

Original Article



Burden of Neurological Disorders Among Older Adults in Iran (During 1990-2023): A Secondary Analysis of Global Burden of Disease 2023 Estimates

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Abstract

Objectives: This study assessed the burden and temporal trends of neurological disorders among adults aged ≥ 60 years in Iran from 1990 to 2023.

Design: Systematic analysis.

Setting(s): Iran.

Participants: Adults aged 60 years and older.

Outcome Measures: Estimates of incidence, prevalence, mortality, years lived with disability (YLDs), years of life lost (YLLs), and disability-adjusted life years (DALYs) for neurological disorders among adults aged ≥ 60 years in Iran were obtained from the GBD 2023 study. All estimates were reported with 95% uncertainty intervals (UIs).

Results: In 2023, there were approximately 4.5 million prevalent cases (95% UI: 4.0 to 5.1 million) of neurological disorders among adults aged ≥ 60 years in Iran, corresponding to a prevalence of 46,163.3 per 100,000 population. In addition, deaths increased from nearly 4,000 in 1990 to 19,000 in 2023, and the mortality rate rose by 63%. DALYs reached 441,000 (95% UI: 257,000 to 802,000), and the DALY rate increased by 27% since 1990. Moreover, the burden was higher in females and sharply rose with age. Absolute case numbers peaked at 60–64 years, whereas rates peaked at ≥ 85 years. Alzheimer's disease and other dementias were the leading contributors to deaths and DALYs, whereas headache disorders had the largest portion of prevalent cases.

Conclusions: The prevalence, mortality, and DALY rates of neurological disorders among older adults in Iran substantially increased between 1990 and 2023, indicating a rise in disease burden that is unlikely to be explained by demographic ageing alone. Thus, strengthening prevention, early detection, long-term care, and equitable service provision will be essential to address the growing neurological needs of Iran's ageing population.

Keywords: Neurological disorders, Epidemiology, Burden of illness, Disability-adjusted life years, Iran

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Introduction

Neurological disorders represent a major global public health concern, as they are among the major causes of premature mortality as well as temporary and permanent disability.¹⁻³ With populations ageing worldwide, the levels of death and disability attributable to neurological conditions have markedly risen, and this burden is expected to further grow over the coming decades. In essence, longer life expectancy, combined with declining

fertility rates, has produced progressively ageing populations. By 2013, approximately three-quarters of the global burden associated with neurological diseases, mental health conditions, and substance use disorders was reported in low-income and middle-income countries.⁴ From 1990 to 2016, the absolute number of deaths and disability-adjusted life years (DALYs) due to all neurological disorders increased, with deaths and DALYs rising by 39% and 15%, respectively.⁵



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Although many health determinants are common in the Middle East and North Africa (MENA) region, considerable disparities in health and disease indicators have been observed across countries. Neurological disorders are one such group of conditions, with variations reported in prevalence, incidence, mortality, and DALYs across these nations. It is, therefore, essential that national health policymakers be informed about the health status of their populations in comparison with societies with similar socioeconomic standing. Moreover, experiences from other countries can be used to support improvements in healthcare systems.⁵

Neurological disorders accounted for approximately 5.6% of total DALYs in Iran in 2023, increasing to about 6.6% among individuals aged 60 years and older. This indicates the greater contribution of neurological conditions to the disease burden in older populations, highlighting the need for clarifying the epidemiological patterns of neurological disorders in this vulnerable group.⁶

To the best of our knowledge, there is no comprehensive report on neurological disorders among the older population in Iran. Accordingly, the present study aims to examine the burden of neurological disorders in this population by age and gender in Iran, using the most recent Global Burden of Disease (GBD) estimates from 1990 to 2023.

Methods

Overview

This study employed data from the GBD 2023 study to estimate the burden of neurological disorders among older adults in Iran. The GBD study provides comprehensive and comparable estimates of mortality, morbidity, and disability for a wide range of diseases and injuries across countries, territories, age groups, and genders over time. Some previous studies have thoroughly described GBD methodology.^{6, 7} Age-specific estimates of incidence, prevalence, mortality, years lived with disability (YLDs), years of life lost (YLLs), and DALYs for neurological disorders among individuals aged 60 years and older in Iran from 1990 to 2023 were reported in this study.

Case Definition

Neurological disorders were defined according to the GBD 2023 cause hierarchy and included epilepsy, headache disorders (migraine and tension-type headache), Alzheimer's disease (AD) and other dementias, Parkinson's disease, multiple sclerosis, motor neuron diseases, and other neurological disorders.^{6, 7} In addition, case definitions were based on established clinical diagnostic criteria used in epidemiological studies and were mapped to the corresponding International Classification of Diseases codes. When variations in case definitions were identified across studies, statistical adjustments were applied to ensure comparability across data sources. Further details on case definitions and inclusion criteria were previously described in GBD

methodological publications.

Mortality Estimation

Cause-specific mortality estimates were derived using the Cause of Death Ensemble model, which is a statistical modelling framework developed by the GBD study to estimate mortality for specific causes from diverse data sources, including vital registration systems, verbal autopsy studies, and surveillance data. This model evaluates a large set of candidate statistical models and combines those with the best predictive performance into an ensemble model. Mortality estimates were generated for each age group, gender, location, and year, and uncertainty intervals (UIs) were calculated based on 1,000 draws from the posterior distribution.⁷

Morbidity Estimation

Non-fatal health outcomes, including incidence and prevalence, were estimated using DisMod-MR, which is a Bayesian meta-regression modelling tool designed to ensure internal consistency between epidemiological parameters, such as incidence, prevalence, remission, and mortality. Furthermore, DisMod-MR synthesizes data from multiple sources, including population-based surveys, cohort studies, hospital records, and disease registries, while adjusting for variations in study design, diagnostic criteria, and measurement methods. YLDs were calculated by multiplying disease prevalence by the corresponding disability weights, which represent the severity of health loss associated with specific health states.⁶

Compilation of Results

DALYs were measured as the sum of YLLs due to premature mortality and YLDs. Final estimates were derived from the mean of 250 posterior draws, and 95% UIs were computed using the 2.5th and 97.5th percentiles of these draws. All analyses were performed in R (version 4.2.1). Further methodological details regarding data sources, modelling strategies, and estimation procedures are described in previous GBD methodological publications.^{6, 7}

Results

National Level

In 2023, the prevalence of neurological disorders among adults aged 60 years and older was approximately 4.5 million cases (95% UI: 4.0 to 5.1), with a prevalence rate of 46,163.3 per 100,000 population (Table 1). This represented a 3.8% increase (95% UI: 1.4 to 6.7) in the prevalence rate since 1990, when there were 1.4 million cases and the rate stood at 44,469.5 per 100,000 (Table S1). The total number of deaths from neurological disorders rose from nearly 4,000 in 1990 to 19,000 in 2023. The corresponding death rate increased by approximately 63% (95% UI: 25.6 to 103.9), rising from 120 to 195.6 per 100,000 individuals (Table S2). In addition, neurological disorders accounted for 441,000 DALYs (95% UI: 257 to

Table 1. Prevalent cases, deaths, and DALYs due to neurological disorders among adults aged 60 years and older in 1990 and 2023, for both sexes, and percentage change in rates per 100,000 population in Iran

	Prevalence (95% UI)			Deaths (95% UI)			DALYs (95% UI)		
	Counts (2023)	Rate (2023)	Pcs in Rate 1990-2023	Counts (2023)	Rate (2023)	Pcs in Rate 1990-2023	Counts (2023)	Rate (2023)	Pcs in Rate 1990-2023
Iran	4556568 (4052585, 5195309)	46163.3 (41057.3, 52634.4)	3.8 (1.4, 6.7)	19303 (7333, 44591)	195.6 (74.3, 451.8)	63 (25.6, 103.9)	441901 (257674, 802078)	4477 (2610.5, 8126)	27 (10.8, 46.1)
Alborz	161802 (143084, 185379)	45074.1 (39859.8, 51642.2)	3 (-0.2, 5.6)	607 (225, 1408)	169 (62.8, 392.3)	58.8 (25.8, 90.7)	15100 (8830, 26716)	4206.4 (2459.9, 7442.3)	27.1 (10.3, 44.2)
Ardebil	67993 (60595, 77347)	45292.3 (40364.1, 51523.3)	4.5 (1, 8.7)	324 (120, 753)	216.1 (79.7, 501.6)	127 (67.9, 180.5)	7136 (4103, 12985)	4753.7 (2733.4, 8649.6)	55.3 (30, 84.9)
Bushehr	49108 (43372, 56191)	44963.4 (39711.7, 51448.9)	3.5 (-0.1, 7)	189 (67, 434)	173 (61.2, 397.5)	69.8 (32.1, 108.8)	4566 (2621, 8243)	4180.8 (2399.4, 7547.3)	31.4 (12.6, 51.8)
Chahar Mahaal and Bakhtiari	51342 (45574, 58767)	45154.9 (40082.6, 51685)	4 (0.4, 7.5)	227 (84, 540)	199.7 (73.5, 474.7)	98 (54.8, 144.1)	5076 (2966, 9288)	4464.3 (2608.9, 8168.8)	40.7 (20.5, 63.2)
East Azerbaijan	236344 (208856, 270286)	45089.2 (39845, 51564.5)	3.8 (0.5, 7.3)	1091 (422, 2493)	208.2 (80.6, 475.5)	82.9 (38.6, 128.6)	24524 (14250, 44825)	4678.6 (2718.7, 8551.6)	38 (16.7, 62)
Fars	280726 (248859, 319905)	44423.8 (39381.1, 50623.8)	3.6 (-0.8, 7.8)	1065 (383, 2441)	168.6 (60.6, 386.3)	63.7 (22.1, 106.3)	26146 (15508, 45420)	4137.6 (2454, 7187.6)	24 (7.1, 42.4)
Gilan	190969 (168768, 218283)	45058.4 (39820.4, 51503.2)	2.9 (-0.3, 6.1)	802 (294, 1911)	189.3 (69.5, 450.9)	38.1 (6.5, 66.2)	18450 (10626, 33703)	4353.3 (2507.2, 7952.2)	15.7 (-0.1, 31.7)
Golestan	92403 (81716, 105683)	45161.1 (39938.2, 51651.9)	3.9 (0.6, 7.7)	350 (126, 803)	171 (61.4, 392.7)	96.7 (43.6, 143.7)	8701 (5101, 15666)	4252.4 (2492.9, 7656.4)	42.3 (19, 68.5)
Hamadan	104775 (93395, 119974)	45226.3 (40314.2, 51786.9)	3.5 (0.4, 7.4)	528 (200, 1280)	227.8 (86.5, 552.5)	88.4 (39, 139.7)	11275 (6495, 20590)	4867 (2803.6, 8887.9)	38.4 (18.1, 64.2)
Hormozgan	69290 (61476, 79097)	45329.9 (40218, 51746.3)	4.3 (0.9, 7.7)	293 (106, 698)	191.8 (69, 456.4)	78.2 (36.5, 130.6)	6674 (3921, 11932)	4366.2 (2565.3, 7806)	32.1 (13.8, 54.9)
Ilam	30522 (27123, 34995)	45308.4 (40263.7, 51949.4)	4.8 (1.1, 8.6)	127 (45, 307)	189 (66.5, 455)	69.8 (31.3, 113.2)	2951 (1686, 5390)	4380.1 (2503.1, 8000.9)	31.6 (13.7, 51.6)
Isfahan	319875 (283432, 366442)	45065.2 (39930.9, 51625.7)	2.5 (-0.2, 5.4)	1441 (525, 3402)	203 (74, 479.3)	36.7 (6.3, 68.1)	32266 (18456, 59816)	4545.7 (2600.2, 8427)	15.5 (0.6, 33.2)
Kerman	150403 (133038, 172264)	45055.6 (39853.7, 51604.6)	3.3 (0.3, 6.5)	602 (223, 1430)	180.3 (66.9, 428.3)	71.1 (24.7, 118.7)	14036 (8294, 25731)	4204.6 (2484.6, 7708.1)	25.5 (8.1, 47)
Kermanshah	119164 (105598, 136331)	45244.7 (40093.9, 51762.5)	4.5 (0.9, 8.3)	478 (181, 1081)	181.4 (68.8, 410.3)	70.3 (23.5, 122.7)	11260 (6757, 19960)	4275.1 (2565.3, 7578.4)	29.5 (8.4, 51.7)
Khorasan-e-Razavi	311665 (277846, 355198)	45229.4 (40321.5, 51547.1)	3.7 (0.4, 7.5)	1502 (532, 3543)	218 (77.2, 514.2)	77.1 (29.7, 131.7)	32744 (18676, 60773)	4751.9 (2710.2, 8819.6)	31.9 (10.4, 54.4)
Khuzestan	210700 (186703, 241156)	45053.7 (39922.4, 51565.9)	2.8 (-0.1, 5.4)	870 (317, 2008)	186 (67.7, 429.4)	42 (10.9, 79.6)	20310 (11979, 36299)	4342.9 (2561.5, 7761.7)	18.6 (2.9, 35.5)
Kohgiluyeh and Boyer-Ahmad	29650 (26492, 33691)	45182.3 (40370.6, 51340.7)	3.9 (0.1, 7.7)	149 (53, 349)	226.4 (80.3, 531.2)	109.7 (65.1, 162.9)	3169 (1828, 5860)	4829.8 (2785.1, 8930)	49.8 (29.7, 75.9)
Kurdistan	91642 (81726, 104322)	45380.4 (40470.2, 51659.1)	4.3 (0.9, 8.2)	510 (188, 1193)	252.4 (93, 590.7)	93 (41.6, 153.2)	10550 (6135, 19560)	5224.5 (3038.1, 9685.8)	44.8 (19.7, 72.2)
Lorestan	88092 (78134, 100830)	45419.7 (40285.4, 51987.2)	4.7 (0.8, 8.4)	396 (152, 904)	204 (78.2, 466.2)	123.8 (68.7, 186.8)	8939 (5154, 16075)	4609.1 (2657.5, 8288.2)	52.3 (27.9, 83.9)
Markazi	92195 (82065, 105082)	45250.7 (40278.5, 51575.7)	2.9 (-0.1, 6.7)	482 (175, 1113)	236.4 (85.7, 546.3)	82 (30.6, 142.8)	9989 (5658, 18220)	4902.9 (2777.3, 8942.8)	31.7 (9.3, 59.5)
Mazandaran	230452 (203432, 263799)	45048.3 (39766.5, 51566.9)	2.8 (-0.1, 5.9)	856 (321, 1973)	167.3 (62.8, 385.6)	43.2 (7.4, 82.9)	20511 (12231, 36254)	4009.5 (2390.9, 7086.8)	13.9 (-1.7, 32.5)
North Khorasan	39863 (35441, 45543)	45179.7 (40167.8, 51616.9)	4.3 (0.3, 8.7)	187 (67, 448)	212.2 (76, 507.9)	112 (48.3, 182.7)	4183 (2393, 7785)	4740.8 (2712.6, 8823)	49.7 (21.2, 84.2)

Table 1. Continued.

	Prevalence (95% UI)			Deaths (95% UI)			DALYs (95% UI)		
	Counts (2023)	Rate (2023)	Pcs in Rate 1990-2023	Counts (2023)	Rate (2023)	Pcs in Rate 1990-2023	Counts (2023)	Rate (2023)	Pcs in Rate 1990-2023
Qazvin	66436 (59114, 75649)	45188.3 (40207.8, 51454.2)	3.3 (0.3, 7.2)	344 (127, 811)	234.1 (86.3, 551.7)	92.6 (46.3, 146.8)	7342 (4236, 13355)	4993.6 (2881, 9083.9)	41.1 (20.1, 64)
Qom	60148 (52945, 69073)	44897.4 (39520.7, 51558.9)	2.3 (-0.7, 5.7)	263 (102, 600)	196.2 (76.3, 448)	75.7 (29.7, 123.4)	5919 (3416, 10746)	4418 (2549.6, 8021.5)	27.7 (6.7, 50.1)
Semnan	41209 (36609, 46977)	45168.7 (40126.5, 51490.5)	2.8 (-0.2, 6.3)	175 (67, 409)	191.9 (73.4, 448.2)	58.6 (24.7, 98.8)	4037 (2383, 7264)	4424.9 (2611.8, 7961.8)	24.2 (6.3, 44)
Sistan and Baluchistan	78479 (69622, 89490)	45164.9 (40068, 51501.8)	4.3 (0.7, 8)	382 (131, 880)	219.7 (75.4, 506.7)	53.5 (20.1, 91.7)	8185 (4703, 14950)	4710.7 (2706.8, 8604)	24.3 (9.3, 41.2)
South Khorasan	40052 (35641, 45620)	45326.8 (40335.1, 51628.9)	4 (0.7, 7.9)	210 (73, 501)	237.4 (82.8, 566.8)	124.1 (61.9, 201.2)	4286 (2391, 8067)	4850.4 (2706.1, 9129.9)	49.4 (23.2, 81.1)
Tehran	977829 (859443, 1125808)	50850.9 (44694.4, 58546.4)	1.8 (-0.9, 5)	3425 (1329, 7752)	178.1 (69.1, 403.2)	42.4 (12.5, 75.5)	83150 (49113, 146152)	4324.1 (2554.1, 7600.5)	17.7 (3.8, 36.7)
West Azerbaijan	166028 (146936, 190601)	45076.8 (39893.5, 51748.5)	3.8 (0.1, 7.2)	767 (295, 1782)	208.1 (80.1, 483.7)	86.3 (45.5, 132.1)	17120 (9970, 31604)	4648.2 (2706.8, 8580.6)	40.4 (21.2, 65.4)
Yazd	50354 (43971, 59829)	41382.1 (36136.3, 49168.6)	2.7 (-0.5, 6.1)	293 (112, 703)	240.9 (91.6, 577.8)	55.7 (16.7, 98.6)	6034 (3462, 11529)	4959 (2845.3, 9474.8)	21.6 (3.7, 42.3)
Zanjan	57060 (50772, 65043)	45268.5 (40280.3, 51602)	4.2 (0.2, 8.5)	369 (146, 871)	293.1 (115.5, 691.2)	137.6 (72.8, 205.1)	7271 (4060, 14054)	5768.1 (3221, 11149.9)	61.5 (33, 95.2)

Note. DALY: Disability-adjusted life years; UI: Uncertainty interval; Pcs, Percentage changes

802) in 2023, with a DALY rate of 4,477.0 per 100,000 population (95% UI: 2610.5 to 8126), demonstrating a 27% increase (95% UI: 10.8 to 46.1) in the DALY rate since 1990 (Table S3).

Provincial Level

In 2023, the highest prevalence estimates were observed in Tehran [50,850.9 (95% UI: 44,694.4 to 58,546.4)], Lorestan [45,419.7 (95% UI: 40,285.4 to 51,987.2)], and Kurdistan [45,380.4 (95% UI: 40,470.2 to 51,659.1)], whereas the lowest estimates were related to Yazd [41,382.1 (95% UI: 36,136.3 to 49,168.6)], Fars [44,423.8 (95% UI: 39,381.1 to 50,623.8)], and Qom [44,897.4 (95% UI: 39,520.7 to 51,558.9)], as illustrated in Figure 1A and Table S1. Figure S1 shows the gender-specific prevalence rates of neurological disorders among adults aged 60 years and older at the provincial level.

Likewise, the highest death rates belonged to Zanjan [293.1 (95% UI: 115.5 to 691.2)], Kurdistan [252.4 (95% UI: 93.0 to 590.7)], and Yazd [240.9 (95% UI: 91.6 to 577.8)] in 2023. In contrast, the lowest rates were found in Mazandaran [167.3 (95% UI: 62.8 to 385.6)], Fars [168.6 (95% UI: 60.6 to 386.3)], and Alborz [169.0 (95% UI: 62.8 to 392.3)] in this year (Figure 1B and Table S2). Figure S2 presents the gender-specific death rates of neurological disorders for adults aged 60 years and older at the provincial level. With respect to DALYs, the highest rates in 2023 were related to Zanjan [5,768.1 (95% UI: 3,221.0 to 11,149.9)], Kurdistan [5,224.5 (95% UI: 3,038.1 to 9,685.8)], and Qazvin [4,993.6 (95% UI: 2,881.0 to 9,083.9)]. Conversely, the lowest DALY rates were observed in Mazandaran [4,009.5 (95% UI: 2,390.9

to 7,086.8)], Fars [4,137.6 (95% UI: 2,454 to 7,187.6)], and Bushehr [4,180.8 (95% UI: 2,399.4 to 7,547.3)] in 2023 (Table S3). The 2023 gender-specific DALY rates at the provincial level are displayed in Figure S3.

The results (Table 1) revealed that Ilam experienced the highest increase in prevalence [4.8% (95% UI: 1.1 to 8.6)] between 1990 and 2023, followed by Lorestan [4.7% (95% UI: 0.8 to 8.4)], Ardebil [4.5% (95% UI: 1.0 to 8.7)], and Kermanshah [4.5% (95% UI: 0.9 to 8.3)]. Contrarily, the lowest increases were reported in Tehran [1.8% (95% UI: -0.9 to 5)], Qom [2.3% (95% UI: -0.7 to 5.7)], and Isfahan [2.5% (95% UI: -0.2 to 5.4)]. Figure S4 depicts the gender-specific estimates at the provincial level for the percentage change in the point prevalence of neurological disorders between 1990 and 2023 in Iran. Based on the findings (Table 1), the death rate attributable to neurological disorders among individuals aged 60 years and older in Iran increased between 1990 and 2023 in all provinces. The highest increases were observed in Zanjan [137.6% (95% UI: 72.8 to 205.1)], Ardebil [127.0% (95% UI: 67.9 to 180.5)], and Lorestan [123% (95% UI: 68.7 to 186.8)]. However, the lowest increases were reported in Isfahan [36.0% (95% UI: 6.3 to 68.1)], Gilan [38.1% (95% UI: 6.5 to 66.2)], and Khuzestan [42.0% (95% UI: 10.9 to 79.6)]. Figure S5 illustrates the gender-specific percentage changes in the death rates among adults aged ≥ 60 years at the provincial level between 1990 and 2023. DALY rates for neurological disorders among adults aged 60 years and older also increased in Iran between 1990 and 2023. The highest increases were belonged to Zanjan [61.5% (95% UI: 33.0 to 95.2)], Ardebil [55.3% (95% UI: 30.0 to 84.9)], and Lorestan [52.3% (95% UI: 27.9 to 83.9)]. In

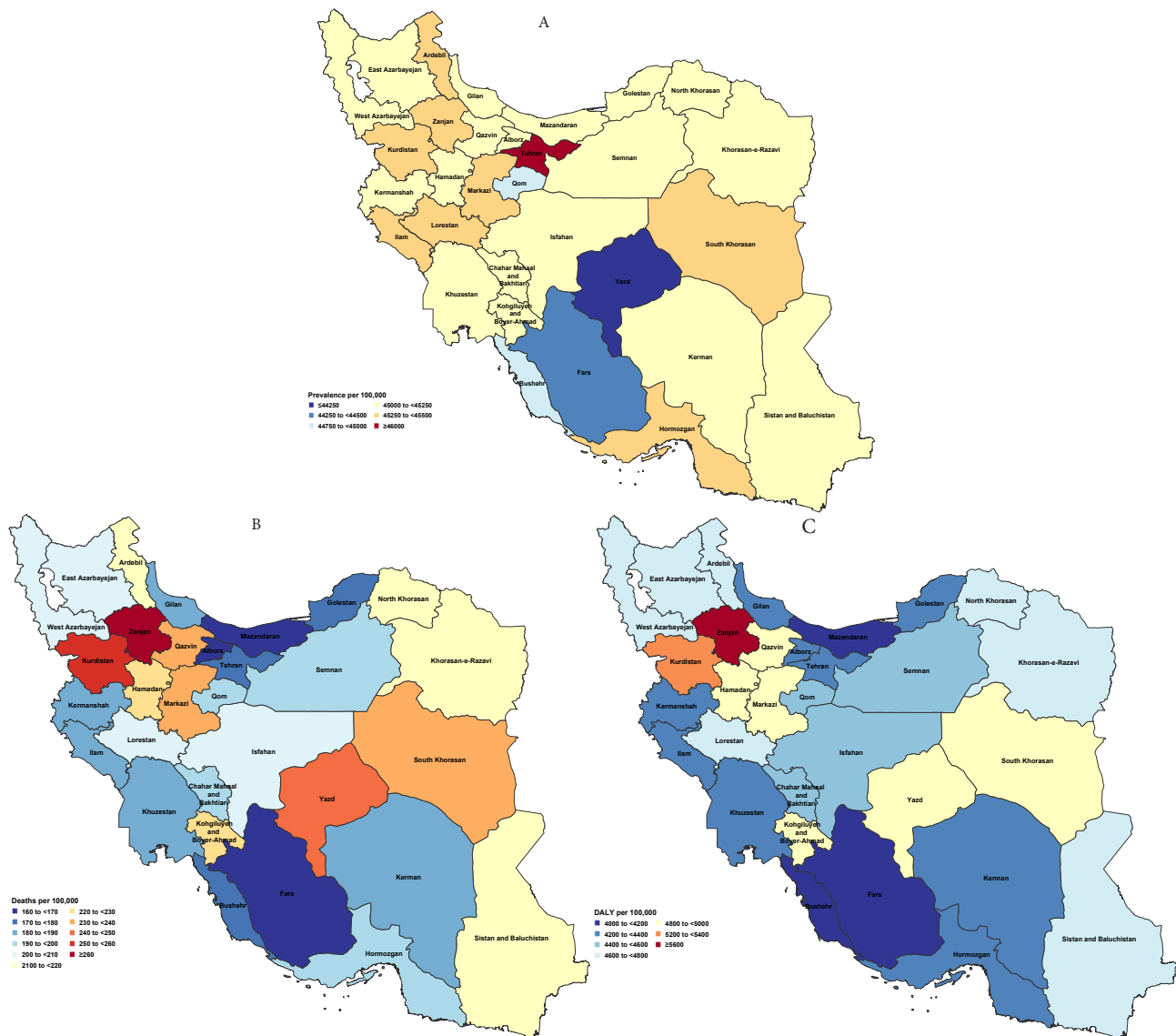


Figure 1. Prevalence (A), death rate (B), and disability-adjusted life year (DALY) rate (C) due to neurological disorders among older adults in Iran in 2023, by province. Rates are reported per 100,000 population. (generated from data available from <http://ghdx.healthdata.org/gbd-results-tool>).

contrast, the lowest increases were found in Mazandaran [13.9% (95% UI: -1.7 to 32.5)], Isfahan [15.5% (95% UI: 0.6 to 33.2)], and Tehran [17.7% (95% UI: 3.8 to 36.7)], the details of which are provided in Table 1. Figure S6 displays the gender-specific percentage change in DALY rates for each province between 1990 and 2023.

Age and Gender Patterns

In 2023, the prevalence of neurological disorders in individuals aged ≥ 60 years increased with advancing age. Females exhibited higher prevalence rates than males across all age categories. The highest number of prevalent cases was observed in the 60–64-year age group for both males and females, reflecting the larger population size in this age group (Figure 2A).

In the same year, the total number of deaths in both males and females consistently increased with age, reaching a peak in the 85–89-year age group. Similarly, death rates rose with age in both genders, with the predominance of females over males (Figure 2B).

Consistent with the patterns found for prevalence and

mortality, the national DALY rate increased with age in both males and females in 2023, with the predominance of females over males. The highest number of DALYs was related to the 80–84-year age group for both males and females (Figure 2C).

The ratio of Iran-to-MENA YLD rates for neurological disorders among adults aged 60 years and older demonstrated that, in 2023, Iranian females had YLD rates that were consistently similar to or higher than the MENA average across nearly all age groups (ratios generally around or above 1.1), except for age groups 70–74 and 75–79 years, where the ratio was approximately equal to 1. In contrast, Iranian males had YLD rates that were generally similar to or slightly lower than the MENA average in most age groups (ratios close to or slightly below 1), particularly for age groups 75–79 and 80–84 years, where the ratio fell below 1 (Figure 3).

Cause-Specific Patterns

The burden of neurological disorders remarkably increased with advancing age from 60 years. Headache

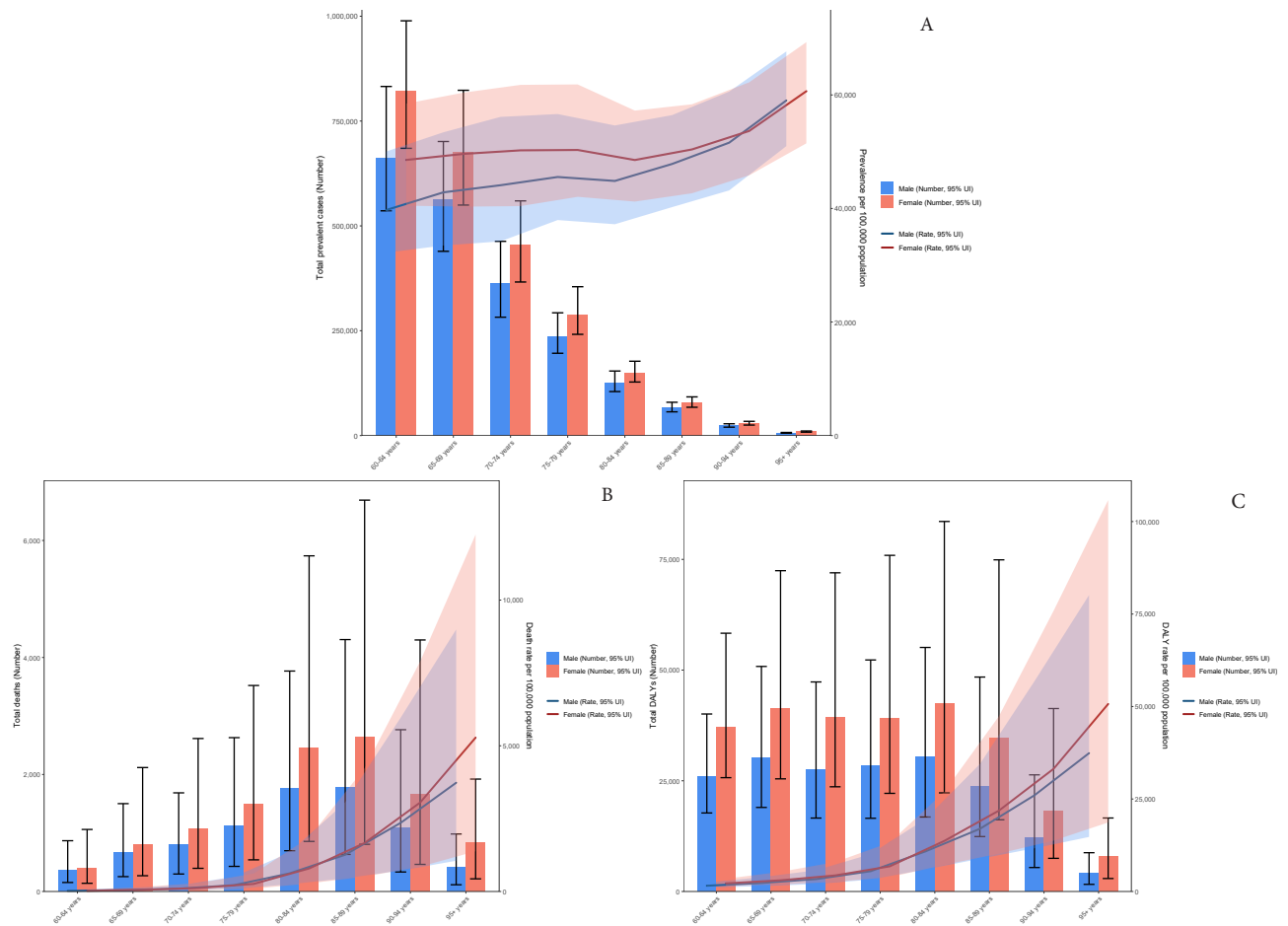


Figure 2. Number of prevalent cases and prevalence (A), number of deaths and death rate (B), and number of disability-adjusted life years (DALYs) and DALY rate (C) due to neurological disorders in Iran in 2023, by age group and sex. Rates are reported per 100,000 population. Shaded areas indicate 95% uncertainty intervals (generated from data available from <http://ghdx.healthdata.org/gbd-results-tool>).

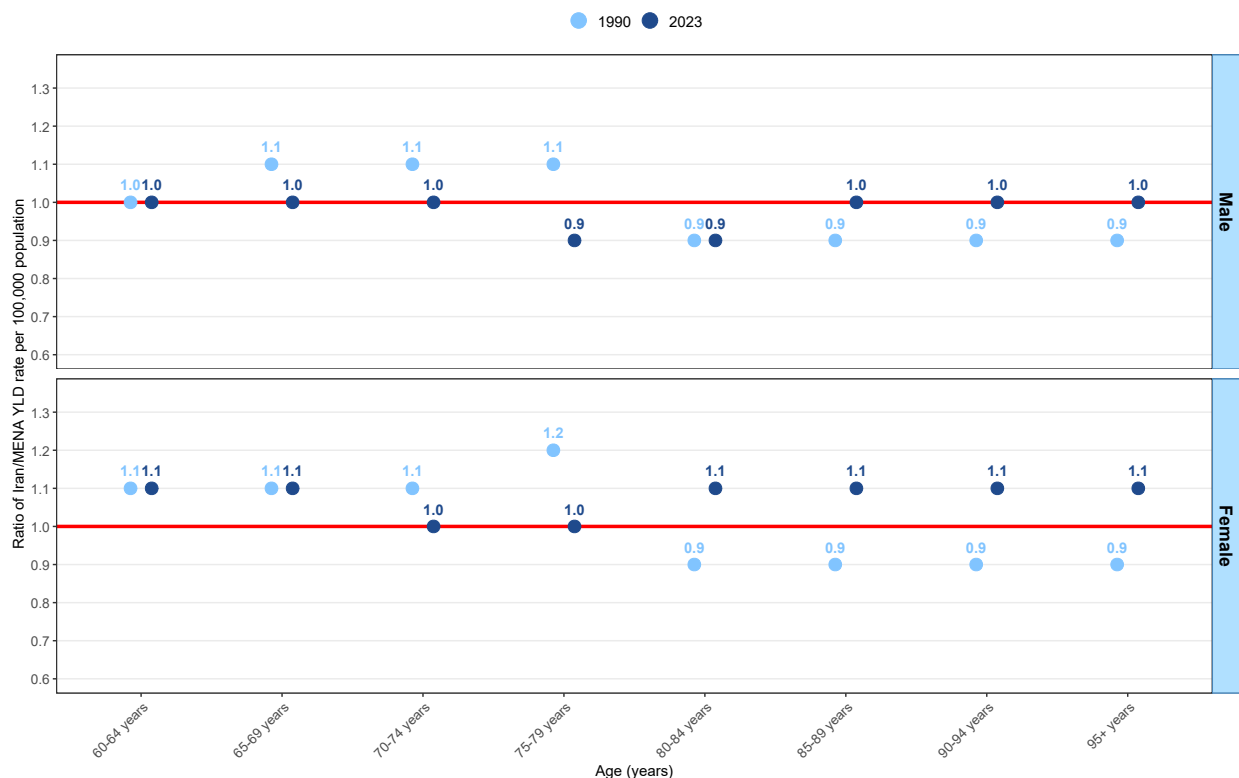


Figure 3. Ratio of national neurological disorder DALY rates in Iran to the MENA regional rates, by age group and sex, from 1990 to 2023.. (generated from data available from <http://ghdx.healthdata.org/gbd-results-tool>).

disorders, AD and other dementias, and Parkinson disease were the leading causes of neurological disorders among adults aged 60 years and older, which reached their highest absolute levels at 60–64 years but declined in older age groups. The prevalence of the predominant causes of neurological disorders and their corresponding rates in 2023, by age category, are presented in [Figure S7](#).

Moreover, mortality from neurological disorders rose with age, with AD and other dementias and Parkinson disease, representing the primary causes of death. The absolute number of deaths peaked at ages 85–89 years in 2023. The distribution of deaths attributable to neurological disorders in 2023, within each age group, is displayed in [Figure S8](#).

DALYs notably increased with age, and AD and other dementias again played the leading role, with the absolute number of DALYs peaking at ages 80–84 years. [Figure S9](#) illustrates the DALY proportions for each cause of neurological disorders, categorized by age group in 2023.

Discussion

The findings of this study revealed that the burden of neurological disorders among older adults in Iran considerably increased between 1990 and 2023, with marked rises in both the absolute number of cases and deaths and the corresponding rates. This pattern contradicts evidence from Europe⁸, the global GBD analyses⁹, and India¹⁰, where counts have also risen due to population ageing, but rates have generally declined over time. The simultaneous increase in both counts and rates in Iran suggests that the growing burden cannot be fully explained by demographic changes alone, emphasizing the possible contribution of underlying risk factors, gaps in prevention and long-term care, and limitations in neurology service capacity to increasing disease risk among older adults. This divergence from international trends highlights the need for strengthened risk-factor control, earlier detection, and improved chronic care and rehabilitation services to address the escalating neurological disease burden in the ageing population of Iran.

Based on our findings, the total number of neurological disorder cases was the highest in the younger old age groups (60–69 years) because they had larger populations, while the number of cases declined in older age groups as the population size decreased. By contrast, the prevalence rates of age-related neurodegenerative disorders, including AD and other dementias, Parkinson's disease, and motor neuron diseases, sharply rose with age and reached their highest levels in the oldest groups (85+ and 95+ years), even though the absolute case counts became smaller. Headache disorders dominated total case numbers across all ages but showed decreasing prevalence rates in the oldest age groups, indicating that they are common but not strongly age-dependent. In general, conditions such as multiple sclerosis and epilepsy have a relatively small contribution and exhibit lower or more stable rates in older age groups. Overall, these patterns demonstrate that

counts are primarily driven by population size at each age, whereas rates substantially increase with advancing age for neurodegenerative conditions.

Provincial differences observed in the prevalence, mortality, and DALY rates of neurological disorders among older adults in Iran suggest potential geographic variations in burden; however, these patterns must be interpreted with caution, as most UIs overlap and may not reflect true statistical differences. Higher estimates in Zanjan, Kurdistan, and Lorestan provinces and lower estimates in Mazandaran and Fars provinces may point to underlying demographic, socioeconomic, or health-system factors, but could also arise from data limitations and modelling uncertainty. Similarly, the apparent long-term increases in mortality and DALYs across provinces between 1990 and 2023 likely reflect population ageing and shifting disease patterns. Nonetheless, the wide uncertainty bounds limit confidence in the exact magnitude of change. Overall, these modelled estimates highlight possible trends while indicating the need for more comprehensive, high-quality, province-level data to better understand and verify the true burden of neurological disorders in Iran.

The higher prevalence, death, and DALY rates observed among Iranian females compared with males in 2023 closely align with patterns reported in previous studies from the United States,^{11, 12} global GBD analyses,¹³ and the India GBD study.¹⁴ Across these references, females consistently bear a greater burden of several major non-communicable neurological disorders, particularly migraine, multiple sclerosis, and AD and other dementias, all substantially contributing to overall DALYs. Similarly, our finding representing that Iranian females generally have higher YLD ratios relative to the MENA region reflects this global tendency toward greater disability from neurological conditions among women. Although some disorders, such as Parkinson's disease, epilepsy, and motor neuron diseases, tend to be more common or burdensome in males internationally, the overall gender distribution in prior studies shows the predominance of neurological disabilities among females, which is consistent with the patterns identified in our analysis. These similarities indicate that the gender differences observed in Iran are not unique but rather mirror established global trends, although interpretation should remain cautious given the width of UIs and limitations of the modelled data.

Our analyses demonstrated a clear age-dependent pattern in the burden of neurological disorders in Iran, with prevalence, mortality, and DALY rates rising steadily across older age groups and reaching their highest levels among individuals aged 90 years and above. This strong age gradient conforms to the findings of the large-scale Indian study,¹⁴ which reported a progressive increase in age-specific DALY burden, with the DALY-to-population ratio reaching 6.9 among those aged 80 years or older, indicating the pronounced concentration of neurological disease burden in late life. Additional evidence from European settings² further supports the observation

that neurological DALYs and deaths are systematically estimated and analyzed by age, with DALY numbers and rates presented across detailed age groups (60–64, 65–69, 70–74, 75–79, 80–84, 85–89, 90–94, and ≥ 95), reinforcing that the burden of neurological disorders is intrinsically age-stratified. Collectively, these converging findings from Iran, India, and Europe underscore that advancing age is the dominant factor shaping neurological disorder burden in diverse populations, representing the urgent need for age-targeted prevention, diagnostic, and care strategies to mitigate the impact of these disorders in older adults.

In addition, increasing counts at older ages in our Iranian data, similar to findings in the Indian and global GBD studies, largely reflect demographic ageing and the accumulation of chronic neurological conditions in older cohorts. The key epidemiological signal is that, in all these analyses, rates (particularly DALY rates and, to a lesser extent, mortality rates) continue to rise or remain high in the oldest age groups, implying a genuine increase in age-specific risk rather than merely a larger older population. The Indian study explicitly showed that the DALY-to-population ratio increases with age and peaks among those aged 80 years and older, and that non-communicable neurological disorders account for an increasing share of DALYs in this age band.¹⁴ Our age patterns for deaths and DALYs in Iran are consistent with this concentration of severe, non-communicable neurological burden at very old ages. Similarly, evidence from the global GBD and risk-factor analyses, although less explicit in its age-pattern wording, emphasizes age-specific estimates, demonstrating that conditions with older age of onset (e.g., dementia) have experienced the highest increases in prevalence and disability.^{15, 16} Overall, these findings present a coherent epidemiological picture: across settings, neurological disorders shift from primarily contributing to chronic morbidity in the younger old ages to driving substantial disability and mortality in those aged 80 years and over, reinforcing the need for mid-life prevention and geriatric-focused neurological care in late life.

Strengths and Limitations

This study had several strengths. It provided the first comprehensive national and subnational description of the burden of neurological disorders among older adults in Iran over more than three decades, used the standardized GBD 2023 framework, and presented results based on age, gender, and province. Nonetheless, it had a number of limitations. First, all estimates were modelled GBD outputs and relied on the availability and quality of the underlying data sources accordingly, remaining limited for some neurological conditions in Iran. Moreover, subnational estimates were probably less stable in provinces with sparse data, and the wide and often overlapping UIs limited the strength of inferences about provincial rankings and trends. Additionally, the analysis was descriptive and could not identify the

specific drivers of the observed trends, including changes in risk factor exposure, diagnostic practices, and access to services. Therefore, comparisons with other countries and regions should be made cautiously, as differences in case ascertainment, data completeness, and modelling approaches may affect apparent similarities or differences.

Conclusions

In general, the burden of neurological disorders among older adults in Iran has markedly risen since 1990, with increases in prevalence, mortality, and DALY rates indicating an increase in disease burden that extends beyond population ageing alone. Provincial differences were observed, though most of them overlapped in uncertainty. The burden sharply increased with advancing age and was consistently higher in females, with neurodegenerative disorders, particularly AD and other dementias, driving the largest share of deaths and disability. These patterns are in line with evidence from international studies, highlighting a concentrated burden in the oldest age groups. Accordingly, strengthened prevention, early detection, and expanded long-term and geriatric neurological care are urgently needed to address this growing challenge.

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Data availability statement

All data used in this study are publicly available.

Ethical approval

This study was approved by the Ethics Committee of Tabriz University of Medical Sciences, Tabriz, Iran (Ethics code: IR.TBZMED.FMD.REC.1404.418).

Consent for publication

Not applicable.

Conflict of interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be interpreted as a potential conflict of interest.

Supplementary files

Supplementary file 1 contains Table S1-S3 and Figure S1-S9.

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