

Incidence of Alzheimer's Disease and Other Dementias: Results from the 2017 Global Burden of Disease Study

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Abstract

Background

The aim is to reveal the trends in the incidence of Alzheimer's disease (AD) and other dementias at the global, region, and national levels using data from 2017 Global Burden of Disease Study (GBD 2017).

Methods

We collected information on the number of incident cases and on the age-standardized incidence rate (ASIR) of AD and other dementias during 1990–2017 from the GBD 2017. We also analyzed differences in the incidence among different age groups. The association of ASIR with the development level was explored using Pearson correlation analysis.

Results

In 2017, the number of incident cases of AD and other dementias was 73.01 million (95% uncertainty interval [CI] = 65.16–81.33 million). This represented an increase of 113.17% from 1990, and an ASIR of 97.46 per 100,000 persons (95% CI = 86.80–108.89 per 100,000 persons). The ASIR was highest in countries in the high-middle sociodemographic index (SDI) quintile, and lowest in low-SDI-quintile countries. The number of incident cases increased from 1990 to 2017, whereas ASIR showed a slight downward trend in most countries. Japan had the highest ASIR in 2017 and showed the largest increase in ASIR over the preceding 28 years. The ASIR increased rapidly with age among those older than 70 years, and was significantly associated with the SDI ($P < 0.0001$, $\rho = 0.68$).

Conclusion

The incidence rate of AD and other dementias has declined in recent decades, but the incidence still remains high. The present findings should be useful for resource allocation and planning health services for AD and other dementias.

Introduction

Alzheimer's disease (AD) and other dementias are among the most common diseases in old age, with the core symptom of cognitive impairment leading to a significant decline in the abilities of affected patients to live and work [1–3]. The disease progression results in continuous deterioration in cognitive function, with patients gradually losing the ability to perform the normal functions of daily living [4, 5]. The symptoms of the disease bring a heavy burden on both the affected family and society as a whole. In 2010, the Alzheimer's Disease International organization considered that the disease has become an important issue affecting global public health [6], and the increasing number of patients resulted in the

World Health Organization listing dementia as a public health priority in 2012 [7]. AD and other dementias now have huge impacts on the global social economy, with the associated increasing costs stemming from increases in both the per-capita costs and the increasing number of patients [6, 8].

The aging global population is also likely to lead to further increases in the incidence of AD and other dementias. However, improvements in the treatments of risk factors—especially for vascular disease, which is considered the second-most-common cause of dementia in the elderly [9]—may have resulted in decreasing the incidence [10]. Therefore, the actual changes in the global incidence of AD and other dementias remain to be evaluated. Although some studies have investigated the trend in the incidence of AD and other dementias, they have been limited to specific countries and specific samples [11]. This potentially makes the data unreliable since the incidence of AD and other dementias varies with race and the development level of the country [10]. Therefore, there is a need for a more-systematic analyses of the incidence of AD and other dementias at the global, region, and country levels.

This study analyzed the incidence of AD and other dementias using data obtained from the Global Burden of Disease (GBD) database for the period from 1990 to 2017 to clarify the long-term trend in the incidence of these diseases. The study results are expected to be useful for estimating the morbidity status of AD and other dementias in the context of the rapid aging of the global population, thereby providing a basis for the primary prevention of these diseases.

Methods

Data on the incidence of AD and other dementias according to sex, 21 regions, and 195 countries or territories from 1990 to 2017 were obtained from the GBD 2017 database using the interactive data-downloading tool of the GHDx (Global Health Data exchange) software (<http://www.healthdata.org/gbd/>). This tool can be used to retrieve data on different aspects of a disease by choosing the appropriate selection boxes: in the Context option of the tool we chose “Cause,” in the Metric option we chose “Number” and “Rate,” in the Measure option we chose “incidence,” and in the Cause option we chose “B.5.1. Alzheimer’s disease and other dementias.” We also analyzed the incidence of AD and other dementias according to the following 12 age groups used in the GBD 2017 database: eleven 5-year periods from 40 to 94 years, plus ≥ 95 years.

Data on the age-standardized incidence rate (ASIR) in the GBD 2017 database were obtained for the global age-standardized population. The ASIR was calculated by summing up the products of the age-specific incidence rates (a_i , where i is the i^{th} age class) and the number of persons (or weight w_i) in age subgroup i of the selected reference standard population, then dividing by the sum of the standard

$$\text{ASIR} = \frac{\sum_{i=1}^A a_i w_i}{\sum_{i=1}^A w_i} \times 100,000$$

population weights: ASIR . The ASIR corresponds to the number of incident cases per 100,000 persons after performing age standardization.

The sociodemographic index (SDI) is a comprehensive indicator of the fertility rate, per-capita income, and education level, and can be used to represent the development status of a country. GBD 2017 divides the 195 countries or territories into the following 5 SDI quintiles: high, high-middle, middle, low-middle, and low. We compared the incidence of AD and other dementias among the countries categorized into these five SDI quintiles. We additionally explored the association of the ASIR with the SDI in 2017 at the country level using Pearson correlation analysis, with $P < 0.05$ considered indicative of statistical significance.

All of the analyses were conducted using the R program (version 3.5.1, R Core Team). The SDI values from 1990 to 2017 at the global, region, and country levels can be found at the official website of the GBD 2017 database (<http://www.healthdata.org/gbd/>).

Results

Incidence of AD and other dementias at the global level

The number of incident cases of AD and other dementias globally in 2017 was 73.01 million (95% confidence interval [CI] = 65.16–81.33 million), comprising 28.34 million males (95% CI = 25.27–31.66 million) and 44.67 million females (95% CI = 39.88–49.86 million). The global number of incident cases of AD and other dementias had increased by 113.17% from 1990, when it was 34.25 million (95% CI = 30.30–38.53 million). The number of female incident cases exceeded that of males in any year; for example, in 1990 there were 21.67 million (95% CI = 19.15–24.36 million) female incident cases and 12.58 million (95% CI = 11.02–14.20 million) male incident cases (Table 1). Among both males and females in 2017, the number of incident cases of AD and other dementias increased with age from 40 to 84 years, and then declined from 84 to ≥ 95 years. In general, the incidence number was highest among people aged 75–89 years, who accounted for 56.98% of the entire age population (Fig. 1A).

Table 1.
The incident cases and age-standardized incidence rate of Alzheimer's disease and other dementias in 1990 and 2017.

	Cases in 1990 (No.×10 ³)	ASIR in 1990 (per 100,000 persons)	Cases in 2017 (No.×10 ³)	ASIR in 2017 (per 100,000 persons)
Global	3425.21(3029.84- 3853.12)	102.8(91.2-115.24)	7300.64(6515.68- 8133.4)	97.46(86.8- 108.89)
Sex				
Male	1258.11(1102.41- 1419.52)	92.64(81.99- 103.99)	2833.56(2527.16- 3165.61)	88.94(79.05- 99.62)
Female	2167.1(1914.58- 2436.21)	109.09(96.94- 122.15)	4467.08(3988.3- 4986.27)	103.55(92.36- 115.57)
Socio- demographic index				
High SDI	1379.85(1221.96- 1553.72)	103.8(92.49- 116.11)	2579.67(2319.27- 2867.25)	98.35(88.44- 108.68)
High-middle SDI	813.67(714.64- 921.79)	108.78(96.52- 121.97)	1755.53(1560.25- 1965.42)	106.82(94.91- 119.67)
Low SDI	177.42(154.99- 201.33)	88.32(77.86-99.77)	395.38(346.19- 448.69)	81.57(71.56- 92.16)
Low-middle SDI	350.96(306.97- 399.01)	92.04(81.01- 103.97)	743.17(654.7- 841.48)	84.19(74.2- 95.2)
Middle SDI	690.19(604.97- 781.18)	100.92(89.27- 113.46)	1792.65(1586.34- 2019.63)	96.13(85- 108.26)
Region				
Andean Latin America	16.09(14.2- 18.13)	92.8(81.63-104.93)	45.04(39.88- 50.67)	85.94(75.97- 96.66)
Australasia	24.11(21.08- 27.31)	102.06(90.02- 114.8)	48.32(43.2- 54.05)	87.17(77.87- 97.05)
Caribbean	22.91(20.12- 25.83)	95.25(84.01- 107.14)	43.94(38.74- 49.51)	86.1(75.97- 97.22)
Central Asia	40.49(35.72- 45.46)	102.65(90.35- 115.61)	54.88(48.25- 62.03)	99.97(88.14- 112.74)
Central Europe	148.69(129.75- 168.55)	110.21(97.21- 123.75)	247.59(218.36- 279.87)	106.9(94.54- 120.31)
Central Latin America	71.46(63.06- 80.73)	101.75(89.75- 115.02)	194.65(171.6- 221.01)	90.55(79.78- 102.82)
Central Sub-	12.06(10.43-	96.93(85.19-	28.44(24.94-	96.84(85.03-

Saharan Africa	13.86)	109.31)	32.32)	109.29)
East Asia	671.4(586.7-759.47)	100.84(89.29-113.39)	1884.17(1670.44-2117.84)	104.48(92.74-117.7)
Eastern Europe	280.45(244.01-321.28)	111.11(98.24-125.37)	393.41(344.92-448.49)	109.16(96.19-123.26)
Eastern Sub-Saharan Africa	42.68(37.15-48.59)	93.86(82.8-105.93)	89.75(79.03-101.76)	89.06(78.47-100.71)
High-income Asia Pacific	188.14(165.57-213.38)	102.7(90.78-115.74)	665.44(586.35-756.46)	118.62(104.87-134.17)
High-income North America	380.93(332.94-436.3)	97.5(85.48-111.09)	578.06(528.57-633.24)	84.84(77.45-92.9)
North Africa and Middle East	141.43(125.52-158.64)	112.86(100.3-126.26)	355.63(316.41-395.04)	108.27(95.92-121.34)
Oceania	1.63(1.42-1.86)	103.74(91.98-116.61)	3.52(3.1-4)	98.67(87.28-110.78)
South Asia	296.62(258.85-337.64)	81.37(71.38-92.21)	715.21(623.27-817.72)	73.65(64.44-83.8)
Southeast Asia	195.33(172.67-219.44)	106.52(94.45-119.14)	465.79(414.37-519.82)	100.31(89.04-112.31)
Southern Latin America	43(37.85-48.56)	101.6(89.86-114.42)	78.98(69.66-89.1)	91.39(80.71-103.12)
Southern Sub-Saharan Africa	23.13(20.49-25.94)	105.2(92.84-118.65)	42.09(37.37-47.37)	97.74(86.14-110.4)
Tropical Latin America	85.34(74.93-96.41)	120.58(107.24-135.62)	204.82(182.97-228.6)	94.46(84-105.66)
Western Europe	683.74(606.65-762.62)	107.05(96.12-118.35)	1061.64(955.42-1181.47)	95.89(86.49-105.96)
Western Sub-Saharan Africa	55.58(48.6-63.1)	87.59(77.08-98.97)	99.27(87.76-111.51)	80.98(71.52-91.36)

ASIR, age-standardised incidence rate.

The global ASIR showed a downward trend, from 102.80 per 100,000 persons (95% CI = 91.20–115.24 per 100,000 persons) in 1990 to 97.46 per 100,000 persons (95% CI = 86.80–108.89 per 100,000 persons) in 2017. Such a trend was also present separately in males, from 92.64 per 100,000 persons (95% CI = 81.99–103.99 per 100,000 persons) in 1990 to 88.94 per 100,000 persons (95% CI = 79.05–99.62 per 100,000 persons) in 2017, and in females, from 109.09 per 100,000 persons (95% CI = 96.94–122.15 per 100,000 persons) to 103.55 per 100,000 persons (95% CI = 92.36–115.57 per 100,000 persons) (Table 1, Fig. 2).

We also analyzed the incidence rate for males and females in the different age groups in 2017, and found that this increased with age. The incidence rate increased slowly with age from 40 to 70 years, but then increased rapidly above 70 years. In addition, incidence rate was higher for females than for males in any age group (Fig. 1B).

Incidence of AD and other dementias at the country level

The countries with the largest numbers of incident cases of AD and other dementias in 2017 were the most-populous countries, headed by China (17.94 million, 95% CI = 15.89–20.18 million) and followed by Japan (5.75 million, 95% CI = 5.04–6.56 million), India (5.71 million, 95% CI = 4.96–6.54 million), and the USA (5.16 million, 95% CI = 4.71–5.65 million) (Supplementary Table 1). These four countries accounted for 47.55% of the global number of incident cases. The number of incident cases of AD and other dementias increased from 1990 to 2017 in all of the 195 countries or territories, with the increases being largest in the United Arab Emirates (443.07%) and Qatar (627.95%), and smallest in Micronesia (13.07%) and Denmark (13.32%). Among the 50 most-populous countries globally, Japan had the largest increase (255.22%) and Ukraine had the smallest increase (22.14%) (Fig. 3A).

The ASIR in 2017 was highest in Japan (121.22 per 100,000 persons, 95% CI = 107.04–137.07 per 100,000 persons) and lowest in Bhutan (66.91 per 100,000 persons, 95% CI = 58.73–75.91 per 100,000 persons) and India (72.83 per 100,000 persons, 95% CI = 63.69–82.92) (Fig. 3B). The changes in the ASIR of AD and other dementias from 1990 to 2017 in most countries or territories were very small, with only slight decreases or increases. Japan showed the largest increase, from 100.64 per 100,000 persons (95% CI = 88.92–113.83 per 100,000 persons) in 1990 to 121.22 per 100,000 persons (95% CI = 107.04–137.07 per 100,000 persons) in 2017, while Brazil showed the largest decrease, from 120.89 per 100,000 persons (95% CI = 107.50–136.00 per 100,000 persons) to 94.52 per 100,000 persons (95% CI = 84.04–105.71 per 100,000 persons) (Supplementary Table 1).

Incidence of AD and other dementias at the region level

The overall numbers of incident cases in the 21 analyzed regions were higher in 2017 than in 1990. The number of incident cases in 2017 was largest in East Asia (18.84 million, 95% CI = 16.70–21.18 million), followed by Western Europe (10.62 million, 95% CI = 9.55–11.81 million), while it was smallest in Oceania (3519.16, 95% CI = 3104.83–3998.34) (Table 1).

The ASIRs in 1990 and 2017 at the region level were the lowest in South Asia and Western Sub-Saharan Africa, at about 80. In contrast, the regions with the highest ASIRs differed in 1990 and 2017. The ASIR was highest in 1990 in North Africa and Middle East (112.86 per 100,000 persons, 95% CI = 100.30–126.26 per 100,000 persons) and Tropical Latin America (120.58 per 100,000 persons, 95% CI = 107.24–135.62 per 100,000 persons), and highest in 2017 in Eastern Europe (109.16 per 100,000 persons, 95% CI = 96.19–123.26 per 100,000 persons) and high-income Asia-Pacific (118.65 per 100,000 persons, 95% CI = 104.87–134.17 per 100,000 persons).

Figure 4 shows the SDI and ASIR in the 21 regions from 1990 to 2017. The SDI increased over this 28-year period in all 21 regions. In contrast, the ASIR showed a downward trend from 1990 to 2017 in all regions with the exceptions of Central Sub-Saharan Africa (essentially unchanged), high-income Asia-Pacific (upward trend), and East Asia (initially decreasing and then an increasing trend). As shown in Fig. 4, the ASIR generally increased with the SDI, except when SDI was > 0.78 , when the ASIR decreased with further increases in the SDI.

Relationship of the incidence of AD and other dementias with SDI

From 1990 to 2017, the number of incident cases for each SDI-quintile country showed an increasing trend, which was most rapid for middle-SDI-quintile countries and the least rapid for high-SDI-quintile countries (Table 1). The numbers of incident cases were higher for high-SDI-quintile countries in any year, being 13.80 million (95% CI = 12.22–15.54 million) in 1990 and 25.80 million (95% CI = 23.19–28.67 million) in 2017, and lower in low-SDI-quintile countries, at 1.77 million (95% CI = 1.55–2.01 million) in 1990 and 3.95 million (95% CI = 3.46–4.45 million) in 2017.

Among the five SDI quintiles, the ASIR was highest in high-middle-SDI-quintile countries in both 1990 (108.78 per 100,000 persons, 95% CI = 96.52–121.97 per 100,000 persons) and 2017 (106.82 per 100,000 persons, 95% CI = 94.91–119.67 per 100,000 persons), and lowest in low-SDI-quintile countries in both 1990 (88.32 per 100,000 persons, 95% CI = 77.86–99.77 per 100,000 persons) and 2017 (81.57 per 100,000 persons, 95% CI = 71.56–92.16 per 100,000 persons). The countries in the middle-, low-middle-, and low-SDI quintiles have basically shown slow downward trends over the past 28 years. In contrast, for high-SDI-quintile countries the ASIR increased from 1990 to 1995 and then decreased from 1995 to 2017, while for high-middle-SDI-quintile countries the ASIR first decreased from 1990 to 2000 and then slowly increased. The same trends apply separately for males and females in the five SDI quintiles. In any year the ASIR was higher than the global average for countries in the high-SDI and high-middle-SDI quintiles, and lower than the global average for countries in the other three SDI quintiles (Fig. 1).

We analyzed the relationship between the ASIR and SDI values of the 195 countries or territories in 2017, which revealed that the ASIR was positively correlated with SDI ($P < 0.0001$, $\rho = 0.68$) (Fig. 5).

Discussion

This study used GBD 2017 data to systematically describe the incidence of AD and other dementias at the global, region, and country levels. We found that there were 73 million incident cases of AD and other dementias worldwide in 2017, which was more than double the number in 1990. However, the incidence rate of these diseases has been declining during the past 28 years, which is consistent with other reports in the literature that the incidence rate of AD and other dementias has stabilized or decreased slightly [15–19]. The present study also examined the differences in the incidence rates according to different countries, ages, and sexes. We found that the incidence rate among elderly people (older than 70 years) has increased significantly, with the incidence rate being slightly higher in females than in males. The

incidence rate is higher in high-income Asia-Pacific countries, and the lowest in South Asia. We also found that the incidence rate of AD and other dementias has a significant positive correlation with the development level of a country.

The decline in the incidence rate of AD and other dementia is mainly related to improvements in education and the control of risk factors such as vascular disease. According to the viewpoint of Stern [20] regarding the concept of cognitive reserve, at any given level of brain pathology, a higher education level is associated with better cognitive function. That is, individuals who are better educated and have higher cognitive function can tolerate a greater extent of neuropathologic changes before they reach the threshold at which the early symptoms of dementia manifest [20]. Vascular disease is an important factor in the onset of AD and other dementias. Vascular brain lesions are very common in people aged ≥ 70 years, and a large proportion of dementia cases might be attributable to cerebrovascular disease [21]. Pase et al. [22] also found that better cardiovascular health, including better management of stroke risk factors, could be responsible for the observed reduction in the incidence rate of dementia.

Hamad et al. [23] pointed out that at the beginning of the 21st century in Qatar, because the public generally believed cognitive impairment to be a normal aging process, many patients and families arrived at the hospital later than the actual onset time of dementia. The results of the present study show that from 1990 to 2017, Qatar had both the fastest growth rate and the largest increase in the number of incident cases of AD and other dementias among the 195 countries or territories. Another reason might be that public awareness of these diseases is gradually improving as the level of education continues to increase, resulting in more patients visiting their doctors in time, which ultimately leads to an increase in the diagnosis rate. Another major contributing factor that the population of Qatar increased by more than 470% from 1990 to 2017.

The incidence rate of AD and other dementias in Japan showed a slight upward trend from 1990 to 2017, whereas in most other countries it was declining. This is consistent with the investigation by Ohara et al. [24] of the trend in the incidence rate of dementia in a Japanese elderly population. This trend may be related to the relatively high life expectancy of Japanese people [25], the aging of the population, and changes in the diet structure. Under increasing influence of the West, the typical diet structure in Japan has undergone great changes in recent decades, from the traditional low-fat, rice-based diet to a high-fat diet [26, 27]. Since an increased intake of fat is closely related to increases in the incidence rate of AD and other dementias [28], the diet changes may have directly led to the increased incidence rate of AD and other dementias in Japan.

Seblova et al. [29] found that the incidence rate of dementia in Sweden may have declined from 1987 to 2016. The results of the present study further support that result. The decline in the incidence rate of AD and other dementias was clear in all countries, and most obviously in Sweden. In addition to improvements in education and the control of cardiovascular and other risk factors, lifestyle changes may also play an important role, such as a decrease in the smoking rate [30, 31].

At present there is no cure for AD and other dementias, with drug treatments only being able to delay the progression of the disease, which makes primary prevention of these diseases particularly important. Norton et al. [30] pointed out that one-third of AD cases worldwide are due to intervenable risk factors such as education level, physical exercise, smoking, hypertension, and obesity [32, 33]. Shimada et al. [34] researched the association of lifestyle factors with the risk of dementia in Japanese elderly, and they found that regularly participating in activities such as conversation, shopping, driving, and gardening can reduce the risk of dementia. Therefore, managing these intervenable risk factors and encouraging the elderly to adopt active lifestyles are highly significant for the primary prevention of AD and other dementias.

Our research was subject to certain limitations. First, data in the GBD database are calculated using an algorithm based on the available data for each country, which makes the accuracy of these data highly dependent on the quality and quantity of the data used in the algorithm. This means that the data for countries with low levels of development have greater limitations, and so conclusions about countries with the highest and lowest disease levels reported here should be treated with caution. Second, the GBD database does not specifically classify the diagnosis of dementia. Therefore, we cannot calculate the long-term trends in specific types of dementia such as AD, vascular dementia, Lewy-body dementia, and frontotemporal dementia, or which type of dementia declines lead to a general trend in the decline of cognitive function.

Conclusion

The present study used the GBD 2017 database to describe the incidence of AD and other dementias at the country, region, and global levels. The results could be significant in guiding the formulation of suitable medical and economic policies at both the country and region levels. While the long-term trend is that the incidence rate of AD and other dementias is declining in most countries around the world, the absolute number of cases is still increasing. Both governments and societies need to increase public awareness of these diseases.

Abbreviations

AD: Alzheimer's disease; GBD 2017: 2017 Global Burden of Disease Study; ASIR: age-standardized incidence rate; SDI: sociodemographic index; 95% CI: 95% confidence interval

Declarations

Ethics approval and consent to participate:

Not applicable. The data used in this article were from public database.

Consent for publication:

Not applicable.

Availability of data and materials:

The raw data of this study can be found through the Global Health Data exchange software (<http://www.healthdata.org/gbd/>).

Competing interests:

The authors declare that they have no competing interests.

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Authors' contributions:

Study design: Jun Lyu, Qiumin Qu. Data collection: Xiaojuan Guo, Hairong He. Data analyses: Xiaojuan Guo, Yan Qu and Jie Liu. Results interpretations: All authors. Manuscript writing: Xiaojuan Guo, Hairong He. Manuscript proofing: Jun Lyu and Qiumin Qu.

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Figures

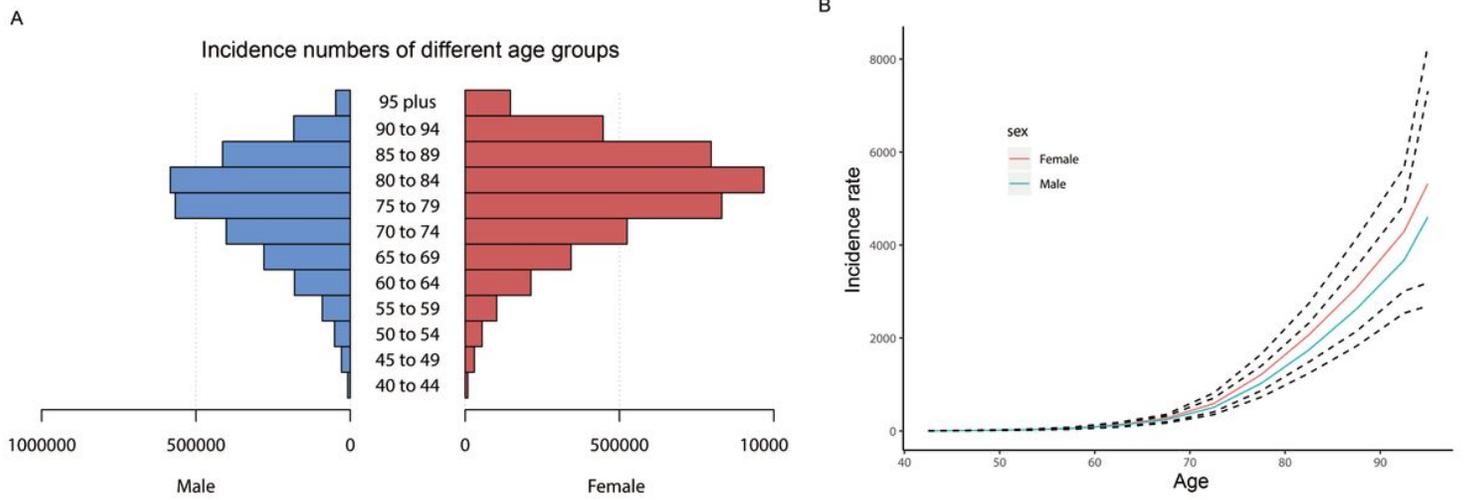


Figure 1

The incident number (A) and rate (B) of Alzheimer's disease and other dementias of different age group globally.

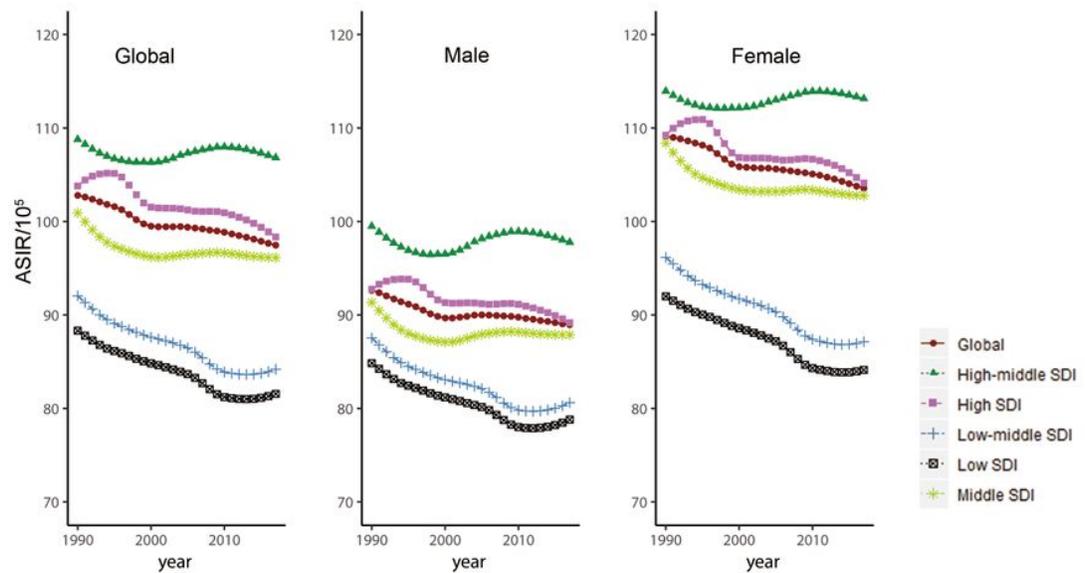


Figure 2

The age-standardised incidence rate of Alzheimer's disease and other dementias at the global level from 1990 to 2017.

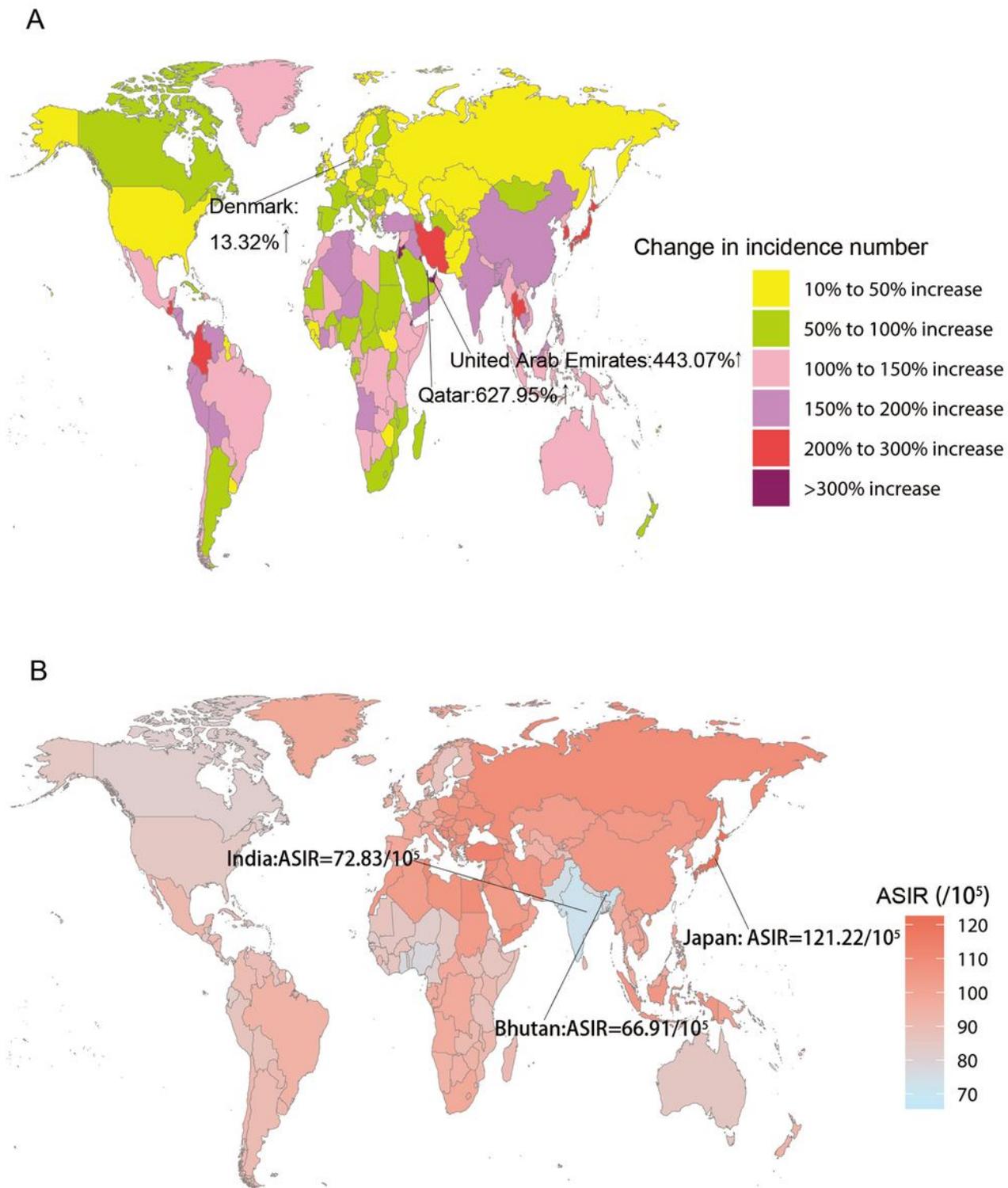


Figure 3

The global incidence of Alzheimer's disease and other dementias in 195 countries or territories. (A) The relative change in incident cases of Alzheimer's disease and other dementias between 1990 and 2017; (B) The age-standardised incidence rate of Alzheimer's disease and other dementias in 2017. (The map is our own)

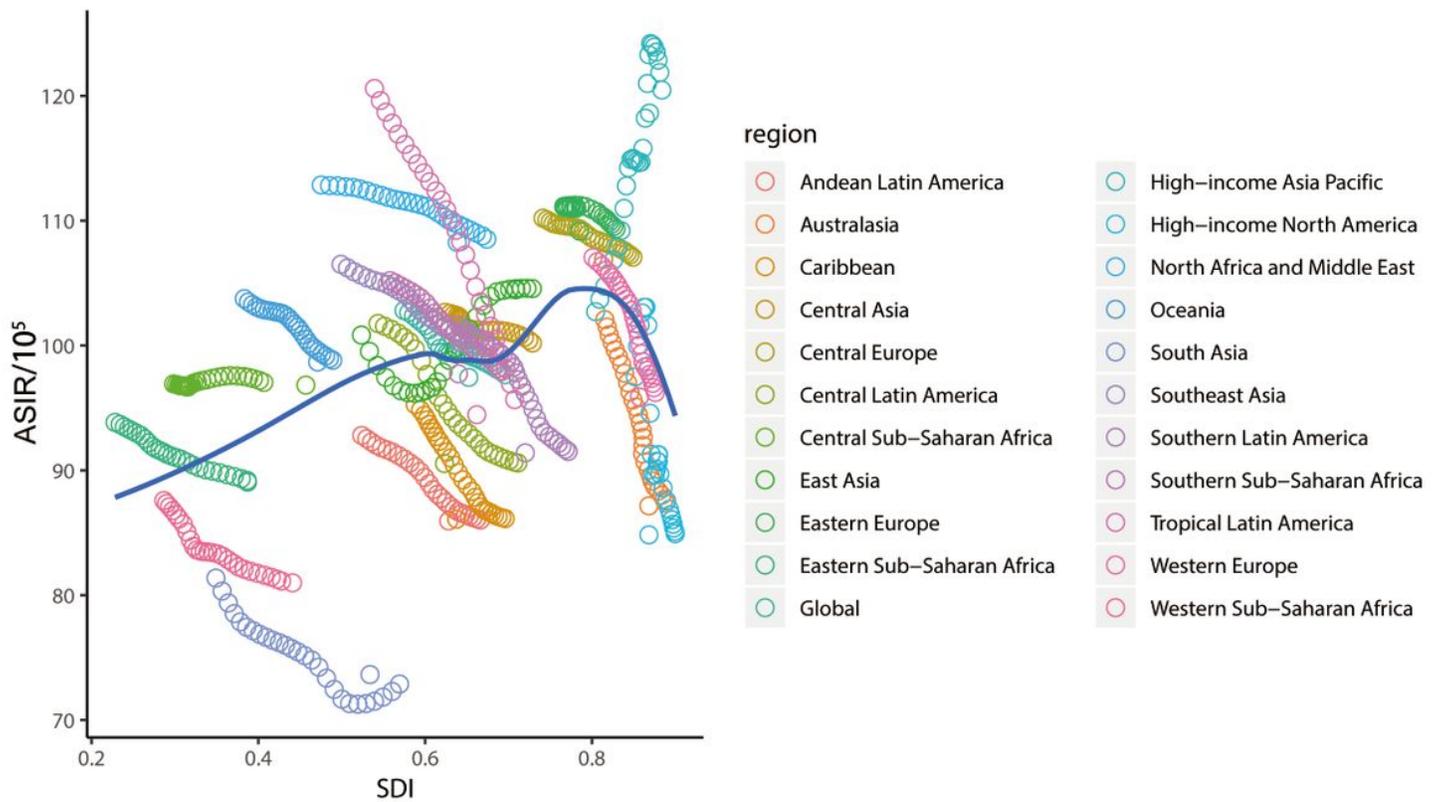


Figure 4

The age-standardised incidence rate for Alzheimer’s disease and other dementias by SDI, 1990–2017, and expected value-based SDI. The line represents the average expected relationship between SDI and incidence rate for Alzheimer’s disease and other dementias based on values from all countries over the 1990–2017 estimation period.

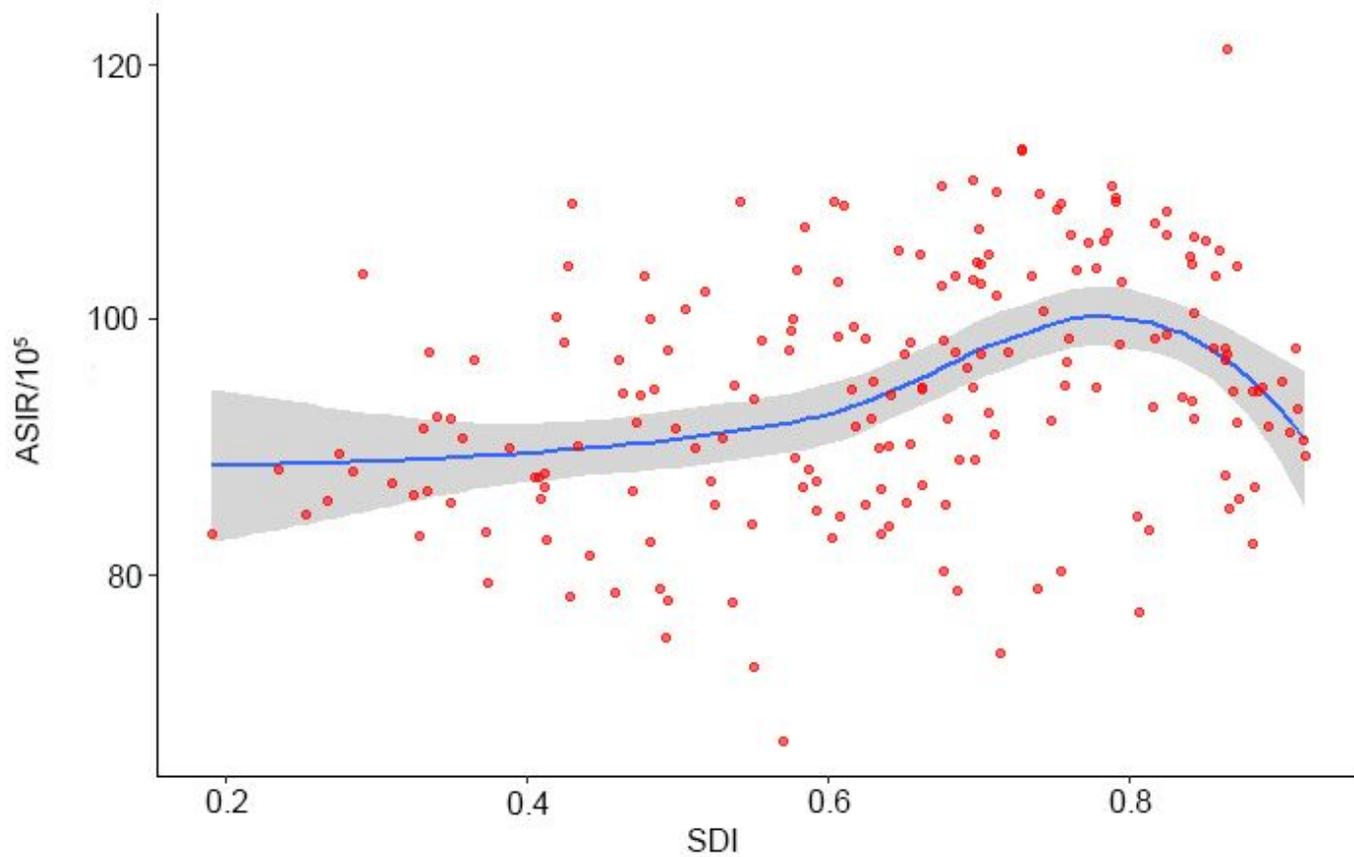


Figure 5

The correlation between age-standardised incidence rate of Alzheimer's disease and other dementias and SDI of 195 countries or territories in 2017.