

The worldwide societal costs of dementia: Estimates for 2009

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Abstract

Background: The purpose of this study was to update the previous estimate of the worldwide cost of dementia in 2005 to 2009.

Methods: The cost model is based on prevalence estimates, country and region-specific data on Gross Domestic Product per person and average wage, with results from previously published cost-of-illness studies in different countries. Prevalence figures are updated to 2009 and costs were adjusted to 2009 constant US dollars (\$).

Results: The total worldwide societal cost of dementia, based on a dementia population of 34.4 million demented persons, was estimated to \$422 billion in 2009, including \$142 billion for informal care (34%).

Conclusions: The worldwide cost of dementia has increased by 34% (18% in fixed prices) between 2005 and 2009.

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Keywords:

Dementia; Alzheimer's disease; Economic impact; Global burden of disease; Costs; Economics; Prevalence; Informal care; Africa; Asia; Caribbean; Central America; Europe; North America; Oceania; South America

1. Introduction

The worldwide direct costs of dementia care were estimated to be \$315 billion for 29.3 million demented in 2005 [1]. Seventy-seven per cent of the costs occurred in the more developed regions of the world (according to the UN classification), with 46% of the estimated prevalence. Costs of dementia are a major economic burden on the care systems in the developed countries and are an increasing challenge in the developing countries.

Due to demographic changes, it is also forecasted that the major increase in the prevalence of dementia will occur in developing countries [2,3]. Because of the dynamics of the expected change in prevalence, it is useful to update the estimated worldwide costs of dementia from 2005 to 2009.

2. Methods

The basic cost model in the Dementia Worldwide Cost Database (DWCD) is described in detail elsewhere [1,4]. In

short, it is based on the estimated prevalence of dementia in different countries and regions of the world, cost of illness studies from different countries, and studies of the amount of informal care. Two options for informal care are used: 1.6 hours per day (basic ADLs), and 3.7 hours per day (basic ADLs and instrumental ADLs). The cost of informal care is based on country-specific figures of average wages [5]. For countries with missing or insufficient data, we assume a relationship between costs per demented person and Gross Domestic Product (GDP) per person (Purchase Power Parities [PPP]-based) in different countries [6]. The 2009 figures in this paper are based on an update of prevalence, and the costs are inflated to 2009 by country-specific data on consumer price index [7]. The same source for the age-specific prevalence figures is used [8,9] as in the previous paper. According to the UN, the countries are divided into more-developed regions (MDR) and less-developed regions (LDR).

3. Results

The total societal worldwide costs of dementia are estimated to be \$422 billion in 2009 (Table 1) (direct costs

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Table 1
Summary of worldwide costs of dementia care (base cases, in 2005 and 2009 (in US\$ billions))

Major areas/regions	Prevalence (x1000) 2005	Prevalence (x1000) 2009	Direct costs 2005	Direct costs 2009	Informal care costs 2005	Informal care costs 2009	Total costs 2005	Total costs 2009
Africa	1428	1771	1.9	3.4	2.5	0.5	4.4	7.9
Eastern	372	506	0.2	0.4	0.3	0.2	0.5	1.0
Middle	174	180	0.1	0.2	0.1	1.0	0.2	0.3
Northern	403	522	0.9	1.5	0.6	1.4	1.5	2.5
Southern	89	134	0.4	0.9	0.7	1.4	1.1	2.3
Western	391	429	0.2	0.4	0.9	0.5	1.1	1.8
Latin America	2000	2774	7.8	13.7	6.0	10.8	13.8	24.5
Caribbean	199	248	0.7	1.0	0.6	1.0	1.3	2.0
Central America	461	636	1.8	3.0	0.9	1.5	2.7	4.5
South America	1340	1889	5.3	9.7	4.5	8.3	9.8	18.0
North America	3413	3953	60.5	76.8	23.1	29.3	83.6	106.2
Asia	14185	16542	56.7	77.8	32.0	44.3	88.7	122.0
Eastern	7743	9561	44.5	59.8	23.9	32.0	68.4	91.8
South Central Asia	4302	4490	6.5	9.6	4.0	6.0	10.5	15.6
South Eastern Asia	1552	1880	3.5	5.5	2.4	3.8	5.9	9.3
Western Asia	588	611	2.2	2.9	1.7	2.5	3.8	5.4
Europe	8067	9032	80.5	103.3	39.9	51.3	120.4	154.6
Eastern Europe	2578	2741	12.1	18.4	6.2	9.4	18.3	27.8
Northern Europe	1252	1333	16.7	19.6	8.2	9.6	25.0	29.3
Southern Europe	1844	2189	19.9	26.0	10.1	13.3	30.1	39.2
Western Europe	2392	2769	31.8	39.3	15.3	18.9	47.1	58.3
Oceania	243	304	3.0	4.2	1.5	2.2	4.5	6.4
WORLD	29336	34376	210.3	279.3	105.0	142.3	315.4	421.6

\$279 billion, and costs of informal care \$142 billion) (Table 1). If both basic ADLs and IADLs are considered, the costs of informal care increase to \$329 billion, and the total costs to \$608 billion. Seventy-four percent of the costs occur in the MDR countries, with 46% of the dementia population.

The highest costs occur in North America and Europe; in individual countries, the total cost is by far highest in the United States (\$97 billion in base option, and \$133 billion if the higher figure of informal care is considered), followed by Japan (\$45 billion) and China (\$41 billion, with the greatest dementia population in the world: about 6.7 million demented persons).

If only the prevalence change is considered (and not inflation), the total cost increased from \$315 billion to \$372 billion (fixed prices), instead of \$422 billion.

In terms of costs per case, the worldwide annual cost per case is estimated at \$12,200, with the lowest cost in Africa (\$4400), and the highest in North America (\$26,700) in the base case alternative. If the higher cost of informal care is used, the highest cost-per-case is found in the North America, \$36,600/year (Table 2). Individual country data is presented in Table 3.

4. Discussion

The worldwide societal costs of dementia have increased from \$315 to \$422 billion in only few years. Given the various challenges estimating dementia prevalence (ie, regional, age, class differences), the global prevalence of demented has increased to more than 34 million and the greatest increases

occur in the developing countries. The present update is based on changes in prevalence and inflation. Whether there has been a great change in the care structure and treatment that may jeopardize the basic assumptions of the model is hard to gauge. Furthermore, the limitations of the basic model of course still remain (eg, the lack of papers from the developing countries and Eastern Europe, the assumption of a relationship between the direct costs of dementia per patient and the GDP per person, the lack of sub-costing the direct costs—eg, in direct medical and direct non-medical costs—and the assumption of a worldwide similar age class prevalence of dementia). The fact that we only use basic ADLs as the basis for the costing of informal care in the base option is a conservative approach which is illustrated by the much-higher costs of informal care if instrumental ADLs are also included. Based on these considerations, the cost of illness update presented here must still be regarded as rough estimates. Nevertheless, the economic impact of dementia is enormous and

Table 2
Cost per case of dementia in different regions of the world 2009 (US\$)

Major areas/regions	Direct costs	Informal care 1.6 h/d	Total costs 1	Informal care 3.7 h/d	Total costs 2
Africa	1928	2521	4449	5831	7759
Latin America	4943	3881	8824	8974	13,917
North America	19,437	7423	26,860	17,166	36,603
Asia	4702	2676	7378	6188	10,890
Europe	11,442	5675	17,117	13,123	24,565
Oceania	13,974	7183	21,157	16,610	30,584
WORLD	8125	4139	12,264	9571	17,696

Table 3
Costs of dementia in 2009 (millions US\$)

	Demented	Direct costs (a)	Informal care 1.6h/d (b)	Total cost 1 (a+b)	Informal care 3.7h/d (c)	Total cost 2 (a+c)
Africa						
Eastern Africa						
Burundi	12347	6.2	3.5	9.7	8.1	14.3
Comoros	1142	1.1	1.1	2.2	2.5	3.7
Djibouti	1395	1.8	1.6	3.4	3.8	5.6
Eritrea	6158	3.7	7.7	11.4	17.9	21.6
Ethiopia	132430	105.6	50.3	155.9	116.2	221.9
Kenya	59415	59.6	87.2	146.7	201.6	261.2
Madagascar	32076	18.6	47.5	66.2	109.9	128.5
Malawi	23461	8.9	6.4	15.3	14.9	23.8
Mauritius	5835	45.1	26.1	71.3	60.5	105.6
Mozambique	38327	32.2	34.8	67.0	80.4	112.6
Reunion	4100	16.3	17.9	34.2	41.4	57.7
Rwanda	13431	12.4	13.9	26.2	32.1	44.4
Somalia	12300	4.7	13.5	18.3	31.3	36.0
Uganda	44827	40.9	39.2	80.2	90.7	131.6
United Republic of Tanzania	70221	31.0	59.1	90.1	136.6	167.6
Zambia	19543	12.3	31.6	43.8	73.0	85.3
Zimbabwe	28932	33.3	90.2	123.5	208.7	242.0
Middle Africa						
Angola	21974	44.0	33.0	77.0	76.4	120.4
Cameroon	36750	44.6	39.0	83.6	90.1	134.7
Central African Republic	8644	5.2	8.0	13.2	18.5	23.8
Chad	15012	11.4	13.2	24.6	30.5	41.9
Congo	7469	5.4	8.4	13.8	19.4	24.8
Democratic Republic of the Congo	85366	56.5	34.4	91.0	79.6	136.1
Equatorial Guinea	1121	9.5	4.4	13.9	10.1	19.6
Gabon	3996	13.8	13.3	27.1	30.8	44.6
Northern Africa						
Algeria	91613	333.3	108.7	442.0	251.4	584.7
Egypt	202767	572.9	493.3	1066.2	1140.7	1713.6
Libyan Arab Jamahiriya	15171	96.1	56.5	152.5	130.6	226.6
Morocco	92348	204.1	189.8	393.9	439.0	643.1
Sudan	79266	128.0	102.5	230.5	237.1	365.1
Tunisia	40467	170.7	48.7	219.4	112.6	283.3
Western sahara	520	0.1	1.3	1.4	3.0	3.1
Southern Africa						
Botswana	3529	25.6	13.8	39.4	32.0	57.6
Lesotho	5564	7.0	6.2	13.2	14.3	21.3
Namibia	4413	18.9	6.0	24.8	13.9	32.7
South Africa	118352	840.9	1346.8	2187.7	3114.5	3955.4
Swaziland	1857	5.9	12.1	18.0	28.0	33.9
Western Africa						
Benin	13941	8.4	31.5	39.9	72.8	81.3
Burkina Faso	13343	8.8	29.9	38.7	69.2	77.9
Cape verde	1266	4.2	1.4	5.6	3.3	7.5
Cote d'Ivoire	37880	29.3	84.6	114.0	195.7	225.0
Gambia	1824	1.9	5.3	7.2	12.2	14.1
Ghana	45302	87.9	178.2	266.1	412.1	500.0
Guinea	15320	27.9	87.5	115.5	202.4	230.4
Guinea-Bissau	2509	0.9	1.7	2.6	3.9	4.8
Liberia	5732	4.0	17.4	21.4	40.2	44.2
Mali	12518	7.3	26.8	34.0	62.0	69.2
Mauretania	3661	5.2	10.5	15.7	24.2	29.4
Niger	12649	5.6	32.8	38.4	75.8	81.4
Nigeria	235702	174.0	820.5	994.6	1897.5	2071.5
Senegal	12039	10.5	25.1	35.6	58.1	68.6
Sierra Leone	3902	2.4	15.9	18.3	36.8	39.2
Togo	11648	9.8	25.9	35.7	59.8	69.6

(Continued)

Table 3
Costs of dementia in 2009 (millions US\$) (Continued)

	Demented	Direct costs (a)	Informal care 1.6h/d (b)	Total cost 1 (a+b)	Informal care 3.7h/d (c)	Total cost 2 (a+c)
Asia						
Eastern Asia						
China	6692787	23638.2	17542.9	41181.2	40568.1	64206.3
China, Hong Kong Special Administrative Region	75703	1187.5	356.0	1543.5	823.3	2010.8
China, Macao Special Administrative Region	2928	34.8	8.1	42.9	18.7	53.5
Democratic People's Republic of Korea	109784	81.4	269.9	351.3	624.2	705.6
Japan	2352632	31575.7	13341.8	44917.5	30852.9	62428.6
Mongolia	6110	9.0	11.6	20.6	26.9	35.9
Republic of Korea	321155	3246.0	463.5	3709.5	1071.8	4317.8
Southern Central Asia						
Afganistan	28573	22.3	58.7	81.0	135.8	158.1
Bangladesh	320824	372.7	443.4	816.0	1025.3	1397.9
Bhutan	1642	3.6	2.5	6.1	5.8	9.3
India	3165827	6094.6	3288.8	9383.4	7605.4	13699.9
Iran (Islamic Republic of)	212956	1378.3	826.7	2204.9	1911.6	3289.9
Kazakhstan	66008	362.7	171.1	533.8	395.6	758.4
Kyrgyzstan	17421	24.8	25.6	50.4	59.1	84.0
Maldives	503	2.2	1.2	3.4	2.7	4.9
Nepal	58444	59.8	82.1	141.9	190.0	249.8
Pakistan	409580	745.2	788.7	1533.9	1823.9	2569.1
Sri Lanka	98985	309.1	111.6	420.7	258.1	567.2
Tajikistan	15669	15.3	26.7	42.1	61.8	77.2
Turkmenistan	13066	61.0	32.7	93.7	75.7	136.7
Uzbekistan	80136	109.2	157.7	266.9	364.6	473.8
South-Eastern Asia						
Brunei	777	8.8	6.0	14.8	13.8	22.6
Cambodia	25675	38.1	48.0	86.1	110.9	149.1
East Timor	1471	1.5	2.3	3.8	5.4	6.9
Indonesia	703288	1890.3	1557.8	3448.1	3602.5	5492.8
Lao People's Dem Republic	12364	13.7	21.1	34.9	48.9	62.6
Malaysia	73423	399.1	272.5	671.7	630.3	1029.4
Myanmar	173365	281.3	57.4	338.6	132.6	413.9
Philippines	200341	527.8	321.3	849.2	743.1	1270.9
Singapore	31628	428.6	204.9	633.6	473.9	902.5
Thailand	294207	1197.2	530.3	1727.5	1226.4	2423.6
Viet Nam	363791	736.2	779.5	1515.7	1802.7	2538.8
Western Asia						
Armenia	23234	52.2	22.3	74.5	51.5	103.7
Azerbaijan	33445	104.7	67.8	172.5	156.8	261.5
Bahrain	1052	11.1	2.6	13.7	6.1	17.2
Cyprus	8302	83.9	57.0	140.9	131.7	215.7
Gaza Strip	7501	2.7	11.9	14.6	27.6	30.2
Georgia	38990	80.9	47.1	128.0	108.9	189.8
Iraq	53413	92.2	429.9	522.1	994.1	1086.3
Israel	58011	660.0	342.2	1002.2	791.3	1451.4
Jordan	13536	38.8	38.6	77.4	89.3	128.1
Kuwait	3036	27.1	8.7	35.9	20.2	47.3
Lebanon	16996	61.7	51.1	112.8	118.2	179.9
Oman	4477	41.9	14.5	56.4	33.4	75.4
Qatar	939	18.8	3.9	22.7	9.0	27.8
Saudi Arabia	41700	338.6	125.5	464.1	290.3	628.9
Syrian Arab Republic	38679	92.8	128.1	221.0	296.3	389.2
Turkey	235814	1142.7	1041.8	2184.5	2409.2	3551.9
United Arab Emirates	3119	53.1	12.0	65.2	27.8	81.0
Yemen	28962	14.6	47.5	62.1	109.9	124.5

(Continued)

Table 3
Costs of dementia in 2009 (millions US\$) (Continued)

	Demented	Direct costs (a)	Informal care 1.6h/d (b)	Total cost 1 (a+b)	Informal care 3.7h/d (c)	Total cost 2 (a+c)
Europe						
Eastern Europe						
Belarus	87969	445.1	200.3	645.4	463.3	908.3
Bulgaria	88100	470.5	205.7	676.1	475.6	946.1
Czech republic	108951	987.3	454.4	1441.7	1050.8	2038.1
Hungary	112568	1026.5	555.9	1582.4	1285.5	2312.0
Poland	378747	2393.6	1643.6	4037.1	3800.7	6194.3
Republic of Moldova	23624	37.7	3.2	40.9	7.5	45.2
Romania	201162	979.7	506.5	1486.1	1171.3	2150.9
Russian federation	1232190	9085.1	3923.0	13008.1	9071.9	18157.0
Slovakia	45486	362.6	164.6	527.2	380.5	743.1
Ukraine	462147	2603.8	1777.0	4380.8	4109.3	6713.0
Northern Europe	1332577	0.0	0.0	0.0	0.0	0.0
Denmark	71388	1178.2	930.2	2108.4	2151.0	3329.2
Estonia	16139	141.9	71.5	213.4	165.4	307.3
Finland	71541	1051.0	284.0	1334.9	656.7	1707.6
Iceland	2875	62.0	24.5	86.5	56.8	118.7
Ireland	38675	734.2	261.5	995.6	604.7	1338.8
Latvia	26493	203.9	83.2	287.1	192.4	396.3
Lithuania	36518	284.8	120.1	404.9	277.8	562.6
Norway	63767	1289.1	556.2	1845.4	1286.3	2575.4
Sweden	145535	2069.8	829.4	2899.2	1917.9	3987.7
UK	859646	12610.8	6472.0	19082.7	14966.5	27577.2
Southern Europe						
Albania	18481	48.2	24.9	73.1	57.5	105.7
Bosnia and Herzegovina	30463	93.5	155.1	248.6	358.6	452.2
Croatia	51685	321.5	289.9	611.4	670.3	991.8
Greece	139036	1522.5	770.5	2293.1	1781.9	3304.4
Italy	1026196	13884.9	7002.3	20887.2	16192.8	30077.7
Malta	3983	37.8	25.3	63.1	58.4	96.2
Portugal	142790	1296.5	356.3	1652.8	823.9	2120.4
Slovenia	23932	256.6	163.7	420.4	378.6	635.3
Spain	639955	8120.9	4232.4	12353.3	9787.3	17908.3
The former Yugoslav Republic of Macedonia	14098	54.2	27.5	81.7	63.7	117.8
Serbia	93383	320.6	207.4	528.0	479.7	800.3
Montenegro	4786	11.0	7.1	18.2	16.5	27.6
Western Europe						
Austria	114417	1797.5	898.0	2695.5	2076.6	3874.1
Belgium	151513	2250.5	1197.9	3448.4	2770.1	5020.6
France	948486	12936.8	4497.5	17434.3	10400.5	23337.3
Germany	1242511	17744.1	9718.8	27462.9	22474.7	40218.8
Luxembourg	5279	174.7	40.9	215.6	94.6	269.3
The Netherlands	195545	2801.5	1509.4	4310.9	3490.4	6291.9
Switzerland	111535	1644.8	1060.0	2704.8	2451.3	4096.1
Latin America and Caribbean						
Caribbean	248480	1006.9	985.4	1992.2	2278.7	3285.6
Central America						
Belize	848	3.4	2.8	6.2	6.5	9.9
Costa Rica	21962	149.7	93.4	243.1	216.0	365.7
El Salvador	33692	78.2	58.8	137.1	136.1	214.3
Guatemala	39121	91.8	105.0	196.8	242.9	334.7
Honduras	22001	38.5	60.5	98.9	139.9	178.3
Mexico	486521	2580.0	1071.5	3651.5	2477.9	5057.9
Nicaragua	17268	41.5	59.3	100.8	137.2	178.7
Panama	15041	56.7	37.6	94.3	87.0	143.7
South America						
Argentina	321801	2738.8	1854.5	4593.3	4288.5	7027.3
Bolivia	25872	41.4	85.2	126.6	197.0	238.4
Brazil	927461	4141.6	3754.6	7896.2	8682.4	12824.0

(Continued)

Table 3
Costs of dementia in 2009 (millions US\$) (Continued)

	Demented	Direct costs (a)	Informal care 1.6h/d (b)	Total cost 1 (a+b)	Informal care 3.7h/d (c)	Total cost 2 (a+c)
Chile	112415	700.6	424.9	1125.5	982.6	1683.2
Colombia	168584	663.2	558.3	1221.5	1291.1	1954.3
Ecuador	61602	139.4	145.9	285.3	337.4	476.8
Guayana	2845	7.6	8.1	15.7	18.7	26.3
Paraguay	20978	60.0	59.8	119.8	138.4	198.4
Peru	108962	322.2	279.1	601.3	645.4	967.6
Suriname	1953	7.1	9.7	16.8	22.5	29.5
Uruguay	36824	229.6	159.5	389.2	368.9	598.6
Venezuela (Bolivarian Republic of)	99616	611.7	950.8	1562.5	2198.7	2810.4
North America						
Canada	387326	6182.9	2586.9	8769.8	5982.3	12165.1
USA	3565684	70652.8	26757.1	97409.9	61875.8	132528.6
Oceania						
Australia	243821	3690.7	1818.2	5508.9	4204.6	7895.3
New Zealand	44236	534.2	313.1	847.3	724.1	1258.3
Melanesia	12515	8.6	41.9	50.5	97.0	105.6
Micronesia	1315	1.7	2.6	4.3	5.9	7.6
Polynesia	2061	12.2	7.4	19.6	17.1	29.3
World	34376044	279318.6	142275.0	421593.6	329010.8	608329.4

reinforces an important challenge of any care system due to dementia in terms of organizing and financing care.

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