

Burden of Alzheimer's Disease and other Dementias in Elderly People in Asia: A Systematic Analysis for the Global Burden of Disease Study in 2019

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Abstract

Background: Alzheimer's Disease (AD) is a progressive and damaging brain disease of unknown etiology. The goal of this study is to investigate the burden of AD in Asia in 2019. **Materials & Methods:** All data sources accessible from the 2019 Global Burden of Disease study were used to estimate prevalence, mortality and disability-adjusted life years of the Alzheimer's disease and other dementias as well as Alzheimer's disease's attributable risk factors in Asia from 1990 to 2019. We estimated all-cause and cause-specific mortality, Years of Life Lost (YLLs), Years Lived with Disability (YLDs), Disability-Adjusted Life-Years (DALYs) and attributable risks. All estimates were presented as counts and age-standardized rates per 100,000 populations with Uncertainty Intervals (UIs). **Results:** The highest incidence, prevalence, mortality, burden of disease, YLL and YLD belonged to high-income areas and the lowest to middle-income areas. There is a positive and significant correlation between Human Development Index (HDI) and disease incidence ($r=0.319$, $P<0.05$) and the prevalence of the disease ($r=0.325$, $P<0.05$). The results revealed a positive and significant correlation between HDI and disease burden (DALY) in women ($r=0.325$, $P<0.05$). There is also a positive and significant correlation between HDI and YLD in both sexes ($r=0.414$, $P<0.05$). However, no positive and significant correlation was found between HDI and YLL ($P>0.05$). There incidence of AD in the elderly was positively and significantly related to the mean years of schooling ($r=0.428$, $P<0.05$). Also, life expectancy at birth was positively and significantly correlated with the burden of disease (DALY) ($r=0.362$, $P<0.05$) and YLL ($r=0.317$, $P<0.05$). The results also illustrated a positive and significant correlation between YLD and mean years of schooling ($r=0.510$, $P<0.05$) life expectancy at birth ($r=0.397$, $P<0.05$) and expected years of schooling ($r=0.399$, $P<0.05$). **Conclusion:** These estimates can be used to guide the elderly care planning and interventions. Hence, policymakers and health care providers need to be informed of these trends to provide appropriate services.

Keywords: Dementia; Alzheimer's disease; Burden disease; DALY; Elderly

Abbreviation: HDI: Human Development Index; NCDs: Non-Communicable Diseases; GNI: Gross National Income; LEB: Life Expectancy at Birth; GDP: Gross Domestic Product

Introduction

One of the serious repercussions of the aging is the Alzheimer's Disease (AD), which is a dominant and well-known cause of dementia (70%-60%) in the elderly population. AD begins with the progressive cognitive decline and its prevalence and incidence varies according to population structure worldwide. The incidence of dementia increases exponentially with age, peaking in the seventh and eighth decades of life. In light of the prolonged life expectancy and population aging, there has been an explosion of research on this disease. ^[1,2]

The genetics of AD is a complex subject from an epidemiological perspective. This disease is a progressive neurodegenerative disorder of unknown etiology. Age, sex, blood pressure, cardiovascular diseases, alcohol consumption, and socioeconomic status are considered risk factors for AD. ^[1,3]

Today, 24.3 million people suffer from dementia, with 4.6 million new cases of dementia being reported each year. That is, every 7 seconds, one new case of AD is recorded worldwide. In 2000, the number of people aged +65 in the world was estimated at 420 million. With a change ratio of 7 to 12, this figure is estimated to reach one billion by 2030. ^[1,4] The highest prevalence and rates of dementia is in people over 60 years of age in North America and Western Europe, followed by Latin America, China, and the western Pacific states. The greatest rise

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in the incidence of AD is projected in developing countries, and it is estimated to triple from 249 million people per year in 2000 to 690 million people in 2030. The growing rate of dementia cases varies in the world, and the figures are estimated to surge by 100% in developed countries from 2001 to 2040. China, India and other countries in South Asia and the Western Ocean are expected to experience a 300% growth. About 70% of these cases are attributed to AD. [5-7]

AD is a major public health issue associated with huge social and economic costs in the world. In this regard, a pressing issue is covering the costs of healthcare services to people with AD. 43% of these patients need a high level of care. The total global cost of dementia in 2010 was estimated at \$604 billion. In the United States, AD is estimated to incur \$172 billion costs annually. AD also imposes a considerable financial burden with high levels of anxiety and depression being reported in caregivers of these patients. AD is a leading cause of mortality worldwide. [7-9] As far as AD and Human Development Index (HDI) are concerned, the burden of AD-related problems is lower in areas with high HDI. [10] HDI is the gist of human development measures that assess the average success of a country in the three main dimensions of human development, *i.e.* a long and healthy life, access to knowledge and appropriate living standards.

Given the prevalence of AD in the world, it is necessary to explore its causes in order to plan and manage financial and human resources to curb its prevalence. It is essential for each country to take necessary interventions by comparing its data with other countries regarding the effect of socio-economic situation on the causes of depression.

Given the growing cases of AD in recent years, raising awareness about the disease is crucial to plan and manage financial and human resources for the prevention of this disease. Despite the rising burden of AD, little is known about its medical costs and further studies are required for this purpose. The main goal of this study is to evaluate AD burden in the elderly in Asia based on data taken from the World Bank in 2019.

Materials and Methods

This is a correlational analytical study that aims to investigate the trend of AD burden and its relationship with the HDI during 1990-1990 in Asia. The burden of disease study is the most comprehensive and accurate global epidemiological research. The burden of disease study is the outcome of 359 diseases and 84 health risk factors in 195 countries and regions worldwide (including developed and developing countries). Information on the burden of disease, YLL and YLD is publicly accessible on Global Burden of Disease website.

Disability-Adjusted Life Years (DALY)

DALY is a health distance index that measures years of life lost, whether due to premature death or non-fatal illness. This index was defined and used in the study of Global Burden of Disease (GBD) to measure the burden of disease.

Years of Life Lost (YLL)

To identify and prioritize the causes of premature death, YLL was introduced by the World Health Organization in the study

of the global burden of disease. This index relies not only on the number of deaths but also on the age of the deceased at the time of death, so that the younger the age of the deceased at the time of death, the greater the years of life lost. YLL describe years in which an individual can lead a useful life, but were lost due to the premature death.

Years Lived with Disability (YLD)

It refers to years a person has lost due to the disease-related disability.

Human Development Index (HDI)

The HDI, estimated annually for all developing and developed countries, is publicly available on the World Health Organization website for researchers. In this study, data related to this index is derived from the WHO website.

The HDI, reported by the World Health Organization, provides the latest information on global development and embraces national, regional, and global estimates. In the Human Development Report, countries are assigned to several groups including very high human development, high human development, medium human development and low human development based on HDI. The numerical value of HDI is between 0 and 1. This index shows how far countries have progressed towards the highest possible value (*i.e.* 1), thereby allowing comparisons between countries. The HDI, as the gist of human development measures, measures the average success of a country in the three main dimensions of human development, namely a long and healthy life, access to knowledge and living standards.

Statistical Analysis

In this study, the two-variable correlation method was used for data analysis to examine the correlation of the burden of Alzheimer's disease and other dementias with HDI. A significance level of $P < 0.05$ was considered. The analyses were made using Stata software 12 (Stata Corp, College Station, TX, USA).

Results

According to the results of Table 1 in 2019, the incidence of AD in the elderly (+70 years old) worldwide were 987.3 per 100,000 in men and 1413.3 per 100,000 in women. The prevalence of this disease in both sexes was 8997.6 per 100000 and the associated death rate of the disease was 326.1 per 100000. According to the results, the DALY index for this disease (4538.9 per 100,000), YLL (3650.9) and YLD (1342.2) were calculated for 2019. Figure 1 shows the burden trend for YLD, YLL, and DALY during 1990-2019 periods in four continents. As can be seen, the highest burden of disease index, YLL and YLD were related to the Americas and the lowest to the Africa. The trend of DALY in Asia suggests that the trend of AD in the elderly (+70 years ago) in this continent has taken an upturn, increasing from 864.8 in 1990 to 1186.3 in 2019. The YLL in Asia has taken an upturn from 1990 to 2019, surging from 629.5 in 1990 to 840.3 in 2019. In exploring the trend of the index of YLD, the results manifested the rising trend of this index in Asia during 1990 to 2019. As can be seen, this index soared from 235.3 in 1990 to 345.9 in 2019.

Table 1: Alzheimer's disease and other dementias in the world in 2019(Source: GBD Compare).

Index	Rate per 100,000		
	Male	Female	Both
Incidence	987.3(802.6-1170)	1413.3(1182.1-1640.7)	1226.4(1015.8-1437.1)
Prevalence	6999.5(5804.4-825.2)	10516.5(8809.6-12295.1)	8973.6(7557.9-10528.9)
Death	249.9(59.8-687.3)	385.6(97.1-994)	326.1(82.3-849.2)
YLL	2615.3(611.5-7270.2)	3650.9(919.4- 9527.5)	3650.9(919.4- 9527.5)
YLD	1044.9(723.8-1418.6)	1574.6(1107-2127.7)	1342.2(393.1-1806.9)
DALY	3660.3(1607-8252.4)	5225.6(2405.5-11044)	4538.9(2033.6-9859.1)

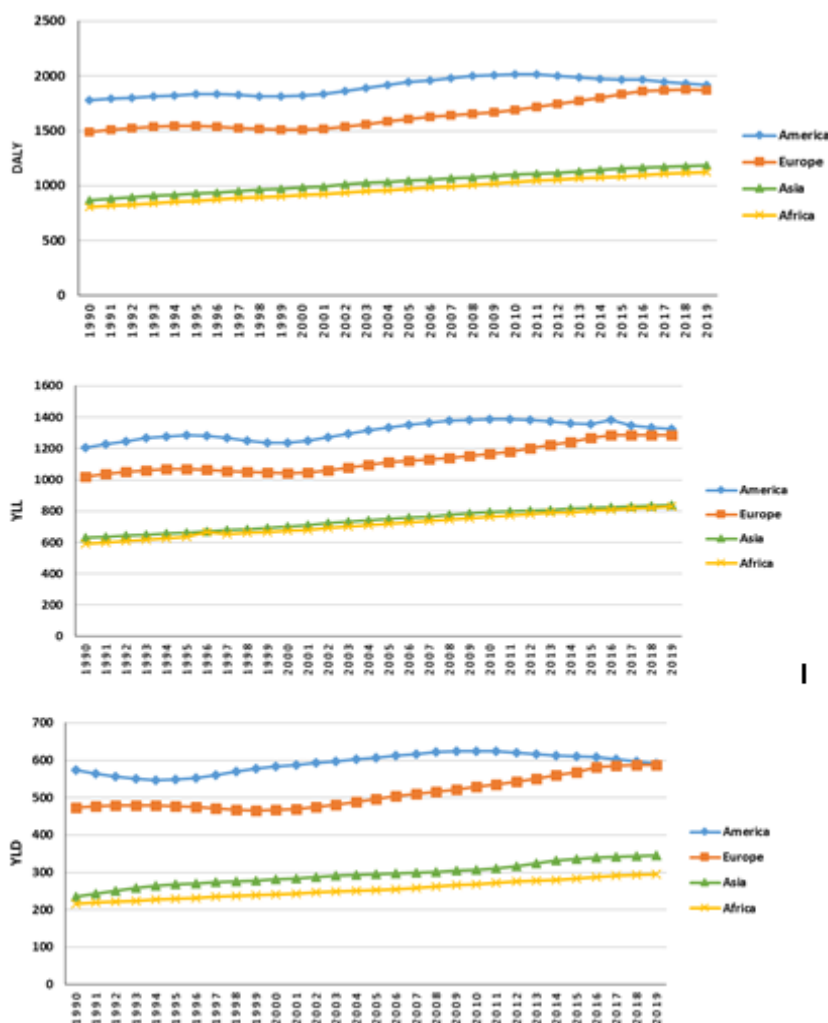


Figure 1: Shows the burden trend for YLD, YLL, and DALY during 1990-2019 periods in four continents. Trend of burden Alzheimer's disease and other dementias in 1990- 2019 in four regions of the world (Source: GBD Compare).

Table 2 shows the burden of disease (DALY) as well as YLL and YLD indices by gender and country in Asia in 2019. As is depicted, the lowest burden of AD in the elderly (+70 years old) (DALY) in 2019 belonged to India (2910.98) and the highest to Japan (7084.64). The lowest burden of disease (DALY) in women was related to Bangladesh (3007.37) and the highest to Japan (8352.23). In men, the lowest burden of disease was reported in Brunei (2366.21) and the highest in Japan (5351.44)

The lowest values of YLD in both sexes were reported in India (653.99) and the highest in Japan (2061.13). In women, the lowest YLD was related to India (693/27) and the highest to Japan (2570/15) and in men, the lowest YLD had been registered

in India (609/36) and the highest in Kuwait (1585/58). The lowest YLL in both sexes was related to India (1935/32) and the highest to Japan (5023/51). In women, the lowest YLL was recorded in India (2174/37) and the highest in Japan (5782/07), and in men, the lowest YLL was related to India (1613/61) and the highest to Japan (3986/31).

Table 3 displays the incidence and prevalence of AD in the elderly (+70 years old) in Asia by country and gender. As can be seen, the highest incidence of AD in both sexes was registered in Japan (1798/74 per 100,000) and the lowest incidence in Pakistan (719.75 per 100,000). The highest incidence of AD in men was reported in Iran (1473/67) and in women was registered

Table 2: Burden of Alzheimer's disease and other dementias in Asia in 2019 (Source: GBD Compare).

Country	YLL			YLD			DALY		
	M	F	Both	M	F	Both	M	F	Both
Afghanistan	3732.623	3507.184	3614.09	1185.035	1179.304	1182.022	4917.659	4686.488	4796.112
Armenia	3431.553	3812.703	3665.283	1417.664	1745.558	1618.736	4849.217	5558.261	5284.02
Azerbaijan	2692.026	3075.964	2922.11	1117.775	1396.057	1284.542	4472.021	4206.652	3617.192
Bahrain	2511.531	3243.203	2864.707	1051.326	1299.619	1171.177	3562.856	4542.822	4035.884
Bangladesh	2162.072	2217.36	2187.743	956.9617	790.0054	879.4407	3119.034	3007.365	3067.184
Bhutan	2496.069	2878.35	2684.916	825.1935	816.3563	820.8279	3321.262	3694.706	3505.744
Brunei	1722.861	2797.371	2341.773	643.3464	1179.118	951.9477	2366.207	3976.489	3293.721
Cambodia	2770.654	3509.157	3228.679	742.9361	1091.502	959.119	3513.59	4600.659	4187.797
China	2163.379	3417.286	2845.412	1026.984	1660.165	1371.388	3190.363	5077.45	4216.8
Georgia	2164.091	3180.236	2747.264	1420.602	1994.534	1793.195	3377.758	4860.849	4228.914
India	1613.608	2174.373	1935.322	609.3661	693.276	653.9925	2711.067	3086.954	2910.978
Indonesia	2103.833	2990.488	2605.499	691.032	1018.723	876.4384	2794.865	4009.211	3481.937
Iran	3686.098	3796.9	3741.756	1577.376	1589.727	1583.58	5263.474	5386.627	5325.336
Iraq	2928.746	3440.58	3201.752	1198.927	1446.603	1331.034	4127.673	4887.183	4532.786
Israel	2561.626	3604.666	3145.797	1113.243	1668.109	1424.005	3674.87	5272.775	4569.802
Japan	3986.31	5782.077	5023.511	1365.129	2570.15	2061.126	5351.44	8352.228	7084.637
Jordan	2677.077	2840.025	2757.03	1196.685	1256.324	1225.948	3873.761	4096.35	3982.978
Kazakhstan	2530.058	3092.986	2908.136	1087.134	1481.801	1352.203	3617.192	4574.788	4260.339
Kuwait	3705.145	4315.736	3935.792	1585.582	1889.874	1700.527	5290.728	6205.609	5636.319
Kyrgyzstan	3275.213	3848.258	3632.565	1387.107	1786.177	1635.968	4662.32	5634.435	5268.533
Lao People's Democratic Republic	2212.18	3225.176	2758.007	734.982	1127.002	946.2124	2947.162	4352.178	3704.22
Lebanon	3318.407	4139.663	3770.613	1410.496	1643.165	1538.61	4728.904	5782.828	5309.222
Malaysia	2413.748	3018.794	2718.757	826.6255	1186.882	1008.234	3240.374	4205.676	3726.991
Maldives	3111.903	3664.792	3378.23	1023.986	1351.5	1181.75	4135.889	5016.292	4559.98
Mongolia	2485.767	2899.306	2737.643	1054.875	1393.131	1260.898	3540.642	4292.437	3998.542
Myanmar	2314.71	3470.222	3006.052	766.8756	1174.12	1010.53	3081.585	4644.342	4016.582
Nepal	1836.078	2523.612	2192.81	726.43	748.0327	737.6387	2562.508	3271.645	2930.448
Oman	2543.175	3414.452	2962.148	983.6239	1256.695	1114.936	3526.799	4671.146	4077.083
Pakistan	2135.434	2557.186	2342.664	710.2131	697.7018	704.0657	2845.647	3254.888	3046.729
Philippines	2532.46	3186.467	2921.755	777.8357	1092.301	965.0195	3310.296	4278.768	3886.774
Qatar	2055.708	2286.444	2121.052	820.7656	889.9888	840.3694	2876.474	3176.432	2961.421
Saudi Arabia	2749.074	3663.83	3107.578	1084.804	1454.671	1229.759	3833.878	5118.501	4337.337
Singapore	2540.057	3649.352	3155.925	978.8314	1636.793	1344.124	3518.888	5286.144	4500.05
Sri Lanka	2336.578	3291.384	2896.988	754.0907	1152.462	987.9089	3090.669	4443.846	3884.897
Syrian Arab Republic	3044.748	3025.929	3035.727	1240.928	1222.664	1232.172	4285.676	4248.593	4267.899
Tajikistan	2462.319	3263.794	2893.951	1003.36	1446.976	1242.268	3465.678	4710.77	4136.22
Thailand	2768.141	3923.016	3425.255	929.7976	1418.109	1207.642	3697.938	5341.125	4632.897
Timor-Leste	2171.153	2844.601	2517.87	710.2001	949.0087	833.148	2881.353	3793.61	3351.018
Turkey	3344.327	4245.02	3842.923	1466.155	1738.751	1617.056	4810.482	5983.77	5459.979
Turkmenistan	2940.375	3823.416	3479.896	1264.73	1813.851	1600.232	4205.105	5637.267	5080.128
United Arab Emirates	2186.553	2285.979	2221.51	892.6295	945.9741	911.3846	3079.182	3231.953	3132.894
Uzbekistan	1817.74	2184.887	2041.934	827.7778	1098.711	993.2202	2645.518	3283.598	3035.154
Viet Nam	3205.251	4906.207	4289.052	823.0317	1374.286	1174.275	4028.283	6280.493	5463.327
Yemen	2795.876	3215.725	3009.378	1136.147	1328.724	1234.076	3932.023	4544.448	4243.455
Republic of Korea	2478.913	3847.785	3287.29	929.2544	1747.486	1412.455	3408.168	5595.271	4699.745
Democratic People's Republic of Korea	1873.572	3246.762	2819.866	748.1586	1329.143	1148.527	2621.731	4575.905	3968.392

in Japan (2181/99). The highest prevalence of this disease in both sexes was recorded in India (13602.2) and the lowest in Pakistan (4866.02). The highest prevalence of AD in men was reported in India (11397/6) and in women was reported in Japan (16513).

Figure 2 shows the trend of AD-related indices in the elderly (+70 years old) during 1990-2019 period. As can be seen, the trend of incidence, prevalence, mortality, burden of disease (DALY), YLL and YLD were greater in higher income regions.

Moreover, the highest incidence, prevalence, mortality, burden of disease (DALY), YLL and YLD were reported in high-income regions and the lowest in middle-income regions.

Figures 3-7 shows the association of HDI with incidence, prevalence, mortality, burden of disease (DALY), YLL, YLD in the elderly patients with AD (+70 years old) in Asia in 2019. As can be seen, there is a positive and significant correlation between HDI and disease incidence in both sexes ($r=0.319$,

Table 3: Incidence and Prevalence of Alzheimer's disease and other dementias in Asia in 2019(Source: GBD Compare).

Country	Incidence			Prevalence		
	M	F	Both	M	F	Both
Afghanistan	1216.73	1222.695	1219.866	8143.646	8345.556	8249.808
Armenia	1359.688	1551.445	1477.278	9165.69	11321.35	10487.59
Azerbaijan	1110.847	1301.109	1224.866	7323.807	9168.751	8429.434
Bahrain	1046.752	1260.587	1149.97	7339.279	9062.419	8171.036
Bangladesh	860.6695	763.8145	815.6979	6373.562	5355.412	5900.816
Bhutan	799.2615	789.0031	794.1938	5525.557	5570.344	5547.682
Brunei	679.1704	1207.048	983.2253	4564.61	7988.038	6536.486
Cambodia	738.2726	1064.963	940.8879	5110.24	7498.723	6591.593
China	931.9648	1443.423	1210.161	6869.627	11205.19	9227.856
Georgia	1378.609	1738.962	1612.548	8553.786	11712.25	10366.45
India	1390.612	1914.346	1691.081	11397.56	15240.35	13602.19
Indonesia	696.8359	1015.5	877.135	4778.837	7080.569	6081.148
Iran (Islamic Republic of)	1473.672	1477.553	1475.622	10417.68	10743.01	10581.1
Iraq	1158.617	1362.093	1267.148	8095.667	9817.337	9013.984
Israel	1025.34	1490.512	1285.867	7160.124	10830.15	9215.581
Japan	1274.732	2181.986	1798.744	8850.816	16513.01	13276.35
Jordan	1136.554	1192.519	1164.014	8025.399	8561.478	8288.435
Kazakhstan	1084.253	1361.633	1270.549	7225.122	9774	8937.018
Kuwait	1433.011	1644.21	1512.791	10461.45	12495.61	11229.85
Kyrgyzstan	1339.842	1589.599	1495.591	8922.043	11437.08	10490.42
Lao People's Democratic Republic	730.3675	1097.808	928.3533	4988.503	7622.212	6407.611
Lebanon	1330.694	1495.881	1421.65	9479.76	11093.99	10368.6
Malaysia	770.9453	1068.343	920.8662	5620.575	8114.595	6877.832
Maldives	965.8054	1237.862	1096.855	6761.961	9064.398	7871.048
Mongolia	1073.496	1301.785	1212.541	6984.122	9111.259	8279.709
Myanmar	765.952	1149.108	995.1936	5228.167	8038.464	6909.566
Nepal	726.5878	734.9739	730.939	4934.218	5171.108	5057.13
Oman	975.4679	1206.9	1086.757	6879.652	8729.596	7769.238
Pakistan	729.979	709.1625	719.7507	4867.056	4864.954	4866.023
Philippines	783.6504	1060.962	948.719	5268.325	7430.151	6555.143
Qatar	838.1949	941.9743	867.5848	5903.965	6579.993	6095.413
Saudi Arabia	1061.009	1371.371	1182.643	7545.677	10064.02	8532.647
Singapore	937.3983	1508.229	1254.317	6361.564	10501.21	8659.854
Sri Lanka	737.2889	1089.014	943.7286	5263.69	7945.896	6837.972
Syrian Arab Republic	1198.144	1194.001	1196.158	8381.314	8475.857	8426.636
Tajikistan	1028.324	1347.331	1200.125	6661.595	9464.93	8171.325
Thailand	875.2037	1269.635	1099.632	6178.685	9370.371	7994.727
Timor-Leste	712.8565	941.8066	830.7288	4919.924	6604.725	5787.324
Turkey	1350.1	1565.096	1469.115	9671.998	11627.08	10754.27
Turkmenistan	1239.015	1608.37	1464.683	8196.038	11644.65	10303.07
United Arab Emirates	895.4348	976.051	923.7781	6217.614	6770.947	6412.157
Uzbekistan	867.3843	1081.841	998.34	5640.311	7425.624	6730.492
Viet Nam	791.2814	1270.666	1096.732	5534.788	9171.494	7851.994
Yemen	1120.992	1290.817	1207.352	7661.815	9061.648	8373.66
Republic of Korea	874.8746	1540.664	1268.052	6200.688	11449.75	9300.482
Democratic People's Republic of Korea	732.7926	1264.088	1098.919	4964.941	8817.914	7620.104

P<0.05). This correlation was positive and significant in women (r=0.423, P<0.05) but non-significant in men (r=0.132, P>0.05).

The results indicated a positive and significant correlation between HDI and the prevalence of disease in both sexes (r=0.325, P<0.05), which was again significant in women (r=0.420, P<0.05) but non-significant in men (r=0.137, P>0.05).

The results showed revealed a positive and significant correlation between HDI and burden of disease (DALY) in woman (r=0.325,

P<0.05), but this positive correlation was non-significant in both sexes (r=0.277, P>0.05) and in men (r=0.111, P>0.05).

The results also manifested a positive and significant correlation between HDI and YLL in both sexes (r=0.414, P<0.05), which was also significant in women (r=0.499, P<0.05) but non-significant in men (r=0.219, P>0.05).

The results of YLD analysis suggested that HDI was no positively and significantly related to YLL in both sexes (r=202,

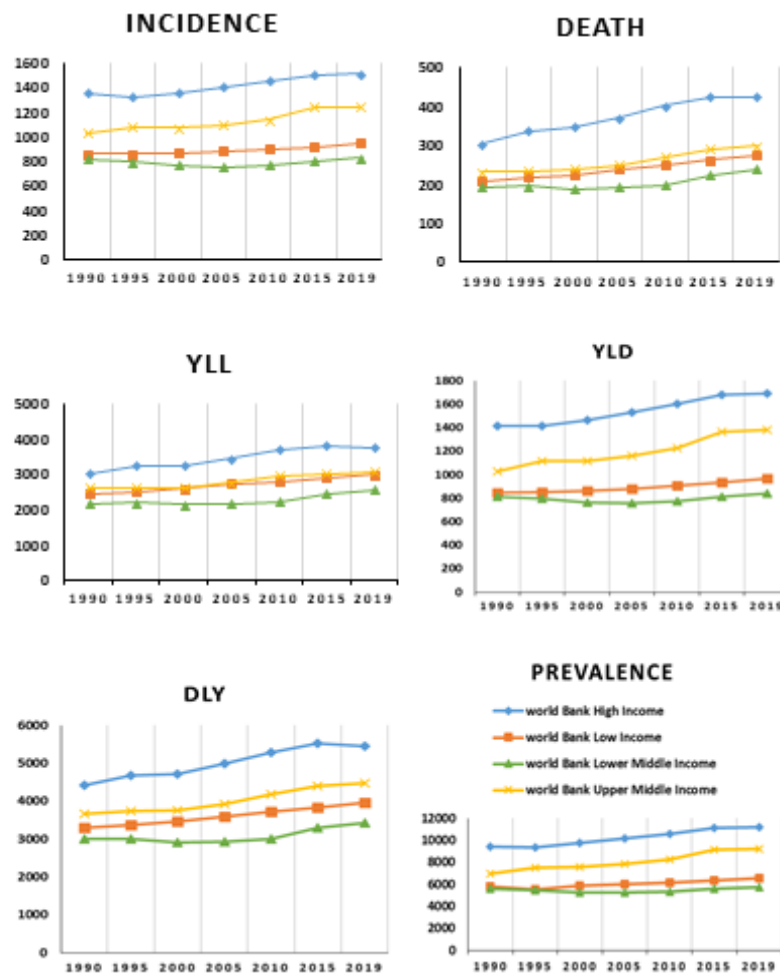
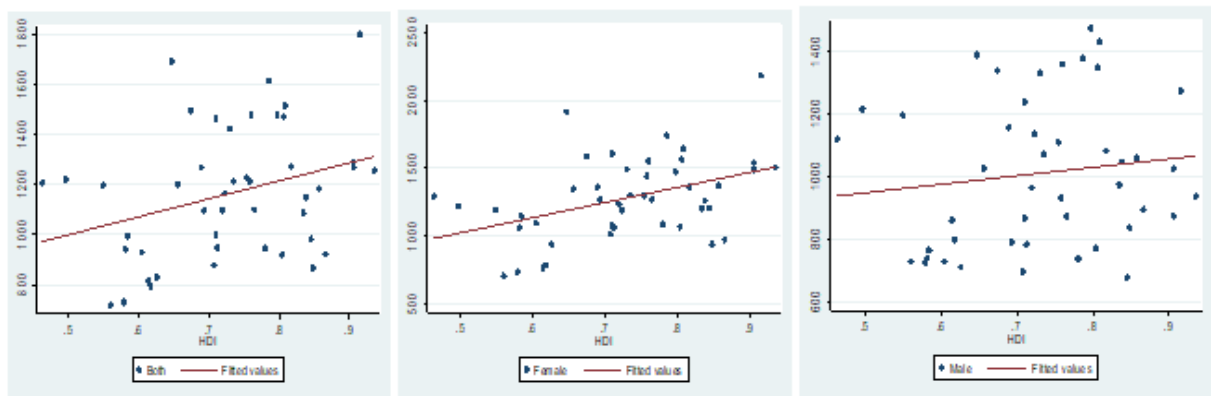


Figure 2: AD and other dementias in 1990- 2019 by world bank income level (Source: GBD Compare).



R Sq. linear=0.319, P<0.05

R Sq. linear=0.423, P<0.05

R Sq. linear=0.132, P>0.05

Figure 3: Correlation of HDI with incidence of Alzheimer's disease and other dementias in Asia in 2019 by sex.

P>0.05), in men (r=0.292, P>0.05) and in women (r=0.063, P>0.05).

Table 4 shows the relationship between components of HDI and all indices of AD in the elderly (+70 years old). Clearly, there is a positive and significant correlation between the incidence of AD in the elderly and the mean years of schooling (r=0.428, P<0.05) and expected years of schooling. The results also showed that

the prevalence of AD was positively and significantly related to the mean years of schooling (r=0.383, P<0.05), life expectancy at birth (r=0.295, P<0.05) and expected years of schooling (r=0.337, P<0.05).

There is also a positive and significant correlation between life expectancy at birth and burden of disease (DALY) (r=0.362, P<0.05) and YLL (r=0.317, P<0.05).

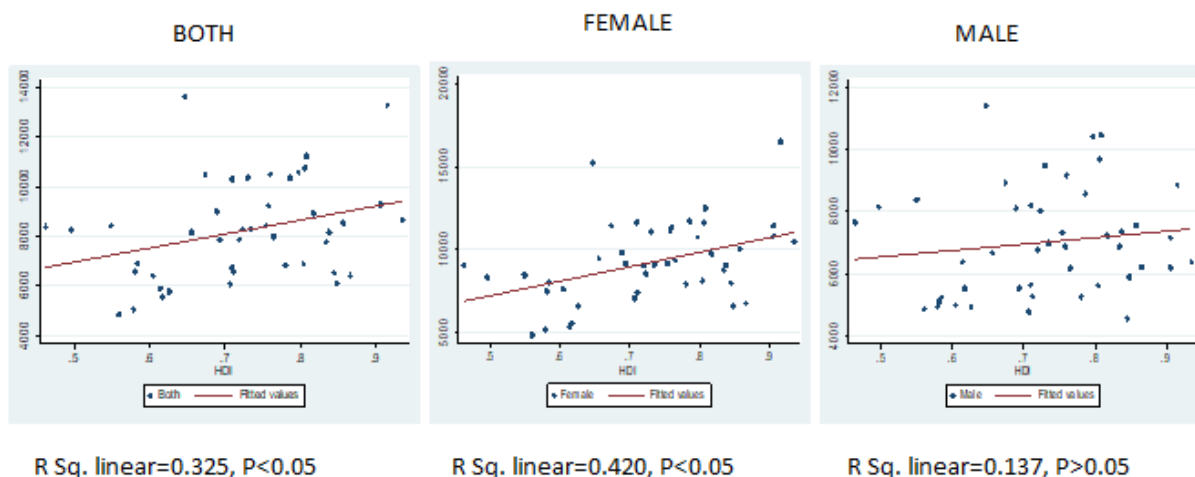


Figure 4: Correlation of HDI with Prevalence of Alzheimer's disease and other dementias in Asia in 2019 by sex.

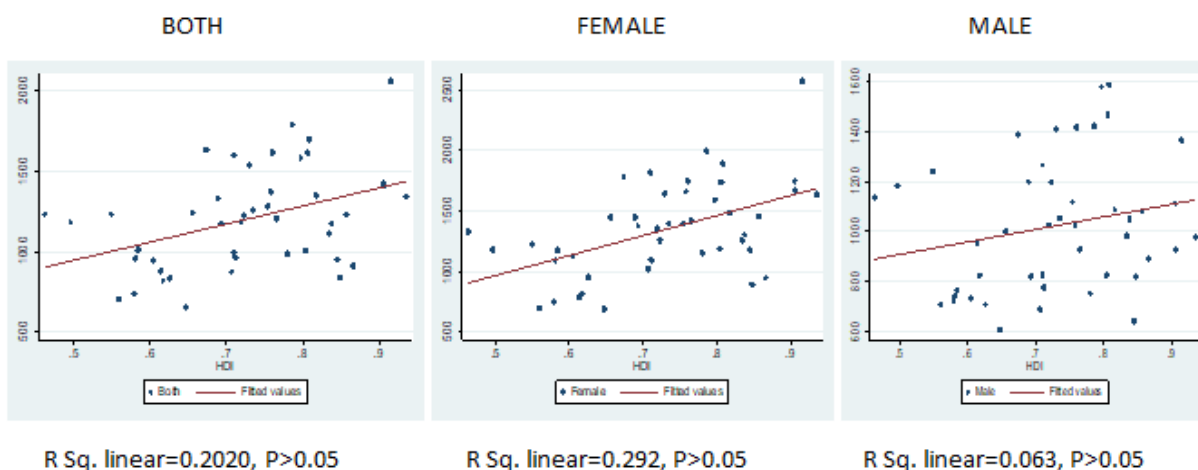


Figure 5: Correlation of HDI with DALYs of Alzheimer's disease and other dementias in Asia in 2019 by sex.

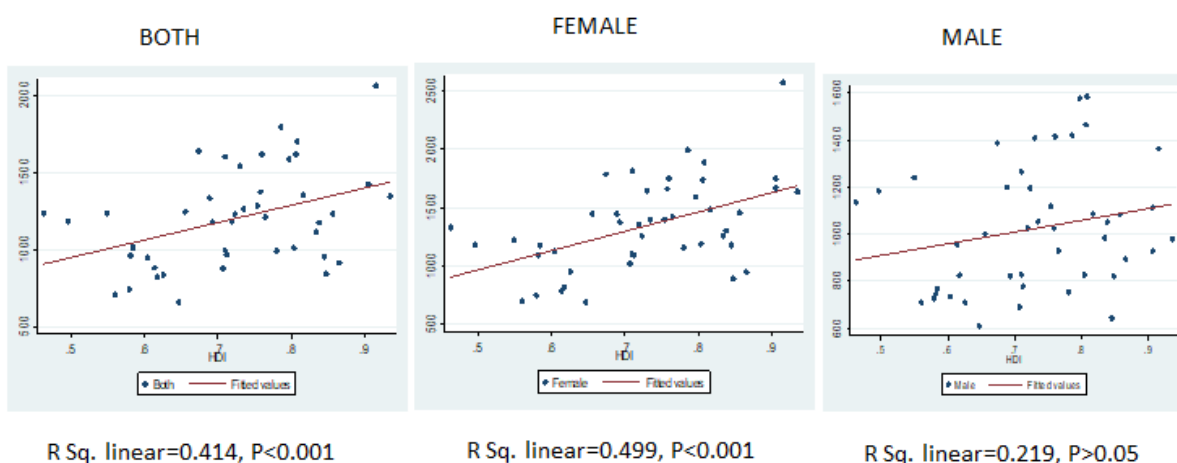


Figure 6: Correlation of HDI with DALYs of Alzheimer's disease and other dementias in Asia in 2019 by sex.

As shown by the results, YLD was also positively and significantly correlated with mean years of schooling ($r=0.510$, $P<0.05$), life expectancy at birth ($r=0.397$, $P<0.05$) and expected years of schooling ($r=0.399$, $P<0.05$). Figures 8-10 depicts the share of metabolic and genetic factors associated with AD in the elderly (+70 years) in all AD-related indices. As can be seen,

the share of behavioral factors relative to metabolic in YLL was 719.1 vs. 387.1 in men and 192.7 vs. 550.3 in women. It suggests that behavioral factors in men and metabolic factors in women have a crucial role in determining YLL. The results of YLD analysis showed that the share of behavioral and metabolic factors was 296.2 and 149.1 in men and 86.6 and

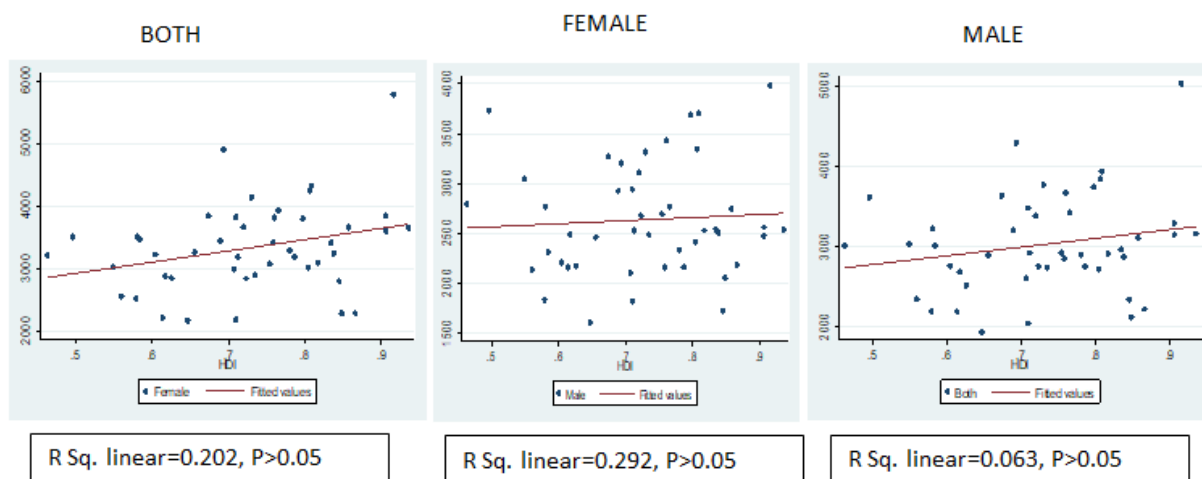


Figure 7: Correlation of HDI with YLL of Alzheimer's disease and other dementias in Asia in 2019 by sex.

Table 4: Correlation of indexes Alzheimer's disease and other dementias to decomposites of human development index in Asia in 2019.

HDI components	Incidence		Prevalence		DALY		YLL		YLD	
	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value
Gross national income per 1000 capita	0.034	P>0.05	0.043	P>0.05	0.014	P>0.05	-0.031	P>0.05	0.082	P>0.05
Mean years of schooling	0.428	P<0.05	0.383	P<0.05	0.275	P>0.05	0.172	P>0.05	0.51	P<0.05
Life expectancy at birth	0.263	P>0.05	0.295	P<0.05	0.362	P<0.05	0.317	P<0.05	0.397	P<0.05
Expected years of schooling	0.334	P<0.05	0.337	P<0.05	0.291	P>0.05	0.221	P>0.05	0.399	P<0.05

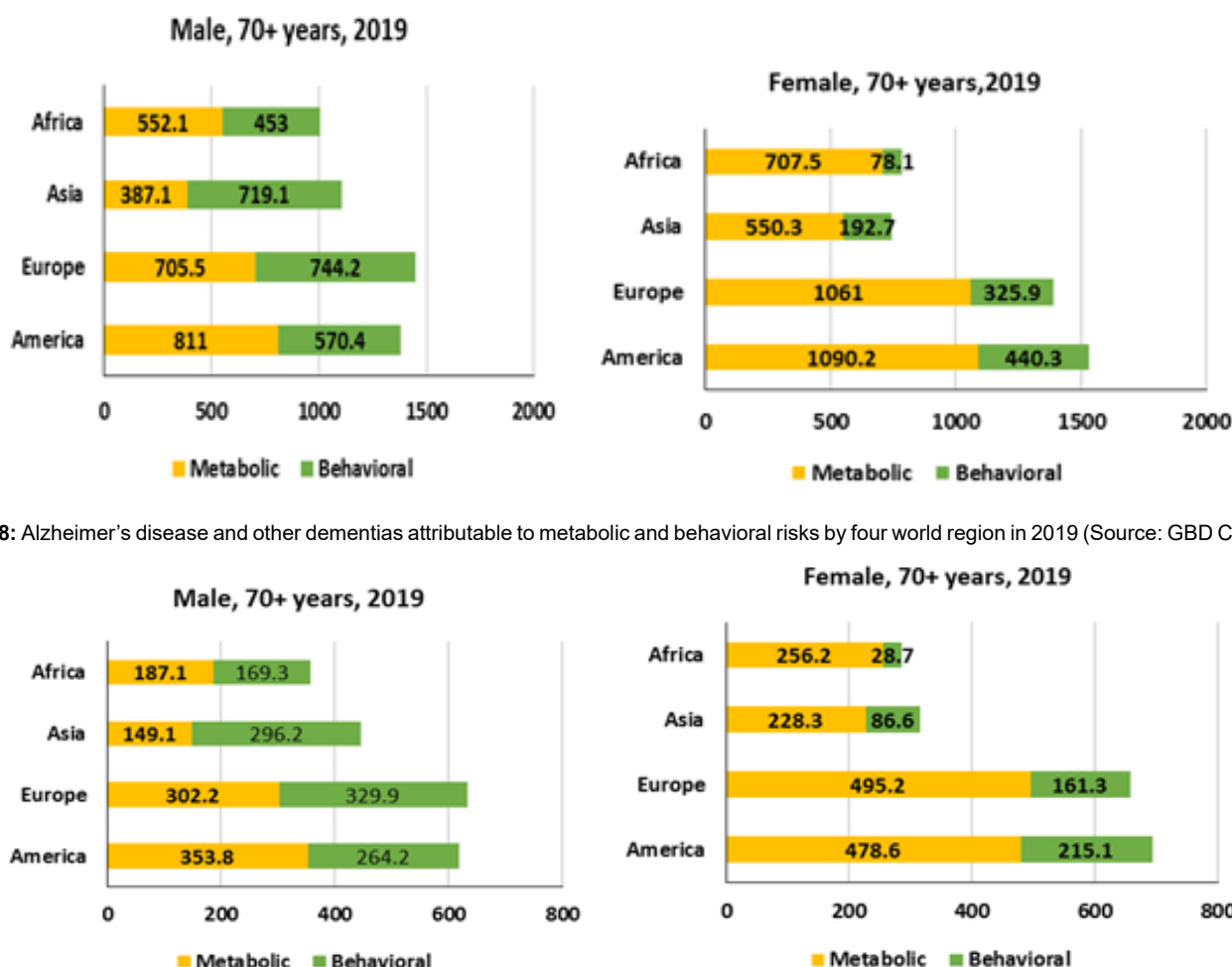


Figure 9: Alzheimer's disease and other dementias attributable to metabolic and behavioral risks by four world region in 2019 (Source: GBD Compare).

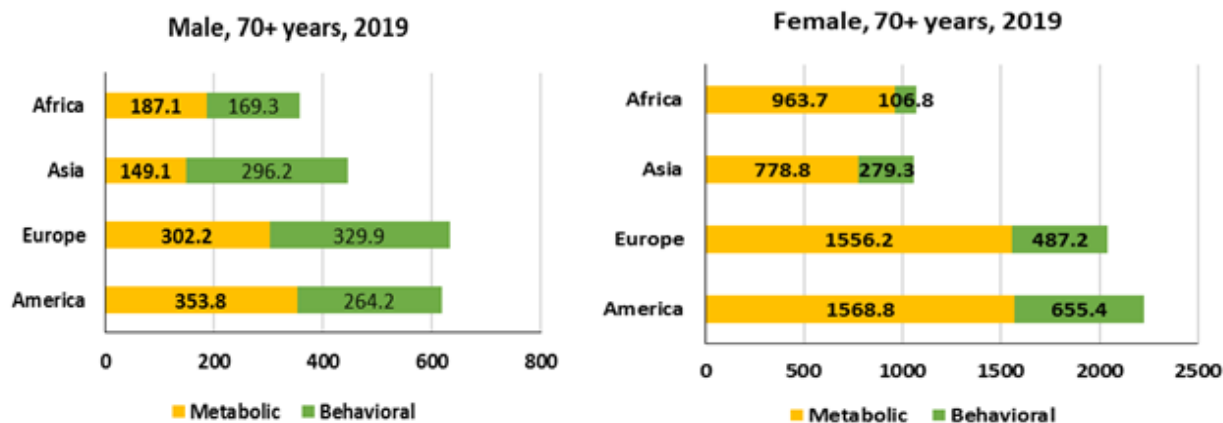


Figure 10: Alzheimer's disease and other dementias attributable to metabolic and behavioral risks by four world region in 2019 (Source: GBD Compare).

228.3 in women, respectively. As is evident, behavioral factors have a greater share in men and metabolic factors have a greater share in women. On the other hand, the analysis of the burden of disease (DALY) in men shows that the share of behavioral and metabolic factors is 1015.3 vs. 536.3 in men and 279.3 vs. 778.8 in women, indicating that the proportion of metabolic factors in the burden of disease in women.

Discussion

AD is the most common and recognized cause of dementia, which ensues progressive and irreversible brain dysfunction. During the decades of demographic transition, the burden of the disease has posed a huge challenge to the health system. [11,12] AD can provoke depression and anxiety in people around the patient on top of the disability and mortality of the patient. 46.8 million People with dementia live worldwide and it is predicted to double every 20 years. [13,14]

The results of this study revealed a positive and significant correlation between HDI and disease incidence in both sexes ($r=0.319$, $P<0.05$) which was positive and significant in women ($r=0.423$, $P<0.05$) but non-significant in men ($r=0.132$, $P>0.05$).

The highest incidence of AD in both sexes was reported in Japan whereas Pakistan had the lowest incidence of AD in both sexes in the world. The highest and lowest prevalence in both sexes were reported in India and Pakistan, respectively. Disparity in the rate of Alzheimer's in different countries could also be attributed to discrepancy in socioeconomic status, heterogeneity in study design, differences in health care systems, various diagnostic methods, and heterogeneity in demographic characteristics. Today, the increase in the incidence and prevalence of AD in the world could be ascribed to factors such as the higher efficiency of diagnostic tests and increased awareness of people about Alzheimer's disease over time. [3-15]

In recent years, the incidence of dementia has surged in developing countries. China and the Pacific have a high incidence of dementia. The rate was 5% in the People's Republic of China, 2% in Japan, and 4% in Taiwan, as well as 5 million in the European Union, 2.9 million in the United States and 1.5 million in India. [16-18] The highest incidence of HDI-related AD in the world was reported in countries with higher HDI. The lowest incidence of HDI-related AD was reported in countries

with medium HDI. In Japan, there were more than 4.6 million Japanese with dementia in 2013, which is expected to reach 7 million by 2025, indicating that one in five elderly people in Japan suffer from dementia. [14]

The results of a study by Han et al. in 2018 illustrated a significant connection between the rising rate of AD and some components of HDI, such as socioeconomic factors, the low level of education and lifestyle. [19]

A 2005 study by Wilson et al. found that there was a significant positive correlation between the incidence of AD in children from birth to adulthood and HDI. This association was also related to the reduced risk of AD in adulthood in people with higher socioeconomic status. [10]

A 1997 study by Evans et al. showed that there was no significant relationship between the incidence of AD in people with high socioeconomic status and HDI. The observed difference in the incidence of AD was significantly linked to education but irrelevant to job and income components. [20]

Social and economic developments have exerted a major impact on the incidence, prevalence and mortality of AD. In high-income countries, the risk of AD is on rise. Factors such as gender, education and life expectancy at birth are known as HDI-related risk factors for AD. The incidence and death of AD are linked to the economic growth of societies. Statistics shows that the majority of AD-induced cases have been reported in high-income countries. [19]

Also, the results of this study displayed a positive and significant correlation between HDI and disease prevalence in both sexes ($r=0.325$, $P<0.05$). This correlation was significant in women ($r=0.420$, $P<0.05$). But non-significant in men ($r=0.137$, $P>0.05$). Moreover, the higher incidence of AD in countries with higher HDI could be explained in terms of advanced diagnostic methods, higher economic status and meticulous data recording. HDI is the average of the geometric development of normal indices that measure the success of each dimension (optimal life, knowledge, and longevity). Beyond income and possessions, this index assesses long-term life satisfaction of individuals in the society, underscoring HDI and the fact that the ultimate goal of development programs should be providing conditions for healthy, creative and happy living for human beings.

Finally, caution should be exercised in interoperating such studies because in addition to the epidemiological risk factors for AD, the inherent limitations of ecological studies should also be taken into account. Issues such as differences in screening criteria and differences in reported age groups have to be taken into account. By the introduction of primary prevention methods, epidemiological studies timely treatment, and follow-up of AD patients, especially in less developed countries, effective steps can be taken to inhibit the incidence of the disease.

Conclusion

The incidence of AD in the elderly continues to pose a public health challenge and there are social inequalities regarding the burden of the disease. These estimates can be helpful for public health planning in order to provide a basis for planning and interventions, especially for areas with a higher incidence of the disease. The disproportionate surge in AD cases and consequently dementia, in addition to the composition of the population in different countries, can be linked to other factors that require further research in these countries.

Limitations and Problems

This study was constrained to countries whose data are recorded on the burden of disease website. Given the fact that the present study is an ecological study, exposure or outcome data were not collected at the individual level, but data were taken from all exposed individuals in a specific community or time frame. A main drawback of these studies is ecological fallacy, which attributes characteristics observed at the group level to the individual. To avoid this error, the results of such studies should be interpreted with caution.

Acknowledgments

Declaration of conflicting interests

The authors declare that they have no conflict of interest.

Availability of data and materials

The datasets generated during the present study can be provided by the corresponding author upon reasonable request.

Author Contributions

Elhamgoodarzi and Zaherkhazaei carried out the design of the study and carried out analyzing the data and prepared the manuscript. Kobra Rashidi and Victoria Momenabadi critically reviewed the manuscript, applied comments and finalized the manuscript. All authors have read and approved the content of the manuscript.

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