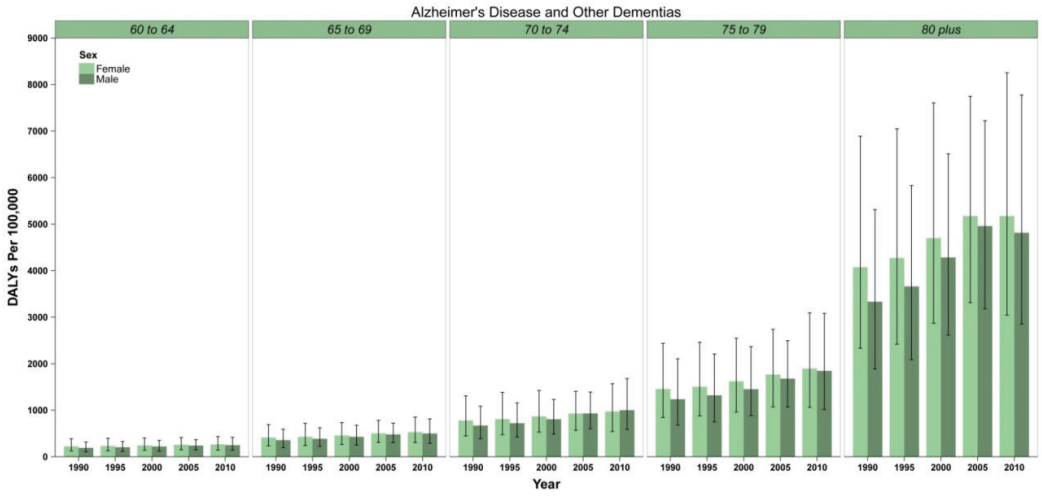

Figure 15. Alzheimer's Disease and Other Dementias DALYs per 100000 population based on sex and age groups between 1990 and 2010.

Figures 1 and 2 present the deaths and DALYs rates attributable to IHD. Figure1 shows that the IHD death rate increased from 1990 to 2010, and then decreased slightly. The IHD DALYs rate also showed such a trend. However, the deaths and DALYs attributed to IHD were lower in women than men during these two decades. Figures 3 and 4 are related to ischemic stroke. Deaths and DALYs rates were similar to those of IHD, but these rates increased up to 1995, after which there was a decreasing trend to 2010. The present study showed that the deaths and DALYs rates decreased slightly from 1995 in both women and men in Iran. In general, the deaths and DALYs rates due to ischemic stroke among Iranian women were lower than for men during these two decades. The GBD study 2010 results showed that the LBP DALYs rate had a slightly increasing trend in both Iranian women and men from 1990 to 2010, but its DALYs rate was generally higher in men than women (Figure 5). Figures 6 and 7 show the rates of deaths and DALYs due to neoplasms, and indicate that although the death rate has decreased since 1995 in all elderly age groups, its rate had generally increased remarkably in accordance with age, and a decreasing trend in DALYs rate was associated with people aged 75 years and above. However, the rate of death and disability due to neoplasms in Iranian women was substantially lower than that observed in men. Figures 8 and 9 show the deaths and DALYs associated with diabetes mellitus and their increasing trends between 1990 and 2010. The results indicate no remarkable difference between the rates of deaths and DALYs in elderly Iranian women and men. COPD was the other disease that was prevalent in Iranian elderly people between 1990 and 2010, and its death and DALYs rates are shown in Figures 10 and 11. Although these rates did not change very remarkably in all of the elderly age groups during this time, they dramatically increased in accordance with rising age. Moreover, the deaths and DALYs rates due to COPD were always higher in men. The deaths rate attributable to falls is shown in Figure 12. This rate increased as a result of aging, but there was a slight decrease from 2000 onwards. The DALYs rate of falls was a relative improvement on that of death, and a slight, but consistent, lowering trend was observed in all age groups from 1990 to 2010 (Figure 13). The deaths and DALYs rates due to falls were higher in men at all times. Figures 14 and 15 show that the rate of deaths due to Alzheimer's disease and other dementias was higher in elderly Iranian men, but the DALYs rate of this group of diseases was higher in elderly women. Both deaths and DALYs due to this group of diseases continuously increased in both genders from 1990 to 2010.

Discussion

The life expectancy of Iranian men increased from 63 to 76 years, and the life expectancy of Iranian women reached to 80 from 69 years during the study period (1990 to 2010). As a result of the aging of the population, the pattern and type of diseases in Iran will change and calculating the burden of diseases would represent a transitional status that many developing countries may experience it in the near future or have experienced it before.

The GBD study 2010 study results revealed that cardiovascular diseases (CVDs) were the most prevalent cause of deaths in elderly Iranian people during 1990 to 2010. This group of diseases is also the leading causes of morbidity and death in both developed and developing countries.[21–23] The high number of CVDs means that it is one of the most burdensome chronic diseases. Studies have shown not only European and American countries,[24,25] but the countries of the Eastern Mediterranean Region including Iran also suffer from the high rates of CVDs (26). Therefore, adoption of an efficient management program to treat and control these diseases in older adults would be reasonable. Similar to other parts of the world,[22,27] the leading predictor of CVDs in Iran is aging.[28] In contrast with other studies that have shown there are more women than men with CVDs,[21,22] the results of the GBD study 2010 that pertained to Iran revealed that Iranian men both suffer (high DALYs rate) and die from CVDs more than women (high deaths rate). The most prevalent cause of deaths in Iranian elderly people was IHD, and this result was similar to those observed in some other studies.[29]

The second most important cause of deaths and DALYs in Iran was ischemic stroke. Stroke is mainly a disease of middle-aged and older people[30] and accounts for 9.9% of all deaths in the world, with over than 85% of these deaths occurring in developing countries.[31] It should be mentioned that although the stroke data varies across different countries,[32] but the stroke mortality rate has decreased[33,34] due to improvements in diagnosis, treatment, and control of stroke's risk factors such as hypertension.[35,36] Since the changes in stroke mortality were due to a decrease in fatality

rather than in event rates,[37] the necessity of adopting changes in stroke management is an important issue.[38]

Musculoskeletal disorders were another common problem in older people. Approximately 80% of people experience at least one attack of low back pain (LBP) during their lives, irrespective of age and sex.[39] This problem is a condition with a multifactorial origin and a different duration that leads to significant disability.[40] LBP can affect all age groups, but the literature shows the amount of LBP increases remarkably with aging.[41] Elderly people are therefore particularly susceptible to LBP, which leads functional disability and dependency in these individuals.[40]

Falls and their consequences are important health problems in older adults, worldwide.[42] Even in developed countries, around one in three adults over the age of 65 years experiences at least one annual fall annually,[43] that 20-30% of those who survive; suffer from moderate-to-severe injuries that limit their mobility.[44] It is possible that the increase in available information is the reason for the decreasing deaths and DALYs rates due to falls from 1990 to 2010 in Iran. Another reason for this decrease of DALYs could be improvements in the health of older adults during these 20 years in that nation. However, these rates were always higher in elderly Iranian men. This could be explained by the fact that older men are at higher occupational and environmental risk of fall than women.

In general, dementia is a disease of the elderly,[45] and age is the most important risk factor.[46] The irreversible and progressive nature of this disease and its high prevalence in the elderly population means that dementia has a great burden in elderly.[44] The number of people with dementia worldwide was 44.35 million in 2013, but this will exceed 75.62 million in 2030 and 135.46 million in 2050.[47] Currently, 62% of patients with dementia live in low-income countries.[48] The GBD study 2003 showed that dementia contributed to 11.2% of YLDs in people aged over 60 years. Such a rate was higher than that found for stroke (9.5%), musculoskeletal disorders (8.9%), and all cancers (2.4%).[44] According to a study conducted by the Alzheimer's Europe Consortium and Harvard School of Public Health, dementia of the Alzheimer's type is a major health concern in adults.[45] In accordance with this result, the GBD study 2010 showed that the dementias deaths and DALYs rates increased in the Iranian elderly between 1990 and 2010.

However, it should be mentioned that despite the value of the GBD study 2010 in estimating the burden of diseases, its estimations have some crucial limitations due to the lack of accurate data, especially in developing countries.[44] Following the rarity of appropriate community-based studies regarding the epidemiologic characteristics of some of health conditions, a number of prevalence estimations were entirely depended on statistical models. For instance, there was no specific population-based epidemiologic study regarding specific diseases and risk factors such as dementia of elderly people at national level in Iran. In addition, even when the GBD study 2010 estimations were based on a country's evidences, these estimations were sometimes related to a single or a few studies. In this way, generalization of the results may be questionable.[44] In this regard, the GBD study team had to estimate the burden of diseases and risk factors, using advanced statistical models to meet this problem although data-driven estimations are more reliable than model-driven estimations that this problem forms another challenge of the GBD study 2010 results, which is its model-driven estimations. This type of estimations has large-scale uncertainties, and cannot form an appropriate basis for health policymaking and adoption public health strategies.

In addition, the GBD study 2010 estimations were made only at national level. Calculation of information regarding the burden of diseases and risk factors at a sub-national, alongside a national, level is necessary to help the health authorities for appropriate and reasonable resource allocation and health interventions. Estimation of the burden of diseases at sub-national level will provide different figures, due to different approaches in calculations and, sometimes, data sources. The further limitations of the GBD study 2010 have been described elsewhere.[19–26]

By the way, regardless of the GBD study 2010 limitations, its results are useful and valuable to estimate the burden of diseases at both regional and national levels, but it is important for countries to estimate their own burden of diseases individually. For instance, in the 2010 estimates, lack of necessary data was still an unsolved problem, but there is a need to provide extensive data for estimating YLDs that due to the limited epidemiologic studies in developing countries, it is hardly available.[49] Even in Iran that has an appropriate health system- health network-, there are few cohort studies, therefore, Iranian health authorities must rely on the information about diseases and sequelaes based on the studies conducted in developed countries and calculate the burden of diseases using statistical models. In this regard, due to the necessity of estimating the burden of diseases, injuries, and risk factors in Iran at both national and sub-national levels, and following the limitations of the GBD study 2010, the Iranian health authorities decided to conduct a comprehensive study to estimate the burden of diseases at national level. Thus, the National and Sub-national Burden of Disease (NASBOD) study is underway, conducted by the Non-Communicable Diseases Research Center (NCDRC), and it is using a standardized protocol of data collection, statistical methods and estimation processes to calculate the burden of diseases, injuries, and risk factors at both national and sub-national levels from 1990 to 2013.[50] Further details regarding the two advanced statistical methods used in the NASBOD study are available elsewhere.[51,52] It provides precise information for estimation of the health status over the time in a province or across provinces. The results of such a study will be a major source for identifying the national and sub-national priorities, and provides the necessary context to apply effective strategies for priority setting and policy-making in different regions of Iran.

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Competing interests

The authors declare no competing interests.

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