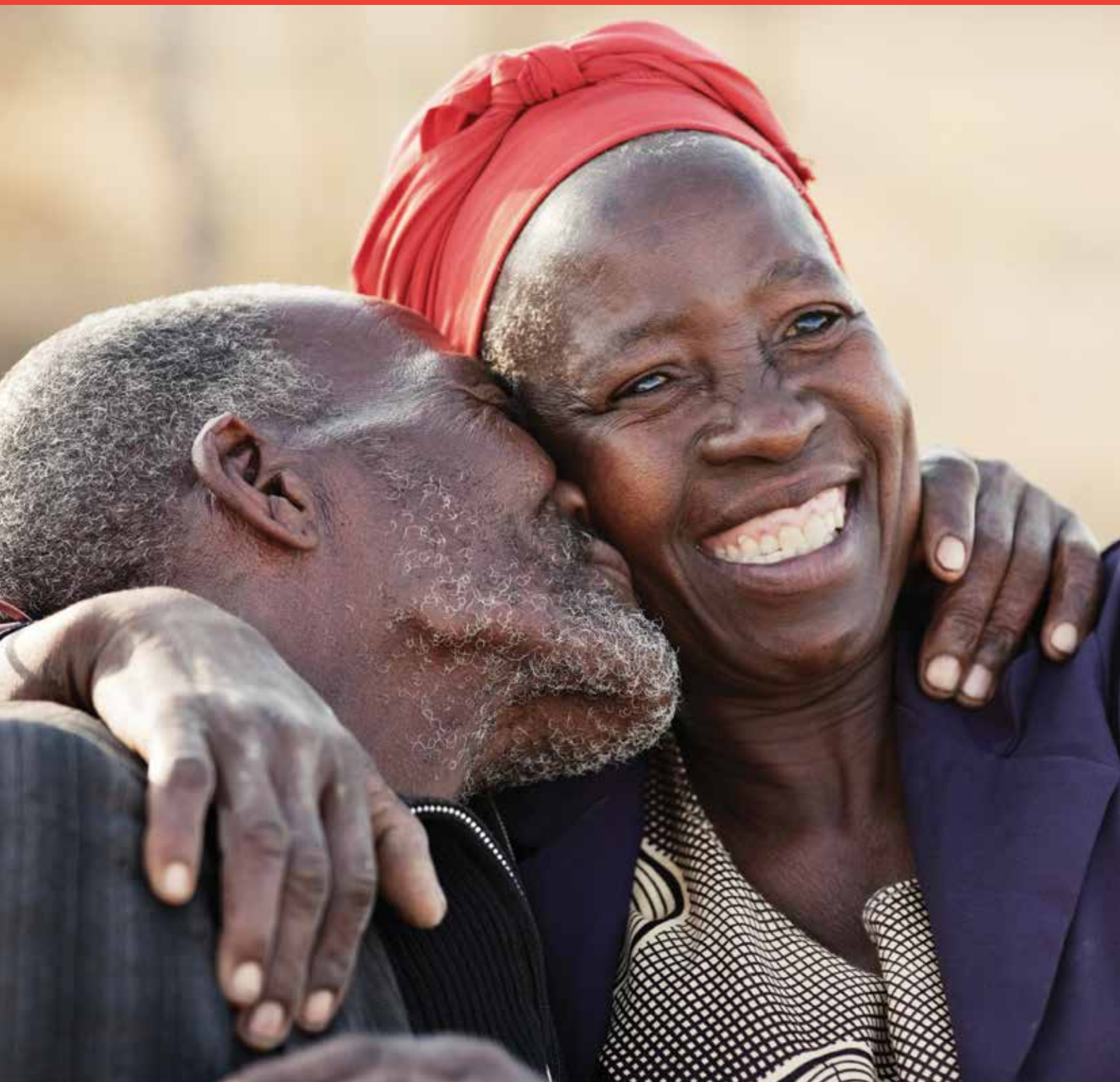
Alzheimer's Disease International

The global voice on dementia

World Alzheimer Report 2015

The Global Impact of Dementia

AN ANALYSIS OF PREVALENCE, INCIDENCE, COST AND TRENDS



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All the authors and investigators of dementia studies who provided us more specific data from their work.

Foreword

Today, over 46 million people live with dementia worldwide, more than the population of Spain. This number is estimated to increase to 131.5 million by 2050.

Dementia also has a huge economic impact. Today, the total estimated worldwide cost of dementia is US $818 billion, and it will become a trillion dollar disease by 2018. This means that if dementia care were a country, it would be the world's 18th largest economy, more than the market values of companies such as Apple (US$ 742 billion), Google (US$ 368 billion) and Exxon (US$ 357 billion).

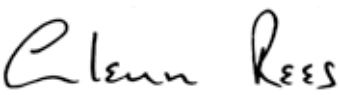
In many parts of the world, there is a growing awareness of dementia, but across the globe it remains the case that a diagnosis of dementia can bring with it stigma and social isolation. Today, we estimate that 94% of people living with dementia in low and middle income countries are cared for at home. These are regions where health and care systems often provide limited or no support to people living with dementia or to their families.

The 2015 World Alzheimer Report updates data on the prevalence, incidence, cost and trends of dementia worldwide. It also estimates how these numbers will increase in the future, leaving us with no doubt that dementia, including Alzheimer's disease and other causes, is one of the biggest global public health and social care challenges facing people today and in the future.

The two organisations we lead are ADI, the only worldwide federation of Alzheimer associations and global voice on dementia, and Bupa, a purpose-driven global health and care company that is the leading international provider of specialist dementia care, caring for around 60,000 people living with dementia each year. Together, we are committed to ensuring that dementia becomes an international health priority. We believe national dementia plans are the first step towards ensuring all countries are equipped to enable people to live well with dementia, and help to reduce the risk of dementia for future generations. There is now a growing list of countries which have such provision in place or which are developing national dementia plans, but it's not enough.

Given the epidemic scale of dementia, with no known cure on the horizon, and with a global ageing population, we're calling on governments and every part of society to play an active role in helping to create a world where people can enjoy a better quality of life today, and also help reduce the risk of dementia for future generations. It is our belief that this report will help sustain the momentum of recent global collaboration, mobilising governments, policy makers, health care professionals, researchers, Alzheimer associations, and businesses, to work together on a solution for the global challenge of dementia.

Providing a better quality of life for people with dementia can be a reality, but only if governments and societies make it an urgent priority. We're committed to making this happen.



Glenn Rees

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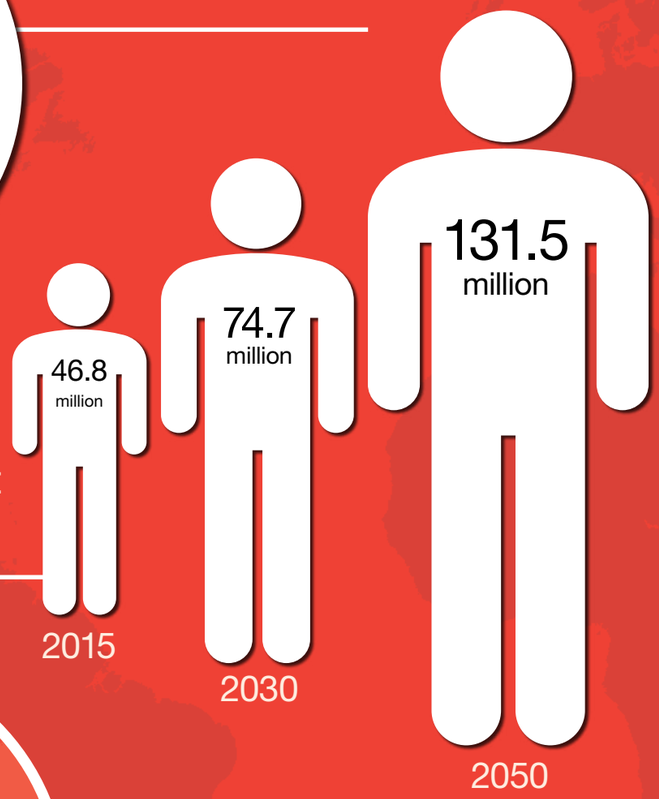
INFOGRAPHIC

The global impact of dementia

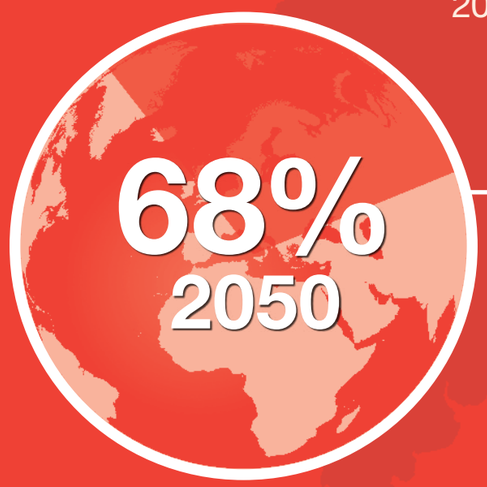
Around the world, there will be 9.9 million new cases of dementia in 2015,

one every 3 seconds

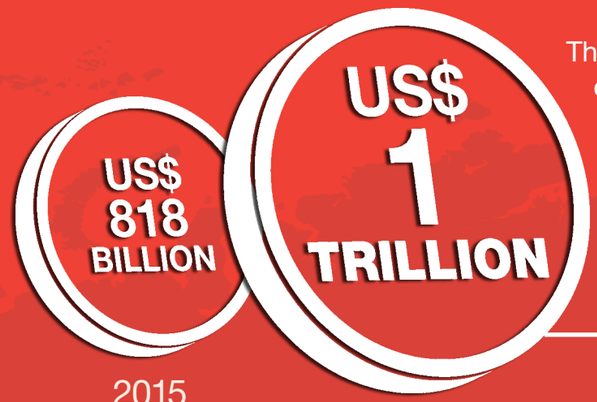


46.8 million people worldwide are living with dementia in 2015.

This number will almost double every 20 years.



Much of the increase will take place in low and middle income countries (LMICs): in 2015, 58% of all people with dementia live in LMICs, rising to 63% in 2030 and 68% in 2050.



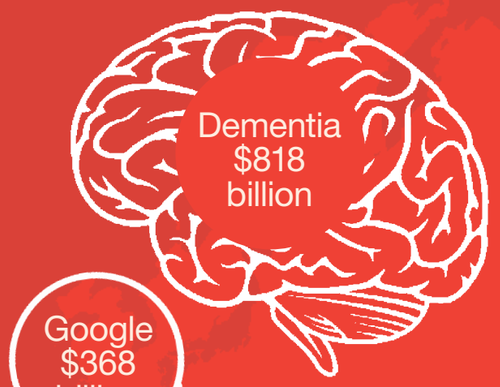
The total estimated worldwide cost of dementia in 2015 is US$ 818 billion. By 2018, dementia will become a trillion dollar disease, rising to

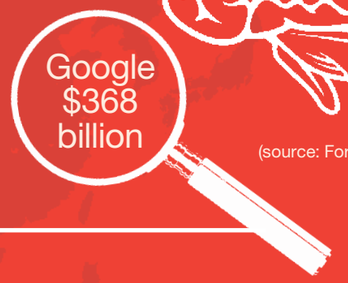
US$ 2 trillion by 2030

If global dementia care were a country, it would be the

18th largest economy

in the world exceeding the market values of companies such as Apple and Google





(source: Forbes 2015 ranking).

This map shows the estimated number of people living with dementia in each world region in 2015.

We must now involve more countries and regions in the global action on dementia.

Alzheimer's Disease International

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The Global Impact of Dementia

AN ANALYSIS OF PREVALENCE, INCIDENCE, COST & TRENDS

The Global Observatory for Ageing and Dementia Care

The Global Observatory for Ageing and Dementia Care, hosted at the Health Service and Population Research Department, King's College London, was founded in 2013. Supported by Alzheimer's Disease International, and King's College London, the Observatory has a tripartite mission:

1. To build upon ADI's 10/66 Dementia Research Group program of population-based and intervention research in low and middle income countries, maximising the impact that research findings from our data can have upon policy and practice.
2. To develop, evaluate, and promote primary care and community interventions for people with dementia.
3. To synthesise global evidence for policymakers and public, in particular, continuing and developing our role in the preparation of high impact evidence-based reports for Alzheimer's Disease International (World Alzheimer Reports 2009, 2010, 2011, 2013 and 2014, and Nutrition and dementia), the World Health Organization (Dementia: a public health priority, 2012) and other relevant intergovernmental organisations.

The World Alzheimer Report 2015 was independently researched and authored by Prof Martin Prince, Prof Anders Wimo, Dr Maëlenn Guerchet, Gemma-Claire Ali, Dr Yu-Tzu Wu and Dr Matthew Prina, with contributions from others as listed. The evidence reported in Chapters 1-6, and the inferences drawn, are the responsibility of the authors alone. Chapter 7 was developed by the Global Observatory and Alzheimer's Disease International.

Contents

WORLD REPORT 2015

In summary

CHAPTER 1

Dementia and ageing in a developing world

1. We have updated our previous estimates of the global prevalence, incidence and costs of dementia. As a new feature, we have included a systematic review of the evidence for and against recent trends in the prevalence and incidence of dementia over time.
2. There are almost 900 million people aged 60 years and over living worldwide. Rising life expectancy is contributing to rapid increases in this number, and is associated with increased prevalence of chronic diseases like dementia.
3. Between 2015 and 2050, the number of older people living in higher income countries is forecast to increase by just 56%, compared with 138% in upper middle income countries, 185% in lower middle income countries, and by 239% (a more than three-fold increase) in low income countries.
4. Older people also constitute an increasing proportion of total population, as the rise in life expectancy is being accompanied by declining fertility rates in most countries.
5. Poorer countries have fewer economic and human professional resources to meet the health and social care needs of their rapidly growing older populations. Many of these countries face the challenge of a 'double burden' of persistently high rates of maternal, childhood and infectious diseases, combined with a growing epidemic of chronic non-communicable diseases.
6. Even with the unprecedented benefits of double digit annual economic growth, rapidly developing countries in Asia and Latin America have struggled to establish comprehensive and effective systems of social protection for older people, failing to guarantee adequate income and universal access to health and social care.
7. Overall economic growth at the national level can conceal gross inequities in income distribution, and older people are often among the least likely and the last to benefit directly from economic development.

CHAPTER 2

The global prevalence of dementia

1. We have updated our 2009 systematic review of the global prevalence of dementia, bringing the total number of studies to 273. This is 116 more than we found in 2009. Changes in estimates in this chapter reflect inclusion of these new studies but cannot be interpreted as secular trends, which are discussed in Chapter 4.
2. Our regional estimates of dementia prevalence in people aged 60 years and over now range from 4.6% in Central Europe to 8.7% in North Africa and the Middle East, though all other regional estimates fall in a relatively narrow band between 5.6 and 7.6%.
3. When compared to our 2009 estimates, estimated prevalence has increased in Asia and Africa, but decreased in Europe and the Americas.
4. We estimate that 46.8 million people worldwide are living with dementia in 2015. This number will almost double every 20 years, reaching 74.7 million in 2030 and 131.5 million in 2050. These new estimates are 12-13% higher than those made for the World Alzheimer Report 2009.
5. We estimate that 58% of all people with dementia live in countries currently classified by the World Bank as low or middle income countries. The proportion of people with dementia living in these same countries is estimated to increase to 63% in 2030 and 68% in 2050.
6. Continuing the trend noted in our 2009 report, proportionate increases in the number of people living with dementia will be much steeper in low and middle income countries than in high income countries. Between 2015 and 2050, the number of people living with dementia in what are now high income countries will increase by 116%. This compares to a 227% increase in upper middle income countries, 223% in lower middle income countries, and 264% in low income countries.
7. Regions that stand out as persistently lacking in research – both in terms of number of studies and relative to population size – are Central Asia, Eastern Europe, Southern Latin America, and Eastern and Southern sub-Saharan Africa. Despite reasonable coverage in terms of numbers of studies, the evidence-base for South and Southeast Asia is still sparse with respect to population size.

8. In our 2009 report, we noted a marked decrease in dementia prevalence research in high income countries since the 1990s. This trend has not been reversed, causing the evidence-base to become increasingly out of date.
9. Quality issues identified in 2009 are still common among recent studies. We urge researchers conducting prevalence studies to ensure that two-phase study designs are correctly applied and analysed, and to include an informant interview in their diagnostic assessment of dementia.

CHAPTER 3

The incidence of dementia

1. We have updated our 2011 review of the global incidence of dementia, bringing the total number of studies to 62. This is 23 more than we found in 2011. Of these, 12 new studies provided data in a format that could be included in our age-stratified meta-analysis, which now comprises 46 studies.
2. Through meta-analysis of the available evidence, we estimate over 9.9 million new cases of dementia each year worldwide, implying one new case every 3.2 seconds. These new estimates are almost 30% higher than the annual number of new cases estimated for 2010 in the 2012 WHO/ADI report (7.7 million new cases, one every 4.2 seconds).
3. The regional distribution of new dementia cases is 4.9 million (49% of the total) in Asia, 2.5 million (25%) in Europe, 1.7 million (18%) in the Americas, and 0.8 million (8%) in Africa. Compared to our 2012 estimates, these values represent an increased proportion of new cases arising in Asia, the Americas and Africa, while the proportion arising in Europe has fallen.
4. Overall incidence of dementia in low and middle income countries is only 10% lower (RR 0.90, 95% CI: 0.70-1.15) than in high income countries. In contrast to our previous meta-analysis, this is not statistically significant.
5. The incidence of dementia increases exponentially with increasing age. For all studies combined, the incidence of dementia doubles with every 6.3 year increase in age, from 3.9 per 1000 person-years at age 60-64 to 104.8 per 1000 person-years at age 90+.
6. The number of new cases increases and then declines with increasing age in each region. In Europe and the Americas peak incidence is among those aged 80-89 years, in Asia it is among those aged 75-84, and in Africa among those aged 65-74
7. The evidence-base continues to be dominated by studies from Europe and North America, but less so than in 2011. Of the 46 studies that could be included in the meta-analysis, 19 were conducted outside Europe and North America, and 17 were conducted in low or middle income countries. 50% of the 12 new studies were conducted in low and middle income countries, up from just 32% of those included in the original meta-analysis.
8. The studies included in the meta-analysis account for 109,952 older people 'at risk', representing 332,323 person-years of follow-up. The Western European studies account for 42% of the total person years, the North American studies 24%, the East Asian studies 16%, and the Latin American studies 13%. Just 5% of person-years are contributed by the studies from Australasia, Asia Pacific, South Asia and sub-Saharan Africa combined.

CHAPTER 4

Trends in the prevalence and incidence of dementia, and survival with dementia

1. Almost all current projections of the coming dementia epidemic assume that age- and gender-specific prevalence of dementia will not vary over time, and that population ageing alone drives the projected increases. In reality, future prevalence could be affected by changing incidence and disease duration.
2. The prevalence of any condition is a product of its incidence and the average duration of the disease episode. Changes in either or both of these indicators could lead to changes in age-specific prevalence. Trends in the two indicators may not move in the same direction; for example, reductions in incidence might be accompanied by increases in duration of survival with dementia, or vice versa, the one effect tending to cancel out the other in terms of their overall impact on prevalence.
3. One should not expect that secular trends will be the same across all world regions, or even among different population subgroups within one country. Experience with changing rates of cardiovascular disease, obesity, diabetes and cancer shows this clearly. The considerable variability in secular trends for these chronic diseases reflects different degrees of progress in improving public health, and in improving access to healthcare and strengthening health systems and services to better detect, treat and control these conditions.
4. In order to investigate this assumption, studies of secular trends in dementia prevalence, incidence and mortality were identified from the systematic review of dementia prevalence studies, from the reference lists of these studies, and by conducting a search using the terms "(dementia or alzheim*) and (mortality or survival) and trend*".
5. Findings across the identified studies (mostly conducted in high income countries) are currently too inconsistent to reach firm and generalisable conclusions regarding underlying trends. Three

studies are reporting significant or non-significant decline in the prevalence of dementia (MRC-CFAS (UK), Zaragoza (Spain) and HRS (USA)) while other studies from Sweden and USA indicated a stable prevalence of dementia. Another Swedish study and two Japanese studies of trends in dementia prevalence reported that prevalence had increased.

6. There has been a general trend in many high income countries towards less smoking, lower cholesterol and blood pressure, and increased physical activity. On the other hand, the prevalence of obesity and diabetes has been increasing. To the extent to which these factors are causally associated with dementia, one would expect to see corresponding changes in dementia incidence.
7. In many low and middle income countries, the trends in cardiovascular health among older people are in an adverse direction, with a pattern of increasing stroke, and ischaemic heart disease morbidity and mortality, linked to an epidemic of obesity, and increasing blood pressure levels. This could result in upward trends in the incidence and prevalence of dementia in these countries.
8. Since most of the public health interventions that have been proposed to reduce the incidence of dementia also have benefits in reducing incidence and mortality from other chronic diseases, one should expect that reductions in prevalence arising from reduced incidence of dementia may be offset, at least to some extent, by reduced mortality and longer survival with dementia.
9. One indicator of successful dementia risk reduction is deferral of dementia incidence to older ages. By increasing the average age of onset, dementia mortality may increase and duration of survival with dementia fall, without changing age-specific mortality for people with dementia. This phenomenon – described by Langa as 'the compression of cognitive morbidity' – is a desirable outcome for public health and individual quality of life, as it represents dementia onset occurring closer to the 'natural' end of life.
10. Studies that use fixed methodology to estimate changes in dementia prevalence, incidence and mortality over time, in defined populations, are uniquely valuable assets. It is important in the future that more such studies are commissioned.
11. Previous modelling exercises have sought to predict future trends in dementia prevalence, given our best estimates of risk associations and changes in risk factor profiles over time. In the light of the current review, these estimations appear over-optimistic. An alternative approach is to observe and correlate actual changes in risk factor profiles and dementia incidence over time. Similar studies could, in the future, be carried out to monitor the impact of prevention programs on the future scale of the dementia epidemic.

CHAPTER 5

The impact of dementia worldwide

1. The impact of dementia can be understood at three inter-related levels: the individual with dementia, their family and friends, and wider society.
2. While dementia does shorten the lives of those affected, its greatest impact is upon quality of life, both for individuals living with dementia, and for their family and carers.
3. Global Burden of Disease (GBD) estimates express disease 'burden' in terms of associated disability and mortality. The key indicator – disability adjusted life years (DALYs) – is calculated as the sum of Years Lived with Disability (YLD) and Years of Life Lost (YLL), thus reflecting disease effect on both quality and quantity of life.
4. Revised GBD estimates using Institute of Health Metrics and Evaluation (IHME) disability weights have caused dementia to fall from 5th to 9th most burdensome condition for people aged 60 years and over. While burden from years of life lost (YLL) remains stable across the two methodologies, there has been a substantial reduction in the estimation of years lived with disability attributed to dementia, with a knock-on effect on the DALY estimates. Per capita, the IHME GBD estimates of YLL are 0% lower than WHO GBD estimates, YLD 65% lower, and DALYs 54% lower. This is, for the most part, because of changes in disability weights, which are 2/3 lower for the IHME than the WHO GBD, rather than in the estimates of the frequency of these disorders.
5. The most important critique of the GBD estimates is that they fail to capture the full impact of chronic diseases on disability, needs for care, and attendant societal costs. This limitation is most significant for older people and for conditions like dementia, where most of the impact comes from disability rather than associated mortality. Failure to reflect societal impacts of dementia relative to other chronic diseases makes the GBD estimates an unreliable tool for prioritising research, prevention, and health or social care among older people.
6. A UK study has estimated that the health and social care costs for dementia almost match the combined costs of cancer, heart disease and stroke. In a Swedish study, the annual costs of dementia exceeded those of depression, stroke, alcohol abuse and osteoporosis. An analysis using data from the 10/66 Dementia Research Group baseline surveys in Latin America, India and China found that the directly attributable cost of dementia exceeded that of depression, hypertension, diabetes, ischaemic heart disease and stroke in all countries except India.
7. Dementia is typically associated with particularly intense needs for care, exceeding the demands

associated with other conditions. In the USA, caregivers of people with dementia were more likely to be required to provide help with getting in and out of bed, dressing, toileting, bathing, managing incontinence and feeding than caregivers of people with other conditions.

CHAPTER 6

The worldwide costs of dementia

1. The estimates of global societal economic costs of dementia provided in this report have been generated using the same general approach as for the World Alzheimer Report 2010. Costs are estimated at the country level and then aggregated in various combinations to summarise worldwide cost, cost by Global Burden of Disease world region, cost by World Bank country income level, and cost for G7 and G20 countries.
2. For each country, we have estimated cost per person (per capita), which is then multiplied by the number of people estimated to be living with dementia in that country. Per capita costs are divided into three cost sub-categories: direct medical costs, direct social care costs (paid and professional home care, and residential and nursing home care) and costs of informal (unpaid) care. Informal care is valued using an opportunity cost approach, valuing hours of informal care by the average wage for each country.
3. The global costs of dementia have increased from US$ 604 billion in 2010 to US$ 818 billion in 2015, an increase of 35.4%. Our current estimate of US$ 818 billion represents 1.09% of global GDP, an increase from our 2010 estimate of 1.01%. Excluding informal care costs, total direct costs account for 0.65% of global GDP.
4. Regional distribution of costs has not changed markedly from those published in 2010. Cost estimates have increased for all world regions, with the greatest relative increases occurring in the African and in East Asia regions (largely driven by the upwards revision of prevalence estimates for these regions).
5. Distribution of costs between the three major sub-categories (direct medical, social care, and informal care) has not changed substantially. As reported in 2010, direct medical care costs are modest, accounting for roughly 20% of global dementia costs, while direct social sector costs and informal care costs each account for roughly 40%.
6. As country income level increases, the relative contribution of direct social care sector costs increases and the relative contribution of informal care costs decreases. The relative contribution of informal care is greatest in the African regions and lowest in North America, Western Europe and some South American regions, while the reverse is true for social sector costs.
7. These new estimates should be seen as a partial update of the previous (2010) estimates, rather than a full-scale revision. We did not carry out a fully systematic review of service utilisation and cost of illness studies, but these estimates do benefit from a fully systematic review of dementia prevalence studies, and we have identified several important cost of illness studies published since 2010.

CHAPTER 7

Conclusions and recommendations

1. We estimate that there are now 46.8 million people with dementia worldwide, with numbers projected to almost double every 20 years. There will be an estimated 9.9 million new cases of dementia in 2015, equivalent to one every 3.2 seconds. The 2015 global societal economic cost of dementia will be an estimated US$818bn, with huge quality of life impacts both for individuals living with dementia and for their families and carers.
2. In December 2013, the UK government used its presidency of the G8 (now the G7) to launch a Global Action Against Dementia. The outcome of the first summit was an impressive commitment to identifying a cure or disease-modifying therapy for dementia by 2025. This was supported by a series of initiatives linked to research: increase funding, promote participation in trials, and collaborate to share information and data.
3. Over the course of four 'Legacy Events', this agenda has broadened substantially. The broader agenda comprises five key elements: a global approach to a global problem; the need for 'care now, if cure later'; a public health orientation (awareness, accessible services, and prevention); a focus on equity and rights; and a rational approach to research prioritisation.
4. Earlier this year, as a final event linked to the G7 Global Action Against Dementia, the World Health Organization convened a 'First WHO Ministerial Conference on Global Action Against Dementia'. The resulting 'call for action' identifies eight overarching principles and eleven action points for the global fight against dementia.
5. Alzheimer's Disease International applauds the action taken by the G7 in launching a 'Global Action Against Dementia', and calls for this initiative to be continued with a broader agenda and wider representation from the countries and regions most affected by the ongoing dementia epidemic. Since 92% of global dementia costs arise in the G20 countries, we advocate for a transfer of political leadership to the full G20 group of nations.

6. Alzheimer's Disease International has proposed elements that should be part of a call for action at global and country levels, including awareness raising, dementia friendly communities, workforce strategies and good quality care.
7. Dementia risk reduction should be made an explicit priority in the general work stream on non-communicable diseases led by the World Health Organization, with clear linked actions including targets and indicators.
8. Research investment for dementia should be upscaled, proportionate to the societal cost of the disease. This research investment should be balanced between prevention, treatment, cure and palliative care. A specific work stream should be established for low and middle income countries, involving partners from these countries to develop programmes that raise awareness of dementia and improve health system responses.

CHAPTER 1

Introduction

The World Alzheimer Report 2015 comprises an overview of current knowledge regarding the evolution of the dementia epidemic worldwide. For this purpose, we have updated our previous estimates of the global prevalence of dementia, and numbers affected (previously published in the World Alzheimer Report 2009[1]), the incidence of dementia (WHO/ADI report 2012[2]), and the Global Economic Impact of Dementia (World Alzheimer Report 2010[3]). As a new feature, we have included a systematic review of the evidence for and against recent trends over time in the prevalence and incidence of dementia. We have also reviewed the broader societal impact of dementia, compared with that of other chronic diseases, and how this is best measured.

The focus, as with previous reports, is upon people aged 60 years and over. Younger onset dementia is, thankfully, a rare condition, accounting according to previous estimates, for some 2-8% of all cases[2;4]. The proportion may well be higher in countries in Southern Africa with a high seroprevalence of HIV infection[2]. We did not find any new evidence to revise our previous estimates in this area, and more research is required. We address some of the particular needs of younger people living with dementia in the recommendations at the end of this report.

As with all previous reports, we have tried to provide a global perspective throughout, with particular attention to low and middle income countries, where most older people, and most people with dementia live. In the preparation of this report, one issue that we had to address was that the distinction between 'low and middle income countries' and 'high income countries' is not static, the classification of countries having changed significantly since 2009. This is one aspect of the current rapid pace of global transition, with changes in demography, health, and human and economic development. We therefore begin the report with a brief overview of some of the trends that are apparent, their global distribution, and likely future impact.

1.1 Dementia in a rapidly changing world

The world's older population currently comprises nearly 900 million people. Most live in what are currently relatively poor countries. Mortality rates among older people are falling, and life expectancy from age 60 continues to increase in all world regions, with no upper limit in sight (population ageing or the 'demographic transition'). As people live longer, so chronic diseases become more prevalent, a trend exacerbated by changes towards lifestyles and behaviours that predispose towards them. This 'epidemiologic transition', linked to increases in high fat, salt and sugar diets, sedentariness, and tobacco use, is particularly evident in middle income countries.

With urbanisation, and economic and industrial development, traditional societies are needing to adapt to rapidly changing circumstances. This 'social transition' is less often discussed, but is as profound in its impacts as the accompanying demographic and epidemiologic change. This is the context in which the coming dementia epidemic, largely concentrated in what are now considered to be low and middle income countries, will play out.

1.2 Economic development

Each year the World Bank publishes a revised list of country income levels, dividing economies into four groups according to their Gross National Income (GNI) per capita. This index of average income is a general indicator of development status; people living in countries with higher GNI per capita tend to have longer life expectancies, higher literacy rates, better access to safe water, and lower infant mortality rates. The four groups are low income countries (LIC), lower middle income (L-MIC), upper middle income (UMIC), and high income countries (HIC). The first three of these groups (LIC, L-MIC and UMIC) are sometimes referred to as 'developing economies', or 'developing countries', and HIC as 'developed economies/countries', although this terminology is now considered controversial (the World Bank refers to economies rather than countries – in this report we have used 'countries' as a general term although some may be considered regions or territories). In 2009 the income thresholds were; LIC, $995 or less; L-MIC, $996-$3,945; UMIC, $3,946-$12,195; and HIC, $12,196 or more. These thresholds are revised upwards for inflation so that by 2015 they were LIC, $1,045 or less; L-MIC, $1,046-4,125; UMIC $4,126-$12,735; HIC, $12,736 or more. The transitions between income categories provide a broad indication of the global pace of economic development. In all, 41 countries have achieved a higher income classification since 2009 (14 have moved from LIC to L-MIC, 17 from L-MIC to UMIC, and 10 from UMIC to HIC). None have moved in the reverse direction, although South Sudan, originally part of Sudan, a L-MIC, has been reclassified as a LIC. The overall effect therefore is that fewer countries are now LIC or L-MIC, and more are UMIC or HIC.

1.3 Population ageing in a developing world

The effect of these revisions upon the older population, and its global distribution, is summarised in Table 1.2. In this table, we indicate the distribution of the world's older population in 2010, according to the 2009 World Bank classification, which was applied for that year's World Alzheimer Report. 70% of older people were living in low or middle income countries. If the same 2009 classification were applied to the -regional

Table 1.1
Transitions between income categories (World Bank Classifications 2009 and 2015)

LIC to L-MIC 14 countries	L-MIC to UMIC 17 countries	UMIC to HIC 10 countries
Bangladesh	Albania	Argentina
Ghana	Angola	Chile
Guatemala	Azerbaijan	Latvia
Kenya	Belize	Lithuania
Kyrgyz Republic	China	Poland
Lao PDR	Ecuador	Russia
Mauritania	Iran	Seychelles
Myanmar	Iraq	St Kitts and Nevis
Senegal	Jordan	Uruguay
Tajikistan	Maldives	Venezuela, RB
Yemen	Marshall Islands	
Zambia	Mongolia	
Uzbekistan	Paraguay	
Vietnam	Thailand	
	Tonga	
	Tunisia	
	Turkmenistan	

distribution of older people in 2015, then this proportion would have increased to 71%. However, because of upwards reclassification of 41 countries, when the new 2015 classification is applied, the proportion living in what are now considered low and middle income countries (LMIC) falls to 65%. Within LMIC, there has been a dramatic reduction in the proportion of older people living in what are now considered to be LIC and L-MIC, and a large increase in the proportion living in what are considered to be UMIC. These shifts are largely explained, given their very large population sizes, by the transition of Bangladesh from a LIC to a L-MIC, and of China from a L-MIC to an UMIC.

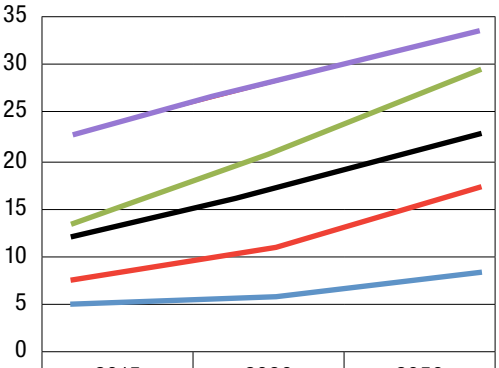
If we apply the current 2015 World Bank classification to projections of population growth from 2015 to 2050, we can see that the proportion living in what are now considered LMIC will increase from 65% in 2015 to 71% in 2030 and 76% in 2050. This is explained by more rapid population ageing in what are currently poorer, compared with what are currently richer, parts of the world. Through to 2050, numbers of older people are forecast to increase by just 56% in HIC, but by 138% in UMIC, 185% in L-MIC and by 239% (a more than threefold increase) in LIC. Population ageing is a crucial factor in determining the future global distribution of the dementia epidemic, given that age is the strongest risk determinant; more older people means more people at higher risk of developing the condition. Population ageing has another aspect; while older people are living longer, fertility rates are

Table 1.2
The world's population of older people (age 60 and over, millions), and their distribution according to country income level (World Bank Classification 2009 and 2015)

	Current and projected numbers of older people (% of total population)					% increase over time	
Year	2010	2015		2030	2050	2015-2030	2015-2050
World Bank income classification	2009	2009	2015	2015	2015	2015	2015
HIC	232.3 (30.4%)	258.7 (28.9%)	309.4 (34.6%)	403.9 (29.4%)	482.5 (23.9%)	31%	56%
UMIC	116.4 (15.2%)	135.3 (15.1%)	319.8 (35.7%)	531.5 (38.7%)	760.8 (37.7%)	66%	138%
L-MIC	356.2 (46.6%)	431.7 (48.2%)	233.1 (26.0%)	386.0 (28.1%)	665.3 (32.9%)	66%	185%
LIC	59.8 (7.8%)	69.5 (7.8%)	32.9 (3.7%)	53.5 (3.9%)	111.4 (5.5%)	63%	239%
World	764.7 (100%)	895.2 (100%)		1347.8 (100%)	2020.0 (100%)	51%	126%

declining in most countries. Therefore, older people come to constitute a higher proportion of the total population. These trends are displayed in Figure 1.1, for the world population, and for the countries that are currently considered LIC, L-MIC, UMIC and HIC. In 2015, worldwide, 12.2% of the population is aged 60 years or over. This proportion is highest in HIC and lowest in LIC; the country with the highest percentage of older people is Japan (33.2%), and the lowest is Uganda (3.7%). The stratification by country income level persists to 2050, with a range from 42.7% (Japan) to 5.1% (Mali). However, the process of population ageing, when expressed in these terms, will be most rapid in what are now UMIC, which will have nearly 'caught up' with HIC by 2050.

Figure 1.1
Percentage of the total population aged 60 years and over, by country income level, 2015 to 2050



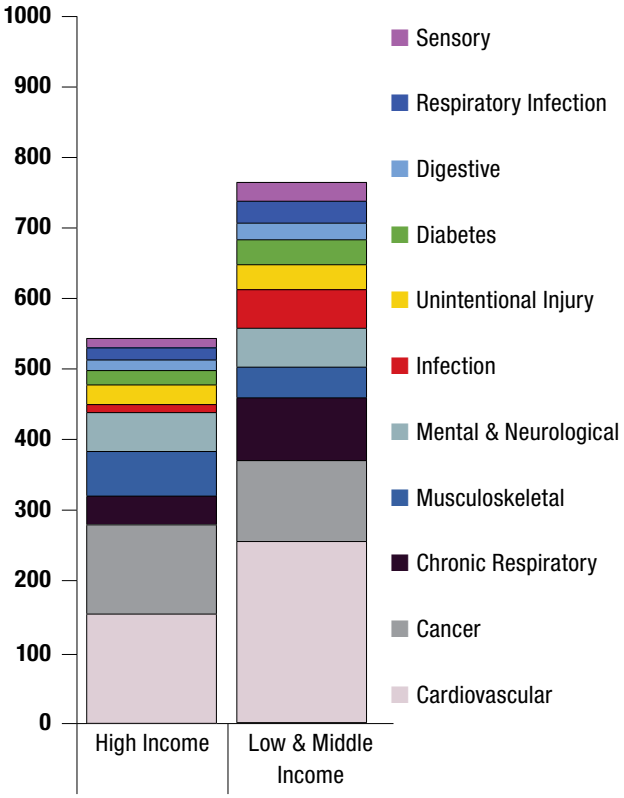
	2015	2030	2050
LIC	5.2	6.0	8.4
L-MIC	8.1	11.2	16.3
UMIC	13.3	20.5	28.9
HIC	22.0	27.3	31.6
World	12.2	16.3	21.2

1.4 Most lower income countries will remain relatively poor, and face particular challenges

The projections provided above, stratified by country income level, fail to take into account continued economic development, which, barring catastrophes, should see more and more countries and their populations lifted out of poverty. Perusal of the World Bank list of promoted countries (Table 1.1) reveals several that have achieved this despite war, sanctions and political and economic upheaval.

Nevertheless, we believe that it is instructive and valid to consider the likely future evolution and impact of the epidemic in countries that are currently LIC, L-MIC, UMIC and HIC (see Chapter 2 on prevalence and numbers, and Chapter 6 on economic costs). Poorer countries evidently have fewer economic and human professional resources to meet the health and social care needs of their rapidly growing older populations. These profound structural limitations are not resolved with a few dollars increase in average income, albeit that this may be sufficient to cross a World Bank threshold (the current threshold for high income country status is less than a quarter, and that for UMIC status less than one fourteenth, of the per capita GNI for the USA). Many face the challenge of a 'double burden' of persistently high rates of maternal, childhood and infectious diseases, combined with a growing epidemic of chronic non-communicable diseases, including cardiovascular diseases, cancer, diabetes and dementia. Figure 1.2 illustrates the significant burden of chronic disease already evident among older people living in low and middle income countries[5]. Differences in population size are adjusted for by expressing the burden (Disability Adjusted Life Years – see Chapter 5) per 1,000 older people. While the impact of infectious diseases is many times greater in low and middle income countries than in HIC, the impact of cancer is only slightly less, and that of diabetes, chronic respiratory and cardiovascular disease is greater.

Figure 1.2
Leading contributors to burden of disease among people aged 60 years and over - DALYs (per 1000 population) among people aged 60 and over, by cause and income region [5]



With the demographic and health transitions come profound social as well as economic change. Rapidly declining fertility rates, the increased participation of women in the labour force, urbanisation and migration for work are all trends conspiring to reduce the availability of traditional informal family care[6]. Even with the unprecedented benefits of double digit annual economic growth, rapidly developing countries in Asia and Latin America have struggled to establish comprehensive and effective systems of social protection for older people, guaranteeing adequate income, and universal access to health and social care[7-9] Overall economic growth at the national level can conceal gross inequities in income distribution, and it is probably fair to say that older people are often among the least likely and the last to benefit directly.

References

1 Alzheimer's Disease International. World Alzheimer Report 2009. London: Alzheimer's Disease International; 2009.

2 World Health Organization. Dementia: a public health priority. Geneva: World Health Organization; 2012.

3 Wimo, A. and Prince M. World Alzheimer Report 2010; The Global Economic Impact of Dementia. London: Alzheimer's Disease International; 2010.

4 Prince, M., Knapp, M., Guerchet, M., McCrone, P., Prina, M., Comas-Herrera, A., Wittenberg, R., Adelaja, B., Hu, B., King, D., Rehill, A., and Salimkumar, D. Dementia UK: Update. London: Alzheimer's Society; 2014.

5 Prince MJ, Wu F, Guo Y, Gutierrez Robledo LM, O'Donnell M, Sullivan R et al. The burden of disease in older people and implications for health policy and practice. Lancet 2015 February 7;385(9967):549-62.

6 Prince M, Acosta D, Albanese E, Arizaga R, Ferri CP, Guerra M et al. Ageing and dementia in low and middle income countries-Using research to engage with public and policy makers. Int Rev Psychiatry 2008 August;20(4):332-43.

7 Cecchini, S. and Martinez, R. Inclusive Social Protection in Latin America: A Comprehensive, Rights-based Approach. Santiago, Chile: United Nations; 2012.

8 Pozen, R. C. Tackling the Chinese Pension System. Chicago: The Paulson Institute; 2013.

9 Gan, L. Income Inequality and Consumption in China. Texas A&M University, USA and Southwestern University of Finance and Economics, Chengdu, China; 2013.

CHAPTER 2

The global prevalence of dementia

2.1 Introduction

In the World Alzheimer Report 2009[1], ADI published estimates of the global prevalence of dementia based on a systematic review of 154 studies conducted worldwide since 1980, with prevalence estimates applied to United Nations population projections through to the year 2050. We estimated that 36 million people were living with dementia in 2010, nearly doubling every 20 years to 66 million by 2030 and to 115 million by 2050. In 2013, for the G8 'Global Action Against Dementia' summit in London, we carried out a limited update of the numbers published in 2009 by incorporating new evidence from sub-Saharan Africa and China[2] and recently revised United Nations population estimates. Six years on from the last comprehensive review the global evidence-base has expanded considerably, and a full update is required. As stressed throughout this chapter, any changes in our estimates of age-specific or age-standardised prevalence likely reflect changes in the quality and/or quality of evidence available, and should not be construed as implying that there has been a change in the true underlying prevalence of dementia in the regions concerned since 2009. However, increases in the numbers of people affected are to be expected, given significant increases in the size of the older population.

This report uses essentially the same method as we had previously used in the World Alzheimer Report 2009 (see Methods section below). We have conducted a new, fully systematic review of the prevalence studies conducted worldwide from 2009. Studies conducted in China are often not available in English, as was demonstrated in two comprehensive reviews published in 2013[2-4]. For this report, following the precedent established by these reviews, we searched Chinese databases to include all available evidence. The systematic review presented in this report is therefore both the most exhaustive and up to date review carried out on the prevalence of dementia worldwide.

2.2 Methods

2.2.1 Search strategy

Two teams searched English and Chinese databases separately. The English language search updated the previous World Alzheimer Report review conducted in 2009[5], by searching for studies published from 2009 onwards, and the Chinese database search updated Wu et al.'s review conducted in 2012[2], by searching for studies published from 2011 onwards. The following search strategies were used.

English Database Search
Search date: February 2015
Databases: EMBASE, Global Health, MEDLINE, PsychExtra and PsychInfo
Search terms: dementia AND (prevalence OR epidemiology)

Chinese Database Search
Search date: March 2015
Databases: CNKI, Wanfang, Airti

Search terms: (癡呆/dementia OR 失智/dementia OR 阿爾茨海默/Alzheimer) AND (患病率/prevalence OR 盛行率/prevalence OR 流行/epidemiology)

The Chinese search team also reappraised, for eligibility, those Chinese language publications that had been included in the 2009 World Alzheimer Report, on the basis of a review published in 2007 of studies conducted in China between 1980 and 2004[6]. This had not been possible in 2009.

2.2.2 Inclusion criteria

Population-based studies of the prevalence of dementia among people aged 60 years and over (according to DSM-IV or ICD-10 criteria, or similar pre-existing clinical criteria), for which the field work started on or after 1st January 1980.

2.2.3 Exclusion criteria

- Base population
  - Studies of prevalence from the follow-up phase (rather than the inception phase) of a population cohort
  - Studies sampling from an out-of-date population register (prepared more than three years prior to the survey)
  - Studies of nursing home or residential care populations
  - Studies of primary care attendees or other unrepresentative service-user populations
- Ascertainment/outcome definition
  - Studies in which the ascertainment of dementia depended upon help-seeking and/or receipt of dementia care services
  - Studies in which 'dementia' was diagnosed purely on the basis of cognitive impairment, for example according to a cutpoint on the MMSE
  - Studies of the prevalence of Alzheimer's disease or other subtypes of dementia
  - Studies restricted to young-onset dementia (up to 59 years of age)

2.2.4 Procedures

All stages of the search were completed by two reviewers. For the English search, all abstracts were read by GA and by either YW or MG. Papers were excluded at this stage only when the abstract clearly demonstrated that the paper did not meet the above criteria. Full texts of the remaining publications were read by GA and by either YW or MG, and a consensus decision was made on those that met all criteria. These papers were published in English, French, Spanish and Portuguese, all of which could be read by our team using translation programmes. The Chinese search was conducted independently by Dr Yu-Tzu Wu and Dr Kit Yee Chan, who compared their study selection at each stage of screening and review.

All eligible studies were systematically coded for their study design and quality according to the following criteria:

1 Country
2 WHO/Global Burden of Disease World Region (see Appendix A for list of countries and regions)
3 Inclusion of residents of long term care institutions
4 Start and finish dates for fieldwork, and census dates if provided
5 Lower and upper age limits
6 Sampling (simple random, stratified random, whole population, other)
7 Design (one phase/two phase/three phase)
8 Overall sample size (first phase)
9 Numbers interviewed (first phase) and proportion responding
10 For two-phase surveys only
   a. Numbers selected for the second phase (for two phase surveys)
   b. Numbers interviewed (second phase) and proportion responding
   c. Screen negatives sampled for the second phase (yes/no)
   d. Screen negatives given same assessment as screen positives (yes/no)
   e. Weighting back carried out (no weighting back/appropriate weighting back/no weighting back, but no false positives)
   f. Time interval between first and second phase
   g. Screening instrument/s
11 Diagnostic criteria (not specified, ICD, DSM, GMS/AGECAT, CAMDEX, other clinical criteria)
12 Use of multidomain cognitive assessment, informant interview, disability assessment, neuroimaging

An overall quality score was derived by summing scores for the following elements:

Sample size – <500, 0.5 points; 500-1499, 1 point; 1500-2999, 1.5 points; >=3000 2 points

Design – Two-phase study with no sampling of screen negatives, 0 points; two-phase study with sampling of screen negatives but no weighting back, 1 point; one-phase study or two-phase study with appropriate sampling and weighting, 2 points

Response proportion – <60%, 1 point; 60-79%, 2 points; >=80%, 3 points

Diagnostic assessment – one point each for multidomain cognitive test battery, formal disability assessment, informant interview and clinical interview

2.2.5 Data extraction

Prevalence data was extracted from the studies as follows.

For unweighted prevalence, we extracted (according to the data presented in the paper) either numerator and denominator, prevalence and denominator, prevalence and standard error, or prevalence and 95% confidence intervals. Numerator and denominator could then be calculated from any of these combinations.

For weighted prevalence we extracted (according to the data presented in the paper) either weighted prevalence and weighted standard error, or weighted prevalence and weighted 95% confidence intervals. Effective numerators and denominators (taking into account the design effect) could then be calculated from either of these combinations.

Prevalence estimates were stratified differently in different publications. To maximise the precision of our meta-analysis, we required prevalence estimates in five-year age-bands, separately for men and women (age- and gender-specific prevalence). In practice, some studies:

a) Simply gave an overall prevalence for the whole sample, stratified by neither age nor gender

b) Provided gender-specific estimates, not stratified by age

c) Provided age-specific estimates, not stratified by gender

In each of the above scenarios, we wrote to the authors to request age- and gender-specific prevalence data. Prevalence data in formats a) and b) could not be used in our meta-analyses, since the main aim was to model the effect of age on dementia prevalence. Such studies therefore had to be excluded. Age-specific prevalence data (c) above) could be used, and these data were generally available or could be calculated from age- and gender-specific estimates. We could therefore model the effect of age on dementia prevalence for all included studies, and the effects of age and gender for the subset of studies that had provided age- and gender-specific estimates.

2.2.6 Meta-analytical methods for estimating dementia prevalence within regions

Within each GBD region where there was sufficient data to conduct a meta-analysis, we used a random effect exponential (Poisson) model to assess the effect of age, and of age and gender, on the prevalence of dementia. Random effects are assumed to have a gamma distribution – the alpha coefficient is an estimate of over-dispersion and an index of between-study heterogeneity.

Age was coded as the mean for each reported age group. For high income countries, this was calculated from the US Census, while for low and middle income countries we estimated this as the mean observed in the relevant 10/66 Dementia Research Group population-based study[7]. For SSA countries, this was calculated from the mean observed in four population-based studies in West and Central Africa for which individual data was available[8-10]. We ran two models for each region: one for the effect of age, and one for the effects of age, gender, and an interaction between age and gender. We then applied the relevant mean ages and gender codings to the coefficients estimated by the models, producing age- and gender-specific prevalence estimates in five year age-bands from 60-89 years, and for those aged 90 and over.

2.3 Results

2.3.1 The extent of the evidence-base

The initial searches yielded 8,736 English abstracts and 1,941 Chinese abstracts (a total of 10,677 unique hits). Through screening the titles and abstracts, 10,483 publications were excluded as clearly ineligible, leaving 194 publications for further review (160 from the English abstract search and 34 from the Chinese search). We obtained full texts of all the full published papers, which were then carefully assessed against inclusion/exclusion criteria. A further 129 publications were excluded at this stage, leaving 65 publications that were provisionally eligible for inclusion. For 10 of these publications, we could not include the data in the form in which it was provided in the publication, and authors did not respond to requests for age-stratified data. These publications were coded 'pending', awaiting clarification from authors. Finally, 55 new publications (included in neither the 2009 World Alzheimer Report, nor the Wu et al. 2013 review) were fully eligible for inclusion in the meta-analysis. The Chinese database search identified 10 new studies from China, and one from Taiwan, published since Wu et al.'s 2013 review. Three recent English language publications describing China studies were identified from the English database search. Four studies from

the 2007 review[6] used for the 2009 report were found not to meet our inclusion criteria. However, an additional 28 publications identified in Wu et al.'s 2013 review[2] would have been eligible for inclusion in the 2009 review, had they been identified at that time. All in all, we identified 86 eligible publications for the East Asia region (72 from the Wu et al. review, and 14 from the updated searches), referring to 89 studies. 78 of these provided data in the form that could be used for the meta-analysis (we were unable to source age-stratified prevalence estimates for 6 studies, and a further 5 provided age-stratified prevalence estimates without information from which we could back-calculate number of cases and denominator).

Combining the new studies with the results of the original systematic reviews[2, 5], we were left with 273 studies potentially eligible for inclusion in the meta-analysis, with 224 in the required data format to be included. For a complete list of studies included in and excluded from the meta-analysis, see the online appendix at www.alz.co.uk/research/world-report-2015

2.3.2 The coverage of the evidence-base

The number of studies identified in each GBD world region, and the number of older participants studied are listed in Table 2.1.

Good to reasonable coverage was identified for 12 of the 21 GBD regions. Three regions – East Asia (89 studies), Western Europe (71 studies) and Asia Pacific High Income (30 studies) – account for the majority of the world's studies. The next best represented regions are North America (16 studies) and Latin America

Table 2.1
Coverage, by region, with respect to size of elderly population

Region	Over 60 year old population (millions)	Number of eligible dementia prevalence studies (additional studies since WAR 2009)	Number of studies/ 10 million population	Total population studied	Total population studied/ million population
ASIA	485.83	144 (71)	3.0	420143	865
Australasia	5.80	4 (0)	6.9	2223	383
Asia Pacific, High Income	52.21	30 (8)	5.7	46843	897
Asia, Central	7.43	0 (0)	0.0	0	0
Asia, East	218.18	89 (55)	4.1	342231	1569
Asia, South	139.85	14 (7)	1.0	19673	141
Asia, Southeast	61.72	6 (1)	1.0	7144	116
Oceania	0.64	1 (0)	15.6	2029	3170
EUROPE	176.61	78 (17)	4.4	106909	605
Europe, Western	107.89	71 (15)	6.6	104447	968
Europe, Central	26.92	6 (2)	2.2	2462	91
Europe, Eastern	41.80	1 (0)	0.2	Not available	Could not be calculated
THE AMERICAS	145.51	34 (6)	2.3	94875	643
North America	74.88	15 (2)	2.0	42361	548
Caribbean	5.78	5 (1)	8.7	24625	4260
LA, Andean	5.51	3 (0)	5.4	3465	629
LA, Central	24.64	6 (2)	2.4	12665	514
LA, Southern	9.88	1 (0)	1.0	4689	475
LA, Tropical	24.82	4 (1)	1.6	7070	285
AFRICA	87.19	17 (12)	1.9	18126	208
North Africa/ Middle East	38.93	6 (4)	1.5	8371	215
SSA, Central	4.78	4 (4)	8.4	3020	632
SSA, East	19.86	1 (1)	0.5	1198	60
SSA, Southern	6.06	1 (0)	1.7	150	25
SSA, West	17.56	5 (3)	2.8	5387	307
WORLD	895.14	273 (106)	3.0	640053	715

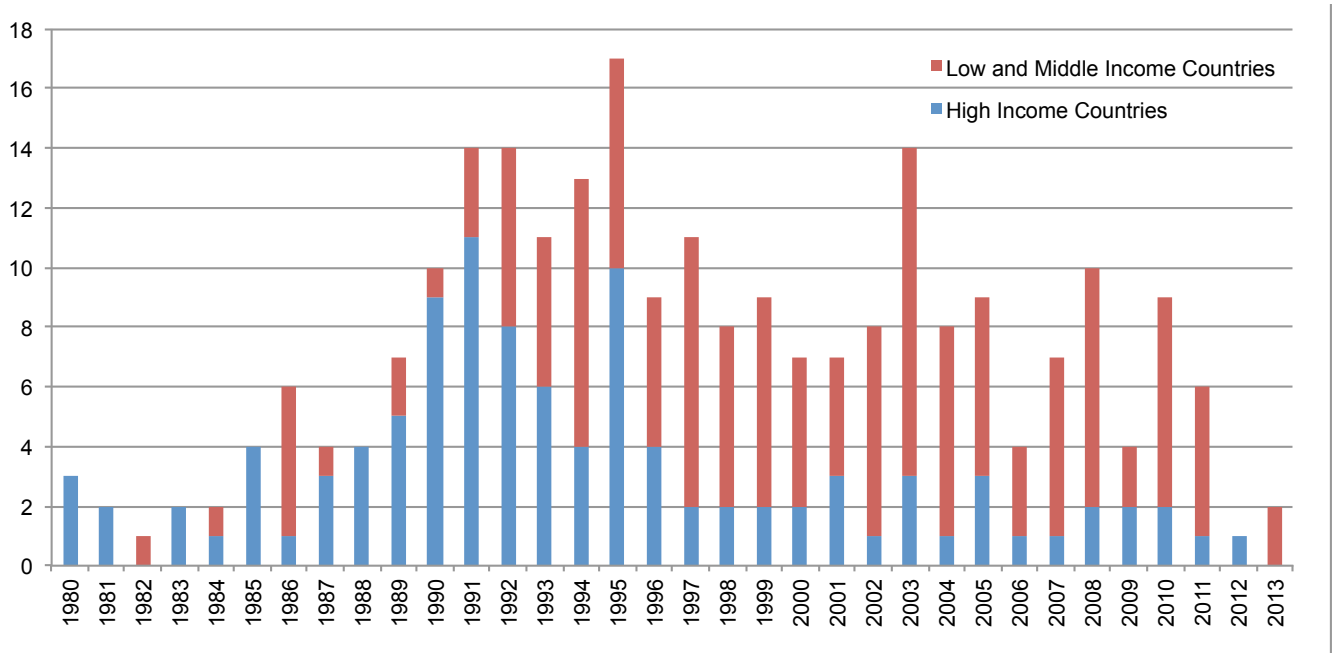
if considered as a single region (14 studies). Other regions with reasonable coverage are South Asia (14 studies), Southeast Asia (6 studies) and Australasia (4 studies). Sparse coverage only was achieved in three regions: Central Europe (5 studies), and Eastern and Southern sub-Saharan Africa (1 study each). No eligible studies were identified for Central Asia.

The participants per million older population (Table 2.1) provides an index of the research effort relative to the size and probable diversity of the countries and regions concerned. According to these criteria, broadly similar coverage was achieved in the Asia Pacific, East Asia, Western Europe, North America, Latin America and Caribbean regions. There was a higher density of studies in Western Europe, but these tended to be smaller in size than those in North America and East Asia. The greatest improvements in coverage since our 2009 review have been seen in Central and Western sub-Saharan Africa, where coverage has improved from sparse to reasonable. Apart from the region with no studies (Central Asia), the regions that stand out as persistently lacking in research relative to population size are Central Europe, and Eastern and Southern sub-Saharan Africa. Despite reasonable coverage in terms of numbers of studies in South and Southeast Asia, these are still sparse with respect to population size.

Adequate coverage of large and populous countries such as the USA or China would require a large number of studies in different regions encompassing the racial, cultural, economic and social diversity of the nation as a whole. This has been achieved for China[3]. The most informative approach would be a study of a nationally representative sample, but to our knowledge such studies have only been carried out in the USA[11] (but on a very small sample), Canada[12], Mexico[13], Korea[14] and Singapore[15]. The MRC CFAS study in the UK[16] provides good coverage of different regions and urban and rural populations, but is not nationally representative. By the same token, studies carried out in just one or two countries may not safely be generalised to a large number of other countries in the same GBD region. For example, the Caribbean's evidence base derives from three studies in Cuba, one in Jamaica, and one in the Dominican Republic. The remaining 24 Caribbean countries include some of the world's poorest (Haiti) and richest (The Bahamas). They also differ markedly due to different colonial histories. Limits to generalisability are particularly significant when the few available studies are small, were conducted some time ago, and/or are of poor methodological quality. All of these limitations apply, for example, to the one study identified in Southern sub-Saharan Africa[17].

When the 10/66 Dementia Research Group was founded in 1998, the group's name (10/66) referred to the 10% of population-based research that had been conducted in low and middle income countries (LMIC), relative to the two-thirds of people with dementia living in those regions. By 2009, the situation had been transformed – 65 of the 167 dementia prevalence studies (39%) had been conducted in LMIC. With the additional evidence unearthed from China, and the recent preponderance of studies from LMIC, the updated proportion for studies conducted through to 2015 is 52%. Of more concern is the finding that studies in high income countries peaked in the early 1990s and declined sharply thereafter. This trend, noted in our 2009 report, has continued. From 1980-1994, 35% of all studies were conducted in LMIC,

Figure 2.1
Numbers of prevalence studies, by year of data collection and income level of the country where the research was carried out



compared with 69% from 1995-2004 and 76% from 2005 onwards. This has an impact, also on the recency of the evidence-base; in HIC 45% of all studies were conducted post-1995, compared with 76% of available studies from LMIC.

2.3.3 The quality of the research

The principal characteristics of the included studies are described in Table 2.2, by world region.

2.3.3.1 Study design

The major quality control issue concerns the use of surveys with two or more phases. Multiphase survey designs are popular in dementia research because of perceived efficiencies in interviewer time and cost. A fundamental and common error is to fail to submit a random sample of those scoring above the pre-defined cutpoint on the first phase screening assessment ('screen-negatives') to the same diagnostic assessment as 'screen-positives'. No screening assessment is perfectly sensitive, and it is therefore likely that some cases of dementia will be missed in phase one. The correct procedure is to estimate the false positive rate among the screen negatives and then 'weight back', calculating an overall prevalence that accounts for the different sampling proportions of screen positives and screen negatives. Unfortunately, most investigators using a multiphase design did not sample screen negatives, and those that did often did not weight back appropriately. 77% of the dementia prevalence studies included in our meta-analysis used a multiphase design, yet only 17% of these correctly applied the design and appropriately analysed the results. This problem therefore affects 64% of all studies. Failure to include a sample of negative screens and weight back accordingly will produce results that tend towards an under-estimation of true dementia prevalence and an over-estimation of precision. Even when applied correctly, multiphase studies are often complicated by the relatively high levels of loss to follow-up that occur between screening and definitive diagnostic assessment[18]; this is again likely to lead to bias, which could over- or under-estimate true prevalence[19]. Of the studies conducted in the last ten years (since 2005), 78% used a multiphase design and of these only 11% applied it correctly. In this respect, study quality has clearly not improved since our 2009 meta-analysis.

2.3.3.2 Scope of definitive diagnostic assessment

Dementia diagnosis requires demonstration of cognitive impairment (and decline from a previous level of functioning) in memory and other domains of intellectual function, and demonstration of consequent social or occupational impairment. Other causes of cognitive and functional impairment, such as functional psychosis, depression and delirium, should be excluded. A diagnostic assessment should therefore include multi-domain cognitive testing, disability assessment, a clinical interview and an informant interview. Overall, only 34% of all included studies fully met this requirement. Informant interviews were the most commonly missed element. The effect of applying a less thorough diagnostic assessment of dementia prevalence is uncertain. In principle it could lead to either under- or over-estimation of true prevalence. Looking only at studies conducted since 2005, the proportion with a comprehensive diagnostic assessment rises to 52%. Study quality in this respect does appear to be improving, although the informant interview is still too often missing.

2.3.3.3 Sample size

Over half (52%) of all eligible studies had sample sizes smaller than 1500, and this figure rises slightly to 54% when considering studies conducted since 2005. Nearly a third of Western European studies had sample sizes smaller than 500, though of the recent studies this falls to less than a quarter. East Asia (China, Hong Kong and Taiwan) contributed a relatively high proportion of the large studies sampling over 3000 people. Sample sizes tended to be larger in studies conducted in LMIC. In principle, sample size should not have any consistent effect on prevalence, although larger studies will estimate prevalence with greater precision. A study of 500 participants could estimate a true prevalence of 6% with a precision of +/- 2.1%. Precision increases to +/- 1.2% for a sample size of 1500 and to +/- 0.8% for a sample size

2.3.3.4 Response proportion

Those who cannot be contacted or do not consent to take part in a survey may have different characteristics from those included in the final sample. People with dementia may be under-represented in the interviewed sample, due to relatives being reluctant for them to participate or because those that consent to participate find it more difficult to complete the questionnaires. Alternatively, they may be over-represented due to an increased likelihood of people with dementia being at home when interviewers call. The direction of the bias is hard to predict, but studies with higher proportions of participants responding should provide more accurate prevalence estimates. Participation rates in the studies included in our meta-analysis were generally adequate to good; only 13 studies (5%) reported fewer than 60% of eligible participants responding, while more than half (58%) reported 80% or more responding. Response proportions seem to be slightly higher for studies carried out since 2005. However, in some studies conducted in high income countries, response proportions have declined over time[20].

Table 2.2
Study characteristics, by region and by country income level

	Western Europe	Central Europe	North America	Latin America and Caribbean	Asia Pacific High Income	Austral-asia	Asia, East	Asia, South	Asia, South East	Sub-Saharan Africa	HIC	LMIC	All regions
Total number of studies[1]	65	4	14	18	24	4	82	11	6	9	117	130	247
Year of Research													
1980-1989	13 (20%)	0	3 (21%)	0	7 (29%)	2 (50%)	4 (5%)	2 (19%)	1 (17%)	0	25 (21%)	7 (5%)	32 (13%)
1990-1999	37 (57%)	1 (25%)	9 (64%)	3 (16%)	10 (42%)	1 (25%)	36 (44%)	4 (36%)	2 (33%)	1 (11%)	64 (55%)	43 (33%)	107 (43%)
2000-09	10 (15%)	2 (50%)	2 (14%)	13 (72%)	6 (25%)	1 (25%)	24 (29%)	7 (64%)	3 (50%)	4 (45%)	21 (18%)	56 (43%)	77 (31%)
2010 onwards	3 (5%)	0	0	1 (6%)	1 (4%)	0	12 (15%)	0	0	3 (33%)	5 (4%)	15 (12%)	20 (8%)
Not specified	2 (3%)	1 (25%)	0	1 (6%)	0	0	6 (7%)	0	0	1 (11%)	2 (2%)	9 (7%)	11 (5%)
Sample size													
<500	20 (31%)	1 (25%)	0	1 (6%)	3 (13%)	2 (50%)	10 (12%)	2 (19%)	1 (17%)	1 (11%)	28 (24%)	15 (12%)	43 (17%)
500-1499	25 (38%)	3 (75%)	4 (28%)	6 (35%)	8 (35%)	2 (50%)	21 (26%)	4 (36%)	4 (66%)	7 (78%)	43 (37%)	43 (33%)	87 (35%)
1500-2999	11 (17%)	0	5 (36%)	8 (47%)	7 (30%)	0	33 (40%)	4 (36%)	1 (17%)	1 (11%)	25 (21%)	51 (39%)	75 (30%)
>=3000	9 (14%)	0	5 (36 %)	2 (12%)	5 (22%)	0	18 (22%)	1 (9%)	0	0	21 (18%)	21 (16%)	42 (17%)
Outcome													
ICD-10	1 (1%)	1 (25%)	1 (7%)	0	1 (4%)	0	5 (6%)	2 (18%)	0	1 (11%)	5 (4%)	9 (7%)	14 (6%)
DSM-IV/ III-R	48 (74%)	2 (50%)	9 (64%)	11 (61%)	21 (88%)	3 (75%)	63 (77%)	6 (55%)	4 (67%)	7 (78%)	87 (74%)	93 (72%)	180 (73%)
GMS/ AGECAT	3 (5%)	0	1 (7%)	0	0	0	2 (2%)	0	2 (33%)	0	4 (3%)	4 (4%)	8 (3%)
CAMDEX	7 (11%)	1 (25%)	0	0	0	0	0	0	0	0	8 (7%)	1 (1%)	9 (4%)
Other	6 (9%)	0	3 (21%)	7 (39%)	2 (8%)	1 (25%)	12 (15%)	3 (27%)	0	1 (11%)	13 (11%)	23 (18%)	36 (15%)
Design													
1 phase	21 (32%)	1 (25%)	2 (14%)	10 (56%)	4 (17%)	3 (75%)	9 (11%)	3 (27%)	1 (17%)	2 (22%)	32 (27%)	25 (19%)	57 (23%)
2+ phases	44 (68%)	3 (75%)	12 (86%)	8 (44%)	20 (83%)	1 (25%)	73 (89%)	8 (73%)	5 (83%)	7 (78%)	85 (73%)	105 (81%)	190 (77%)
Multiphase design applied and analysed correctly[2]	20%	33%	50%	38%	15%	100%	5%	0%	0%	40%	24%	12%	17%
Response Proportion													
<60%	8 (12%)	1 (25%)	1 (7%)	0	0	0	1 (1%)	0	0	0	11 (9%)	2 (2%)	13 (5%)
60-79%	26 (40%)	1 (25%)	6 (43%)	3 (17%)	5 (21%)	2 (50%)	10 (12%)	2 (18%)	1 (17%)	1 (11%)	42 (36%)	18 (14%)	59 (24%)
80-100%	29 (45%)	2 (50%)	5 (36%)	12 (66%)	12 (50%)	2 (50%)	58 (71%)	7 (64%)	2 (33%)	8 (89%)	52 (44%)	89 (69%)	142 (58%)
Not specified	3 (5%)	0	2 (14%)	3 (17%)	7 (29%)	0	13 (16%)	2 (18%)	3 (50%)	0	12 (10%)	21 (16%)	33 (13%)
Assessment Quality													
Comprehensive diagnostic assessment[3]	37 (57%)	0	6 (43%)	13 (72%)	5 (21%)	0	12 (15%)	5 (45%)	1 (17%)	9 (100%)	50 (43%)	35 (27%)	84 (34%)
Overall Quality Score[4]													
Mean (SD)	8.1 (1.7)	6.4 (2.1)	8.3 (1.6)	9.5 (1.8)	7.0 (1.6)	8.3 (0.9)	6.2 (1.8)	8.2 (1.8)	6.0 (0.9)	9.0 (0.8)	7.8 (1.7)	7.1 (2.3)	7.4 (2.0)

1 These numbers differ from the totals listed in Table 2.1, as we were not able to ascertain some or all study characteristics for some of the 'pending' studies, about which we were seeking further information from authors.

2 As a proportion of all studies using a multiphase design (i.e. with two or more phases, with screening performed on all in the first phase, and definitive diagnostic assessment on a sub-sample based on screening score)

3 Defined as a multi-domain cognitive battery, an informant interview, a formal assessment of disability, and a clinical interview

4 Derived from sample size, design, response proportion and assessment quality (see text for details)

2.3.3.5 Overall quality

Mean scores for our quality index varied significantly between regions. Overall study quality was especially high in Latin America and sub-Saharan Africa, and particularly poor in East Asia, Southeast Asia, Central Europe and the Asia Pacific High Income regions. Study quality did not differ significantly between high income and low/middle income countries. Despite lack of progress regarding appropriate use of multiphase design, there remains a pronounced tendency for overall study quality to have improved over time.

2.3.4 Meta-analysis of dementia prevalence within GBD regions

We considered the evidence-base to be sufficient in terms of coverage and the number and quality of studies to conduct meta-analyses for 16 of the 21 GBD regions: Western Europe, Central Europe, North America, Latin America (combining the Latin American Andean, Central, Southern and Tropical regions), Asia Pacific High Income, Australasia, East Asia, Southeast Asia, South Asia and sub-Saharan Africa (combining the central, southern, eastern and western sub-Saharan regions). This is five more regions than we were able to meta-analyse in 2009, due to increased evidence from Central Europe and evidence considered generalisable to all four of the regions comprising sub-Saharan Africa. Because the North American region included just two countries (Canada and the USA) and because Canada was represented by a large and well-conducted survey on a nationally representative sample[3], we used a slightly different approach for this region. We meta-analysed studies conducted in the US to generate estimates for the USA only, and applied the Canadian Study of Health and Aging (CSHA) prevalence findings to Canada. A summary of which countries are included in each region, the countries for which prevalence studies have been conducted, and the approach used to generate regional prevalence and numbers can be found in Appendix A.

2.3.4.1 The effects of age and gender

In fitting the models, we noted a strong effect of age in each region. The prevalence of dementia increased exponentially with age, doubling with every 5.5 year increment in age in North America, 5.7 years in Asia Pacific, 5.9 years in Latin America and, with every 6.3 year increment in East Asia, every 6.5 years in West and Central Europe, every 6.6 year increment in South Asia, and every 6.9 years in Australasia, 7.2 years in the Caribbean and SSA, and 10.6 years in South East Asia. We also noted an independent effect of gender in some regions: East Asia, Asia South, the Caribbean, Western Europe and Latin America, where the predicted prevalence for men was between 14% and 32% lower than that for women. This effect wasn't significant for the other regions. An interaction was noted between age and gender, with a tendency in all regions for the divergence in prevalence between men and women to rise with increasing age; however, this was statistically significant only for the Asia Pacific and Latin America regions.

2.3.4.2 Heterogeneity of prevalence within regions

There was statistically significant overdispersion in all of the models other than that for Australasia and Europe Central, indicating significant heterogeneity in age-specific or age- and gender-specific prevalence between studies, within regions. Heterogeneity was most marked for South Asia (alpha=0.37), East Asia (alpha=0.20) and Western Europe (alpha=0.16). Heterogeneity in all regions was quite similar to that which was observed in 2009.

An advantage of modelling prevalence with Poisson random effects exponential regression is that it allows us to explore possible sources of heterogeneity between study estimates. With the new data available from China, we are now able to carry out these meta-regressions for two world regions; East Asia, in addition to Western Europe. Given that limited data is available for some design and methodological factors from the Chinese studies, we limited the analyses to the effects of one or two phase design (correctly or incorrectly applied), whether or not an informant interview was included, the year in which the survey was carried out, and the country. All regressions were controlled for age in the first stage. The results are summarised in Table 2.3.

Table 2.3
Modelling the effects of study characteristics upon observed prevalence in East Asia (73 studies) and western Europe (63 studies)*

Study characteristics	East Asia (73 studies)	Europe (63 studies)
Design		
One phase survey	1 (ref)	1 (ref)
Two phase survey correctly applied	0.84 (0.39-1.79)	1.20 (0.84-1.72)
Two phase survey incorrectly applied	1.02 (0.66-1.56)	1.16 (0.85-1.58)
Informant interview not applied	0.84 (0.63-1.11)	0.98 (0.80-1.19)
Year		
1980 – 1994	1 (ref)	1 (ref)
1995 – 2005	1.79 (1.26-2.53)	0.86 (0.69-1.08)
2005 –	2.32 (1.62-3.32)	0.94 (0.71-1.24)
Alpha	0.29 (0.21-0.40)	0.09 (0.06-0.13)

* controlling for other variables in the table, and for 'country'

The most striking finding was a marked trend for a higher prevalence to be recorded in more recent studies in East Asia, an effect which was not evident in Western Europe. When the effect of year of survey was examined as a linear variable (per year) the trend was clearly apparent for East Asia (RR 1.041, 95% CI: 1.020-1.062) but, again, not for Western Europe (RR 0.996, 95% CI: 0.981-1.012). There appeared to be no effect of study design or methodological factors in either region. However, when additional factors were tested in Western Europe, prevalence was higher for those studies that had excluded long term care institutions from sampling (RR 1.66, 95% CI: 1.02-2.71), lower when a multi-domain cognitive test battery had not been applied (RR 0.51, 95% CI: 0.39-0.67), but with no effect of the absence of a structured disability assessment (RR 1.22, 95% CI: 0.79-1.90). Inspection of the alpha coefficient, as an index of residual variance at different stages of the model, confirmed that study year was the major source of heterogeneity for East Asia, and country for Western Europe (Table 2.4).

In East Asia, there was no significant variation by country; compared with Taiwan, the prevalence ratios were; China (PR 1.31, 95% CI: 0.80-2.17) and Hong Kong (PR 1.31, 95% CI: 0.26-6.52). These comparisons were evidently underpowered due to the relatively small number of studies from Taiwan and Hong Kong. For Western Europe, as noted in the 2009 World Alzheimer Report, Israel was a clear outlier with a substantially and significantly higher prevalence than that noted in almost all other countries. Excluding Israel, heterogeneity between countries is reduced, but still present, with no clear interpretable pattern (Table 2.5). With reference to Italy (the country with the largest number of studies), prevalence is higher in France, and lower in Finland, San Marino and the United Kingdom.

Table 2.4
Coefficient alpha, as an index of residual between study variability in dementia prevalence

Model	East Asia meta-analysis	Western Europe meta-analysis
Age only	0.38	0.15
+ methodology	0.36	0.14
+ study year	0.30	0.14
+ country	0.30	0.09
+ country (excluding Israel)	N/A	0.07

Table 2.5
The effect of country on dementia prevalence (Western Europe, excluding Israel) – 61 studies

Country	Prevalence ratio
Italy	1 (ref)
France	1.93 (1.09-3.42)
Netherlands	0.76 (0.53-1.09)
Sweden	0.78 (0.55-1.10)
Germany	1.01 (0.66-1.57)
Finland	0.55 (0.30-1.00)
Denmark	0.88 (0.57-1.35)
Spain	1.02 (0.81-1.29)
Belgium	1.28 (0.83-1.96)
Norway	1.04 (0.59-1.84)
San Marino	0.66 (0.34-1.29)
United Kingdom	0.68 (0.51-0.93)
Switzerland	0.95 (0.48-1.86)
Portugal	0.94 (0.48-1.85)

2.3.5 Generating prevalence estimates

As described earlier, we generated both age-specific and age- and gender-specific meta-analysed dementia prevalence estimates for each region. For the East Asia region, given the prominent temporal trend for estimated prevalence observed in our meta-regression analysis, we restricted the meta-analysis of prevalence to studies conducted in China from 2005 onwards and included all the other studies from the region. The origins of the temporal trend have been debated, specifically whether or not it reflects a true change in underlying prevalence over time, or alternatively merely an artefact of a shift towards the use of more current dementia diagnostic criteria[21, 22]. Regardless, this decision seemed justified as likely to represent the most accurate estimation of current prevalence in the region (see Discussion, and Chapter 5 for further details). We prioritised the age- and gender-specific estimates where these had been provided for a large proportion of all studies, since these should in principle provide the most precise overall prediction of regional

Table 2.6
Meta-analysed estimates of dementia prevalence, generated from Poisson random effects models, by GBD region

Global Burden of Disease Region	Number of Included Studies		Gender	Age group							Standardised prevalence† for those aged 60+
	Number in age-specific meta-analysis	Number in age- and gender-specific meta-analysis		60-64	65-69	70-74	75-79	80-84	85-89	90+	
ASIA											
Australasia	3	0	All	1.8	2.8	4.5	7.5	12.5	20.3	38.3	6.91*
Asia Pacific, High Income	17	11	M	1.5	2.3	3.8	6.5	11.2	18.4	35.7	6.54*
			F	1.0	1.8	3.3	6.3	12.1	22.5	50.6	
			All	1.0	1.9	3.3	6.0	11.0	19.6	41.8	5.96
Asia, East (2005-15 only for China)	44	15	M	1.2	1.9	3.0	5.1	8.6	14.2	27.2	6.19
			F	1.5	2.5	4.2	7.3	12.8	21.6	43.0	
			All	1.5	2.4	4.0	7.0	12.1	20.3	40.5	6.61*
Asia, South	11	8	M	1.2	1.9	3.0	5.1	8.5	13.8	26.2	5.63*
			F	1.6	2.5	4.0	6.7	11.2	18.1	34.3	
			All	1.9	3.0	4.9	8.3	14.0	23.0	44.1	7.70
Asia, Southeast	6	2	M	1.8	2.6	3.9	6.2	9.8	15.0	26.4	7.64
			F	1.8	3.0	5.1	9.0	16.0	27.2	54.9	
			All	3.3	4.4	6.0	8.3	11.5	15.6	23.5	7.15*
EUROPE											
Europe, Western	65	54	M	1.1	1.8	2.8	4.7	7.8	12.6	23.7	6.67*
			F	2.0	3.2	5.2	8.7	14.6	23.7	45.1	
			All	1.6	2.6	4.3	7.3	12.4	20.5	39.8	6.80
Europe, Central	4	3	M	1.6	2.3	3.3	4.9	7.3	10.6	17.3	5.18
			F	1.8	2.6	4.0	6.3	10.0	15.4	27.1	
			All	1.1	1.8	2.9	5.0	8.5	14.0	27.1	4.65*
THE AMERICAS											
North America (USA only)	10	6	M	1.3	2.1	3.7	6.8	12.3	21.6	45.2	6.77*
			F	1.0	1.8	3.3	6.4	12.5	23.2	52.7	
			All	1.0	1.7	3.0	5.7	10.6	19.1	41.6	5.73
Latin America	13	9	M	1.4	2.4	4.3	7.4	12.6	21.6	43.7	8.41*
			F	1.3	2.5	4.7	8.9	16.5	30.7	69.4	
			All	1.5	2.6	4.8	8.6	15.2	27.0	57.5	8.34
AFRICA											
Sub-Saharan Africa	9	7	M	1.0	1.5	2.3	3.8	5.7	9.2	17.5	*5.47
			F	2.0	3.0	4.6	7.5	11.5	18.6	35.8	
			All	1.3	2.0	3.1	5.1	8.0	13.1	25.7	4.63

† Standardised using Western Europe as the standard population
* These estimates were used to generate the numbers of people with dementia

prevalence. Age-specific estimates had to be used for Australasia, East Asia, Southeast Asia, and Central Europe. To facilitate comparison between regions and with previous estimates for the same regions, we calculated overall standardised prevalence for all those aged 60 and above, using Western Europe as the standard population[23].

2.3.6 Generation of prevalence estimates for other GBD regions where it was not possible to conduct a meta-analysis

When a lack of available data for a region prevented us from conducting a meta-analysis, our default option was to apply the relevant estimates from the Lancet/ADI Delphi consensus conducted in 2005, representing the best available estimates of likely dementia prevalence in those regions[24]. This process was no longer necessary for Central Europe or the sub-Saharan Africa regions, for which meta-analyses were conducted as part of this update. Lancet/ADI Delphi consensus estimates were therefore only applied to Central Asia, Oceania, Eastern Europe, the Caribbean and North Africa/Middle East. This was complicated by the mismatch between the 14 WHO world regions (based on geography and patterns of mortality) and the 21 new WHO GBD regions (based on geography alone). Using the same general strategy as for the 2009 World Alzheimer Report, we therefore applied the relevant ADI/Lancet regional age-specific estimates to each country in the GBD region, and then aggregated prevalence as a weighted average across the region. For some countries, we felt that recent good quality studies arguably provided better estimates for that country (and in some instances for some of its neighbours) than the ADI/Lancet regional estimate. This applied to the following GBD regions and countries:

Caribbean – Cuba[7, 25, 26], Dominican Republic[7] and Puerto Rico[27]

North Africa/Middle East – Egypt[28-30] (applied to Egypt, and three other EMRO D countries - Iraq, Morocco and Yemen, and Algeria (AFRO D), Turkey[31-33] (applied to Turkey)

The age-specific aggregated dementia prevalence estimates for each region are provided in Table 2.5. To facilitate comparison between regions, we have again calculated overall age- and age- and gender-specific standardised prevalence for all those aged 60 and over, using Western Europe as the standard population.

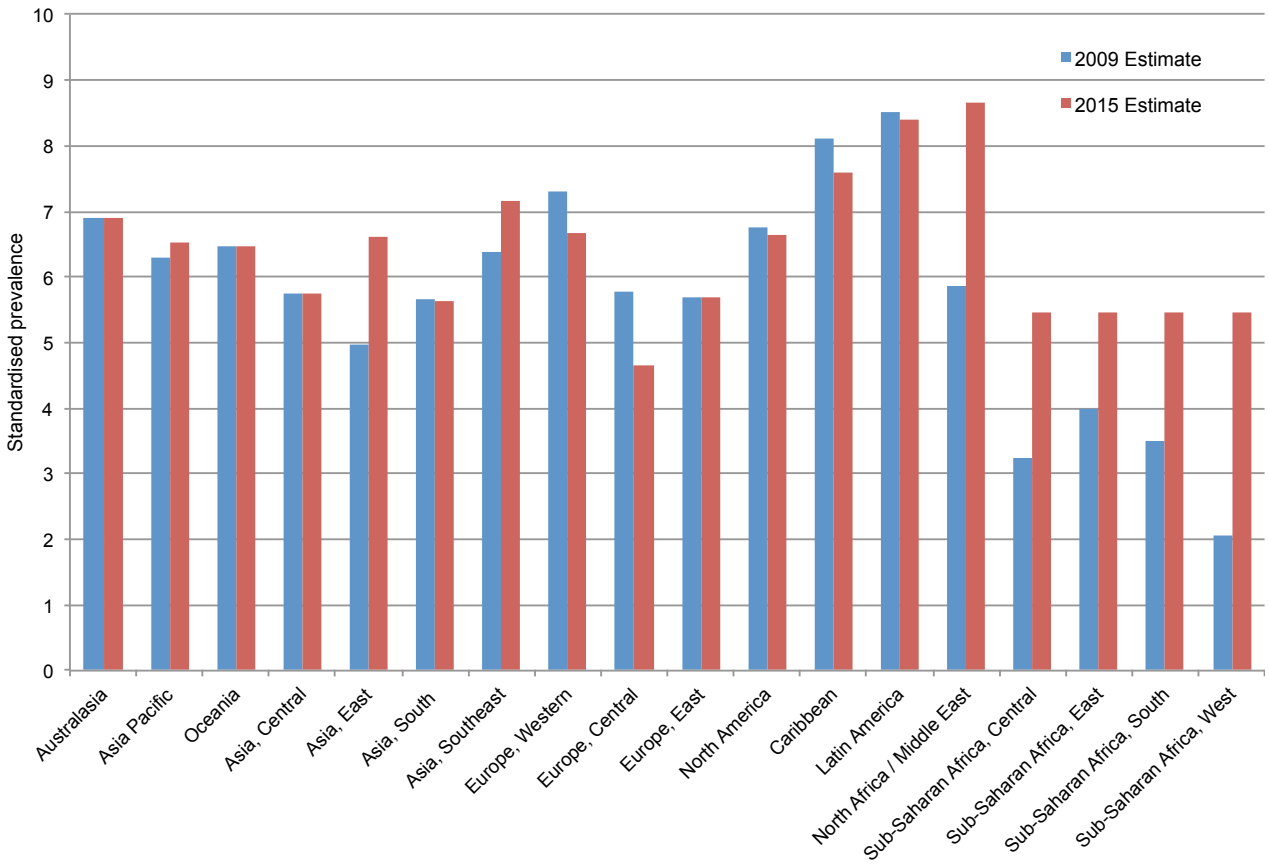
2.3.7 Final summary of estimated prevalence

Estimated prevalence for all those aged 60 years and over, standardised to the Western European population structure, can be compared directly between the 21 GBD regions and between our 2009 and updated estimates (Figure 2.3). The highest standardised prevalences were those in North Africa/Middle East (8.7%) and Latin America (8.4%), and the lowest in Central Europe (4.7%). The other regions occupied a fairly narrow band of prevalence, ranging between roughly 5.6% and 7.6%. When compared with the results of our 2009 systematic review and meta-analysis (age, or age and gender standardised to the same Western European population) the estimates for most regions remain broadly similar. This is not surprising given the relatively small number of new studies for most regions. However, the evidence base has expanded significantly for the East Asia, sub-

Table 2.7
Estimates of dementia prevalence (%) for GBD regions where it was not possible to carry out a quantitative meta-analysis

	Sources of prevalence data used to calculate regional weighted average	60-64	65-69	70-74	75-79	80-84	85+	Age-standardised prevalence For all those aged 60 years and over
ASIA								
Asia, Central	EURO B, EURO C	0.9	1.3	3.2	5.8	12.1	24.7	5.75
Oceania	WPRO B	0.6	1.8	3.7	7.0	14.4	26.2	6.46
EUROPE								
Europe, Eastern	EURO C	0.9	1.3	3.2	5.8	11.8	24.5	5.70
THE AMERICAS								
Caribbean	AMRO B, AMRO D, Cuba[7, 25], Dominican Republic[7], Puerto Rico[27]	1.6	2.9	4.4	8.5	14.3	30.7	7.58
AFRICA								
North Africa / Middle East	EMRO B, Egypt[28-30], Turkey[31-33]	2.2	3.6	6.0	9.7	16.4	29.4	8.67

Figure 2.3
Estimated prevalence of dementia for those aged 60 and over, standardised to Western Europe population, by GBD region



Saharan Africa, and North Africa/Middle East regions, and review of the additional evidence has resulted, in each case, in a revision upwards of previous estimates. It should be stressed that this should not be taken to indicate a trend towards an increasing prevalence over time. For China, many of the 'new' studies were conducted pre-2009 but were not available for the previous review, which excluded Chinese language publications. For North Africa/Middle East, evidence from studies has replaced the opinion of the ADI/ Lancet Delphi expert consensus panel[24] for several of the more populous countries in the region. Even where more recent studies do record a higher prevalence, as previously highlighted, factors other than temporal trends may account for the more recent studies having recorded higher prevalences.

2.3.8 Estimation of numbers of people with dementia

Having applied the age-specific, or age- and gender-specific prevalence estimates to the UN population projections (see method section for details), we estimate that **46.8 million people worldwide are living with dementia in 2015** (Table 2.6 and Figure 2.4). This number will almost double every 20 years, to **74.7 million in 2030** and **131.5 million in 2050**. These new estimates are 12-13% higher than those made for the World Alzheimer Report 2009 (41.5m in 2015, 65.7m in 2030 and 115.4m in 2050).

Much of the currently projected increase through to 2050 is attributable to increases in the numbers of people with dementia in low and middle income countries (LMIC). In 2009 we estimated that 58% of all people with dementia lived in LMIC, rising to 63% in 2030 and 71% in 2050. Since then the World Bank classification of income-level has changed for several countries. If we apply the 2009 World Bank classification, in 2015 64% of all people with dementia are living in countries which were considered LMIC in 2009, and this proportion would rise to 67% in 2030 and 72% in 2050. According to the current World Bank classification (Figure 2.4) **in 2015, 58% of all people with dementia live in LMIC, rising to 63% in 2030 and 68% in 2050**.

The change of World Bank income classification for some of the countries (see details in Chapter 1) has had a relatively small impact on the repartition of people with dementia between LMIC and HIC as most of the changes occurred between the three LMIC groups (upper middle income, lower middle income and low income). The numbers and proportion of people with dementia living in what are now considered low income countries has reduced accordingly. The overall pattern reported in 2009, of a greater relative growth in numbers in less compared with more developed

Figure 2.4
The growth in numbers of people with dementia (millions) in high income (HIC) and low and middle income countries (LMIC)

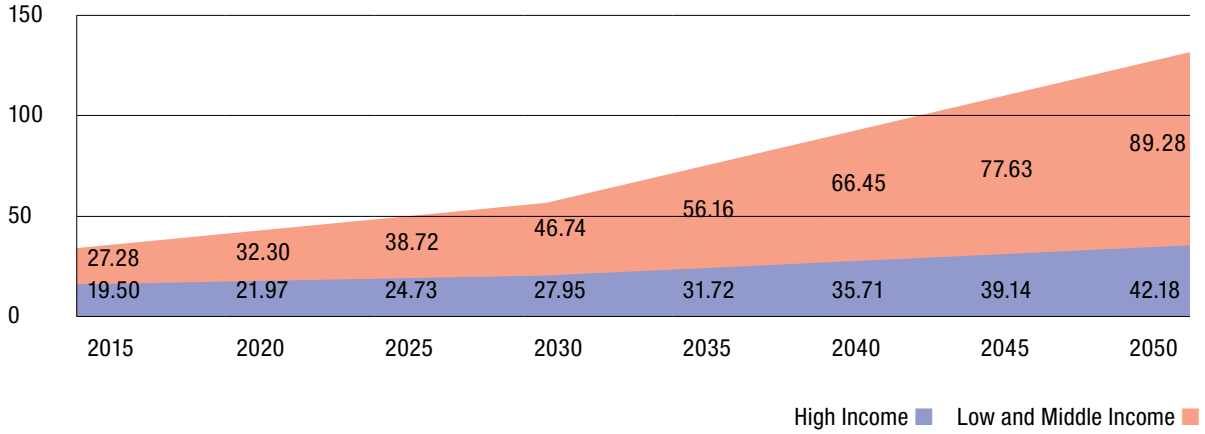


Table 2.8
Numbers of people with dementia (millions) according to the 2015 World Bank income classification

World Bank Income Group	Number of People with Dementia (millions)							
	2015	2020	2025	2030	2035	2040	2045	2050
Low Income	1.19	1.42	1.68	2.00	2.41	2.90	3.55	4.35
Lower Middle Income	9.77	11.52	13.72	16.35	19.48	23.12	27.18	31.54
Upper Middle Income	16.32	19.36	23.33	28.39	34.28	40.43	46.90	53.39
High Income	19.50	21.97	24.73	27.95	31.72	35.71	39.14	42.18
World	46.78	54.27	63.45	74.69	87.88	102.15	116.78	131.45

Table 2.9
Estimated number of people with dementia (2015, 2030 and 2050) and proportionate increases (2015-2030 and 2015-2050) according to wealth (GNP)

	People with dementia (millions) (% of world total)			Proportionate increase (%)	
Region	2015	2030	2050	2015-2030	2015-2050
G7*	12.88 (28)	18.43 (25)	26.28 (20)	43	104
G20**	37.47 (80)	58.99 (79)	99.14 (75)	57	165
G20 excluding G7	24.59 (53)	40.56 (54)	72.86 (55)	65	196
Rest of the world (excluding G20)	9.31 (20)	15.70 (21)	32.31 (25)	69	247
World	46.78 (100)	74.69 (100)	131.45 (100)	60	181

** G7 countries: Canada, France, Germany, United Kingdom, Italy, Japan, and the United States*

*** G20 countries: Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, the United Kingdom, the United States and the remaining EU member countries (Cyprus, Austria, Belgium, Croatia, Czech Republic, Denmark, Finland, Greece, Ireland, Luxembourg, Malta, Netherlands, Portugal, Slovenia, Spain, Sweden, Poland, Romania, Slovak Republic, Bulgaria, Estonia, Hungary, Latvia, Lithuania)*

Table 2.10
Total population over 60, crude estimated prevalence of dementia (2015), estimated number of people with dementia (2015, 2030 and 2050) and proportionate increases (2015-2030 and 2015-2050) by GBD world region

GBD Region	Over 60 population (millions, 2015)	Crude estimated prevalence (%, 2015)	Number of people with dementia (millions)			Proportionate increases (%)	
			2015	2030	2050	2015-2030	2015-2050
ASIA	485.83	4.7	22.85	38.53	67.18	69	194
Australasia	5.80	6.7	0.39	0.62	1.02	59	163
Asia Pacific High Income	52.21	7.0	3.64	5.68	7.81	56	115
Oceania	0.64	3.5	0.02	0.04	0.09	83	289
Asia, Central	7.43	4.2	0.31	0.44	0.88	43	184
Asia, East	218.18	4.5	9.77	16.60	28.64	70	193
Asia, South	139.85	3.7	5.13	8.61	16.65	68	225
Asia, Southeast	61.72	5.8	3.60	6.55	12.09	82	236
EUROPE	176.61	5.9	10.46	13.42	18.66	28	78
Europe, Western	107.89	6.9	7.45	9.99	14.32	34	92
Europe, Central	26.92	4.0	1.07	1.39	1.90	30	78
Europe, East	41.80	4.6	1.94	2.03	2.44	4	26
THE AMERICAS	147.51	6.4	9.44	15.75	29.86	67	216
North America	74.88	6.4	4.78	7.28	11.74	52	145
Caribbean	5.78	6.5	0.38	0.60	1.07	60	183
LA, Andean	5.51	6.1	0.34	0.64	1.43	88	322
LA, Central	26.64	5.8	1.54	2.97	6.88	93	348
LA, Southern	9.88	7.6	0.75	1.15	2.05	52	172
LA, Tropical	24.82	6.7	1.66	3.11	6.70	88	305
AFRICA	87.19	4.6	4.03	6.99	15.76	74	291
North Africa / Middle East	38.93	6.0	2.34	4.35	10.04	86	329
SSA, Central	4.78	3.3	0.16	0.26	0.54	60	238
SSA, East	19.86	3.5	0.69	1.19	2.77	72	300
SSA, Southern	6.06	3.9	0.24	0.35	0.58	46	145
SSA, West	17.56	3.1	0.54	0.85	1.84	58	241
WORLD	897.14	5.2	46.78	74.69	131.45	60	181

Abbreviations: LA = Latin America; SSA = Sub-Saharan Africa

regions, holds true. Between 2015 and 2050, numbers in what are now HIC will increase by 116%, in UMIC by 227%, in L-MIC by 223%, and in LIC by 264%.

28% of all people living with dementia live in the world's seven richest economies (the G7), while 80% live in the world's 20 richest countries (the G20) (Table 2.9).

According to our revised estimates, in 2015, East Asia is the world region with the most people living with dementia (9.8 million), followed by Western Europe (7.4 million). These regions are closely followed by South Asia with 5.1 million and North America with 4.8 million. At the country level, ten countries are home to over a million people with dementia in 2015: China (9.5 million), USA (4.2 million), India (4.1 million), Japan (3.1 million), Brazil (1.6 million), Germany (1.6 million), Russia (1.3 million), Italy (1.2 million), Indonesia (1.2 million) and France (1.2 million).

Our projections for growth in the number of people with dementia support our previous prediction that regional trends fall into three broad groups. Developed regions started from a high base but will continue to experience only a moderate proportionate increase. Latin America and Africa started from a low base but will continue to experience a particularly rapid increase in numbers. India, China, and their south Asian and western-pacific neighbours started from a high base and will also continue to experience relatively rapid growth. These trends are driven mainly by population growth and demographic ageing (Table 2.9). Over the next fifteen years we forecast a 28% increase in numbers in Europe, 52% in North America, 52% in the southern Latin American cone and 56% in the high income Asia Pacific countries. These rates are noticeably lower than the predicted 68% growth in South Asia, 70% in East Asia, 82% in Southeast Asia, 86% in North Africa and the Middle East, and 88-93% in the rest of Latin America. Predictions of growth for Southern sub-Saharan Africa are more modest, consistent with projections for demographic ageing in the light of persistent high child mortality and the effects of the HIV epidemic.

2.4 Conclusions and recommendations

Through systematically reviewing the research evidence for dementia prevalence in population-based surveys, and applying strict inclusion and exclusion criteria, we have identified 273 population-based studies of the prevalence of dementia, with 605,337 individual participants. This is 106 more studies than were identified in 2009. We identified sufficient studies to carry out quantitative regional meta-analyses applicable to 16 of the 21 WHO Global Burden of Disease regions, and several of the previous meta-analyses were enhanced by the inclusion of more recent studies. This is five more regions than we were able to meta-analyse in 2009, due to new evidence from Central Europe and sub-Saharan Africa. The number of studies for East Asia has expanded considerably, both because of further studies published since 2009, and because we were now able to assess and include more pre-2009 Chinese language publications. For regions in which we were unable to conduct a meta-analysis, we were able to supplement the previous ADI/Lancet estimates with data from well-conducted studies, which could be applied to the country concerned and, where appropriate, to some of its regional neighbours. Our estimates are therefore increasingly data-based, and we are close to achieving our aim of doing away with the need for estimates based upon expert opinion.

Our updated prevalence estimates suggest that our 2009 meta-analysis underestimated the current and future scale of the dementia epidemic by 12-13%. In highlighting some of the key changes in estimates of regional prevalence, it is important to reiterate that these updated estimates reflect improvements in the extent and quality of the available evidence, and hence, we would hope, in the precision of the estimates. The increases in our estimates should certainly not be taken to imply that the underlying age-specific prevalence of dementia has changed over the short interval between the two reports.

- A considerable increase (6.6% vs. 3.2%) in the prevalence estimates for East Asia, a region that includes the vast population of China and an estimated 218 million older people in 2015.
- Modest to considerable increases (5.5% vs. 2.1-4.0%) in the prevalence estimates for all four of the sub-Saharan Africa regions.
- An important increase (8.7% vs. 5.9%) in prevalence estimates for the North Africa/Middle East region, a region accounting for 45% of Africa's population of people aged 60 years and over.
- A modest increase (5.8% vs. 4.8%) in the prevalence estimates for Southeast Asia, a region that includes the populous countries of Indonesia, the Philippines, Thailand and Vietnam, and an estimated 62 million older people in 2015.

The main limitations of this review are a) the persistently poor coverage of the evidence-base for several world regions, b) the relatively poor quality of many studies included in the review, and c) the between-study heterogeneity of prevalence estimates within regions. These limitations are each discussed below. The accuracy of our projections for future growth in the numbers of people with dementia is limited by their reliance on population projections, which have proven to be inaccurate in the past, with mis-estimations of trends in both fertility and mortality. Particular caution is advised for projections for specific countries, for population sub-groups, and for longer periods into the future. The projections also assume that age-specific prevalence in each region will remain constant over time, which is unlikely to be the case, particularly in regions undergoing rapid demographic,

epidemiologic and social change. The issue of possible secular (temporal) trends in prevalence is addressed in detail in Chapter 5.

2.4.1 Coverage

For this World Alzheimer Report, coverage of evidence has improved significantly for the East Asia, sub-Saharan Africa, Central Europe and North Africa/ Middle East regions. For the most part this relates to new evidence, from recent studies published since the World Alzheimer Report 2009. However, for East Asia, in 2009 we were dependent upon our own searches for English language publications, and a limited review that included some Chinese language publications (31 studies in all). We have now been able to access a large number of additional studies, which had been published in Chinese language journals. We are indebted to Dr Kit Yee Chan and Prof Igor Rudan for first drawing our attention to this issue through their landmark systematic review and meta-analysis of 75 studies, published in The Lancet in 2013[3]. Once the additional studies were taken into account, the prevalence for China seemed substantially higher than we had previously suspected [4]. At around the same time, Dr Wu and colleagues published a further review, including studies also from Hong Kong SAR and Taiwan (72 publications in all), with findings on prevalence which were consistent with those of the Lancet review. Dr Wu kindly reviewed our 2009 database and removed studies that were not eligible. Dr Wu and Dr Chan then added to it from their previous review, updated from 2011 to the present day. Throughout, they applied the ADI World Alzheimer Report inclusion and exclusion criteria. The result is 89 eligible studies from 1980 to 2015.

Coverage in several other regions remains inadequate. Eastern Europe (including Russia) and Central Asia remain essentially uncovered by research, making our estimates for these regions highly tentative. Southeast Asia is represented by six studies, but none from Indonesia whose 22 million older people account for around 40% of the region's total population aged 60+.

In 2009, we found that descriptive population-based research into dementia in high income countries peaked in the early 1990s and then sharply decreased. This trend has not been reversed in recent years. The relative lack of coverage by recent high quality studies is now becoming a serious concern across the developed world. Prevalence may change over time and future policymaking and planning require accurate up-to-date figures. These are no longer available for most high income countries. Apart from tracking changes in disease prevalence and incidence, descriptive surveys can be used to estimate access to care, and the cost of health and social services provided for people with dementia. It may be that biomedical research funding agencies view such research as unoriginal, and hence uncompetitive when compared with population research orientated to elucidation of risk factors. Arguably, the responsibility for commissioning and funding such research should, increasingly, be devolved to governments, whose ministries and agencies will be the main clients for the data generated. Nationally representative surveys provide the best information for policymaking and planning; however, there are still only five countries (USA[11], Canada[12], Mexico[13], Korea[14] and Singapore [15]) that benefit from such information. As with the USA-ADAMS survey, dementia can be efficiently studied, using a two-phase design nested within an ongoing, nationally representative survey of ageing and health (the US Health and Retirement Survey).

2.4.2 Quality

In 2009, we expressed several concerns regarding the quality of prevalence studies as assessed in the reviews, particularly since the problems identified can all lead to biased, inaccurate estimates of prevalence and numbers. Two main issues were highlighted:

- diagnostic procedures for dementia, which often lack a multi-domain cognitive test battery, an informant interview, a structured disability assessment (which could form part of the informant interview) and a clinical interview to exclude other causes of cognitive impairment.
- misapplication of study designs involving two or more phases, when no screen negatives are included at the second stage and/or no weighting back is carried out in order to estimate the prevalence correctly.

Encouragingly, there has been a noticeable improvement in diagnostic assessments in dementia prevalence surveys, as more than 50% of the most recent studies included a comprehensive dementia assessment. However, the informant interview is still frequently missing from this assessment. More worryingly, analysis of studies carried out post-2005 reveals that multiphase studies remain enduringly popular (78% of all studies), but if anything somewhat less likely to be designed and/or implemented correctly (only 11% of multiphase studies). The correct procedures for designing, conducting and analysing multiphase studies are very well established[34], but it appears that awareness remains poor among dementia researchers. It is therefore important to reiterate our previous recommendations. Research funders and ethics committees should not fund or approve study designs that are faulty in this respect. Journals should adopt clear policies regarding multiphase studies. For studies that correctly sample a subset of screen negatives, journals should not publish findings until results are weighted back in the analysis to account for different sample fractions. Completed studies that did not perform diagnostic analysis on a sample of screen negatives should, of course, still be published,

but with the limitation clearly acknowledged, and a clarification that the study reports minimum prevalence of dementia.

It is both reassuring, and somewhat puzzling, that no clear effect on dementia prevalence of incorrect application of two-phase design, compared with one phase design, can be detected in either of the two regional meta-regressions carried out for this report. Neglecting to sample screen negatives, and/or weight back should always tend to underestimate true prevalence. However, two phase studies have an additional generic problem of substantial attrition between the first (screening) and second (diagnostic) phases. Its effect is difficult to predict; true dementia cases would need to be under-represented among losses between the two phases to counteract the likely effect of incorrect application of the two phase design. Attrition can be minimised by shortening any delay between the two phases. Multiple imputation could be used to correct for the lost diagnostic data in the second phase.

Overall, we observed a tendency for improvement in study quality in recent years, with high quality studies especially in Latin America and sub-Saharan Africa. We have been able to perform a detailed quality assessment of Chinese studies, which was not possible in our previous reviews. These raise concerns over the quality of studies from that region, with only 5% of multistage designs applied correctly and only 15% of studies using a comprehensive diagnostic assessment. The overall quality score, of 6.2, is the lowest for all world regions. Efforts need to be made internationally to ensure dissemination of good research practice, possibly including the development of guidelines.

2.4.3 Heterogeneity

A fundamental assumption, implicit in the modelling approach in this review, was that the prevalence of dementia was uniform within GBD regions. This could then be estimated from the available evidence and applied to all countries in that region. Similarly to our previous observations in 2009, we observed statistically significant heterogeneity of age- and gender-specific prevalence in almost all regions. Heterogeneity has slightly decreased for some regions, and increased for others. In many ways, this is not surprising given the varied languages, cultures, levels of development, and demographic compositions of the national and sub-national units that make up a GBD world region. Indeed, despite the statistical significance of the heterogeneity, arguably one should be more impressed by the similarity rather than the differences in prevalence between studies.

We were only able to explore the possible factors explaining heterogeneity in two regions, Western Europe and East Asia, and with a limited number of covariates. For Western Europe, there seemed to be significant between-country variation, although this did not seem to follow any readily interpretable pattern. For East Asia, as noted in two previous meta-analyses, there was a substantial trend towards a higher prevalence for more recently conducted studies. While this may indicate an increase in the true underlying prevalence over time, Wu et al.[21] have pointed out that the temporal trend is considerably diminished when controlling for study methodological factors, particularly the diagnostic criteria applied. A higher prevalence was recorded in studies using more recent (DSM-IV, 10/66, GMS/AGECAT) versus older (DSM-III, DSM-III-R and ICD-10) diagnostic criteria. It will, in truth, be difficult definitively to disentangle these two competing explanations for the striking temporal trend observed in the region. Our decision, to focus in our regional meta-analysis on more recent studies from China (post-2005), was justifiable, in our view, in either case.

Methodological variability can be reduced through standardisation of study procedures. Common sense indicates that the way in which the diagnosis of dementia is defined and applied may be among the most important sources of variability. Currently, DSM-IV criteria is by far the most widely applied dementia diagnosis, and although it is not fully operationalised, it is possible to do so[35]. It would also be desirable to reach an international consensus regarding what constitutes cognitive impairment, what constitutes social and occupational impairment, and how these should be measured. The new DSM-5 criteria for major neurocognitive disorder may be a step in this direction, but these criteria have yet to be widely adopted, and their validity are not established[36-38]. Of course, cultural adaptations may need to be applied. Clinicians understandably resist the degree of straitjacketing that full operationalisation imposes, but a parallel set of more specific research diagnostic criteria would be highly valuable. Accurate delineation of temporal trends will require studies that maintain a constant methodology over time (see Chapter 4).

References

1. Alzheimer's Disease International. World Alzheimer Report 2009. 2009.
2. Wu Y, Lee H, Norton S, Chen C, Chen H, He C, et al. Prevalence Studies of Dementia in Mainland China, Hong Kong and Taiwan: A Systematic Review and Meta-Analysis. PLOS ONE. 2013;8(6):e66252.
3. Chan KY, Wang W, Wu JJ, Liu L, Theodoratou E, Car J, et al. Epidemiology of Alzheimer's disease and other forms of dementia in China, 1990-2010: a systematic review and analysis. Lancet. 2013 6/8/2013;381(9882):2016-23.
4. Prince M. Dementia in China: east-west collaboration bears fruit. Lancet. 2013;381(9882):1967-8.
5. Prince M, Bryce R, Albanese E, Wimo A, Ribeiro W, Ferri C. The global prevalence of dementia: a systematic review and metaanalysis. Alzheimers Dement. 2013;9(1):63-75.
6. Dong MJ, Peng B, Lin XT, Zhao J, Zhou YR, Wang RH. The prevalence of dementia in the People's Republic of China: a systematic analysis of 1980-2004 studies. Age Ageing. 2007 11/2007;36(6):619-24.

7. Llibre Rodriguez J, Ferri C, Acosta D, Guerra M, Huang Y, Jacob K, et al. Prevalence of dementia in Latin America, India, and China: a population-based cross-sectional survey. Lancet. 2008;372(9637):464-74.
8. Guerchet M, Houinato D, Paraiso MN, von Ahsen N, Nubukpo P, Otto M, et al. Cognitive impairment and dementia in elderly people living in rural Benin, West Africa. Dementia and Geriatric Cognitive Disorders. 2009 2009;27(1):34-41.
9. Paraiso MN, Guerchet M, Saizonou J, Cowppli-Bony P, Mouanga AM, Nubukpo P, et al. Prevalence of dementia among elderly people living in Cotonou, an urban area of Benin (West Africa). Neuroepidemiology. 2011 2011;36(4):245-51. PubMed PMID: 2011579187.
10. Guerchet M, M'Belesso P, Mouanga AM, Bandzouzi B, Tabo A, Houinato DS, et al. Prevalence of dementia in elderly living in two cities of Central Africa: The EDAC survey. Dementia and Geriatric Cognitive Disorders. 2010 2010;30(3):261-8.
11. Plassman BL, Langa KM, Fisher GG, Heeringa SG, Weir DR, Ofstedal MB, et al. Prevalence of dementia in the United States: the aging, demographics, and memory study. Neuroepidemiology. 2007 2007;29(1-2):125-32.
12. Canadian Study of Health and Ageing. Canadian study of health and aging: study methods and prevalence of dementia. CMAJ. 1994 3/15/1994;150(6):899-913.
13. Mejia-Arango S, Gutierrez LM. Prevalence and incidence rates of dementia and cognitive impairment no dementia in the Mexican population: data from the Mexican Health and Aging Study. Journal of Aging & Health. 2011 Oct;23(7):1050-74. PubMed PMID: 21948770. Pubmed Central PMCID: NIHMS424244 PMC3557523.
14. Kim KW, Park JH, Kim M-H, Kim MD, Kim B-J, Kim S-K, et al. A nationwide survey on the prevalence of dementia and mild cognitive impairment in South Korea. Journal of Alzheimer's Disease. 2011 2011;23(2):281-91.
15. Subramaniam M, Chong S, Vaingankar J, Abdin E, Chua B, Chua H, et al. Prevalence of Dementia in People Aged 60 Years and Above: Results from the WiSE Study. J Alzheimers Dis. 2015;45(4):1127-38.
16. The Medical Research Council Cognitive Function and Ageing Study (MRC CFAS). Cognitive function and dementia in six areas of England and Wales: the distribution of MMSE and prevalence of GMS organicity level in the MRC CFA Study. Psychological Medicine. 1998 1998;28:319-35.
17. Ben-Arie O, Swartz L, Teggin AF, Elk R. The coloured elderly in Cape Town--a psychosocial, psychiatric and medical community survey. Part II. Prevalence of psychiatric disorders. SAfrMedJ. 1983 12/24/1983;64(27):1056-61.
18. The 10/66 Dementia Research Group. Methodological issues in population-based research into dementia in developing countries. A position paper from the 10/66 Dementia Research Group. International Journal of Geriatric Psychiatry. 2000 2000;15:21-30.
19. Prince M. Commentary: Two-phase surveys. A death is announced; no flowers please. IntJEpidemiol. 2003 12/2003;32(6):1078-80.
20. Matthews FE, Arthur A, Barnes LE, Bond J, Jagger C, Robinson L, et al. A two-decade comparison of prevalence of dementia in individuals aged 65 years and older from three geographical areas of England: results of the Cognitive Function and Ageing Study I and II. Lancet. 2013 10/26/2013;382(9902):1405-12.
21. Wu YT, Lee HY, Norton S, Prina AM, Fleming J, Matthews FE, et al. Period, birth cohort and prevalence of dementia in mainland China, Hong Kong and Taiwan: a meta-analysis. IntJGeriatrPsychiatry. 2014 5/22/2014:10.
22. Wu Y, Brayne C, Matthews F. Prevalence of dementia in East Asia: a synthetic review of time trends. Int J Geriatr Psychiatry. 2015;30(8):793-801.
23. Hofman A, Rocca WA, Brayne C, Breteler MM, Clarke M, Cooper B, et al. The prevalence of dementia in Europe: a collaborative study of 1980-1990 findings. Eurodem Prevalence Research Group. IntJ Epidemiol. 1991 1991;20(3):736-48.
24. Ferri CP, Prince M, Brayne C, Brodaty H, Fratiglioni L, Ganguli M, et al. Global prevalence of dementia: a Delphi consensus study. Lancet. 2005 12/17/2005;366(9503):2112-7.
25. Llibre J, Fernández Y, Marcheco B, Contreras N, López A, Otero M, et al. Prevalence of Dementia and Alzheimer's Disease in a Havana Municipality: A Community-Based Study among Elderly Residents. MEDICC Review. 2009;11(2):29-35.
26. Llibre RJ, Valhuerdi A, Sanchez II, Reyna C, Guerra MA, Copeland JR, et al. The Prevalence, Correlates and Impact of Dementia in Cuba. A 10/66 Group Population-Based Survey. Neuroepidemiology. 2008 10/20/2008;31(4):243-51.
27. Jiménez-Velázquez I. Dementia & Alzheimer's Research in Puerto Rico 2014. Available from: http://www.alz.co.uk/sites/default/files/conf2014/PL02.pdf.
28. El Tallawy HN, Farghly WMA, Shehata GA, Rageh TA, Hakeem NA, Abo-Elfetoh N, et al. Prevalence of dementia in Al Kharga District, New Valley Governorate, Egypt. Neuroepidemiology. 2012;38(3):130-7. PubMed PMID: 20123201806.
29. El Tallawy HN, Farghly WM, Badry R, Rageh TA, Shehata GA, Hakeem MNA, et al. Prevalence of dementia in Al-Quseir city, Red Sea Governorate, Egypt. Clinical Interventions in Aging. 2014 Dec 2013;9(pp 9-14). PubMed PMID: 2013788203.
30. Farrag A, Farwiz HM, Khedr EH, Mahfouz RM, Omran SM. Prevalence of Alzheimer's disease and other dementing disorders: Assiut-Upper Egypt study. DementGeriatrCogn Disord. 1998 11/1998;9(6):323-8.
31. Arslantas D, Ozbabalik D, Metintas S, Ozkan S, Kalyoncu C, Ozdemir G, et al. Prevalence of dementia and associated risk factors in Middle Anatolia, Turkey. Journal of Clinical Neuroscience. 2009 Nov;16(11):1455-9. PubMed PMID: 19748273.
32. Keskinoglu P, Yaka E, Ucku R, Yener G, Kurt P. Prevalence and risk factors of dementia among community dwelling elderly people in Izmir, Turkey. Turk Geriatri Dergisi. 2013;16(2):135-41. PubMed PMID: 2013370970. Izmir'de yasayan yaslilarda demans sikligi ve risk etmenleri.
33. Gurvit H, Emre M, Tinaz S, Bilgic B, Hanagasi H, Sahin H, et al. The prevalence of dementia in an urban Turkish population. Am J Alzheimers Dis Other Demen. 2008;23(1):67-76.
34. Dunn G, Pickles A, Tansella M, Vazquez-Barquero JL. Two-phase epidemiological surveys in psychiatric research. British Journal of Psychiatry. 1999 1999;174:95-100.
35. Prince MJ, de Rodriguez JL, Noriega L, Lopez A, Acosta D, Albanese E, et al. The 10/66 Dementia Research Group's fully operationalised DSM-IV dementia computerized diagnostic algorithm, compared with the 10/66 dementia algorithm and a clinician diagnosis: a population validation study. BMCPublic Health. 2008 2008;8:219.
36. Sachdev P, Blacker D, Blazer D, Ganguli M, Jeste D, Paulsen J, et al. Classifying neurocognitive disorders: the DSM-5 approach. Nat Rev Neurol. 2014;10(11):634-42.
37. Rogers D, Evans B, Roberts C, Cuc A, Mittenberg W. Neuropsychologists' Preferences for DSM-5 versus ICD-10, NINDS, or Other Diagnostic Criteria. Arch Clin Neuropsychol. 2014;29(6):554.
38. Tay L, Lim W, Chan M, Ali N, Mahanum S, Chew P, et al. New DSM-V Neurocognitive Disorders Criteria and Their Impact on Diagnostic Classifications of Mild Cognitive Impairment and Dementia in a Memory Clinic Setting. Am J Geriatr Psychiatry. 2015;23(8):768-79.

CHAPTER 3

The incidence of dementia

3.1 Introduction

In 2012, a systematic review of the incidence of dementia worldwide was published in the WHO report 'Dementia: a public health priority'[1]. We found 39 potentially eligible studies, of which 34 were fully eligible to be included in the meta-analysis. These studies covered 10 different regions (Western Europe, North America, East Asia, Latin America Andean, Latin America Central, Latin America Tropical, Caribbean, Australasia, Asia Pacific, and West Sub-Saharan Africa) and meta-analysed their results. The incidence of dementia increased exponentially with increasing age. For all studies combined, the incidence of dementia doubled with every 5.9 year increase in age, from 3.1/1000 person years (pyr) at age 60-64 to 175.0/1000 pyr at age 95+. Dementia incidence appeared to be higher in countries with high incomes (doubling every 5.8 years from 3.4/1000 pyr to 202.2/1000 pyr) than in low or middle income countries (doubling every 6.7 years from 2.9/1000 pyr to 99.4/1000 pyr).

The total number of new cases of dementia each year worldwide was then estimated to be nearly 7.7 million, implying one new case every 4.1 seconds.

The dementia incidence evidence-base found at that time was not as extensive as that for the prevalence of dementia, with good coverage for Europe, some recent studies for Latin America and China, but relatively few North American studies, underrepresentation of Africa and East Asia, and no evidence at all for South or South East Asia.

Since 2012, no further systematic reviews of the incidence of dementia have been published. A better understanding of the pattern and level of incidence in different world regions is essential.

3.2 Methods

3.2.1 Systematic review

The systematic review on the incidence of dementia followed a similar process to the review of prevalence (see Chapter 2). We updated a systematic review of the world literature conducted in 2011 for the WHO report 'Dementia: a public health priority'[1]. We aimed to identify population-based studies of the incidence of dementia, defined according to DSM-IV, ICD-10 or similar clinical criteria, including people aged 60 years

and over, and for which the field work for the baseline phase started on or after 1st January 1980.

Two teams searched English and Chinese databases separately to update our previous review. The following search strategy was used to identify relevant papers published in any language.

English Database Search
Search date: February 2015
Databases: EMBASE, Global Health, MEDLINE, PsychExtra and PsychInfo
Search terms: dementia AND (incidence OR epidemiology)

Chinese Database Search
Search date: March 2015
Databases: CNKI, Wanfang, Airti
Search terms: (癡呆/dementia OR 失智/dementia OR 阿爾茨海默/Alzheimer) AND (發生率/incidence OR 發病率/incidence OR 流行/epidemiology)

Again, all stages of the search were completed by two independent reviewers. For the English search, all abstracts were read by GA and by either YW or MG. Papers were excluded at this stage only when the abstract clearly demonstrated that the paper did not meet the above criteria. PDF copies of the remaining publications were read by GA and by either YW or MG, and a consensus was made on those that met all criteria. These papers were published in English, Spanish and Portuguese, all of which could be read by our team using translation programmes. The Chinese search was conducted independently by YW and KC, who compared their study selection at each stage of screening and review.

3.2.1 Data extraction

All eligible studies were systematically coded for their study design and characteristics according to the following criteria:

1 Country
2 WHO/Global Burden of Disease World Region (see Appendix A for list of countries and regions)
3 Inclusion of urban or rural areas
4 Start and finish dates for fieldwork
5 Lower and upper age limits
6 Sampling strategy (whole population, catchment area, random sampling, stratified random sampling)
7 Design (cohort study)
8 Overall sample size
9 Response rate
10 Case ascertainment (community survey only or community + institution survey)
11 Diagnostic criteria (not specified, ICD, DSM, GMS/AGECAT, CAMDEX, other clinical criteria)
12 Presence of clinical diagnosis
13 Diagnostic Instruments (GMS/AGECAT, CAMDEX, MMSE, Dementia Differential Scale, Hachinski Ischemic Index, consensus panel, physical/neurological examination, standardised questionnaire, clinical evaluation, other).

Incidence data was extracted from the studies as follows.

According to the data presented in the paper, we extracted numerator (case) and denominator (person-years), incidence and standard error, or incidence and 95% confidence intervals. Where not provided, numerator and denominator could then be calculated from any of these combinations.

Incidence estimates were stratified differently in different publications. To maximise the precision of our meta-analysis, we required incidence estimates in five-year age-bands. If this was not available in the publication, we wrote to the authors to request age-specific incidence data. We could therefore model the effect of age on dementia incidence for all included studies.

3.2.2 Meta-analysis to estimate incidence rates and heterogeneity

As for the meta-analysis of prevalence data (see Chapter 2) we used a random effect exponential (Poisson) model to assess the effect of age on the incidence of dementia. The alpha coefficient is an estimate of over-dispersion and an index of between study heterogeneity. Age was coded as the mean for each age group reported. We conducted separate meta-regressions on all studies combined, and then separately for high-income countries, low and middle income countries, and for those regions where there was sufficient data to attempt a meta-analysis (Asia East, Western Europe, North America and Latin America and the Caribbean combined). We then applied the relevant mean ages to the coefficients estimated from the models, to estimate incidence in five years age-bands from 60-95 years, and for those aged 90 and over. We further estimated the effect of region and of high income country vs. low or middle income country location.

3.3 Results

3.3.1 Number of studies

In total, 23 new potentially eligible incidence studies were identified (to add to the 39 potentially eligible studies already identified in 2011). Eleven of these had to be excluded from the meta-analysis because case (numerator) and person-years (denominator) data could not be extracted[2-12]. We therefore identified twelve new fully eligible studies of which two had been conducted in Western Europe (Italy[13] and the Netherlands[14]), four in North America (all in the USA [15-18]), one in Latin America (Mexico[19]), four in East Asia (China[20-23]) and one in South Asia (India[24]).

Added to the 34 studies included in the meta-analysis for the previous systematic review, 46 studies could be included in the global meta-analysis. For a complete list of studies included in the meta-analysis, see the online appendix at www.alz.co.uk/research/world-report-2015

3.3.2 Coverage

While the evidence base from Europe and North America dominated, 26 of the 62 studies were from outside these regions, and 23 studies were conducted in low- or middle-income countries. The proportion of new studies conducted in low- and middle-income countries was 48% (up from just 31% of studies in the original review). There were no studies at all from ten of the GBD regions: Oceania, Southeast Asia, Central Asia, Central Europe, Eastern Europe, North Africa/ Middle East, Southern, Central and Eastern Sub-Saharan Africa and Latin America Southern. South Asia now has two studies (both from India) where previously there were none. Five studies (four in Europe and one in the USA) focused on those aged 80 or over, also known as 'oldest old'.

3.3.3 Incidence study characteristics

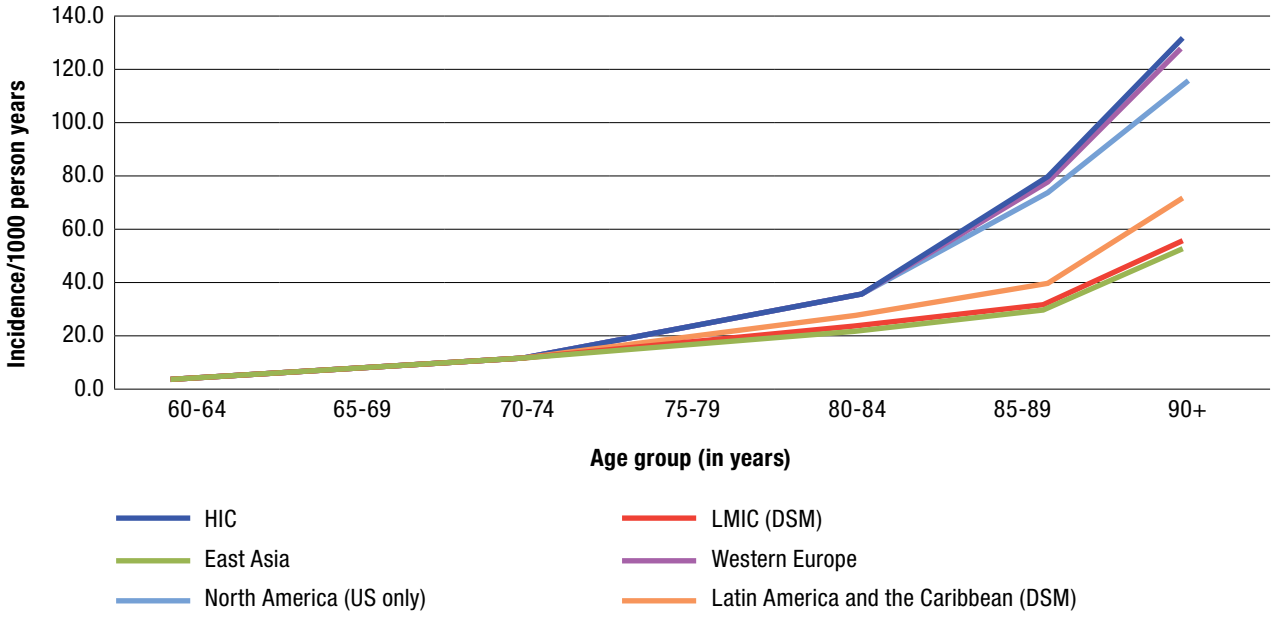
Collectively, the meta-analysed studies included 109,952 older people 'at risk' and accumulated 332,323 person-years of follow-up. The median cohort size at risk was 1,774 (interquartile range 1,187-3,208) and the median person-years were 5415 (interquartile range 3,044-10,225). The Western European studies contributed 42% of the total person years, the North American studies 24%, the East Asian studies 16%, and the Latin American studies 13%. Just 5% of person-years are contributed by the studies from Australasia, Asia Pacific, South Asia and sub-Saharan Africa West combined. For two studies, the research diagnostic criteria were not clearly specified. Accounting for the fact that in some studies more than one set of diagnostic criteria were applied, three studies applied DSM III criteria, 18 applied DSM-III-R criteria, and 21 applied DSM-IV criteria. The six 10/66 Dementia Research Group studies applied their own 10/66 Dementia Criteria, four applied ICD-10 criteria, and one applied GMS-AGECAT.

3.3.4 Estimation of the incidence of dementia

The incidence of dementia increases exponentially with increasing age. For all studies combined, the incidence of dementia doubles with every 6.3 year increase in age, from 3.9/1000 person years (pyr) at age 60-64 to 104.8/1000 pyr at age 90+ (see Figure 3.1). The incidence of dementia appears to be higher in countries with high incomes (doubling every 5.8 years from 3.5/1000 pyr to 124.9/1000 pyr) than in low or middle income countries (doubling every 8.6 years from 5.2/1000 pyr to 58.0/1000 pyr).

Overall the incidence of dementia in LMIC was only 10% lower (RR 0.90, 95% CI: 0.70-1.15) than in countries with high incomes, and, in contrast to our previous meta-analysis, was not statistically significant. The use of the DSM-IV or the cross-culturally validated 10/66 Dementia criteria in the 10/66 Dementia Research Group studies in Latin America and China did not make any difference to overall incidence estimates (RR 1.01, 95% CI: 0.78-1.31). There was significant heterogeneity in the incidence estimates when all studies were combined (alpha = 0.18, 95% CI: 0.12-0.28). Heterogeneity was similar for studies in

Figure 3.1
Estimated age-specific annual incidence of dementia, derived from Poisson random effects models, for world regions for which meta-analytical synthesis was feasible



HIC (0.17, 95% CI: 0.10-0.28) and LMIC (0.16, 95% CI: 0.08-0.34). Heterogeneity reduced somewhat when regions (alpha = 0.12, 95% CI: 0.08-0.19) were added to the model.

For the effect of region, compared to incidence in Western Europe, that in West sub-Saharan Africa (0.86, 95% CI: 0.39-1.88), East Asia (0.87, 95% CI: 0.62-1.21), North America 1.02, 95% CI: 0.75-1.39) and Latin America and the Caribbean (1.04, 95% CI: 0.74-1.46) was similar; and that in Australasia (1.75, 95% CI: 0.78-3.89) and Asia Pacific (1.86, 95% CI: 0.85-4.08) somewhat higher. These findings need to be interpreted cautiously since sub-Saharan Africa, Asia Pacific and Australasia were each only represented by one or two studies.

3.3.5 Estimation of the number of incident cases of dementia per year

We estimated the numbers of annual incident cases for each GBD world region by first estimating the numbers at risk (total population in each age group, minus numbers with prevalent dementia), and then by applying the appropriate incidence rate, as following:

- the Western Europe rate for the European regions,
- the North American rate for the North American region,
- the Latin American rate for the Latin American and Caribbean regions,
- the East Asian rate for the East Asian, South East Asian and South Asian regions,
- the HIC rates for the Australasia, and Asia Pacific regions
- the LMIC rates for the sub-Saharan regions, North-Africa/Middle East and Asia Central regions,
- the Global rate for the Oceania region.

The numbers of new cases increases and then declines with increasing age in each region. In Europe and the Americas peak incidence is among those aged 80-89 years, in Asia it is among those aged 75-84, and in Africa among those aged 65-74 (Table 3.2). **We estimated over 9.9 million new cases of dementia each year worldwide, implying one new case every 3.2 seconds.** These new estimates are almost 30% higher than the annual numbers of new cases estimated, for 2010, in the 2012 WHO/ADI report (7.7 million new cases, one every 4.2 seconds). The regional distribution is similar to that which we had previously reported, with 4.9 million new cases (49% of the total) in Asia, 2.5 million (25%) in Europe, 1.7 million (18%) in the Americas, and 0.8 million (8%) in Africa. Compared to our previous estimates, the proportion of new cases arising in Asia, the Americas and Africa has increased while it has decreased in Europe.

Table 3.1
Meta-analysed estimates of dementia incidence, generated from Poisson random effects models

Global Burden of Disease Region	Number of Studies Included in Meta-Analysis	Age Group							Age- and gender-standardised incidence, for those aged 60+ (using Western Europe as the standard population)
		60-64	65-69	70-74	75-79	80-84	85-89	90+	
GLOBAL	46	3.9	6.4	10.6	18.3	31.7	53.1	104.8	17.30
HIC	30	3.5	5.9	10.3	18.7	34.0	59.6	124.9	18.39
LMIC (DSM)	16	5.2	7.4	10.7	16.1	24.1	35.2	58.0	14.06
ASIA									
East Asia	8	4.9	7.0	10.3	15.4	23.2	34.1	56.6	13.51
EUROPE									
Western Europe	18	3.1	5.3	9.3	17.3	32.0	57.0	122.4	17.29
THE AMERICAS									
North America (US Only)	8	3.8	6.3	10.6	18.7	32.8	55.7	112.0	17.82
Latin America and the Caribbean (DSM)	7	4.6	7.0	11.0	17.2	26.4	40.8	72.1	15.11

Table 3.2
Estimated annual numbers of incident cases of dementia, by age group and world region

Region	60-64	65-69	70-74	75-79	80-84	85-89	90+	Total
Australasia	5,302	7,963	9,970	13,142	15,871	16,734	16,098	85,081
Asia Pacific High Income	39,964	68,251	95,253	135,498	175,788	168,684	136,890	820,329
Oceania	952	1,059	1,140	1,115	895	505	307	5,973
Asia Central	13,845	11,839	10,615	17,134	12,287	7,805	4,243	77,767
Asia East	374,859	355,070	343,826	362,013	312,414	176,473	74,229	1,998,885
Asia South	248,166	238,021	245,465	229,362	173,095	98,859	55,871	1,288,840
Asia Southeast	105,806	99,019	100,042	102,452	85,281	57,518	36,835	586,953
ASIA	788,893	781,223	806,311	860,715	775,632	526,580	324,474	4,863,827
Europe Central	24,550	32,715	39,657	61,567	77,122	65,186	46,693	347,489
Europe Eastern	41,880	45,376	54,177	117,578	97,717	94,641	55,523	506,891
Europe Western	77,053	121,116	169,166	266,762	339,361	343,308	305,006	1,621,773
EUROPE	143,483	199,207	263,000	445,907	514,200	503,135	407,221	2,476,154
North America High Income	80,601	110,721	131,327	159,018	189,253	185,889	147,345	1,004,154
Caribbean	7,893	8,953	10,857	12,187	11,118	8,148	6,846	66,001
Latin America Andean	7,967	9,003	10,283	11,202	9,863	6,302	2,822	57,442
Latin America Central	37,194	40,078	45,438	45,695	42,095	29,051	14,507	254,059
Latin America Southern	12,577	15,517	18,717	20,695	20,592	15,549	7,873	111,520
Latin America Tropical	36,707	40,754	43,609	47,986	41,267	31,747	19,290	261,361
THE AMERICAS	182,939	225,026	260,231	296,784	314,187	276,687	198,683	1,754,536
North Africa / Middle East	70,550	66,606	67,520	68,282	57,115	29,324	12,140	371,538
Sub-Saharan Africa Central	8,904	9,352	9,115	7,827	5,285	2,430	816	43,729
Sub-Saharan Africa East	35,780	38,398	37,179	33,648	25,931	13,126	5,103	189,165
Sub-Saharan Africa Southern	10,863	11,324	10,775	10,358	8,161	6,512	1,719	59,713
Sub-Saharan Africa West	33,931	35,414	33,779	27,014	16,159	6,173	1,492	153,962
AFRICA	160,030	161,095	158,368	147,129	112,651	57,563	21,271	818,106
WORLD TOTAL	1,275,345	1,366,550	1,487,911	1,750,534	1,716,669	1,363,965	951,650	9,912,623

3.4 Discussion

While systematically reviewing the evidence for dementia incidence in population-based surveys, we have identified 12 new population-based studies of the incidence of dementia, including a total of 37,728 new participants 'at risk' in our meta-analysis. New evidence was identified for 6 different regions of the 21 WHO Global Burden of Disease regions. Only one of those regions (South Asia) was not represented in our last meta-analysis in 2012; the number of studies has expanded for four other regions.

The meta-analysed evidence-base for the incidence of dementia is still not as extensive, in terms of coverage, as that for the prevalence of dementia. While the coverage for Europe has not changed much, with only two new studies added to the meta-analysis, a clear improvement has been observed in North America with four new cohort studies included[15, 16, 18, 25]. The meta-analysis's coverage for East Asia has increased with four new studies from China[20-23], but there is still no evidence from Central or Southeast Asia. Likewise, the African continent is currently still only represented by one study.

With a larger number of studies, and only modest heterogeneity among studies included in this review, our new estimates indicated that the incidence of dementia in LMIC was only 10% lower than in countries with high incomes, a non-statistically significant difference. The use of the DSM-IV or the cross-culturally validated 10/66 Dementia criteria in the 10/66 Dementia Research Group studies in Latin America and China did not have a significant impact upon the meta-analysed estimate of global incidence. However, the incidence of 10/66 dementia is higher than that of DSM-IV dementia[26], and when the 10/66 criterion is applied in the meta-analysis the HIC/LMIC country incidence rates converge. Hence, the drift of our findings support the conclusion that there is

little variation in the incidence of dementia between countries and regions worldwide.

More research into the incidence of dementia is required to provide information on regions with no evidence, and better, more up to date and denser coverage in regions where some studies have been conducted. Incidence studies, should, ideally, be repeated using similar methodology in order to track secular trends in the incidence of dementia within populations (see Chapter 4). Incidence is most directly affected by changes in population exposure to modifiable risk factors, and would therefore be the most sensitive indicator of the success of primary prevention programs that seek to reduce dementia risk.

References

1. World Health Organization, Alzheimer's Disease International. Dementia: a public health priority. 2012.
2. Matsui Y, Tanizaki Y, Arima H, Yonemoto K, Doi Y, Ninomiya T, et al. Incidence and survival of dementia in a general population of Japanese elderly: the Hisayama study. Journal of Neurology, Neurosurgery and Psychiatry. 2009;80(4):366-70. PubMed PMID: 20093114178. Pubmed Central PMCID: 18977814.
3. Raina SK, Pandita KK, Sushil R. Incidence of dementia in a Kashmiri migrant population. Annals of the Indian Academy of Neurology. 2009;12(3):154-6. PubMed PMID: 20093315389.
4. De Deyn PP, Goeman J, Vervaet A, Dourcy-Belle-Rose B, Dam Dv, Geerts E. Prevalence and incidence of dementia among 75-80-year-old community-dwelling elderly in different districts of Antwerp, Belgium: the Antwerp Cognition (ANCOG) Study. Clinical Neurology and Neurosurgery. 2011;113(9):736-45. PubMed PMID: 20113353349.
5. Katz MJ, Lipton RB, Hall CB, Zimmerman ME, Sanders AE, Verghese J, et al. Age-specific and sex-specific prevalence and incidence of mild cognitive impairment, dementia, and alzheimer dementia in blacks and whites: A report from the Einstein aging study. Alzheimer Disease and Associated Disorders. 2012 2012;26(4):335-43. PubMed PMID: 2012695688.
6. Wallin K, Bostrom G, Kivipelto M, Gustafson Y. Risk factors for incident dementia in the very old. International Psychogeriatrics. 2013 Jul;25(7):1135-43. PubMed PMID: 23574921.
7. Chene G, Beiser A, Au R, Preis SR, Wolf PA, Dufouil C, et al. Gender and incidence of dementia in the framingham heart study from mid-adult life. Alzheimer's & Dementia: The Journal of the Alzheimer's Association Jan. 2015 10, 2014;11:310-20.
8. Ganguli M, Lee CW, Snitz BE, Hughes TF, McDade E, Chang CCH. Rates and risk factors for progression to incident dementia vary by age in a population cohort. Neurology. 2015;84(1):72-80. PubMed PMID: 20153036583.
9. Tang Z, Meng Z, Chen B. The epidemiology of dementia in Beijing. Chin J Epidemiol. 2003;24(8):734-6.
10. Wang D, Bo S, Fu Y, et al. A survey on the incidence of senile dementia and its correlates in community. Shanghai Archives of Psychiatry. 2000;12(1):10-2.
11. Zhang M, Katzman R, Chen P. Incidence of dementia and Alzheimer's disease. Chinese Journal of Psychiatry. 1998;31(4):195-98.
12. Qu et al. A preliminary analysis of the incidence of dementia and Alzheimer's disease in people aged 75 and over. Shanghai Archives of Psychiatry. 1989;7(3):159-62.
13. Noale M, Limongi F, Zambon S, Crepaldi G, Maggi S, Group IW. Incidence of dementia: evidence for an effect modification by gender. The ILSA Study. International Psychogeriatrics. 2013 Nov;25(11):1867-76. PubMed PMID: 23905558.
14. Schrijvers EM, Verhaaren BF, Koudstaal PJ, Hofman A, Ikram MA, Breteler MM. Is dementia incidence declining?: Trends in dementia incidence since 1990 in the Rotterdam Study. Neurology. 2012 May 8;78(19):1456-63. PubMed PMID: 22551732.
15. Borenstein AR, Wu Y, Bowen JD, McCormick WC, Uomoto J, McCurry SM, et al. Incidence rates of dementia, alzheimer disease, and vascular dementia in the japanese american population in seattle, WA: The kame project. Alzheimer Disease and Associated Disorders. 2014 2014;28(1):23-9. PubMed PMID: 2014135909.
16. Knopman DS, Roberts RO, Pankratz VS, Cha RH, Rocca WA, Mielke MM, et al. Incidence of dementia among participants and nonparticipants in a longitudinal study of cognitive aging. American Journal of Epidemiology. 2014;180(4):414-23. PubMed PMID: 2014568479.
17. Plassman BL, Langa KM, McCammon RJ, Fisher GG, Potter GG, Burke JR, et al. Incidence of dementia and cognitive impairment, not dementia in the united states. Annals of Neurology. 2011 2011;70(3):418-26. PubMed PMID: 2011502821.
18. Zeki Al-Hazzouri A, Haan MN, Kalbfleisch JD, Galea S, Lisabeth LD, Aiello AE. Life-course socioeconomic position and incidence of dementia and cognitive impairment without dementia in older Mexican Americans: results from the Sacramento Area Latino Study on Aging. American Journal of Epidemiology. 2011;173(10):1148-58. PubMed PMID: 20113203701.
19. Mejia-Arango S, Gutierrez LM. Prevalence and incidence rates of dementia and cognitive impairment no dementia in the Mexican population: data from the Mexican Health and Aging Study. Journal of Aging & Health. 2011 Oct;23(7):1050-74. PubMed PMID: 21948770. Pubmed Central PMCID: NIHMS424244 PMC3557523.
20. Chen R, Hu Z, Wei L, Ma Y, Liu Z, Copeland JR. Incident dementia in a defined older chinese population. PLoS ONE. 2011 Sep 2011;6(9). PubMed PMID: 2011533065.
21. Qu Q, Qiao J, Han J, Yang J, Guo F, Luo G, et al. The incidence of dementia among elderly people in Xi' an, China. Chin J Epidemiol. 2005;26(7):529-32.
22. Tang M, Liu X, Qiu C, Han H, Chen J, Lu J, et al. The incidence of dementia and Alzheimer's disease in Chengdu. Natl Med J China. 2005;42(85):3005-7.
23. Wu X, Tang Z, Fang X, Guan S, Liu H, Diao L, et al. Study on the incidence and risk factors of dementia in elderly residents from com munities in Beijing. Chin J Epidemiol. 2010;31(1):1245-9.
24. Mathuranath PS, George A, Neelima R, Sunita J, Kumar MS, Ramsekhar M, et al. Incidence of Alzheimer's disease in India: a 10 years follow-up study. Neurology India. 2012;60(6):625-30. PubMed PMID: 20133052964.
25. Plassman BL, Langa KM, Fisher GG, Heeringa SG, Weir DR, Ofstedal MB, et al. Prevalence of dementia in the United States: the aging, demographics, and memory study. Neuroepidemiology. 2007 2007;29(1-2):125-32.
26. Prince M, Acosta D, Ferri CP, Guerra M, Huang Y, Llibre Rodriguez JJ, et al. Dementia incidence and mortality in middle-income countries, and associations with indicators of cognitive reserve: a 10/66 Dementia Research Group population-based cohort study. Lancet. 2012;379(9836):50-8. PubMed PMID: 20123266009.

CHAPTER 4

Current and future secular trends

4.1 Introduction

Almost all current projections of the scale of the coming dementia epidemic, including those published by Alzheimer's Disease International[1;2] assume that the age- and gender-specific prevalence of dementia will not vary over time, and that population ageing alone (increasing the number of older people at risk) drives the projected increases[1-4]. The basis for this assumption is doubtful, and secular trends (that is, gradual decreases or increases in prevalence over long-term periods) are perfectly plausible[5]. The prevalence of any condition (the proportion of the population affected at a point in time) is a product of its incidence and the average duration of the disease episode. The incidence is the rate at which new cases develop within the population. The duration of dementia equates to time from incidence to death, given that recovery is, sadly, not possible. Changes in either or both of these indicators could lead to changes in age-specific prevalence[1]. It should be noted that

a) Trends in the two indicators may not move in the same direction; for example reductions in incidence might be accompanied by increases in duration of survival with dementia, or vice versa; the one effect tending to cancel out the other in terms of their overall impact on prevalence.

b) One should not expect that secular trends will be the same across all world regions, or even among different population subgroups within one country. Experience with changing rates of cardiovascular disease, obesity, diabetes and cancer shows this clearly. The considerable variability in secular trends for these chronic diseases reflects different degrees of progress in improving public health, in improving access to healthcare, and in strengthening health systems and services to better detect, treat and control these conditions.

4.1.1 Possible future trends in the incidence of dementia

A decline in age-specific incidence of dementia, at least in high income countries, is theoretically possible, driven by changes in exposure to suspected developmental, lifestyle and cardiovascular risk factors for dementia[5]. The World Alzheimer Report 2014 focused upon dementia risk reduction; the evidence-base for modifiable risk factors for dementia[6]. The strongest evidence for possible causal associations with dementia was for low education in early life, for hypertension in midlife, and for smoking and diabetes across the life course. In a recent modelling exercise, it was estimated that a 10% reduction in these and other key risk exposures would lead to an 8.3% reduction in the prevalence of dementia through to 2050, with a 15.3% reduction in prevalence of dementia anticipated if there were a 20% reduction in exposure prevalence[7].

In most world regions, each generation is better educated than the one before. Although trends differ between countries, genders, age groups and time periods, there has been a general trend in many high income countries towards less smoking, falling total cholesterol and blood pressure levels, and increasing physical activity. On the other hand, the prevalence of obesity and diabetes has been increasing in most developed countries. The picture in many low and middle income countries is quite different; the trends in cardiovascular health among older people are in an adverse direction[8], with a pattern of increasing stroke[9] and ischaemic heart disease morbidity and mortality[10-12], linked to an epidemic of obesity, and increasing blood pressure levels[13]. After a lag

period, to the extent that these factors are genuinely causally associated with dementia, one would expect to see corresponding reductions (or increases) in the incidence of dementia.

4.1.2 Possible future trends in survival with dementia

Secular trends in survival with dementia are difficult to measure. Estimates from clinical services are confounded by time of diagnosis. If diagnosis is being made at an earlier stage in the disease process, then duration of dementia may appear to be increasing, whereas this may only signify that people with dementia are in contact with services for a higher proportion of the overall disease duration. Estimates from cause of death on death certificates are generally uninformative for this purpose. In the first instance these provide information only on secular changes in the attribution of dementia as a cause of death, and not on the all-cause mortality rate among people with dementia. Second, the large increases in the age-standardised rates of death attributed to dementia, for example in a recent analysis of trends in Europe from 1979 to 2009[14], are likely to reflect a greater propensity to attribute deaths of people living with dementia to the disease, rather than to changes in dementia incidence or survival.

A proper understanding of trends in survival with dementia will only come from monitoring all-cause mortality rates of those with and without the disease, and the ratio between them (standardised mortality ratio, or hazard ratio) over time. Mortality rates among older people continue to fall in all world regions, and for all age groups, accounting for impressive gains in life expectancy from age 60[15]. This is now one of the main drivers of population ageing, particularly, but not exclusively, in higher income countries. An important, but as yet unanswered, question is whether these trends for declining mortality among older people in general apply equally to people living with dementia. Mortality rates among older people are much higher for those living with dementia. In the 10/66 Dementia Research Group studies in Latin America, India and China, after controlling for age and sex, in a Cox's proportional hazards regression, hazard of death was 1.56 to 5.69 times higher in those with dementia (meta-analysed HR 2.80, 95% CI: 2.48-3.15)[16]. Effect sizes from studies in countries with low or middle incomes have tended to be higher than those indicated by a meta-analysis of studies principally from countries with high incomes (RR 2.63, 95% CI: 2.17-3.21)[17]; a HR of 2.83 (95% CI: 1.10-7.27) in Nigeria[18], and HR of 5.16 (95% CI: 3.74-7.12) in Brazil[19]. If age-standardised mortality rates among people with dementia decline at the same rate as for those without dementia (i.e. the adjusted mortality ratio remains constant over time) survival with dementia, and hence disease duration, will increase progressively. Since most of the public health interventions that have been proposed to reduce the incidence of dementia (for example tobacco control, and prevention, and treatment of hypertension) also have benefits in reducing incidence and mortality from other chronic diseases, one should expect that reductions in prevalence arising from reduced incidence of dementia may be offset, at least to some extent, by reduced mortality and longer survival with dementia[20]. Other factors; for example, improvements in standards of health and social care for people with dementia, and provision or withholding of life-prolonging critical interventions; might also be expected to have an influence on mortality rates among people living with dementia. In well-resourced advanced healthcare settings there is growing awareness that critical interventions should not be withheld, when these would improve quality of life, simply because someone has dementia, and in the context of end of life care the focus should be on palliation to improve quality of life, and interventions that merely prolong life with no other benefit or risk of harm to the patient should be withheld[21].

In low and middle income countries there is evidence that people with dementia currently have particular problems in accessing healthcare that might benefit their health and survival[22].

Finally, it should be noted that one of the indications of successful dementia risk reduction may be that the incidence of dementia is deferred to older ages. Thus, the average age of onset may increase over time. Under these circumstances age-specific or age standardised mortality for people with dementia may not change, but overall, for all people with dementia, mortality may be higher and survival with dementia shorter, reflecting that onset is occurring closer to the 'natural' end of life. Langa has described this phenomenon as 'the compression of cognitive morbidity'[23], a desirable outcome for public health and individual quality of life, resulting in longer, healthier lives, with fewer years spent in a state of reduced independence and needing care.

4.2 Research evidence

In 2009, what very few data were available from certain high income countries did not suggest any clear pattern of a decline or increase over time in either the incidence or prevalence of dementia[1;24;25]. Meta-analyses of European studies conducted since 1980 also did not suggest any secular trend in prevalence. Just a few years later, and linked to a greatly increased interest in the potential for prevention of dementia by targeting modifiable risk factors[26;27], the quality and extent of the evidence has expanded greatly, with reports from several studies of trends in prevalence and/or incidence of dementia, and dementia mortality, within defined populations, using identical or very similar research methodology over time.

Table 4.1
Studies estimating changes in prevalence of dementia or Alzheimer's disease over time

Study, setting, age range	Outcome/s	Relative change (%)	Period	Interval (years)	Relative change (%) per year	Other findings/notes
1. UK, MRC CFAS, 65 years and over[40]	Dementia (GMS/ AGECAT)	30% reduction AOR 0.7 (0.6-0.9)	1993-2011	18 years	-1.7%	Bigger dementia prevalence reduction in older age groups. Reduction in the proportion of older people, and people with dementia living in care homes. Increased prevalence of dementia among care home residents.
2. Spain, Zaragoza, 65 years and over[55]	Dementia (DSM-IV)	Non-significant 25% reduction AOR 0.75 (0.56-1.02) Women AOR 1.02 (0.69-1.51) Men AOR 0.40 (0.25-0.65)	1988-1995	7 years	-3.6%	Bigger (and statistically significant) dementia prevalence reduction in men. No changes observed in education level.
3. HRS. Nationally representative. 70 years and over[23]	Moderate/ severe cognitive impairment	29% reduction AOR 0.65 (0.58-0.73)	1993-2002	9 years	-3.2%	Increases in levels of education, significantly fewer IADL limitations but higher rates of cardiovascular risk factors and cardiovascular disease, including diabetes, hypertension, obesity, and heart disease. Education differences accounted for 43% of the prevalence difference between time points. Residents of care homes were excluded from the 1993 wave. The 6.2% of 2002 respondents who were residents of care homes were excluded from the comparative analysis. This may have biased the comparison.
4. USA, Indianapolis African Americans, 65 years and over [30]	Dementia (DSM-III-R) AD	Stable 6.8% vs 7.5% (dementia, p=0.35) 5.5% vs. 6.8% (AD, p=0.26)	1991-2002	11 years	NA	Increases in levels of hypertension, diabetes, and stroke, but also higher levels of treatment, consistent with national trends for African-Americans over this time period
5. Stockholm, Sweden, 75 years and over[28]	Dementia (DSM-III-R)	Stable 17.5% vs 17.9% AOR 0.85 (0.68-1.05)	1988-2002	14 years	NA	Much higher levels of education at the second time point
6. Germany, insurance claims data, age 65 and over[31]	Dementia (ICD-10)	Stable prevalence in all age groups and both genders, other than women aged 75-84 years AOR 0.97 (0.95-0.98)	2004-2007	3 years	-1.2% (women aged 75-84 years)	
7. Goteborg, Sweden, aged 70, and age 75 [29]	Dementia – historical criteria (Kay et al 1964)	Stable prevalence for both age groups Age 70 M 1.7% vs. 0.9% F 2.2% vs. 3.7% Age 75 M 6.8% vs 6.9% F 3.8% vs. 5.3%	Age 70 1976-2000 Age 75 1976-2005	Age 70 25 years Age 75 30 years	NA	Higher educational level, better results on cognitive tests, better socio-economic status, better treatment of vascular risk factors and better general physical health in the later-born cohorts
8. Umea, Sweden 85 years and over [32]	Dementia (DSM-IV)	40% increase (p=0.001)	2001-2006	5 years	+8.0%	Prevalence differences not adjusted for other covariates, but age distribution was similar. Increase in the prescription of antihypertensive and statin drugs, cholinesterase inhibitors, and more heart surgery
9. Japan, Hisayama, aged 65 years and over [33]	Dementia, AD	38% increase (dementia) AOR 1.34 (0.97-1.87) 255% increase (AD) 3.28 (1.75-6.14)	1985-2005	20 years	+1.9% (dementia) +12.8% (AD)	Ratio of AD/VaD increasing from 0.5 in 1985 to 1.4 in 2005

Table 4.2
Studies estimating changes in the incidence of dementia or Alzheimer's disease over time

Study	Outcome/s	Relative change (%)	Period	Interval (years)	Relative change (%) per year	Other findings
Directly observed						
1. USA, Indianapolis African Americans, 65 years and over[35]	Dementia (DSM-III-R) AD	55% reduction (dementia) 41% reduction (AD)	1991-2002	11 years	-5.0% -3.7%	Biggest reduction in youngest age groups. See also notes for study 1, table 4.1
2. USA, Framingham, 60 years and over[36]	Dementia (criteria not specified)	42% reduction AHR 0.58 (0.38-0.86)	1980-2006	26 years	-1.6%	Biggest reduction in youngest age groups. No reduction among the least educated. Significant improvements in educational status, use of antihypertensive and statin medication, blood pressure and HDL levels, and prevalence of smoking, heart disease, and stroke, whereas prevalence of obesity and diabetes increased.
3. NL, Rotterdam, 60-90 years[37]	Dementia (DSM-III-R)	Non-significant 25% reduction RR 0.75 (0.56-1.02)	1990-2000	10 years	-2.5%	Hypertension, diabetes and obesity increased. Higher education. More diabetes treatment, more antithrombotics and much more statins. More past but less current smoking. Substantial reduction in overall mortality - HR 0.63 (0.52-0.77).
4. Germany, insurance claims data, age 65 and over[38]	Dementia (ICD-10)	20% reduction (women) 19% reduction (men)	2004-2007 / 2007-2010	3 years	-6.7%	Study used claims data of the largest public health insurance company in Germany. Data contained complete inpatient and outpatient diagnoses according to ICD-10. For the analysis of incidence two independent age-stratified samples were taken, the first comprising 139,617 persons in 2004 with a follow-up until 2007; the second 134,653 persons in 2007 with a follow-up until 2010. Secular trends in clinical diagnosis or help-seeking cannot be excluded.
5. USA, Chicago [30]	AD	Stable OR 0.97 (0.90-1.04)	1997-2008	11 years	NA	
6. Nigeria, Ibadan[35]	Dementia (DSM-III-R) AD	Stable 1.5% vs 1.4% (dementia) 1.0% vs 1.3% (AD)	1991-2002	11 years	NA	
Inferred						
7. Stockholm, Sweden, 75 years and over [28]	Dementia (DSM-III-R)	Reduced incidence inferred from stable prevalence but increased survival with dementia	1988-2002	14 years	Not reported	See also notes for study 5, table 4.1

Table 4.3
Changes in mortality among people with dementia

Study	Outcome/s	Change in mortality and/or mortality hazard ratio	Period	Interval (years)	Other findings/notes
Directly observed					
1. USA, HRS [23]	Mortality hazard ratio	Non-significant increase, from HR 2.53 to 3.11, p=0.09	1993-2002	9 years	No report of absolute mortality rates, stratified or unstratified. However, given a presumed decline in overall mortality, it seems likely that mortality has also declined among people with dementia, but to a lesser extent
2. Stockholm, Sweden[28]	Mortality hazard ratio Mortality rate among people with dementia	Stable HR – 2.42 (2.03-2.87) vs. 2.47 (2.03-3.00) 29% reduction in mortality (HR 0.71, 0.57-0.88) adjusted for age, sex, education and MMSE score	1988-2002	14 years	Similar secular trend (30% reduction in mortality) to that for those with no dementia, and for both genders
3. Germany, insurance claims data, age 65 and over[31]	Mortality rate among people with dementia	11% increase in mortality among women (p<0.0001) Stable mortality among men (1% increase, p=0.75)	2004-2007	3 years	
Inferred					
4. USA, Indianapolis, African Americans, 65 years and over[30;35]	Dementia duration	Increase in survival with dementia can be inferred from stable prevalence of dementia[30], but 55% fall in incidence[35]	1991-2002	11 years	Extrapolation from reported prevalence and incidence rates at the two time points suggests that survival time with dementia is 2.4 times longer for the second cohort

4.2.1 Studies of secular trends in dementia prevalence, incidence and mortality, applying constant methods to defined populations

These studies were identified from the systematic review of studies of dementia prevalence (see Chapter 2), from searching the references of those relevant studies identified, and in the case of mortality, by conducting a search using the search terms "(dementia or alzheim*) and (mortality or survival) and trend*". We identified nine studies that had tracked dementia prevalence, seven that had tracked dementia incidence, and four that had tracked mortality among people with dementia. Findings across these studies conducted, mainly, in high income countries, are currently too inconsistent to reach firm and generalisable conclusions regarding underlying trends (see Tables 4.1-4.3).

Dementia prevalence

For studies of the prevalence of dementia, just one study, the MRC Cognitive Function and Ageing Study (MRC-CFAS) reports a statistically significant decline in the prevalence of dementia, between 1993 and 2011. This is, however, consistent with a somewhat higher but statistically non-significant decline in the prevalence of dementia in Zaragoza, Spain, and with a decline in the prevalence of moderate to severe cognitive impairment seen in the USA National Health and Retirement Survey (HRS). The annual rates of relative change in prevalence were -1.7%, -3.6% and -3.2% per year respectively. Set against this, other studies from Sweden[28;29], and USA[30] indicated a stable prevalence of dementia, consistent with short-term trends in German insurance claims data[31]. In a third Swedish study of short-term trends in dementia prevalence among the oldest old, prevalence had increased by 40% between 2001 and 2006[32]. In the Japan Hisayama study, there was a non-significant 38% relative increase in the prevalence of dementia between 1985 and 2005, with a marked increase in the proportion of cases accounted for by Alzheimer's disease[33]. This is consistent with findings from one other Japanese study of secular trends, with a 23% increase in the prevalence of dementia between 1980 and 2000[34]. This study was excluded from this review because its ascertainment procedures did not meet the minimum criteria we have set for our global estimates of dementia prevalence (see Chapter 2). However, although inadequate, they were held constant between the three waves of the study.

Dementia incidence

Evidence for a decline in the incidence of dementia is perhaps marginally stronger. Statistically significant reductions in the incidence of dementia were reported in two US population-based studies, one of African-Americans in Indianapolis[35], the other from the Framingham study[36]. The annual rates of relative change, -5.0% and -1.6% respectively, are consistent with a non-significant -2.5% annual rate of relative change in incidence reported in the Rotterdam study[37]. A very substantial decline in dementia incidence was reported from analysis of German insurance claims data, but with only a three-year interval between the midpoints of the two follow-up periods, this seems unlikely to be explained by a genuine change in underlying population incidence[38]. To the extent that changes in incidence can be inferred from changes in prevalence and mortality, data from repeated surveys in Stockholm, Sweden are also consistent with a decline in dementia incidence[28]. On the other hand, population-based studies conducted in Chicago, USA[30], and Ibadan, Nigeria[35] indicated a stable incidence of dementia over 11 year periods. One study, reporting a stable incidence of dementia in Beijing China, was excluded from the review, since it used different diagnostic criteria at the two time points[39].

Dementia mortality

Very few of these longitudinal studies have taken the opportunity to study or report changes in mortality/survival among people with dementia, or the ratio of mortality rates between those with and without dementia. In the Rotterdam study, overall mortality had declined by 37% in the 10 years between the two cohorts, but this was not stratified by dementia status. In the USA HRS, and in the Stockholm study[28], the mortality ratio remained relatively stable over time, suggesting that, if mortality rates were falling among those without dementia, there would have been similar rates of decline for those living with dementia. This was clearly demonstrated in the Stockholm study, where a relative decline in mortality rates of 30% over 14 years was seen for those with and without dementia, for both genders[28].

The relationships between trends in prevalence, incidence and mortality are particularly unclear, partly because, in most studies, only some of these parameters were directly observed. In Stockholm (where prevalence and mortality were observed), and in Indianapolis (where prevalence and incidence were observed), findings are consistent with declining incidence, but stable prevalence, accounted for by increasing duration of dementia (declining dementia mortality). Only in the German insurance claims data were changes in prevalence, incidence and mortality reported, but these are mutually inconsistent, perhaps because different samples were used for the prevalence[31] and incidence/mortality analyses[38]. If the onset of dementia occurs close to the end of the natural life span, fewer years may be lived with dementia. Two studies suggest that decline in incidence may be greater in younger age groups, suggesting that the incidence of dementia may be being deferred into older age[35;36]. This may be

consistent with the observation of an increasing prevalence of dementia among the oldest in one Swedish study[32], but is inconsistent with the observation from the MRC-CFAS study of greater reductions of dementia prevalence among older age groups[40].

4.2.2 Secular trends within regions estimated from meta-analyses of individual studies

Another approach to estimating secular trends involves combining evidence from all studies conducted within a particular country or region, using a meta-analytical approach, and meta-regression to estimate the effect of time of study upon prevalence. This approach was used in the World Alzheimer Report 2009 to estimate secular trends in dementia prevalence in Europe[1]. One problem with such exercises is that, in contrast with the studies previously reviewed (section 4.2.1), which hold such factors constant, there is inevitably considerable heterogeneity in the nature of the population studied, and the methods used for the surveys, which may in turn affect the prevalence recorded. It is therefore important, to the extent possible, to control for such effects in the meta-regression.

In the European meta-analyses, we found no evidence for a trend in prevalence between 1980 and 2008, and this held true when we updated the evidence base to include more recent surveys, for the current report (see Chapter 2).

East Asia is the one other world region with sufficiently numerous prevalence studies to permit meta-regression and estimation of secular trends in dementia prevalence. A study of secular trends in Japan (part of the adjacent Asia Pacific High Income region) reported a tendency towards increasing prevalence, but this was based on only eight data points, including the four waves of the Hisayama study[33], and did not control for study methodology[41]. The East Asia evidence-base, and the population of older people at risk is dominated by P.R. China, the focus for one meta-analysis[42], while a second also included studies conducted in Hong Kong SAR and Taiwan[43]. Estimates taken from the China meta-analysis suggested a 46% relative increase in age-standardised prevalence from 1990 to 2010 (+2.3% per year), while from the wider review the increase was 171% from studies conducted in the pre-1990 period to 2005-2012. However, in that study, the secular trend was considerably reduced, to 72%, and was no longer statistically significant, having controlled for study methodology. The most important potential confounder appeared to be the choice of dementia diagnostic criteria. Older studies tended to use DSM-III or DSM-III-R criteria, which then tended to record a lower prevalence of dementia than those more recent studies that used DSM-IV dementia, 10/66 Dementia Research Group criteria or GMS/AGECAT criteria. For the purposes of estimating current dementia prevalence, and numbers affected, this is an important finding, which motivated our decision to use estimates from our meta-analysis for the period 2005 onwards in estimating current prevalence for China (see Chapter 2). Whether the higher estimates for this most recent period were explained by real underlying secular trends, or use of more updated and valid diagnostic criteria, or both, was relatively immaterial to this decision. However, for the purposes of forecasting future trends in prevalence and numbers in the region, the distinction is clearly crucially important[44]. As previously indicated, there is evidence that cardiovascular health is deteriorating among older people in China[10], a trend also evident in other middle income countries[8]. The prevalence of smoking among adult men in China is among the highest in the world, and an epidemic among younger women is well underway[45]. Rapid dietary transition is leading to an epidemic of obesity and cardiometabolic disease[46]. A recent modelling exercise assessed the likely impact of recent increases in obesity among middle-aged Chinese on dementia prevalence, assuming a causal link with dementia; it concluded that future dementia prevalence in China may have been underestimated by up to 19% given the additional impact of epidemiologic transition[47].

4.3 Conclusion

There is no clear evidence from this review to justify a departure from our current position of assuming constant age-specific dementia prevalence, when making projections of the numbers likely to be affected in the future. Prudent policymakers should also adopt this approach. Nevertheless, the future course of the global dementia epidemic, through to 2050 is likely to depend, at least to some extent, upon the success or otherwise of continuing efforts to improve public health[6;27]. Those who will be old in 2050 were born around the 1970s, and have already received their basic education. They are now in their third and fourth decades of life, a crucial 'sensitive period' where, evidence suggests, efforts to prevent, detect and control obesity, hypertension, diabetes and dyslipidaemia (high cholesterol) are likely to have maximum positive impact upon brain health and dementia risk in late-life[6;27]. Such public health strategies, alongside secular improvements in education, are plausibly likely to result in a progressive decline in age-specific incidence of dementia in high income countries, the magnitude of which is currently uncertain. However, whether or not this is accompanied by a decline in the age-specific prevalence of dementia will depend upon any coincident changes in survival/mortality patterns for people living with dementia, which are difficult to predict from current data. Most of the more plausible scenarios are more consistent with a stable or modestly increasing disease prevalence[20;48].

Current evidence of adverse trends in cardiovascular risk factors and morbidity in low and middle income countries are consistent with a future increase in dementia age-specific incidence and prevalence in those regions.

Studies that use fixed methodology to estimate changes in dementia prevalence, incidence and mortality over time, in defined populations, are uniquely valuable assets. It is important in the future that more such studies are commissioned. The most valuable will be those that track all three parameters over time, which none of the studies reviewed in this chapter did. Surveys with nationally representative samples will have the greatest generalisability, and the greatest potential both to inform and track the impact of national policies. Where trends are observed it will be important to relate these to compositional changes in the population, particularly to changes in levels of exposure to critical risk factors (see also following paragraph). However, very few studies made a comprehensive assessment of such compositional factors and their changes over time, and in only one study was there an attempt to attribute changes in dementia frequency to changes in risk factor exposure[23]. It is clearly important that such studies do indeed hold methodology constant – several of those reviewed here did in fact make small changes between waves, the effect of which upon the observed trends cannot be determined with complete confidence[30;40].

Naturally, diagnostic criteria change over time, but these too must be held constant to make meaningful comparisons, a problem that can be surmounted by using the updated alongside the original criteria, where feasible and considered important. More intractable problems are the probable changes in clinician training, practice, and opinions regarding the operationalisation of diagnostic criteria[44]. This may also be countered through the application of structured assessments and diagnostic algorithms, such as the AGECAT computerised algorithm linked to the Geriatric Mental State[49], as employed in the MRC-CFAS studies[40], or the 10/66 Dementia Research Group's cross-culturally validated diagnostic algorithm[50;51].

Previous modelling exercises have sought to predict what might happen to the future prevalence of dementia, given our best estimates of risk associations, and possible changes in those risk factor profiles over time[7;47]. In the light of the current review, these estimations appear over-optimistic. An alternative approach is to observe and correlate actual changes in risk factor profiles and dementia incidence over time. This is a well-established modelling approach in the cardiovascular disease field and has contributed greatly to our understanding of the potential for prevention, and the attribution of changes in disease incidence to specific factors, to further guide prevention strategies[52-54]. Similar studies could, in the future, be carried out to monitor the impact of prevention programmes on the future scale of the dementia epidemic.

References

1 Alzheimer's Disease International. World Alzheimer Report 2009. London: Alzheimer's Disease International; 2009.

2 Alzheimer's Disease International. Policy Brief for G8 Heads of Government. The Global Impact of Dementia 2013-2050. London, UK: Alzheimer's Disease International; 2013.

3 Prince M, Bryce R, Albanese E, Wimo A, Ribeiro W, Ferri CP. The global prevalence of dementia: a systematic review and metaanalysis. Alzheimers Dement 2013 January;9(1):63-75.

4 Ferri CP, Prince M, Brayne C, Brodaty H, Fratiglioni L, Ganguli M et al. Global prevalence of dementia: a Delphi consensus study. Lancet 2005 December 17;366(9503):2112-7.

5 Langa KM. Is the risk of Alzheimer's disease and dementia declining? Alzheimers Res Ther 2015 March 26;7(1):34-0118.

6 Prince, M., Albanese, E., Guerchet, M., and Prina, M. World Alzheimer Report 2014. Dementia and Risk Reduction. An analysis of Protective and Modifiable Risk Factors. London: Alzheimer's Disease International; 2014.

7 Norton S, Matthews FE, Barnes DE, Yaffe K, Brayne C. Potential for primary prevention of Alzheimer's disease: an analysis of population-based data. Lancet Neurol 2014 August;13(8):788-94.

8 Prince MJ, Wu F, Guo Y, Gutierrez Robledo LM, O'Donnell M, Sullivan R et al. The burden of disease in older people and implications for health policy and practice. Lancet 2015 February 7;385(9967):549-62.

9 Feigin VL, Lawes CM, Bennett DA, Barker-Collo SL, Parag V. Worldwide stroke incidence and early case fatality reported in 56 population-based studies: a systematic review. Lancet Neurol 2009 April;8(4):355-69.

10 Critchley J, Liu J, Zhao D, Wei W, Capewell S. Explaining the increase in coronary heart disease mortality in Beijing between 1984 and 1999. Circulation 2004 September 7;110(10):1236-44.

11 Gupta R, Joshi P, Mohan V, Reddy KS, Yusuf S. Epidemiology and causation of coronary heart disease and stroke in India. Heart 2008 January;94(1):16-26.

12 Gaziano TA, Bitton A, Anand S, brahams-Gessel S, Murphy A. Growing epidemic of coronary heart disease in low- and middle-income countries. Curr Probl Cardiol 2010 February;35(2):72-115.

13 Anand SS, Yusuf S. Stemming the global tsunami of cardiovascular disease. Lancet 2011 February 12;377(9765):529-32.

14 Mackenbach JP, Karanikolos M, Looman CW. The rise of mortality from mental and neurological diseases in Europe, 1979-2009: observational study. BMC Public Health 2014 August 13;14:840. doi: 10.1186/1471-2458-14-840.:840-14.

15 Howse K. Review of longevity trends to 2025 and beyond. http://www.beyondcurrenthorizons.org.uk/wp-content/uploads/final_-howse_20090202.pdf. Accessed 17/07/2015. 2015. Futurelab (Beyond Current Horizons)/ Oxford Institute of Ageing.

16 Prince M, Acosta D, Ferri CP, Guerra M, Huang Y, Rodriguez JJ et al. Dementia incidence and mortality in middle-income countries, and associations with indicators of cognitive reserve: a 10/66 Dementia Research Group population-based cohort study. Lancet 2012 May 22.

17 Dewey ME, Saz P. Dementia, cognitive impairment and mortality in persons aged 65 and over living in the community: a systematic review of the literature. Int J Geriatr Psychiatry 2001 August;16(8):751-61.

18 Perkins AJ, Hui SL, Ogunniyi A, Gureje O, Baiyewu O, Unverzagt FW et al. Risk of mortality for dementia in a developing country: the Yoruba in Nigeria. International Journal of Geriatric Psychiatry 2002 June;17(6):566-73.

19 Nitrini R, Caramelli P, Herrera E Jr, de C, I, Bahia VS, Anghinah R et al. Mortality from dementia in a community-dwelling Brazilian population. International Journal of Geriatric Psychiatry 2005 March;20(3):247-53.

20 Joly P, Touraine C, Georget A, Dartigues JF, Commenges D, Jacqmin-Gadda H. Prevalence projections of chronic diseases and impact of public health intervention. Biometrics 2013 March;69(1):109-17.

21 Prince, M., Prina, M., and Guerchet, M. World Alzheimer Report 2013. Journey of Caring. An analysis of long-term care for dementia. London: Alzheimer's Disease International; 2013.

22 Albanese E, Liu Z, Acosta D, Guerra M, Huang Y, Jacob K et al. Equity in the delivery of community healthcare to older people: findings from 10/66 Dementia Research Group cross-sectional surveys in Latin America, China, India and Nigeria. BMC Health Serv Res 2011;11:153.

23 Langa KM, Larson EB, Karlawish JH, Cutler DM, Kabeto MU, Kim SY et al. Trends in the prevalence and mortality of cognitive impairment in the United States: is there evidence of a compression of cognitive morbidity? Alzheimers Dement 2008 March;4(2):134-44.

24 Kokmen E, Chandra V, Schoenberg BS. Trends in incidence of dementing illness in Rochester, Minnesota, in three quinquennial periods, 1960-1974. Neurology 1988;38:975-80.

25 Rorsman B, Hagnell O, Lanke J. Prevalence and incidence of senile and multi-infarct dementia in the Lundby Study: a comparison between the time periods 1947-1957 and 1957-1972. Neuropsychobiology 1986;15(3-4):122-9.

26 Barnes DE, Yaffe K. The projected effect of risk factor reduction on Alzheimer's disease prevalence. Lancet Neurol 2011 September;10(9):819-28.

27 Lincoln P, Fenton K, Alessi C, Prince M, Brayne C, Wortmann M et al. The Blackfriars Consensus on brain health and dementia. Lancet 2014 May 24;383(9931):1805-6.

28 Qiu C, von Strauss E, Backman L, Winblad B, Fratiglioni L. Twenty-year changes in dementia occurrence suggest decreasing incidence in central Stockholm, Sweden. Neurology 2013 May 14;80(20):1888-94.

29 Wiberg P, Waern M, Billstedt E, Ostling S, Skoog I. Secular trends in the prevalence of dementia and depression in Swedish septuagenarians 1976-2006. Psychol Med 2013 December;43(12):2627-34.

30 Rocca WA, Petersen RC, Knopman DS, Hebert LE, Evans DA, Hall KS et al. Trends in the incidence and prevalence of Alzheimer's disease, dementia, and cognitive impairment in the United States. Alzheimers Dement 2011 January;7(1):80-93.

31 Doblhammer G, Fink A, Fritze T. Short-term trends in dementia prevalence in Germany between the years 2007 and 2009. Alzheimers Dement 2015 March;11(3):291-9.

32 Mathillas J, Lovheim H, Gustafson Y. Increasing prevalence of dementia among very old people. Age Ageing 2011 March;40(2):243-9.

33 Sekita A, Ninomiya T, Tanizaki Y, Doi Y, Hata J, Yonemoto K et al. Trends in prevalence of Alzheimer's disease and vascular dementia in a Japanese community: the Hisayama Study. Acta Psychiatr Scand 2010 October;122(4):319-25.

34 Wakutani Y, Kusumi M, Wada K, Kawashima M, Ishizaki K, Mori M et al. Longitudinal changes in the prevalence of dementia in a Japanese rural area. Psychogeriatrics 2007;7:150-4.

35 Gao S, Ogunniyi A, Hall KS, Baiewu O, Unverzagt F, Lane KA et al. Alzheimer's Disease Incidence Declined in African Americans, but not in Yoruba. 2014 Jul 17; Copenhagen: AAIC; 2014.

36 Satizabal C, Beiser A, Chene G, Chouraki VA, Himali JJ, Preis SR et al. Temporal trends in Dementia Incidence in the Framingham Study. 2014 Jul 17; Copenhagen: AAIC; 2014.

37 Schrijvers EM, Verhaaren BF, Koudstaal PJ, Hofman A, Ikram MA, Breteler MM. Is dementia incidence declining?: Trends in dementia incidence since 1990 in the Rotterdam Study. Neurology 2012 May 8;78(19):1456-63.

38 Doblhammer G, Fink A, Zylla S, Fritze T, Willekens F. Short-term trends in German Dementia Prevalence, Incidence and Mortality. 2014 Jul 17; Copenhagen: AAIC; 2014.

39 Li S, Yan F, Li G, Chen C, Zhang W, Liu J et al. Is the dementia rate increasing in Beijing? Prevalence and incidence of dementia 10 years later in an urban elderly population. Acta Psychiatr Scand 2007 January;115(1):73-9.

40 Matthews FE, Arthur A, Barnes LE, Bond J, Jagger C, Robinson L et al. A two-decade comparison of prevalence of dementia in individuals aged 65 years and older from three geographical areas of England: results of the Cognitive Function and Ageing Study I and II. Lancet 2013 July 17;(13):10-6736.

41 Dodge HH, Buracchio TJ, Fisher GG, Kiyohara Y, Meguro K, Tanizaki Y et al. Trends in the prevalence of dementia in Japan. Int J Alzheimers Dis 2012;2012:956354. doi: 10.1155/2012/956354. Epub;%2012 Oct 3.:956354.

42 Chan KY, Wang W, Wu JJ, Liu L, Theodoratou E, Car J et al. Epidemiology of Alzheimer's disease and other forms of dementia in China, 1990-2010: a systematic review and analysis. Lancet 2013 June 8;381(9882):2016-23.

43 Wu YT, Lee HY, Norton S, Prina AM, Fleming J, Matthews FE et al. Period, birth cohort and prevalence of dementia in mainland China, Hong Kong and Taiwan: a meta-analysis. Int J Geriatr Psychiatry 2014 May 22;10.

44 Wu YT, Brayne C, Matthews FE. Prevalence of dementia in East Asia: a synthetic review of time trends. Int J Geriatr Psychiatry 2015 August;30(8):793-801.

45 Yang G, Wang Y, Wu Y, Yang J, Wan X. The road to effective tobacco control in China. Lancet 2015 March 14;385(9972):1019-28.

46 Adair LS, Gordon-Larsen P, Du SF, Zhang B, Popkin BM. The emergence of cardiometabolic disease risk in Chinese children and adults: consequences of changes in diet, physical activity and obesity. Obes Rev 2014 January;15 Suppl 1:49-59. doi: 10.1111/obr.12123.:49-59.

47 Loef M, Walach H. Midlife obesity and dementia: Meta-analysis and adjusted forecast of dementia prevalence in the US and China. Obesity (Silver Spring) 2012 September 18.

48 Jacqmin-Gadda H, Alperovitch A, Montlahuc C, Commenges D, Leffondre K, Dufouil C et al. 20-Year prevalence projections for dementia and impact of preventive policy about risk factors. Eur J Epidemiol 2013 June;28(6):493-502.

49 Dewey ME, Copeland JRM. Computerized psychiatric diagnosis in the elderly: AGECAT. J Microcomp Appl 1986;9:135-40.

50 Prince M, Acosta D, Chiu H, Scazufca M, Varghese M. Dementia diagnosis in developing countries: a cross-cultural validation study. Lancet 2003 March 15;361(9361):909-17.

51 Prince MJ, de Rodriguez JL, Noriega L, Lopez A, Acosta D, Albanese E et al. The 10/66 Dementia Research Group's fully operationalised DSM-IV dementia computerized diagnostic algorithm, compared with the 10/66 dementia algorithm and a clinician diagnosis: a population validation study. BMC Public Health 2008;8:219.

52 Ford ES, Ajani UA, Croft JB, Critchley JA, Labarthe DR, Kottke TE et al. Explaining the decrease in U.S. deaths from coronary disease, 1980-2000. N Engl J Med 2007 June 7;356(23):2388-98.

53 Vartiainen E, Laatikainen T, Peltonen M, Juolevi A, Mannisto S, Sundvall J et al. Thirty-five-year trends in cardiovascular risk factors in Finland. Int J Epidemiol 2010 April;39(2):504-18.

54 Laatikainen T, Critchley J, Vartiainen E, Salomaa V, Ketonen M, Capewell S. Explaining the decline in coronary heart disease mortality in Finland between 1982 and 1997. Am J Epidemiol 2005 October 15;162(8):764-73.

55 Lobo A, Saz P, Marcos G, Dia JL, De-la-Camara C, Ventura T et al. Prevalence of dementia in a southern European population in two different time periods: the ZARADEMP Project. Acta Psychiatr Scand 2007 October;116(4):299-307.

CHAPTER 5

The impact of dementia worldwide

5.1 Introduction

In the World Alzheimer Report 2009, we highlighted that a better understanding of the growing numbers of people worldwide living with dementia was necessary, but insufficient to characterise the global impact of the epidemic. Numbers convey neither the quality of the individual experience of living with dementia, nor wider consequences for the household, family, community and society as a whole. We suggested that the impact of dementia could be understood at three inter-related levels:

1. The person with dementia, who experiences ill health, disability, impaired quality of life and reduced life expectancy.
2. The family and friends of the person with dementia, who, in all world regions, are the cornerstone of the system of care and support.
3. Wider society, which, either directly through government expenditure, or in other ways, incurs the cost of providing health and social care and the opportunity cost of lost productivity. Other social impacts may be harder to quantify, but no less real.

5.2 The Global Burden of Disease approach (GBD)

One approach for assessing the impact of dementia, and comparing it with other health conditions, is to use the Global Burden of Disease estimates. These provide information on the relative impact of different health conditions worldwide, and have influenced prioritisation for policymaking and planning nationally, regionally and internationally. The impact is referred to as 'burden' and expressed in terms of associated disability and mortality. The World Health Organization's Global Burden of Disease Report was first published in 1996, and updated through to 2004[1;2]. The key indicator is the Disability Adjusted Life Year (DALY), a composite measure of disease burden calculated as the sum of Years Lived with Disability (YLD) and Years of Life Lost (YLL). Thus, the DALY summarises the effects of diseases, both on the quantity (premature mortality) and quality of life (disability). These effects are summed across estimated numbers of affected individuals to express the regional and global impact of disease. The effect of living for one year with disability depends upon the disability weight attached to the health condition concerned. In a wide international consensus consultation for the Global Burden of Disease report, disability from dementia was accorded a higher disability weight (0.67) than that for almost any other condition, with the exception of severe developmental disorders[3]. This weight signified that each year lived with dementia entails the loss of two-thirds of one DALY.

5.2.1 The IHME Global Burden of Disease estimates

In the 2009 report we explained that the WHO GBD estimates were shortly to be comprehensively revised by the Institute of Health Metrics and Evaluation (IHME) with funding support from the Gates Foundation. IHME introduced three important innovations[4]:

1. The revised estimates would be founded on new updated systematic reviews of prevalence, incidence and associated mortality for 291 diseases and injuries. The reviews for dementia were conducted by ADI's Global Observatory team, and comprised all of the evidence on dementia

prevalence, incidence and mortality summarised in the World Alzheimer Report 2009[5], and the subsequent joint WHO/ADI report[6]. The evidence base had extended considerably from 1996, and our own analyses of these data suggested that prevalence and numbers of people with dementia may previously have been underestimated in several world regions.

2. New disability weights would be calculated for an expanded set of 220 unique health states, based on the views of the general public, from surveys of representative samples of adults in several countries and cultures. Separate weights would be calculated for mild, moderate and severe dementia. Presciently, we warned that "the impact of these revised weights on Years Lived with Disability and Disability Adjusted Life Years is difficult to predict".
3. Age-weighting, by which years lived in old age (and childhood) were accorded a lower value than those lived in 'productive' adulthood, and future discounting (on the basis that a year lived now is accorded greater value than one to be lived in the future) have rightly proved controversial and were abandoned in the IHME GBD. All other things being equal, this should have resulted in an increase in the relative contribution of dementia to global burden of disease.

5.2.2 The IHME disability weights

The disability weights accorded to each health condition have a critical impact upon the estimates of years lived with disability (YLD), but not years of life lost (YLL). However, since DALYs are the sum of YLD and YLL, the impact upon YLD is also apparent in the summary DALY estimate.

The disability weights for IHME GBD were estimated from population surveys of those aged 18 and over in Bangladesh, Indonesia, Peru, Tanzania and the USA (n=13,902), boosted by an international internet survey (n=16,328). The surveys used paired comparison questions, in which respondents considered two hypothetical individuals with different, randomly selected health states and indicated which person they regarded as healthier.

There was a high correlation among respondent judgments, and between countries. The correlation between the new IHME and original GBD disability weights was moderately high (0.70), although higher for moderate and severe than for milder health states. However, the IHME disability weights for dementia were considerably lower than those for the WHO GBD[3;7]. The IHME weights for mild, moderate and severe dementia were 0.08, 0.35 and 0.44 respectively [7], compared to a weight of 0.67 that was applied uniformly to all severities of dementia in the WHO GBD[3]. The highest disability weights accorded in the IHME exercise were for schizophrenia; 0.76 during an acute episode, and 0.58 for the residual chronic state.

For further contextualisation, IHME disability weights for mild, moderate and severe forms of other chronic diseases are summarised in Table 5.1. It can be seen that the weights for dementia are higher than those for hearing loss and distance vision impairment, heart failure and Chronic Obstructive Pulmonary Disease (COPD), similar to those for stroke and Parkinson's diseases, and lower than those for alcohol use disorder, generalised musculoskeletal disorders, multiple sclerosis, and depression.

Table 5.1
Disability weights for selected conditions (IHME GBD), in order of the weight allocated for severe disorder[8]

Condition	Mild	Moderate	Severe
Hearing loss	0.01	0.02	0.03
Distance vision impairment	0.00	0.03	0.19
Heart Failure	0.04	0.17	0.19
Chronic Obstructive Pulmonary Disease	0.02	0.19	0.38
Dementia	0.08	0.35	0.44
Stroke with long term consequences	0.02	0.31	0.54
Parkinson's Disease	0.01	0.26	0.55
Alcohol Use Disorder	0.26	0.39	0.55
Musculoskeletal problems, generalised	-	0.29	0.61
Major Depressive Episode	0.16	0.41	0.66
Multiple sclerosis	0.20	0.45	0.71

The IHME disability weights for dementia can also be compared with those from a Dutch study that used a similar approach to the WHO GBD, but a more structured two phase methodology; 0.27 for mild dementia (with impairments in daily activities of living), 0.63 for moderate dementia (unable to live independently), and 0.94 for severe dementia (requiring permanent supervision)[9]. The later European Disability Weights project estimated a disability weight of 0.46 for mild dementia with little variation across panels from different European countries, and between health care professionals and lay raters[10].

5.2.3 Comparing the WHO and IHME Burden of Disease estimates

The most recent WHO GBD estimates refer to the year 2004, while those for IHME refer to 2010. The frequency of conditions (prevalence and incidence) should not have changed markedly over this interval, but the size of the older population had increased from

Table 5.2
WHO GBD and IHME GBD estimates of Years of Life Lost, Years Lived with Disability and Disability Adjusted Life Years attributed to dementia condition among older people

	WHO GBD (2004)		IHME GBD (2010)	
	Aggregated estimates – millions of years (% of total burden)	Millions of years, per 1,000 older people	Aggregated estimates – millions of years (% of total burden)	Millions of years, per 1,000 older people
Years of Life Lost	3.4 (0.9%)	5.2	3.9 (0.9%)	5.2
Years Lived with Disability	15.4 (13.1%)	23.4	6.2 (3.8%)	8.2
Disability Adjusted Life Years	18.8 (4.2%)	28.7	10.0 (1.7%)	13.2

658.7 million to 754.9 million. Direct comparisons can be made by considering the proportionate contribution of dementia to the total burden of disease, and by comparing estimates per capita (or more precisely per 1,000 older people). With either approach, it is clear that, while burden from years of life lost remains stable across the two methodologies, there has been a substantial reduction in the estimation of years lived with disability attributed to dementia, with a knock-on effect on the DALY estimates (Table 5.2). Per capita, the IHME GBD estimates of YLL are 0% lower than WHO GBD estimates, YLD 65% lower, and DALYs 54% lower.

The IHME estimates were also calculated retrospectively for the year 1990, applying the same methodology, including disability weights, as for the 2010 estimate. This approach incorporates any changes in the estimates of disease frequency, and changes in the population distribution (in 1990 there were 487.5 million people aged 60 years and over compared with 754.9 million in 2010). Among older people, DALYs attributed to dementia had increased from 4.7 million in 1990 (1.1% of the total DALY burden) to 10.0 million (1.7%) in 2010. As highlighted in IHME GBD publications[11], the % DALY increase from 1990-2010 for dementia (113%) is among the largest for any disease or disease group, comparing with 28% for ischaemic heart disease, 22% for stroke, 27% for all cardiovascular diseases, 79% for diabetes, 35% for cancer, 23% for digestive diseases, 46% for sensory impairment, and 55% for musculoskeletal diseases [12]. However, adjusting for population size, the DALYs per 1000 population for dementia were 9.6 million per 1000 in 1990 and 13.2 million per 1000 in 2010, indicating that most of this increase was accounted for by population ageing.

5.2.3.1 Disability Adjusted Life Years (DALY) estimates

Disability Adjusted Life Years (DALYs) are the sum of Years Lived with Disability (YLD) and Years of Life Lost (YLL), hence combining the impact of disability and premature mortality into a single summary indicator. Years of life lost make much the larger contribution to the total. Thus, for the IHME GBD estimates overall there were 411.6 million years of life lost among people aged 60 years and over, and 162.8 million years lived with disability, signifying that, according to the GBD methodology, premature mortality contributes 72% of overall DALY burden, and disability 28%. This is reflected in the list of 10 conditions with the largest contribution to Disability Adjusted Life Years (Table 5.3), which is dominated by ischaemic heart disease, stroke and chronic obstructive pulmonary disease, all conditions with a substantial associated mortality. Collectively, the ten conditions account for just over half of the total disease burden among older people. While the most burdensome conditions are similar across the two methodologies, their rank order has changed. Dementia has slipped from 5th to 9th place on the list, and visual impairment from 4th to 8th. According to IHME GBD, low back pain was now the 5th most burdensome condition among older people.

Considering people of all ages, dementia ranked the 49th most burdensome condition worldwide[11]. However, it ranked between 12th and 20th in high income regions, 26th to 50th in Latin American regions, 41st in East Asia, 70th in south east Asia, and between 66th and 101st in sub-Saharan African regions.

5.2.3.2 Years Lived with Disability (YLD) estimates

Dementia shortens the lives of those affected. However, it is prominent among those conditions of later-life, for which the contribution of chronic disability and needs for care is greater than that of premature mortality[12]. It is therefore important also to analyse the contribution of dementia to years lived with disability (YLD), relative to that of other health conditions. For this purpose we used the second order IHME chronic disease clusters, other than for stroke and heart disease, and dementia, which is part of the neurological disorders cluster but accounts for the large majority of YLDs in this group. This analysis

Table 5.3
The 10 leading contributors to Disability Adjusted Life Years burden among people aged 60 years and over, according to the WHO GBD (2004) and IHME GBD (2010) methodology

WHO GBD (2004)			IHME GBD (2010)		
Condition	Million DALYs (% contribution to total)	Rank order	Condition	Million DALYs (% contribution to total)	Rank order
Ischaemic heart disease	67.6 (15.0%)	1	Ischaemic heart disease	77.7 (13.5%)	1
Stroke	55.4 (12.3%)	2	Stroke	66.4 (11.6%)	2
Chronic obstructive pulmonary disease	33.1 (7.3%)	3	Chronic obstructive pulmonary disease	43.3 (7.5%)	3
Visual impairment	30.9 (6.9%)	4	Diabetes	22.6 (3.9%)	4
Dementia	**18.8 (4.2%)**	**5**	Low back pain	19.1 (3.3%)	5
Diabetes	13.9 (3.1%)	6	Trachea, bronchus or lung cancer	18.6 (3.2%)	6
Hearing loss	13.0 (2.9%)	7	Falls	12.4 (2.2%)	7
Trachea, bronchus or lung cancer	12.8 (2.8%)	8	Visual impairment	10.4 (1.8%)	8
Hypertensive heart disease	9.7 (2.2%)	9	**Dementia**	**10.0 (1.7%)**	**9**
Osteoarthritis	8.1 (1.8%)	10	Tuberculosis	9.2 (1.6%)	10
Total (all conditions)	450.9		Total (all conditions)	574.4	

reveals very important shifts in the rank order of disease contributions, between the GBD and IHME GBD estimates (Table 5.4). The YLDs attributed to dementia have been cut by 60%, those for visual impairment by 66%, those for hearing loss by 42%. Conversely, the YLDs attributed to mental disorders have increased by 131%, for musculoskeletal disorders by 275%, and those for genitourinary disorders by 725%. Dementia has slipped from 2nd to 8th on the list of conditions making the most impact upon years lived with disability, visual impairment from 1st to 4th, and hearing loss from 3rd to 6th. Mental disorders have been elevated from 5th to 2nd place on the list, musculoskeletal disorders from 4th to 1st, and genitourinary disorders from 11th to 7th.

5.2.4 Summary of findings from the Global Burden of Disease estimates

In summary, dementia is among the top 10 most burdensome conditions among older people worldwide. In contrast with other conditions, its impact comes mainly from years lived with disability, rather than years of life lost from premature mortality. The health loss attributed to dementia is much smaller in the latest IHME GBD estimates (2010) than in the previous WHO GBD estimates (2004), and its rank position relative to other impactful conditions has slipped accordingly. Dementia is not the only condition to be affected in this way. The relative impact of sensory impairment is much reduced, while that of mental and musculoskeletal disorders is much increased. This is, for the most part, because of changes in disability weights, rather than in the estimates of the frequency of these disorders. Seismic shifts in the burden of disease between the original WHO 2004 estimates[13] and the IHME 2010 estimates 11 have neither been highlighted nor explained in IHME publications. Instead the focus has been upon the 1990-2010 trends using the IHME methodology, which do indicate an important global increase in the impact of dementia[11].

5.2.5 Limitations of the Global Burden of Disease approach

Concerns have been expressed, in general, regarding the use of global burden of disease estimates to determine allocation of resources. An important critique is that such decisions should be based not on burden alone, but on potential to reduce burden through the scaling up of interventions that are cost-effective[14;15]. A counter argument for conditions such as dementia, where no such interventions yet exist, would be that the size of the burden should be an important factor in determining research spending into new treatments, and that diagnostic and supportive services are required to meet the need arising from the burden.

Table 5.4
The 12 leading contributors to Years Lived with Disability among people aged 60 years and over, according to the WHO GBD (2004) and IHME GBD (2010) methodology

WHO GBD (2004)			IHME GBD (2010)		
Chronic disease/ condition	Million YLD (% contribution to total)	Rank order (YLD)	Chronic disease/ condition	Million YLD (% contribution to total)	Rank order (YLD)
Visual impairment	30.9 (26.4%)	1	Musculoskeletal disorders	42.0 (25.8%)	1
Dementia	**15.4 (13.1%)**	**2**	Mental disorders	16.2 (10.0%)	2
Hearing loss	13.0 (11.1%)	3	Chronic respiratory	11.8 (7.2%)	3
Musculoskeletal disorders	11.2 (9.6%)	4	Visual impairment	10.4 (6.4%)	4
Mental disorders	7.0 (6.0%)	5	Diabetes/ endocrine	9.0 (5.5%)	5
Chronic respiratory	5.8 (5.0%)	6	Hearing loss	7.5 (4.6%)	6
Heart disease	4.7 (4.0%)	7	Genitourinary disorders	6.6 (4.1%)	7
Diabetes/ endocrine	4.6 (3.9%)	8	**Dementia**	**6.2 (3.8%)**	**8**
Stroke	4.4 (3.8%)	9	Heart disease	4.8 (2.9%)	9
Cancer	2.6 (2.2%)	10	Stroke	3.0 (1.8%)	10
Genitourinary disorders	0.8 (0.7%)	11	Cancer	2.9 (1.8%)	11
Digestive disorders	2.2 (1.9%)	12	Digestive disorders	1.0 (0.6%)	12
Total YLD burden (all diseases)	117.0 (100%)			162.8 (100%)	

The Disability Adjusted Life Year (DALY) metric gives undue prominence to those conditions strongly associated with mortality (principally cardiovascular disease and cancer), diverting attention from other conditions; for example dementia, stroke, COPD and vision impairment; where the burden of disease arises as much, if not more, from disability than mortality[16], and where long-term care costs can dwarf health expenditure. The societal costs of these disorders are enormous, particularly in high income countries with welfare-based social care systems.

Perhaps the most important limitation arises from the disability weights attached to individual conditions. The IHME disability weights have proved to be one of the most controversial elements of the new Global Burden of Disease estimates. Other specialist groups have raised concerns, the most telling of which has been that some of the weights fail to pass the 'common sense test', for example that severe distance vision impairment (in effect, blindness) should be accorded a lower weight (0.20) than mild alcoholism (0.26), moderate rheumatoid arthritis (0.29) or neck pain (0.22) [17]. However, one should be cautious when critiquing the new weights. As the leaders of the IHME exercise have pointed out, the weights were developed using a robust methodology that was approved in advance by the expert groups, who themselves drafted the vignettes that were submitted to the respondents in an unprecedentedly extensive international survey[18]. The stratification of many conditions into mild, moderate and severe forms was a valuable innovation introduced by IHME, reflecting the fact that a small minority of people affected by most conditions are living with the most severe form of the disorder. For dementia, arguably, the application of a very high weight (0.67) to all people with dementia regardless of disease stage may have led to an overestimation of impact in the WHO GBD. Apparently, most of the expert groups, including that for dementia, have complained that the IHME weights for their condition were too low, and as the IHME leaders point out, they cannot all be right[18]. There are, however, several valid concerns.

1. Disability weights will be affected by choice of respondents used to determine them. The WHO GBD weights[3] were determined through a consensus of international experts with the experience of treating and caring for people with the health conditions, whereas the IHME weights reflected, mainly, judgments of the general public[7]. Who is best placed to judge the lived experience of someone with a health condition, the person themselves, a carer, a health professional, or a representative sample of the general public, comprising a relatively small proportion of those with more direct experience?
2. The information provided about the health states, and the precise wording of the vignettes used to describe each of the health states is likely to have an important impact upon respondent perceptions. The instruction for the IHME weighting exercise was that the condition could only be described in lay language, and in terms of its impact on health (symptoms and impairments) rather than the wider impact on disability and functioning. This was a

particular challenge for the dementia vignettes, which are provided in full in Box 5.1.

Box 5.1

IHME vignettes for mild, moderate and severe dementia health states

Mild dementia: The person has noticed deterioration in their memory, particularly for recent events. For example, they may forget that their daughter had visited the previous day, or when or whether they had taken their last medication. They also find it difficult to concentrate, think flexibly, plan, and take decisions. They are likely to feel bewildered, anxious and sad. They may become angry and defensive when others point out errors.

Moderate dementia: The person has severe memory problems. Only early memories are retained. Recent events are not remembered, or rapidly forgotten. They may not know the day, date or time of day. They often do not know where they are. They cannot communicate clearly, having problems finding the right word and using the wrong words. They may hear voices or see things that are not there, and can develop false beliefs, for example that children are entering their house and stealing things. They are likely to be anxious, sad, bewildered, and can become agitated or aggressive.

Severe dementia: The person has complete memory loss. They may no longer recognise their close family. They have severe speech difficulties or are unable to communicate. They may be apathetic and totally inactive, but at times can be agitated and verbally and physically aggressive. They cannot coordinate their physical movements; may have lost the ability to walk and feed themselves and have difficulty swallowing. They are likely to be incontinent of urine and faeces.

3. Perhaps the most significant issue is the way in which the questions were framed. Respondents were asked to compare two health states, and decide which person was 'the healthier', not 'the least disabled', nor 'the best able to function independently'. This is consistent with the IHME concept of 'health loss', which is central to the new GBD enterprise. However, this is some way from the original WHO conceptualisation, which was more closely linked to the WHO International Classification of Impairment, Disability and Handicap (ICIDH), and the later WHO International Classification of Functioning (ICF), which consider the impact of health conditions and context upon activity and participation. IHME weights are, in reality, 'health weights' rather than 'disability weights', since they do not measure the limitations of functioning, activity, or social participation that by international consensus define disability[19].

5.2.6 Does the under-prioritisation of dementia in the Global Burden of Disease estimates matter?

The WHO, and now the IHME GBD estimates have been highly influential in setting national, regional and intergovernmental priorities for policy development and investment in health care. An example is the WHO's Mental Health Gap Action Plan (mhGAP); dementia was one of nine priority mental and neurological disorders selected explicitly on the basis of their contribution to global burden of disease (WHO GBD in this instance), as well as the size of the treatment gap in resource poor settings[20]. The WHO has been criticised in the past for failing to align its budgetary allocation to disease burden[21]. Similar considerations applied to the identification of cardiovascular disease, diabetes, cancers and COPD as leading priorities for the UN high-level meeting on non-communicable disease prevention and control, and the acknowledgment that;

> "Mental and neurological disorders, including Alzheimer's disease, are an important cause of morbidity and contribute to the global non-communicable disease burden, for which there is a need to provide equitable access to effective programmes and health-care interventions."[22]

Global Burden of Disease estimates have also been used to hold governments and other bodies to account for the rationality of allocation of research grant funding[23-25], and the generation of research evidence through clinical trials[26] and Cochrane systematic reviews[27].

5.3 Alternative approaches to understanding the impact of dementia

The most important critique of the Global Burden of Disease estimates is that these fail, in important ways, to capture the true impact of different chronic diseases upon disability, needs for care, and attendant societal costs[19]. This limitation is most evident for older people, among whom most of these needs arise, and for conditions such as dementia, vision and hearing loss and musculoskeletal disorders, where most of the impact comes from disability rather than associated mortality[12]. This was already a problem for the WHO

GBD estimates[16], and has been greatly exacerbated with the shift to the IHME system with its new weights, and its focus upon 'health loss'.

One approach would be simply to stop using currently formulated DALYs (or the YLD component) when assessing the impact of disabling conditions[19]. There is, at least, a strong case for renaming the IHME indicators as Health Adjusted Life Years (HALYs) and Years of Health Lost (YHL), to limit the potential for misinterpretation.

An alternative approach would be to incorporate direct survey assessments of activity limitation, and participation restriction derived from information gathered from those affected. Such an approach has been advocated in the past[16;19;28], and seems to be being given active consideration by the IHME leadership[7]. The IHME burden of disease estimates are highly discrepant with findings from studies of the directly measured disability, dependence, and cost associated with chronic diseases, which provide a very different picture regarding the societal impact of dementia relative to other non-communicable conditions. The 'evidence test' is much more important than the 'common sense' test referred to earlier. The relevant evidence has been reviewed previously in the World Alzheimer Report 2009 and the World Alzheimer Report 2013[5;29], and is updated and summarised briefly here:

1. Dementia and cognitive impairment are by far the leading chronic disease contributors to disability, and, particularly, needs for care (dependence) among older people worldwide. While older people can often cope well and remain reasonably independent even with marked physical disability, the onset of cognitive impairment quickly compromises their ability to carry out complex but essential tasks and, later, their basic personal care needs. The need for support from a caregiver often starts early in the dementia journey, intensifies as

Table 5.5
Prevalence ratios (PR)* for the independent associations between health conditions (impairments and diagnoses) and a) disability[16] and b) dependence[30]

	Associations with disability		Associations with dependence	
Health conditions, ranked in order of contribution to dependence	Meta-analysed PR (95% CI)	Median PAPF (range by site)	Meta-analysed PR (95% CI)	Median PAPF (range by site)
Dementia	1.9 (1.8-2.0)	25% (19-44%)	4.5 (4.0-5.1)	34% (23-59%)
Limb paralysis or weakness	1.8 (1.7-1.9)	11% (6-34%)	2.8 (2.4-3.2)	9% (1-46%)
Stroke	1.4 (1.3-1.5)	11% (2-21%)	1.8 (1.6-2.1)	8% (2-17%)
Depression	1.4 (1.3-1.5)	8% (1-23%)	1.7 (1.5-2.0)	8% (0-27%)
Eyesight problems	1.1 (1.1-1.1)	7% (2-18%)	1.2 (1.1-1.3)	6% (0-16%)
Arthritis or rheumatism	1.3 (1.3-1.4)	10% (3-35%)	1.1 (1.0-1.3)	4% (0-6%)
Stomach or intestine problems	1.1 (1.1-1.2)	7% (0-23%)	*1.1 (1.0-1.3)*	*2% (0-16%)*
Hearing difficulty	1.1 (1.1-1.2)	2% (1-9%)	*1.1 (0.9-1.2)*	*1% (0-5%)*
Difficulty breathing	1.2 (1.1-1.3)	4% (2-9%)	*1.2 (1.0-1.4)*	*1% (0-6%)*

* Adjusted for age, sex, education, marital status and other health conditions.
Figures in italics indicate conditions not statistically associated with dependence that have positive PAPF values

the illness progresses over time, and continues until death[29].

2. For low and middle income countries, the population-based surveys carried out by the 10/66 Dementia Research Group have shown clearly that disorders of the brain and mind (dementia, stroke and depression) make the largest independent contribution, both in terms of the strength of the association and the 'population attributable prevalence fraction' (PAPF), to disability[16] and dependence[30] (see Table 5.5). Dementia makes the dominant contribution, particularly to needs for care. These findings are consistent with a large body of pre-existing evidence from population-based studies conducted in Canada[31], the USA [32], Sweden[33;34], and Hong Kong[35], all of which attest to the leading contribution of dementia and/or cognitive impairment to prevalent or incident disability, controlling for comorbidity with other chronic diseases.
3. Dementia is typically associated with a particular intensity of needs for care, exceeding the demands associated with other conditions. In the USA, caregivers of people with dementia were more likely than caregivers of people with other conditions to be required to provide help with getting in and out of bed (54% vs. 42%), dressing (40% vs. 31%), toileting (32% vs. 26%), bathing (31% vs. 23%) managing incontinence (31% vs. 16%) and feeding (31% vs. 14%)[36]. These findings were confirmed in reports from the 10/66 Dementia Research Group; in the Dominican Republic and in China among those needing care, those with dementia stood out as being more disabled, as needing more care (particularly support with core activities of daily living), and as being more likely to have paid caregivers - dementia caregivers also experienced more strain than caregivers of those with other health conditions[37;38].
4. Another proxy indicator of the relevance of dementia to dependence is the extent to which older people with dementia use different types of care services that reflect increasing levels of needs for care, and the extent to which they are over-represented among older users of those services. In the USA, it has been estimated that people with dementia account for 37% of older people who use non-medical home care services, at least half of attendees at adult day centres, 42% of residents in assisted living and residential care facilities, and 64% of Medicare beneficiaries living in a nursing home[36]. In a US study of older people who needed help with personal care or instrumental activities of daily living, those with cognitive impairment were more than twice as likely as others to receive paid home care, and used the services twice as intensively as did cognitively normal users of paid home care[39]. Approximately 30-40% of older Americans with dementia live in a care home, compared with just 2% of older adults without dementia[36;40].
5. Moving into a care home is generally a marker of particularly high needs for care, although other factors can be involved. Predictors of transition into a care home in the USA have been studied in a review including 77 reports across 12 data sources that used longitudinal designs and community-based samples[41]. Cognitive impairment was the health condition that most strongly predicted transition, with a 2.5 fold increased risk (RR 2.54, 95% CI: 1.43-4.51). Other major chronic conditions also conferred a significantly increased risk: RR 1.04 for hypertension, 1.15 for cancer and 2.35 for diabetes, but these were modest compared to the risk associated with cognitive impairment. Other chronic conditions including arthritis, lung disease or cardiovascular disease did not show any significant association. In a study conducted in Sweden, dementia was the main predictor of transition into a care home, with a population attributable fraction of 61%[42].
6. Therefore, the current and future costs of long-term care will be driven to a very large extent by the coming epidemic of dementia[29]. Our success in designing and implementing successful strategies for the prevention of dementia[6], and in identifying treatments that can alter the course of the disease will be important determinants of future health and social care costs, currently rising inexorably in the context of population ageing.
7. The enormous global societal costs of dementia were estimated in the World Alzheimer Report 2010, and these estimates have been updated to 2015 in the next chapter. There have been relatively few attempts to compare dementia costs with those of other chronic diseases. In the UK, it was estimated that the health and social care costs for dementia (£23billion in 2008), almost matched the combined costs of cancer (£12bn), heart disease (£8bn) and stroke (£5bn)[43]. In the US ADAMS study the national societal cost of dementia in 2010 was estimated in the range of US$159bn to US$215bn annually; the component of this that related to care purchased in the marketplace (i.e. excluding informal family care costs) was US$109bn, higher than that for heart disease (US$102bn) and cancer (US$77bn) [44]. In a Swedish study[46], the annual costs of dementia (50bn SEK) exceeded those of depression (32.5bn SEK), stroke (12.5bn SEK), alcohol abuse (21-30bn SEK) and osteoporosis (4.6bn SEK). Few of these studies take into account comorbidity, and estimate the independent or 'attributable' costs of dementia. Dr Zhaorui Liu carried out such an analysis using data from the 10/66 Dementia Research Group baseline surveys in Latin America, India and China (Table 5.6)[45]. For all countries other than India, the attributable cost of dementia exceeded that of other conditions (depression,

Table 5.6
Mean attributable cost (International $) of dementia and other chronic conditions in countries in Latin America, India and China. 10/66 Dementia Research Group

Total cost	Cuba	Dominican Republic	Peru	Venezuela	Mexico	China	India	Whole sample
Dementia	3851*	3804*	10332*	3497*	4781*	8687*	1764*	5164*
Depression	540	197	1306	2203*	461	7660*	588*	705*
Hypertension	-145	-40	7.0	53	-165	-406*	-109	-50
Diabetes	-0.7	20	610	729*	781*	776*	764*	420*
Ischaemic heart disease	-253*	378	-136	-215	-106	-132	-355	-158
Stroke	977*	1405*	3542*	1032	2056*	4072*	3251*	2218*
Chronic obstructive pulmonary disease	-193	-518	-454	-159	-1.6	1961*	209	18

*Statistically significant at 95% level of confidence

hypertension, diabetes, ischaemic heart disease and stroke). Medical care costs for dementia were negligible, reflecting limited access to services, but dementia costs dominated for social care, informal care ad, paid home care.

5.4 Conclusion

The purpose of this section of the report has been to provide information about the contribution of dementia to disability, mortality and dependence, and, at the societal level, to economic costs. We have aimed to compare the effects of dementia with those of other important chronic diseases, taking account, where possible, of the frequent comorbidity between physical, mental and cognitive disorders. We have highlighted that the Global Burden of Disease estimates fail to reflect the societal impact of dementia, relative to other chronic diseases and, as such, cannot be considered to be a reliable tool for prioritisation for research, prevention, and health or social care among older people. As Dr Margaret Chan, Director-General of the World Health Organization, expressed in her opening remarks at the First WHO Ministerial Conference on Global Action Against Dementia (Geneva, 15th March 2015):

> "I can think of no other disease that has such a profound effect on loss of function, loss of independence, and the need for care. I can think of no other disease so deeply dreaded by anyone who wants to age gracefully and with dignity. I can think of no other disease that places such a heavy burden on families, communities, and societies. I can think of no other disease where innovation, including breakthrough discoveries to develop a cure, is so badly needed."

References

1 The Global Burden of Disease. A comprehensive assessment of mortality and disability from diseases, injuries and risk factors in 1990 and projected to 2020. The Harvard School of Public Health, Harvard University Press; 1996.

2 World Health Organization. WHO Statistical Information System. Working paper describing data sources, methods and results for projections of mortality and burden of disease for 2005, 2015 and 2030. 2006.

3 World Health Organization. Global Burden of Disease 2004 Update: Disability Weights for Diseases and Conditions. Geneva: World Health Organization; 2004.

4 Murray CJ, Ezzati M, Flaxman AD, Lim S, Lozano R, Michaud C et al. GBD 2010: design, definitions, and metrics. Lancet 2012 December 15;380(9859):2063-6.

5 Alzheimer's Disease International. World Alzheimer Report 2009. London: Alzheimer's Disease International; 2009.

6 World Health Organization. Dementia: a public health priority. Geneva: World Health Organization; 2012.

7 Salomon JA, Vos T, Hogan DR, Gagnon M, Naghavi M, Mokdad A et al. Common values in assessing health outcomes from disease and injury: disability weights measurement study for the Global Burden of Disease Study 2010. Lancet 2012 December 15;380(9859):2129-43.

8 Salomon JA, Vos T, Hogan DR, Gagnon M, Naghavi M, Mokdad A et al. Common values in assessing health outcomes from disease and injury: disability weights measurement study for the Global Burden of Disease Study 2010. Lancet 2012 December 15;380(9859):2129-43.

9 Stouthard ME, Essink-Bot M, Bonsel GJ. Disability weights for diseases. A modified protocol and results for a Western European region. The European Journal of Public Health 10[1], 24-30. 2000.

10 Schwarzinger M, Stouthard ME, Burstrom K, Nord E. Cross-national agreement on disability weights: the European Disability Weights Project. Popul Health Metr 2003 November 21;1(1):9.

11 Murray CJ, Vos T, Lozano R, Naghavi M, Flaxman AD, Michaud C et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 2013 December 15;380(9859):2197-223.

12 Prince MJ, Wu F, Guo Y, Gutierrez Robledo LM, O'Donnell M, Sullivan R et al. The burden of disease in older people and implications for health policy and practice. Lancet 2015 February 7;385(9967):549-62.

13 World Health Organization. The global burden of disease. 2004 update. Geneva: World Health Organization; 2008.

14 Williams A. Calculating the global burden of disease: time for a strategic reappraisal? Health Econ 1999 February;8(1):1-8.

15 World Economic Forum and World Health Organization. From Burden to "Best Buys": Reducing the Economic Impact of Non-Communicable Diseases in Low- and Middle-Income Countries. Cologny/ Geneva: World Economic Forum; 2011.

16 Sousa RM, Ferri CP, Acosta D, Albanese E, Guerra M, Huang Y et al. Contribution of chronic diseases to disability in elderly people in countries with low and middle incomes: a 10/66 Dementia Research Group population-based survey. Lancet 2009 November 28;374(9704):1821-30.

17 Taylor HR, Jonas JB, Keeffe J, Leasher J, Naidoo K, Pesudovs K et al. Disability weights for vision disorders in Global Burden of Disease study. Lancet 2013 January 5;381(9860):23-6736.

18 Salomon JA, Vos T, Murray CJ. Disability weights for vision disorders in Global Burden of Disease study - Authors' reply. Lancet 2013 January 5;381(9860):23-4.

19 Grosse SD, Lollar DJ, Campbell VA, Chamie M. Disability and disability-adjusted life years: not the same. Public Health Rep 2009 March;124(2):197-202.

20 Dua T, Barbui C, Clark N, Fleischmann A, Poznyak V, Van OM et al. Evidence-based guidelines for mental, neurological, and substance use disorders in low- and middle-income countries: summary of WHO recommendations. PLoS Med 2011 November;8(11):e1001122.

21 Nozaki I. WHO's budgetary allocation and disease burden. Lancet 2013 September 14;382(9896):937-8.

22 United Nations General Assembly. Political declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases. New York: United Nations; 2011. Report No.: A/66/L.1.

23 Mitchell RJ, McClure RJ, Olivier J, Watson WL. Rational allocation of Australia's research dollars: does the distribution of NHMRC funding by National Health Priority Area reflect actual disease burden? Med J Aust 2009 December 7;191(11-12):648-52.

24 Gross CP, Anderson GF, Powe NR. The relation between funding by the National Institutes of Health and the burden of disease. N Engl J Med 1999 June 17;340(24):1881-7.

25 Lamarre-Cliche M, Castilloux AM, LeLorier J. Association between the burden of disease and research funding by the Medical Research Council of Canada and the National Institutes of Health. A cross-sectional study. Clin Invest Med 2001 April;24(2):83-9.

26 Lam J, Lord SJ, Hunter KE, Simes RJ, Vu T, Askie LM. Australian clinical trial activity and burden of disease: an analysis of registered trials in National Health Priority Areas. Med J Aust 2015 July;%20;203(2):97-101.

27 Yoong SL, Hall A, Williams CM, Skelton E, Oldmeadow C, Wiggers J et al. Alignment of systematic reviews published in the Cochrane Database of Systematic Reviews and the Database of Abstracts and Reviews of Effectiveness with global burden-of-disease data: a bibliographic analysis. J Epidemiol Community Health 2015 July;69(7):708-14.

28 Sousa RM, Dewey ME, Acosta D, Jotheeswaran AT, Castro-Costa E, Ferri CP et al. Measuring disability across cultures--the psychometric properties of the WHODAS II in older people from seven low- and middle-income countries. The 10/66 Dementia Research Group population-based survey. Int J Methods Psychiatr Res 2010 March;19(1):1-17.

29 Prince, M., Prina, M., and Guerchet, M. World Alzheimer Report 2013. Journey of Caring. An analysis of long-term care for dementia. London: Alzheimer's Disease International; 2013.

30 Sousa RM, Ferri CP, Acosta D, Guerra M, Huang Y, Ks J et al. The contribution of chronic diseases to the prevalence of dependence among older people in Latin America, China and India: a 10/66 Dementia Research Group population-based survey. BMC Geriatr 2010 August 6;10(1):53.

31 Thomas VS. Excess functional disability among demented subjects? Findings from the Canadian Study of Health and Aging. Dement Geriatr Cogn Disord 2001 May;12(3):206-10.

32 Wolff JL, Boult C, Boyd C, Anderson G. Newly reported chronic conditions and onset of functional dependency. J Am Geriatr Soc 2005 May;53(5):851-5.

33 Aguero-Torres H, Thomas VS, Winblad B, Fratiglioni L. The impact of somatic and cognitive disorders on the functional status of the elderly. J Clin Epidemiol 2002 October;55(10):1007-12.

34 Aguero-Torres H, Fratiglioni L, Guo Z, Viitanen M, von Strauss E, Winblad B. Dementia is the major cause of functional dependence in the elderly: 3-year follow-up data from a population-based study. Am J Public Health 1998 October;88(10):1452-6.

35 Woo J, Ho SC, Lau S, Lau J, Yuen YK. Prevalence of cognitive impairment and associated factors among elderly Hong Kong Chinese aged 70 years and over. Neuroepidemiology 1994;13:50-8.

36 Alzheimer's Association. 2013 Alzheimer's Facts and Figures. Chicago, IL: Alzheimer's Association; 2013.

37 Liu Z, Albanese E, Li S, Huang Y, Ferri CP, Yan F et al. Chronic disease prevalence and care among the elderly in urban and rural Beijing, China - a 10/66 Dementia Research Group cross-sectional survey. BMC Public Health 2009;9:394.

38 Acosta D, Rottbeck R, Rodriguez G, Ferri CP, Prince MJ. The epidemiology of dependency among urban-dwelling older people in the Dominican Republic; a cross-sectional survey. BMC Public Health 2008 August 13;8(1):285.

39 Johnson, R. W. and Wiener, J. M. A profile of frail older Americans and their caregivers. Washington DC: Urban Institute; 2006.

40 MetLife Mature Market Institute. Market Survey of Long-Term Care Costs Care Costs: The 2012 MetLife Market Survey of Nursing Home, Assisted Living, Adult Day Services, and Home Care Costs. New York, NY: Metropolitan Life Insurance Company; 2012.

41 Gaugler JE, Duval S, Anderson KA, Kane RL. Predicting nursing home admission in the U.S: a meta-analysis. BMC Geriatr 2007;7:13.

42 Aguero-Torres H, von Strauss E, Viitanen M, Winblad B, Fratiglioni L. Institutionalization in the elderly: the role of chronic diseases and dementia. Cross-sectional and longitudinal data from a population-based study. J Clin Epidemiol 2001 August;54(8):795-801.

43 Luengo-Fernandez, R., Leal, J., and Gray, A. Dementia 2010. The prevalence, economic cost and research funding of dementia compared with other major diseases. A report produced by the Health Economics Research Centre, University of Oxford for the Alzheimer's Research Trust. Cambridge: Alzheimer's Research Trust; 2010.

44 Hurd MD, Martorell P, Delavande A, Mullen KJ, Langa KM. Monetary costs of dementia in the United States. N Engl J Med 2013 April 4;368(14):1326-34.

45 Liu Z. Economic Cost of Dementia In Low and Middle Income Countries (PhD thesis) King's College London; 2012.

46 Wimo A, Johansson L, Jönsson L. Demenssjukdomarnas samhällskostnader och antalet dementa i Sverige 2005 (The societal costs of dementia and the number of people with dementia in Sweden 2005). Socialstyrelsen (underlag från experter), Stockholm, 2007 (artikel nr 2007-123-32)

CHAPTER 6

The worldwide costs of dementia

6.1 Introduction

In 2010 ADI presented estimates of the global societal economic impact of dementia[1]. The global cost in 2010 was estimated to be US$ 604 billion. This figure constituted around 1% of the aggregated world Gross Domestic Product (GDP), indicating a particularly significant global socioeconomic impact for this one condition. Although most people with dementia live in low or middle income countries (LMIC), almost 90% of the costs were incurred in high income countries. These estimates, also included in the WHO/ADI 2012 report, Dementia: a public health priority[2], and published as a scientific paper[3], have been widely cited, generally accepted, and influential in raising awareness of the scale and impact of the current global epidemic*.

Five years have passed. Our estimates of the likely prevalence of dementia have changed for some regions, and the numbers affected have increased for all regions in line with the increase in the older population (see Chapter 2). Cost of illness (COI) estimates have improved, with more recent and comprehensive studies from several high income countries, and with coverage extended to include more high and middle income countries. Thus, it is time to update our global estimates of the economic impact of dementia.

6.2 Methods

6.2.1 General approach

The estimates of the global societal economic cost of dementia provided in this report have been generated using the same general approach as for the 2010 report. Costs are estimated at the country level and then aggregated in various combinations to summarise worldwide cost, cost by Global Burden of Disease world region, cost by World Bank country income level (high income, upper middle income, lower middle income, and low income countries), and costs for the G7 and G20 countries. For each country there is a cost per person (per capita) estimate which is then multiplied by the number of people estimated to be living with dementia in that country. The per capita costs are divided into three cost sub-categories: direct medical costs, direct social care costs (paid and professional home care, and residential and nursing home care) and costs of informal (unpaid) care. The base option for costing informal care is an opportunity cost approach, valuing hours of informal care by the average wage for each country.

* See for example WHO Director-General Margaret Chan's opening comments to the WHO First Ministerial Conference on Dementia (http://www.who.int/dg/speeches/2015/dementia-conference/en/) and UK Prime Minister David Cameron's speech to the first G7 Global Action on Dementia Legacy Event (https://www.gov.uk/government/news/pm-launches-next-phase-of-britains-fight-against-dementia)

6.2.2 What is new?

These new estimates should be considered to be a partial update of the previous (2010) estimates, rather than a full-scale revision. They do benefit from a fully systematic review of the prevalence of dementia, and numbers affected (see Chapter 2). We did not carry out a fully systematic review of service utilisation and cost of illness studies. However, we have identified several important cost of illness studies published since 2010. We have selected those that could be used to replace much older (and hence outdated) COI data, or could provide data-based estimates for countries where estimates had previously had to be imputed due to lack of relevant data, and have a significant influence on previous cost estimates. From high income countries, we have included new cost estimates from the USA[4], UK[5], Germany[6], Norway[7] Sweden(8), and Ireland [9]. For middle income countries, there is more information available regarding costs of dementia care, and their distribution between sub-categories, from seven countries surveyed by the 10/66 Dementia Research Group: China, India, Cuba, Peru, Venezuela, Dominican Republic and Mexico (PhD thesis by Dr Zhaorui Liu[10]).

As in 2010, for countries with no cost data, cost estimations are derived by imputation. The assumption for the imputation is that there is a relationship between a country's per capita GDP and annual per capita direct costs of dementia. In the 2010 report, for LMIC, the partitioning of the imputed total direct costs into direct medical and social care sector costs was derived from the only available relevant study, from China (Wang et al[11]), where two-thirds of the direct costs were medical and one-third derived from the social care sector. These proportions were used as a basis for imputation in many Asian and African countries. Now there is more information available from the 10/66 COI studies (China, India, Cuba, Peru, Venezuela, Dominican Republic and Mexico)[10], where the proportions are similar to those from Wang et al, but with a higher proportion of medical care costs in Latin America (Table 6.1). Data from Africa is still lacking.

Table 6.1
Proportional distribution of direct medical and social care costs, by sector

	Wang[11]	Zhaorui Liu's thesis[10]		
	China	Latin America	Asia	All
Direct medical costs	0.67	0.74	0.66	0.73
Social care sector costs	0.33	0.26	0.34	0.27

For the 2010 report, there was only one published cost of illness study from Latin America[12], which was used for imputation of estimates across the region. Zhaorui Liu's thesis has broadened the available information from Latin America considerably, making the imputations much more representative. For further details and discussions of the principles for imputation, please see the 2010 report. The correlation between GDP per capita and annual direct costs of dementia in the updated set of cost of illness studies used in the current report is 0.86 ($p<0.001$).

6.2.3 Updating cost estimates from 2010 to 2015

For the current estimates, all costs are expressed as 2015 US$. In the USA, one dollar in 2010 would purchase US$1.09 in 2015, a cumulative inflation rate over the five years of 9.4%, based on the US consumer price index. The IMF/WEO (International Monetary Fund/World Economic Outlook) database (consumer prices index) was used to generate similar cost adjustments, between 2010 and 2015, for each country[13]. For countries where no such figures were available, imputations based on trends from 2010 to latest available CPI were used (for example: trends between 2010 and 2012 were applied between 2010 to 2015). For a few countries with very small populations and not included in the WEO database, United Nations country profiles were used[14] .

Such imputations were not required for any country with a major impact on the costs.

6.2.4 Comparing 2010 and 2015 estimates

Besides the updated estimates of prevalence and numbers, the additional cost of illness data, the enhancements to the imputation process, and the cost adjustments, two other issues are important when interpreting comparisons between 2010 and 2015 costs.

First, there have been shifts in the World Bank (WB) classification of country income level between 2010 and 2015 (several countries have been "upgraded", see Chapter 1). To facilitate 'like for like' comparisons between 2015 and 2010, the 2015 costs by country income level are presented according to both a) the current 2015 World Bank Classification, and b) the 2010 World Bank Classification, which was used to generate the estimates for high income countries (HIC), upper middle income countries (UMIC), lower middle income countries (L-MIC) and low income countries (LIC) presented in the World Alzheimer Report 2010.

Second, our current revised estimates of regional dementia prevalence arguably provide a better estimate of likely numbers of people with dementia in 2010, as well as 2015 (Chapter 2). For the World Alzheimer Report 2009, we estimated 35.6 million people with dementia in 2010. However, if we apply

Table 6.2
Worldwide costs of dementia in 2010 and 2015 (billion US$), based on current World Bank country classification each year

Year for cost estimates (basis for prevalence estimates)	2010 (WAR 2009)		2015 (WAR 2015)	
World Bank Country Classification Year	2010		2015	
	US$ (billions)	Per cent	US$ (billions)	Per cent
Low income	4.4	0.7%	1.2	0.1%
Lower middle income	29.2	4.8%	15.3	1.9%
Upper middle income	32.5	5.4%	86.3	10.5%
High income	537.9	89.1%	715.1	87.4%
Total	604.0	100.0%	817.9	100.0%

the prevalence estimates from the current report, than we would have estimated 40.1 million people with dementia in 2010. The estimated numbers for China have increased considerably as have those for some countries in Northern Africa, while the estimates for some high income countries (for example the USA and UK) are somewhat lower. The 2010 estimates based on the original prevalence estimates from the World Alzheimer Report 2009 will be labelled in tables as 'WAR 2009', while those based on the prevalence estimates from the current report will be labelled as 'WAR 2015'.

6.2.5 Forecasting beyond 2015

Using the trends (2010-2015) in per capita cost and numbers of people with dementia, both based upon World Alzheimer Report 2015 prevalence, it is technically possible to make tentative forecasts of future growth in costs. We present the estimated costs in 2030 as well as an estimate of the date when global cost will cross the threshold of US$ 1 trillion.

6.2.6 Sensitivity analyses

Three sensitivity analyses have been included.

In the 2010 report, the most significant effect in the sensitivity analysis was the method of quantifying informal care[1, 3]. In the main option, informal care is quantified in terms of time spent assisting with basic and instrumental ADLs (activities of daily living), while a lower cost (only basic ADLs) and a higher cost (basic and instrumental ADLs, and time spent in supervision) are included. In the 2010 report, different alternatives for costing informal care (regression, replacement cost, 25% and 50% of average wage) were used as well as PPPs (purchase power parities) instead of currency exchange rates, but these alternative inputs had smaller effects on the resulting costs than the variation in caregiver time, and have not been repeated here.

The CPI is used for cost adjustments between 2010 and 2015 in the base option. In a second sensitivity analysis, the change in GDP in the different countries is used instead for the cost adjustments.

In a third 'fixed costs' sensitivity analysis, a crude prevalence-based alternative is presented, without any new cost of illness data included and without cost adjustments. This sensitivity analysis focuses on the impact on costs of the changes in numbers of people affected.

6.3 Results

6.3.1 Aggregated costs, worldwide, and by country income level

In the base option, **the global costs of dementia have increased from US$ 604 billion in 2010 to US$ 818 billion in 2015** (Table 6.2), an increase of 35.4%. Our current estimate of US$ 818 billion represents 1.09% of global GDP, an increase from our 2010 estimate of 1.01%. However, while in HIC the proportion has increased from 1.24% to 1.42%, there have been slight falls in costs as a proportion of GDP in LIC (0.24% to 0.21%), L-MIC (0.35% to 0.29%), and UMIC (0.50% to 0.46%). Excluding informal care costs, total direct costs account for 0.65% of global GDP.

The proportion of costs incurred in high income countries (HIC) is similar to that reported in the World Alzheimer Report 2010. Since many countries that were classified as low income or low middle income countries in 2010 have been "upgraded" (see Chapter 1), the proportion of worldwide costs incurred in upper middle income countries (UMIC) has increased from 5.4% to 10.5%, and the proportion incurred in LIC and L-MIC has decreased commensurately compared with 2010.

The effect of the World Bank reclassification of country income status is clearer if we compare 2010 and 2015 cost distributions, on a 'like for like' basis, using the 2010 WB classification for both time points (Table 6.3). On this basis, the proportion of costs incurred in what were low and middle income countries in 2010

Table 6.3
Worldwide costs of dementia in 2010 and 2015 (billion US$), based on World Bank country classification 2010

Year for cost estimates (basis for prevalence estimates)	2010 (WAR 2010)		2015 (WAR 2015)	
World Bank Country Classification Year	2010		2010	
	US$ (billions)	Per cent	US$ (billions)	Per cent
Low income	4.4	0.7%	6.6	0.8%
Lower middle income	29.2	4.8%	57.1	7.0%
Upper middle income	32.5	5.4%	84.5	10.3%
High income	537.9	89.1%	669.6	81.9%
Total	604.0	100.0%	817.9	100.0%

Table 6.4
Worldwide costs of dementia in 2010 and 2015 (billion US$), based on World Bank country classification 2010 and adjusted prevalence figures for 2010

Year for cost estimates (basis for prevalence estimates)	2010 (WAR 2009)		2015 (WAR 2015)	
World Bank Country Classification Year	2010		2010	
	US$ (billions)	Per cent	US$ (billions)	Per cent
Low income	5.2	0.9%	6.6	0.8%
Lower middle income	41.2	6.8%	57.1	7.0%
Upper middle income	49.4	8.1%	84.5	10.3%
High income	510.9	84.2%	669.6	81.9%
Total	606.7	100.0%	817.9	100.0%

(particularly middle income countries) has increased, and the proportion in what were HIC has decreased.

To complete the adjustments for a 'like for like' comparison, we adjusted the 2010 cost of illness estimates to take account of the revised estimates of the regional prevalence of dementia published in this report, which were used to estimate the 2015 costs (Table 6.4). Despite the 4.9 million (14%) increase in the estimated numbers of people with dementia in 2010 when applying the World Alzheimer Report 2015 prevalence estimates, the total (worldwide) cost for 2010 has increased only marginally, from US$ 604.0 billion to US$ 606.7 billion. The explanation for this is that most of the upwards adjustments of numbers of people with dementia occurred in low and middle income countries (where per capita costs are low), while there were some downwards adjustments in the estimates of numbers of people affected in HIC (e.g. USA, Germany, UK) where per capita costs are high. On the basis of this completely 'like for like' comparison, it is clear that there have been only modest changes in the distribution of costs by country income level, with a modest increase in the proportion arising in countries classified in 2010 as UMIC, and a modest reduction in the proportion arising in countries classified in 2010 as HIC. Global costs have increased by 35%, HIC costs by 31%, UMIC costs by 71%, L-MIC costs by 39%, and LIC costs by 27%.

The G7 countries have initiated and lead the 'Global Action Against Dementia' accepting dementia as a national and global public health priority. We also thought that it would be instructive to analyse worldwide costs according to membership of the G7 and the wider G20 group of nations (Table 6.5). This analysis reveals a striking concentration of global costs among the world's wealthiest nations. Although the G7 countries account for just over a quarter of global prevalence, over three-fifths of global costs are incurred in these seven countries. The G20 nations account for a remarkable 92% of global costs. The 182 nations that are members of neither G7 nor G20 account for 20% of the global prevalence, but just 8% of the costs.

6.3.2 Aggregated costs by cost sub-category

The pattern of distribution of costs between the three major sub-categories (direct medical, social care, and informal care) has not changed substantially (Table 6.6). As reported in 2010, the proportional contribution of direct medical care costs is modest, particularly

Table 6.5
Costs of dementia in 2015 (billion US$), by G7 and G20 country classification

	2015 (WAR 2015)			
	US$ (billions)	Per cent of costs	Numbers of people with dementia (millions)	Per cent of prevalence
G7*	508.7	62.2%	12.9	27.6%
G20**	754.2	92.2%	37.5	80.1%
G20 excluding G7	245.5	30.0%	24.6	52.6%
Rest of the world (excluding G20)	63.6	7.8%	9.3	19.9%
World	817.9	100%	46.8	100%

* G7 countries: Canada, France, Germany, Great Britain, Italy, Japan, and the United States

** G20 countries: Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, the United Kingdom and the United States. The EU is the 20th 'country' in the G20, for the purposes of this analysis the remaining EU member countries (Cyprus, Austria, Belgium, Croatia, Czech Republic, Denmark, Finland, Greece, Ireland, Luxembourg, Malta, Netherlands, Portugal, Slovenia, Spain, Sweden, Poland, Romania, Slovak Republic, Bulgaria, Estonia, Hungary, Latvia, Lithuania) were allocated to the G20 group.

Table 6.6
Sub-category costs of dementia in 2010 and 2015 (billion US$, and percent of total costs), by country income level based on current World Bank country classification

	Direct medical costs		Direct social sector costs		Informal care costs	
	US$ (billions)	Per cent	US$ (billions)	Per cent	US$ (billions)	Per cent
2010 (WAR 2009)						
Low income	0.1	22.3%	0.1	11.5%	0.3	66.2%
Lower middle income	2.9	29.4%	1.6	16.4%	5.3	54.2%
Upper middle income	12.6	28.1%	8.3	18.6%	23.9	53.3%
High income	80.8	14.7%	245.7	44.8%	222.4	40.5%
Total	96.4	16.0%	255.7	42.3%	251.9	41.7%
2015 (WAR 2015)						
Low income	0.2	20.4%	0.1	10.4%	0.8	69.2%
Lower middle income	3.7	23.9%	2.0	13.2%	9.6	62.9%
Upper middle income	19.3	22.4%	17.7	20.5%	49.3	57.1%
High income	136.0	19.0%	308.1	43.1%	271.1	37.9%
Total	159.2	19.5%	327.9	40.1%	330.8	40.4%

in HIC. There is an increasing relative contribution of direct social care sector costs and a decreasing relative contribution of informal care costs with increasing country income level.

6.3.3 Aggregated costs by Global Burden of Disease regional country classification

According to the Global Burden of Disease regional country classification (Table 6.7), the regional distribution of costs has not changed markedly from those published in 2010. Cost estimates have increased for all world regions. The greatest relative increase occurred in the African and in East Asia regions, driven, largely, by the upwards revision of the prevalence estimates for those regions.

The partition of total costs by sub-categories (direct medical care costs, social care costs, and informal care) varies by region, consistent with the pattern

of variation by country income level. The relative contribution of informal care is greatest in the African regions and lowest in North America, Western Europe and some South American regions (Table 6.8), while the reverse is true for social sector costs.

6.3.4 Annual costs per person with dementia

The comparison of costs per person with dementia, between the World Alzheimer Report 2010 and the current update, is most easily summarised and understood stratified by Global Burden of Disease region. The issue of whether the World Alzheimer Report 2010 or World Alzheimer Report 2015 prevalence estimates are applied to the 2010 population to generate numbers of people with dementia is not relevant, because the prevalence estimates are region specific, and these are per capita estimates. For our updated estimates annual costs per person range from US$872 (South Asia) to US$56,218 (North America). For all but two regions, the estimate of per person costs has increased. The median change among regions was +26.3% (interquartile range +7.8% to +57.9%)

Direct comparison of costs per person by World Bank country income level is complicated both by the year of the World Bank classification (2010 vs 2015), and the basis for prevalence estimates (WAR 2009 vs WAR 2015). The optimal 'like for like' comparison uses the World Bank classification of 2010 and the World Alzheimer Report 2015 prevalence estimates for both the 2010 and 2015 time points (column 3 vs. column 5 in Table 6.10 below). According to each of four approaches, per person costs increase steeply with

Table 6.7
Costs of dementia in 2010 and 2015 (billion US$, and percent of worldwide costs), by Global Burden of Disease world region classification

Year for cost estimates (basis for prevalence estimates)	2010 (WAR 2009)		2015 (WAR 2015)		2010-2015
	US$ (billions)	Per cent	US$ (billions)	Per cent	Per cent change
Australasia	10.1	1.7%	14.1	1.7%	39.6%
Asia Pacific High Income	82.1	13.6%	109.9	13.4%	33.9%
Oceania	0.1	0.0%	0.2	0.0%	59.0%
Asia Central	0.9	0.2%	1.2	0.1%	28.6%
Asia East	22.4	3.7%	42.9	5.2%	91.7%
Asia South	4.0	0.7%	4.5	0.5%	11.8%
Asia Southeast	4.0	0.7%	7.3	0.9%	81.9%
Europe Central	14.2	2.3%	15.0	1.8%	5.7%
Europe Eastern	14.3	2.4%	23.5	2.9%	64.3%
Europe Western	210.1	34.8%	262.6	32.1%	25.0%
North America High Income	213.0	35.3%	268.9	32.9%	26.3%
Caribbean	3.0	0.5%	3.5	0.4%	18.2%
Latin America Andean	0.9	0.2%	1.1	0.1%	27.0%
Latin America Central	6.6	1.1%	15.9	1.9%	140.8%
Latin America Southern	5.1	0.8%	10.1	1.2%	98.7%
Latin America Tropical	7.3	1.2%	15.6	1.9%	113.8%
North Africa / Middle East	4.5	0.7%	16.7	2.0%	270.7%
Sub-Saharan Africa Central	0.1	0.0%	0.3	0.0%	198.6%
Sub-Saharan Africa East	0.4	0.1%	1.5	0.2%	267.4%
Sub-Saharan Africa Southern	0.7	0.1%	2.3	0.3%	221.7%
Sub-Saharan Africa West	0.2	0.0%	0.8	0.1%	298.6%
Total	604.0	100.0%	817.9	100.0%	35.4%

Table 6.8
Costs of dementia in 2015 (US$ billions), by Global Burden of Disease region classification. Costs in cost categories. Percentages of each GBD region class costs

Cost sub-category	Direct medical costs		Direct social sector costs		Informal care costs	
GBD World region	US$ (billions)	Per cent	US$ (billions)	Per cent	US$ (billions)	Per cent
Australasia	1.0	6.9%	7.1	50.3%	6.0	42.8%
Asia Pacific High Income	7.0	6.3%	56.4	51.3%	46.5	42.4%
Oceania	0.0	17.4%	0.0	8.6%	0.1	74.0%
Asia Central	0.3	29.6%	0.3	25.3%	0.5	45.1%
Asia East	2.2	5.2%	10.2	23.8%	30.5	71.0%
Asia South	0.5	10.7%	0.1	3.3%	3.8	86.0%
Asia Southeast	2.7	36.8%	1.3	18.2%	3.3	45.0%
Europe Central	2.8	18.8%	3.1	20.4%	9.1	60.8%
Europe Eastern	5.7	24.1%	4.9	20.7%	13.0	55.2%
Europe Western	50.8	19.3%	113.0	43.0%	98.9	37.6%
North America High Income	61.1	22.7%	115.5	43.0%	92.3	34.3%
Caribbean	0.8	21.3%	0.8	21.8%	2.0	56.9%
Latin America Andean	0.2	17.8%	0.4	32.6%	0.6	49.5%
Latin America Central	6.2	39.2%	5.5	34.3%	4.2	26.5%
Latin America Southern	2.8	27.8%	2.6	25.2%	4.8	47.0%
Latin America Tropical	5.7	36.8%	5.2	33.4%	4.7	29.9%
North Africa / Middle East	8.5	50.7%	1.2	7.2%	7.0	42.0%
Sub-Saharan Africa Central	0.1	28.5%	0.0	14.1%	0.2	57.3%
Sub-Saharan Africa East	0.3	20.8%	0.2	10.3%	1.0	68.9%
Sub-Saharan Africa Southern	0.4	16.4%	0.2	8.1%	1.7	75.6%
Sub-Saharan Africa West	0.2	22.8%	0.1	11.3%	0.5	66.0%
Total	159.2	19.5%	327.9	40.1%	330.8	40.4%

country income status. Comparison of column 2 with column 3 illustrates that the reclassification "upwards" of populous countries that are still poorer than most of those in the group that they join brings down the average per person cost for the higher income level group. Thus (column 3) in 2015, according to the latest World Bank income level classification, there is now little difference in mean per capita cost between LIC and L-MIC. According to the optimal 'like for like' comparison (column 4 vs column 3), per person costs have increased at each of the 2010 country income levels between 2010 and 2015, but most markedly in what were, in 2010, upper middle income countries.

In 2015, the mean cost per person with dementia was US$ 43,680 in G7 countries, US$ 20,187 in G20 countries, and US$ 6,757 in countries that were members of neither G7 nor G20.

6.3.5 Sensitivity analyses

Depending on how informal care is quantified, there is great variability in worldwide costs, from US$651 bn (only basic ADLs) to US$ 1,057 billion (all ADLs, and supervision), but with little variation in distribution by country income level (Table 6.11).

If the change in per capita GDP, rather than CPI is used to update costs from 2010 to 2015 (Table 6.12), the total costs are somewhat higher than for the CPI base option (Table 6.2). The marked increase in estimated costs for upper middle income countries had the most significant impact on worldwide costs, resulting in a lower proportion of the total costs for high income countries compared with the main CPI based option. Evidently, this reflects patterns of global economic growth over the period, with a recession in many HIC, but sustained growth rates in many UMIC.

Table 6.9
Costs of dementia in 2010 and 2015 (costs per person with dementia, US$, and percentage change from 2010 to 2015), by Global Burden of Disease regional classification

	2010 (WAR 2009)	2015 (WAR 2015)	Change (%) in per capita costs (2010-2015)
Australasia	32,370	36,404	12.5%
Asia Pacific High Income	29,057	30,206	4.0%
Oceania	6,059	7,021	15.9%
Asia Central	2,862	3,723	30.1%
Asia East	4,078	4,397	7.8%
Asia South	903	872	-3.5%
Asia Southeast	1,601	2,021	26.3%
Europe Central	12,891	14,056	9.0%
Europe Eastern	7,667	12,104	57.9%
Europe Western	30,122	35,255	17.0%
North America High Income	48,605	56,218	15.7%
Caribbean	9,092	9,387	3.2%
Latin America Andean	3,663	3,375	-7.9%
Latin America Central	5,536	10,349	86.9%
Latin America Southern	8,243	13,448	63.2%
Latin America Tropical	6,881	9,426	37.0%
North Africa / Middle East	3,926	6,955	77.2%
Sub-Saharan Africa Central	1,081	1,880	74.0%
Sub-Saharan Africa East	1,122	2,120	89.0%
Sub-Saharan Africa Southern	6,834	9,490	38.9%
Sub-Saharan Africa West	969	1,482	53.0%

Table 6.10
Per person costs of dementia (US$) in 2010 and 2015, based on World Bank country classification (2010 or 2015) and prevalence estimates (WAR 2009 or 2015)

	2010		2015		
Column	1	2	3	4	5
Year for cost estimates (basis for prevalence estimates)	2010 (WAR 2010)	2010 (WAR 2015)	2015 (WAR 2015)	2015 (WAR 2015)	Change (%) in costs per person (WAR 2015)
World Bank Country Classification Year	2010	2010	2015	2010	2010
Low income	868	875	1,019	939	7.3%
Lower middle income	3,109	3,259	1,560	3,865	18.6%
Upper middle income	6,827	7,224	5,284	10,467	44.9%
High income	32,865	34,735	36,669	39,595	14.0%

Table 6.11
Costs of dementia in 2015 (billion US$), by 2015 World Bank country income level, according to different approaches to costing informal care based on different caregiver inputs

	Base option		More restrictive		More inclusive	
	All ADLs		Only basic ADLs		All ADLs and supervision	
	US$ (billions)	Per cent	US$ (billions)	Per cent	US$ (billions)	Per cent
Low income	1.2	0.1%	0.9	0.1%	1.6	0.2%
Lower middle income	15.3	1.9%	10.7	1.6%	21.7	2.1%
Upper middle income	86.3	10.5%	75.0	11.5%	121.2	11.5%
High income	715.1	87.4%	564.9	86.7%	912.2	86.3%
Total	817.9	100.0%	651.5	100.0%	1056.8	100.0%

Table 6.12
Costs of dementia in 2010 and 2015 by World Bank country income level (billion US$ and percent of total costs), based on current World Bank country classification for each year and cost adjustments (2010-2015) based on change in per capita GDP in each country

	2010 (WAR 2009)		2015 (WAR 2015, GDP based cost adjustments)	
	US$ (billions)	Per cent	US$ (billions)	Per cent
Low income	4.4	0.7%	1.1	0.1%
Lower middle income	29.2	4.8%	15.0	1.7%
Upper middle income	32.5	5.4%	182.4	21.0%
High income	537.9	89.1%	671.0	77.2%
World	604.0	100.0%	869.6	100.0%

If a prevalence-based option is used (holding the costs per person fixed, and ignoring new cost of illness data), worldwide costs increase by US$ 91.2 billion (15.1%) compared with US$ 213.9 billion (35.4%) (Table 6.13), suggesting that just less than half of the increase in costs between the 2010 and 2015 World Alzheimer Report estimates are accounted for by increases in prevalence and numbers affected. The proportion of costs incurred in HIC decreases somewhat, reflecting the fact that the greatest increase in estimates of numbers of people with dementia (between World Alzheimer Report 2009 and World Alzheimer Report 2015) occur in low and middle income countries.

6.3.6 Forecasts beyond 2015

To make a forecast of future trends in the global societal economic cost of dementia, we need to estimate trends in the numbers of people with dementia, and trends in the per person costs. Trends per annum between 2010 and 2015 need to be estimated on a 'like for like' basis. This means a) applying the World Alzheimer Report 2015 prevalence estimates to the 2010 and 2015 population structures to estimate numbers of people with dementia at both time points, and b) using the same approach, for each country, to weight the worldwide aggregation of mean per capita costs.

Based on the estimates from the World Alzheimer Report 2010, the number of people with dementia has increased by 31.5% between 2010 (35.6 million) and 2015 (46.8 million). However, if we adjust the estimated numbers for 2010, by applying the updated prevalence estimates generated for this report, there would have been 40.1 million with dementia in 2010, and the numbers would have increased by 16.6%, or by 3.3% per year. During the same period the aggregated costs increased by 35% (7.0% per year), this estimate being very little affected if calculated instead on the basis of the adjusted numbers for 2010, applying World Alzheimer Report 2015 prevalence estimates (see Table 6.4).

Between 2010 and 2015, the average worldwide cost per person (a weighted average across countries, calculated on a 'like for like' basis) increased from US$15,122 to US$17,483 US$ per year (an increase of 15.6% or 3.1% per year).

The overall annual trends can then be calculated as the product of the annual inflation factors from increasing numbers (1.033) and increasing per capita costs (1.031) = 1.033 x 1.031 = 1.065, or around 6.5% per annum.

Table 6.13
Costs of dementia in 2010 and 2015 (billion US$), using World Bank country classification 2010 and cost adjustments (2010-2015) based on a prevalence-based option

	2010 (WAR 2009)		2015 (WAR 2015)	
	US$ (billions)	Per cent	US$ (billions)	Per cent
Low income	4.4	0.7%	6.1	0.9%
Lower middle income	29.2	4.8%	48.2	6.9%
Upper middle income	32.5	5.4%	57.8	8.3%
High income	537.9	89.1%	583.0	83.9%
World	604.0	100.0%	695.2	100.0%

The contribution of the increase in numbers of people with dementia and the increase in cost per person with dementia have a similar impact.

Applying this constant annual inflation factor, **the costs in 2030 will be around US$ 2 trillion and the threshold of US$ 1 trillion will be crossed in 2018** (Figure 6.1).

6.4 Discussion

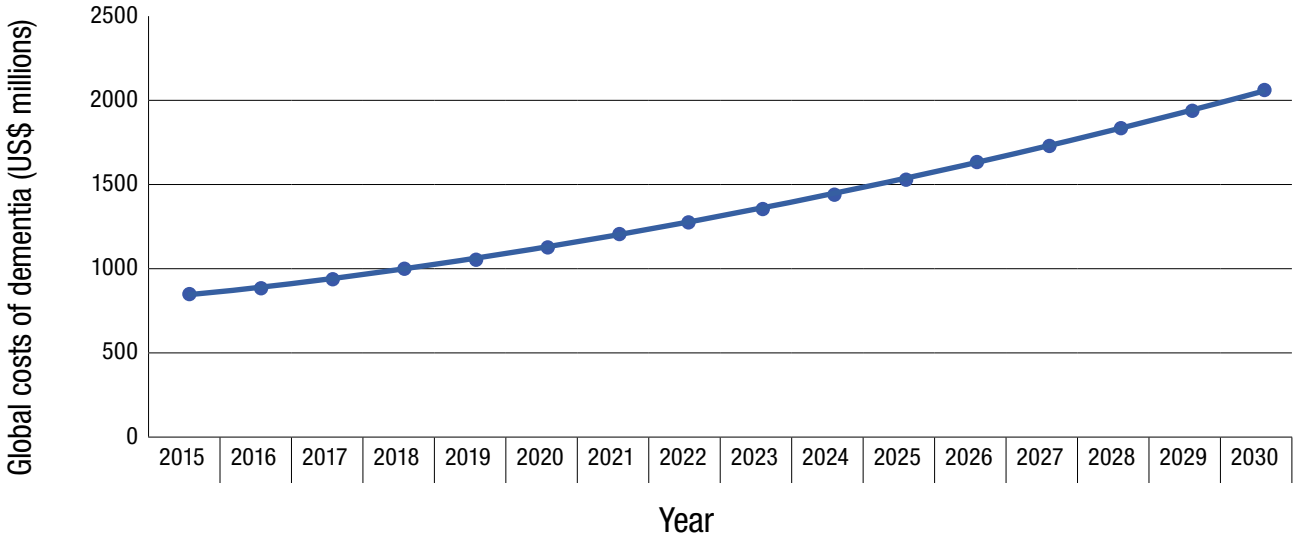
6.4.1 The results

The global societal economic cost of dementia, US$ 818 billion, is an enormous sum; similar in magnitude to the Gross Domestic Product (GDP) of countries like Indonesia, the Netherlands, and Turkey, the 16th to 18th largest economies in the world. **The global costs are also larger than the market values of companies such as Apple (US$ 742 billion), Google (US$ 368 billion) and Exxon (US$ 357 billion)** (source Forbes: 2015 ranking).

As we reported in 2010, the costs remain concentrated in countries with higher income levels. There is a disjunction between the global distribution of prevalence, 58% of which is accounted for by people with dementia living in LMIC, and costs, 87% of which are incurred in HIC. This is accounted for by the lower per person costs in LMIC, reflecting lower wage costs and a higher proportion of care provided by informal unpaid carers rather than professional home carers or residential care. Costs when expressed as a proportion of GDP are certainly not negligible in LMIC (ranging from 0.2 to 0.5%) but again lower than those in HIC (1.4%). Differences in per person costs by country income level were only slightly attenuated when the different purchasing power of one US$ was taken into account in sensitivity analyses conducted for the 2010 World Alzheimer Report. The uneven distribution of global costs is even more striking when stratified according to G7 (62% of worldwide costs incurred by just seven nations) or G20 membership (92% of global costs).

Our sensitivity analysis confirms that the assumptions regarding costing of informal care have a great impact upon the total costs. Although difficult to quantify, supervision is an important and significant part of daily informal care with significant opportunity cost for carers. If that component is included, the costs

Figure 6.1
Forecasted global costs of dementia 2015-2030



increase considerably. Other assumptions may have a lesser impact upon the results and comparisons. Transparency regarding assumptions is crucial to make comparisons meaningful in any cost of illness analysis.

Our current estimates of global societal costs of dementia have increased by around 35% compared with those published in the World Alzheimer Report 2010. Interpreting these increases is complex given the multiplicity of plausible underlying explanations. Increases in aggregated costs can arise from increases in numbers of people with dementia, and/or increases in per person costs. The exploratory analyses that we have conducted suggest that these two elements each contribute around one half of the total increase. This estimate is based upon standardising age-specific prevalence estimates to those generated for the current report (World Alzheimer Report 2015) on the assumption that the revised prevalence estimates merely reflect an enhancement in the evidence-base rather than any underlying secular trends in age-specific prevalence between 2010 and 2015 (see Chapters 2 and 4). Therefore, the increase in numbers, for the purposes of these cost trend analyses, arises solely from the effects of population ageing, which is occurring more rapidly in LMIC than in HIC. Changes in per capita costs are even harder to interpret. The one thing that is certain is that the cost of any given service or item of care inflates over time. We have adjusted costs between 2010 and 2015 according to consumer price indices (CPI) in each country. On this basis cumulative cost inflation in the USA was around 9.4% over the five year period. As developing economies grow, the cost of salaries and services tend to inflate more rapidly than prices (a 'positive income elasticity effect'), so this approach may have underestimated cost inflation in LMIC relative to HIC, as indicated by our GDP-based inflation sensitivity analysis. In either scenario, cost inflation can have accounted for only part of the increase in per capita costs.

Per capita costs may also increase because;

a) we have estimated them better, with more up to date studies, larger and more precise studies, and studies that have taken a more comprehensive approach to the range of costs estimated;

b) some services have become more costly, over and above the rate of inflation;

c) new services have been established, or the coverage of existing services has improved, or existing service users are using the same services more intensively.

We do not have adequate data to discern between these three sets of explanations; a) seems plausible, since the inclusion of new cost of illness studies has generally led to increases in estimated per capita costs for the countries concerned; b) would require carefully conducted comprehensive unit cost estimates updated over time, which do not exist or are not readily accessible (most COI studies use our approach of updating costs in line with inflation); c) would require representative population-based surveys of people with dementia (rather than clinical samples) repeated over time, to determine secular trends in service utilisation, which, again are not readily available. Some studies suggest that the proportion of people with dementia living in residential care has begun to decline in HIC, consistent with policy initiatives to provide care at home where possible[15]. However, such a strategy may not be associated with reduced costs, when all of the costs of home care, including informal care, are properly accounted for[16]. It has also been suggested that cost reduction initiatives may be reducing the intensiveness of home care (for example shorter and less frequent care worker visits) in the UK[5].

Economic development is proceeding apace in many low and, particularly, middle income countries. This has posed a challenge for us in making meaningful comparisons between country income level groups for 2010 and 2015, since a significant number of countries, some of them very populous, have moved "upwards" in the World Bank classification. The average cost per person with dementia in the higher WB groups is "diluted" by newly promoted countries with lower economic strength than the original countries in that particular WB group. At the same time, the remaining lower income countries are "drained" by the loss of more prosperous countries that have moved upwards in the WB classification. We addressed this problem by stratifying the 2015 estimates according to the 2010 as well as the 2015 classification.

However, the important issues here are that these trends for economic growth may result in increased awareness, help-seeking and medical diagnosis (leading to increased direct medical care costs) and a shift from unpaid informal care to direct costs from the social care sector. The long term care sector is very underdeveloped in most LMIC, but economic growth, accompanied by social and demographic change may increase demand resulting in the establishment and/or expansion of a formal long term care sector as a complement to informal care. If so (and there is some support for such trends in the current report), the increase in costs per person with dementia may be much greater than the basic assumption used for our forecast of dementia costs globally.

6.4.2 Methodological issues

Although the basics for the global cost estimates are available cost of illness studies of dementia, the costing model imputes missing country data based on the assumed relationship between the economic strength of a country and resources for dementia care. For details, please see the World Alzheimer Report 2010[1]. Despite an improvement in coverage, COI studies from LMIC are rare, with, therefore, a greater reliance on imputation for these countries. Nevertheless, the correlation between the GDP per

capita and direct costs per person with dementia seems to be robust.

The current report is not a complete systematic update, although some important new COI studies are added as well as data on resource use and costs from the 10/66 Dementia Research Group. However, the number of cost components that are included in cost of illness studies varies, which can make comparisons problematic. For example, in the new UK report, a cost estimate of people who had gone missing due to dementia was included[5] and in the Swedish update, detailed costs of drug use were included[8]. The use of consumer prices is not the optimal way of adjusting care costs. Price inflation indices specific to the health care and social care sector would be better, but such data are not yet available globally. For the cost estimates of informal care, an update of the country-specific average wage would have been preferable.

The cost forecasts should be treated with particular caution. Besides the generic heterogeneity of COI studies, and the uncertain impact of including more recent, but also more comprehensive estimates, we also had to make assumptions regarding the appropriate age-specific prevalence estimates to use at each time point. Furthermore, the dynamics of change in care patterns across regions, the impact of diagnostic and treatment strategies such as the 'Global Action Against Dementia' aspiration for a disease modifying treatment for Alzheimer´s disease by 2025, and the potential for effective primary prevention programs for dementia, are all hard to forecast. The assumption of constant annual growth in costs may well not be correct. As with all forecasts, the near future (US$ 1 trillion by 2018) is easier to predict than the distant future (over US$2 trillion by 2030).

6.4.3 The future

It is our hope that more service utilisation and cost of illness studies will be carried out, improving the overall quality, coverage and recency of the evidence base, which, coupled with an ongoing commitment to monitor trends in prevalence and numbers, will allow us to estimate global costs and trends with more accuracy. Our first outstanding task is to address the limitations with the current estimates, in particular by completing and documenting a fully systematic review of relevant studies, and exploring more effective ways of capturing cost inflation. We are eager to integrate this work within plans for a Global Observatory to be coordinated by the World Health Organization, and to provide regular updates accessible and analysable through a web interface.

References

1. Wimo A, Prince M. World Alzheimer Report 2010. The global economic impact of dementia. London; 2010
2. WHO. Dementia: a public health priority. WHO, editor. Geneva: WHO; 2012.
3. Wimo A, Jonsson L, Bond J, Prince M, Winblad B. The worldwide economic impact of dementia 2010. Alzheimers Dement. 2013 Jan;9(1):1-11 e3.
4. Hurd MD, Martorell P, Langa KM. Monetary costs of dementia in the United States. N Engl J Med. 2013 Aug 1;369(5):489-90.
5. Prince M, Knapp M, Guerchet M, McCrone P, Prina M, Comas-Herrera A, et al. Dementia UK: an update. London; 2014 Contract No.: Document Number|.
6. Leicht H, Heinrich S, Heider D, Bachmann C, Bickel H, van den Bussche H, et al. Net costs of dementia by disease stage. Acta Psychiatr Scand. Nov;124(5):384-95.
7. Vossius C, Rongve A, Testad I, Wimo A, Aarsland D. The Use and Costs of Formal Care in Newly Diagnosed Dementia: A Three-Year Prospective Follow-Up Study. Am J Geriatr Psychiatry. 2013 Mar 13.
8. Wimo A, L J, Fratiglioni L, Sandman P, Gustavsson A, Sköldunger A. Demenssjukdomarnas samhällskostnader i Sverige 2012. Stockholm: Socialstyrelsen; 2014. Report No.: 2014-6-3
9. Connolly S, Gillespie P, O'Shea E, Cahill S, Pierce M. Estimating the economic and social costs of dementia in Ireland. Dementia (London). 2014 Jan;13(1):5-22.
10. Zhaorui L. Economic Costs of Dementia in Low and Middle Income Countries. London: King´s College; 2012.
11. Wang H, Gao T, Wimo A, Yu X. Caregiver time and cost of home care for Alzheimer's disease: a clinic-based observational study in Beijing, China. Ageing Int (in press). 2010.
12. Allegri RF, Butman J, Arizaga RL, Machnicki G, Serrano C, Taragano FE, et al. Economic impact of dementia in developing countries: an evaluation of costs of Alzheimer-type dementia in Argentina. Int Psychogeriatr. 2007 Aug;19(4):705-18.
13. IMF. International Monetary Fund, World Economic Outlook Database. 2015 April 2015.
14. UN data. Country profile [database on the Internet]. United Nations. 2015 [cited. Available from: https://data.un.org/CountryProfile.aspx.
15. Matthews FE, Arthur A, Barnes LE, Bond J, Jagger C, Robinson L, et al. A two-decade comparison of prevalence of dementia in individuals aged 65 years and older from three geographical areas of England: results of the Cognitive Function and Ageing Study I and II. Lancet. 2013 Oct 26;382:1405-12.
16. ADI. World Alzheimer Report 2013. Journey of Caring. An analysis of long term care for dementia. London; 2013

CHAPTER 7

Conclusions and recommendations

7.1 Summary

7.1.1 Prevalence and numbers affected

We estimate that there are now 46.8 million people living with dementia worldwide, with numbers projected to nearly double every 20 years, increasing to 74.7 million by 2030 and 131.5 million by 2050. These estimates are 12-13% higher than those for the corresponding years in our World Alzheimer Report 2009. The increases are accounted for by two factors. First, the 2012 UN population estimates include larger numbers of older people than had previously been thought. Second, the evidence base regarding the prevalence of dementia has expanded considerably, particularly for East Asia, sub-Saharan Africa and North Africa/Middle East. The enhanced evidence base indicates a higher age-standardised prevalence of dementia in those regions than had previously been estimated, but does not necessarily indicate a secular trend towards increased prevalence over time.

We estimate that 58% of people with dementia live in low or middle income countries, a proportion that is anticipated to rise to 63% by 2030 and 68% by 2050. Increases in numbers of people with dementia will be much steeper in low and middle income countries (LMIC) than in high income countries (HIC). The numbers of people living with dementia will double in HIC and more than treble in LMIC through to 2050.

From our comprehensive review and meta-analysis of incidence rates worldwide, we estimate that there will be 9.9 million new cases of dementia in 2015, or one every 3.2 seconds. 49% of these will arise in Asia, compared with 25% in Europe, 17% in the Americas and 8% in Africa. The estimate of annual new cases for the 2012 WHO/ADI report (7.7 million, or one new case every 4.1 seconds) referred to 2010, and is therefore not directly comparable.

7.1.2 Possible future trends in prevalence and incidence

Our current projections for numbers and costs assume that the age-specific prevalence of dementia will remain stable over time. While there has been much interest in the possibility that the age-specific prevalence of dementia may have been declining recently in high income countries, the evidence to support this is currently weak and inconclusive. Some studies do support such a secular trend, but others do not, and the number of studies that have been able to address this question using standardised methodology, applied to comparable populations over time has been quite limited. Evidence for a decline in incidence in HIC studies is slightly stronger, although still inconclusive. For high income countries, a pattern of stable or increasing prevalence despite declining incidence seems plausible and is suggested by findings from some studies and modelling exercises. The public health improvements that may drive declining incidence rates may also result in improved survival of people living with dementia. There is a consistent trend from several reviews for an increasing

trend in the recorded prevalence of dementia in East Asia, and in China specifically. However, it is uncertain whether this relates to a genuine trend in underlying prevalence, or an artefact arising from changes in diagnostic criteria over time.

7.1.3 Impact

While dementia shortens the lives of those affected, its greatest impact is upon the quality of life, both of those living with dementia, and their family and caregivers. A large body of evidence, reviewed in this report, suggests that, among older people and at the population level, dementia makes a much larger contribution than other chronic physical and mental disorders to disability, needs for care and attendant costs. These findings are not, however, reflected in the results of the Global Burden of Disease Study most recently conducted by the Institute of Health Metrics and Evaluation (IHME), and, previously, by the WHO. The IHME findings are particularly discrepant with other data sources and methodological approaches. The problem appears to arise first from the Disability Adjusted Life Year (DALY) metric of overall disease burden, which gives a much greater weight to conditions associated with mortality, even in later life, and second from the methods used to attribute disability weights to individual conditions and health states. This is a matter of concern given the importance accorded to the Global Burden of Disease estimates as a guide to prioritisation for research, health and social care investment.

7.1.4 Cost

We have carried out a provisional update of our previous estimates of the global societal economic cost of dementia. We estimate the global societal economic cost of dementia for 2015 to be US$818 billion, a 35% increase from the cost estimate for 2010, which was US$604 billion. Projecting this trend forwards, we estimate that the global cost of dementia will have reached US$1 trillion in 2018. Around half of this increase can be attributed to growth in the numbers of people with dementia, and half to increases in per capita costs, particularly in low and middle income countries.

88% of the costs in 2015 were incurred in what are currently high income countries. If the same country classification (World Bank 2009) is applied for 2015 as for 2010, then the proportion of global costs incurred in what were then LMIC has risen from 11% to 18%. While

Box 7.1

G7 Dementia Legacy Events

Sponsoring G7 countries	Setting	Date	Agenda
UK	London	June 2014	Finance and social impact investment
Canada and France	Ottawa	September 2014	Harnessing the Power of Discoveries: Maximizing Academia and Industry Synergies
Japan	Tokyo	November 2014	New Care and prevention models
USA	NIH Bethesda	February 2015	State of the Science/Global Research Collaboration

The key developments have been:

- An explicit acknowledgement that dementia is a global issue, and that the effects of the future epidemic will be felt particularly in low and middle income countries
- A better understanding of the extent of the current treatment gap in terms of diagnosis, treatments, services and support, and the need for ‘care now’, if we must wait for ‘cure later’
- The need for a public health approach to treatment and care, with more focus on raising awareness, creating Dementia Friendly Communities (DFCs), and providing accessible health and social care services for all
- A recognition of the importance of prioritisation of efforts towards brain health promotion and dementia risk reduction, in an effort to reduce the future toll
- New, and broader, priorities for research, going far beyond the original aim of developing a disease-course modifying treatment
- A commitment in principle to continue the G7 process, with sustainable leadership, and a defined set of agendas

the G7 countries alone account for 62% of the costs, a remarkable 92% of the costs arise in the broader group of G20 countries.

Around one fifth of total costs are attributed to direct medical care with little variation by country income level. However, the distribution between formal social care and unpaid informal care varies considerably by country income level with formal costs preponderating in HIC while informal care is responsible for most costs in LMIC.

This update benefited from a) the fully revised and updated estimates of numbers of people with dementia, b) improved data on per capita costs from new cost of illness studies or analyses from several high income countries (USA, UK, Germany, Norway, Sweden, and Ireland), and c) more detailed data to inform the imputation of the distribution of direct medical and social care costs in low and middle income countries from the 10/66 Dementia Research Group studies in countries in several countries in Latin America, India and China. We did not, however conduct a fully systematic review of resource utilisation and cost studies, and we updated cost estimates solely on the basis of country-specific consumer price index ratios between 2010 and 2015.

7.2 Global Action Against Dementia

In December 2013, the UK government used its presidency of the group of the world's leading economies (the so called 'G8' which later became the G7 – United States, Japan, Germany, France, UK, Italy, Canada - following the suspension of Russia) to launch a Global Action Against Dementia. The outcome of the first summit was an impressive commitment to set an ambition to identify a cure, or a disease-modifying therapy, for dementia by 2025. This was supported by a series of initiatives linked to research; increasing funding, promoting participation in trials, collaboration to share information and data; and the appointment of a new global envoy for dementia innovation, Dr Dennis Gillings. Over the course of four 'Legacy Events' (see Box 7.1) this agenda has broadened substantially, with significant input from civil society (including Alzheimer's Disease International), the World Health Organization, the Organization of Economic Co-operation and Development (OECD), G7 governments and their policymakers, and dementia experts from many fields. The voices and opinions of people with dementia, who were not given a platform at the first event, began to be heard.

Earlier this year, as a final event linked to the G7 Global Action Against Dementia, the World Health Organization convened a 'First WHO Ministerial Conference on Global Action Against Dementia' with the participation of 80 member states, 80 philanthropic foundations, 45 NGOs and 4 UN Agencies. This was a truly global event, offering proper representation to the world's 127 low and middle income countries, alongside the G7 and the 67 other high income countries. The 'call for action'* was unanimously adopted on 17th March 2015. Given the enormous impact of the condition worldwide, the call notes that:

Box 7.2

Overarching principles, integral to global efforts

- Empowering and engaging the full and active participation of people living with dementia, their caregivers and families, as well as overcoming stigma and discrimination;
- Fostering collaboration between all stakeholders to improve prevention and care, and to stimulate research;
- Incorporating the aspects of dementia prevention, care and rehabilitation in policies related to ageing, disability and noncommunicable diseases, including mental health;
- Building on and utilising existing expertise, collaborative arrangements and mechanisms to maximise impact;
- Balancing prevention, risk reduction, care and cure so that whilst efforts are directed towards finding effective treatments and practices and risk reduction interventions, continuous improvements are made on care for people living with dementia and support for their caregivers;
- Advocating for an evidence-based approach and shared learning, allowing advances in open research and data sharing to be available to facilitate faster learning and action;
- Emphasising that policies, plans, programmes, interventions and actions are sensitive to the needs, expectations and human rights of people living with dementia and their caregivers;
- Embracing the importance of universal health coverage and an equity-based approach in all aspects of dementia efforts, including facilitation of equitable access to health and social care for people living with dementia and their caregivers.

* http://www.who.int/mediacentre/news/releases/2015/action-on-dementia/en/

> "A sustained global effort is thus required to promote action on dementia and address the challenges posed by dementia and its impacts. No single country, sector or organization can tackle this alone."

The call for action identifies eight overarching principles (Box 7.2), and 11 action points (Box 7.3).

7.3 Beyond the G7 process

The G7 countries, and their heads of government, are to be congratulated for the priority that they have accorded to dementia over the past two years. This is on the back of new national policy initiatives, dementia plans and strategic investment in most of these countries, in the years leading up to the G7 process. The 'game changer' introduced by UK Prime Minister David Cameron was the acknowledgement that dementia was too big and too global an issue to be addressed by nation states in isolation, and that trans-national approaches and solutions would be required, with an accent on cooperation and collaboration. It was natural, in many ways, that the G7 should initiate and lead this process. The world's wealthiest nations have borne the brunt of the first wave of the dementia epidemic, and it is in these countries that the fiscal challenges of meeting the rising demand for health and social care are currently most acute. The search for a treatment or cure is led by multinational pharmaceutical industries based mainly in these countries. However, it became clear to most over the course of the G7 process that with a global epidemic concentrated in low and middle income countries[1], substantial problems with service coverage and access to care[2], and, realistically, only modest expectations for therapeutic advances[3], a much broader agenda would be required. This would need to be supported by a wider international coalition, and sustained over a much longer period than the first phase of the Global Action Against Dementia.

7.4 Building upon the Global Action Against Dementia

The broader agenda comprises five key elements; a global approach to a global problem; the need for 'care now, if cure later'; a public health orientation (awareness, accessible services, and prevention); a focus on equity and rights; and a rational approach to research prioritisation.

7.4.1 A global approach, with an accent on low and middle income countries

The world's seven wealthiest economies, the G7, currently account for 10% of the world's population, nearly half of its GDP and two thirds of net global wealth. 21% of the world's population of older people live in G7 countries, and 28% of all people living

Box 7.3

Actions for people living with dementia, their caregivers, families and community

- Raising the priority accorded to global efforts for dementia on the agendas of relevant high-level forums and meetings of national and international leaders;
- Strengthening capacity, leadership, governance, multisectoral action and partnerships to accelerate responses to address dementia;
- Promoting a better understanding of dementia, raising public awareness and engagement, including the respect for their human rights, reducing stigma and discrimination, and fostering greater participation, social inclusion and integration of people living with dementia;
- Advancing prevention, risk reduction, diagnosis and treatment of dementia, consistent with current and emerging evidence;
- Facilitating technological and social innovations to meet the needs of people living with dementia and their caregivers;
- Increasing collective efforts in dementia research and fostering collaboration;
- Facilitating the coordinated delivery of health and social care for people living with dementia, including capacity building of the workforce, supporting mutual care taking across generations on an individual, family and society level, and strengthening support and services for their caregivers and families;
- Supporting a gender-sensitive approach in the elaboration of plans, policies and interventions aimed at improving the lives of people living with dementia;
- Promoting further work in identifying and addressing barriers to dementia care, particularly in low-resource settings;
- Strengthening international efforts to support plans and policies at all levels for people living with dementia, in particular in low- and middle-income countries;
- Supporting the efforts of the World Health Organization, within its mandate and work plans, to fulfil its leadership role in full collaboration with national and international partners, to promote and monitor global efforts on dementia.

with dementia, generating 62% of all global societal economic costs linked to dementia.

The world's 20 major economies, the G20, account for 64% of the world's population. 76% of the world's population of older people live in these 43 countries, and 80% of all people living with dementia, accounting for 92% of all global societal economic costs.

Projecting forwards from 2015, global numbers of people with dementia will have increased by nearly 85 million by 2050. 16% of these additional cases will be in G7 countries, and 67% in G20 countries; therefore, more than half of the growth will be occurring in G20 countries who are not members of the G7. Most significantly, these include the populous and rapidly developing middle income countries where population ageing will be occurring most rapidly, represented in the G20 by China, India, Indonesia, Brazil, Mexico and Turkey.

Demand will rise most rapidly in low and middle income countries, as the increasing numbers of people affected drive increasing awareness. However, the supply of services is restricted, given limited resources. This applies most particularly to specialist healthcare services, and the whole apparatus of long-term community-based and residential care[4]. Also, primary care services are currently neither appropriately designed nor trained to assume responsibility for primary attention and continuing care; this is a general problem for management of non-communicable diseases in an ageing population[5], with particular implications for dementia care[6]. The seamlessness of traditional extended family care systems was probably always exaggerated[7;8], and will, increasingly, come under strain given the pace of social, demographic and economic change. The fiscal implications of these transitions, in the context of increasing demands for state-assured social protection and long-term care, need urgent consideration by countries well beyond the confines of the OECD[4;9].

It would seem logical for the G20 to assume political leadership of the Global Action Against Dementia, hence ensuring the involvement of countries in all continents, including those that will be most affected by the growing numbers of people with dementia over the next generation. A petition to the Australian government, to put dementia on the G20 agenda in 2014, although widely supported, was not successful. Turkey will host the next G20 summit in Antalya, 15-16th November 2015, and then hand over the chair to China, home to the world's largest population of people living with dementia. This is therefore a highly opportune moment to renew this call.

The World Health Organization Ministerial Conference 'call for action' has asked the WHO 'to fulfil its leadership role in full collaboration with national and international partners, to promote and monitor global efforts on dementia'. This is a welcome development. The WHO is concerned, first and foremost, with global public health. It has a role in monitoring health trends, disseminating information, and providing leadership, policy guidance and technical assistance to governments. Much of its work is focused upon resource-limited low and middle income countries. The WHO has been particularly energetic and effective in recent years in the dementia field. In 2009, dementia was included among 10 'priority neurological and mental disorders' for the WHO Mental Health Gap Action Plan (mhGAP), seeking to close the treatment gap by scaling up evidence-based packages of care to be delivered by trained and supervised non-specialist health workers[10;11]. The WHO/ADI joint report, published in 2012, signalled, through its title 'Dementia: a public health priority', a new approach, emphasising the need for awareness, policies and plans, scaled up services accessible to all on an equitable basis, and a focus upon prevention[12]. The 2015 WHO World Health Report focuses upon ageing and health. The WHO's contribution to the G7 process has evidently been another potential 'game-changer'. However, we need to be aware that the 'call for action' is currently nothing more than that. It does not commit nation states, individually or collectively to any specific investments, policies or actions. The 'call for action' specifies, in carefully chosen language that the signatories will be 'supporting the efforts of the World Health Organization, within its mandate and work plans'. These can only be extended through a motion for a resolution proposed by several Member States, to the World Health Assembly. This could call, for example, for the WHO Secretariat to work with Member States to develop a 'Dementia Action Plan'. Such a plan, as was the case, with the 'WHO Comprehensive Mental Health Action Plan 2013-2020'[13], could include specific actions for Member States, international, regional and national level partners, and the WHO Secretariat with indicators and targets that can be used to evaluate levels of implementation, progress and impact, and hold governments to account.

7.4.2 Care now/cure later

On the one hand, 2025 is a cruelly long time to wait for a cure or disease-modifying treatment for dementia. On the other hand most participants in the G7 process acknowledged that even this would be a very challenging target. While there has been a productive pipeline of promising new agents with plausible targets linked to Alzheimer's disease pathology, there has been a dispiritingly high proportion of failures in phase II human trials, and phase III definitive randomised controlled clinical trials[2]. This raises legitimate questions regarding the validity of our current disease models, and the continued willingness of pharmaceutical companies to meet the heavy research and development costs. Partnership between industry, governments and universities, international collaboration, and data and information sharing all

potentially have much to offer in maintaining and increasing efforts in this direction.

In the meantime, clearly we cannot and should not wait to implement currently available evidence for services, treatments and care that improve the health and wellbeing of people with dementia and their carers. There are considerable challenges in achieving acceptable levels of coverage and access to care. Currently, far too few people with dementia receive a diagnosis, let alone treatment and support. Around half of those affected are not diagnosed in HIC, the proportion diagnosed falling to below 10-20% in LMIC where awareness is even lower[14-17]. Even if the progressive course of dementia cannot be altered, symptomatic treatments and support are helpful. Earlier diagnosis allows those affected to participate in advanced care planning while they still have capacity to do so[15]. Education, training and support for carers is effective in reducing carer strain and psychological morbidity, and, in HIC, in delaying or avoiding transition into care homes[18]. Such interventions may be more effective early in the disease course[15;19]. Support groups for people with dementia, acetylcholinesterase inhibitors and cognitive stimulation to improve cognitive function, and behavioural interventions for depression are all effective interventions in early-stage dementia[15]. Early diagnosis and intervention is likely to be cost-effective in HIC, assuming delayed or averted transfer into costly institutional care settings[15]. The cost-effectiveness of scaling up diagnosis and care in LMIC is unknown. However, the psychological and economic strain on caregivers is substantial, and compensatory benefits practically non-existent[20;21].

While we wait, in hope, for technological advances in diagnosis, treatment and care we should be mindful that delivery systems are currently hugely ineffective worldwide, with very limited coverage of even the most basic services. These problems need to be addressed, urgently, with a balanced research agenda that gives equal priority to translation of existing knowledge into policy and practice (see section 7.4.6). Failure to address these limitations also risks substantial ethical problems regarding the ability of lower versus higher income countries to implement, and benefit from advances in treatment and care (see section 7.4.4).

7.4.3 A public health approach

Awareness

Raising awareness is a cornerstone of the public health approach to addressing the dementia epidemic. In Chapter 6 of the WHO/ADI report, Dementia: a public health priority, a six stage incremental "Acceptance of Dementia" model was proposed in which countries might progress from stage 1) Ignoring the problem, to 2) Some awareness, 3) Building dementia infrastructure, 4) Advocacy efforts, 5) Policies and dementia plans or strategies, to 6) Normalisation. Pragmatically, it may not be possible to miss out stages in this essentially bottom-up process, although political will, prioritisation and investment from governments will help to speed the transition.

For governments that have developed policies and plans, the concept of 'Dementia Friendly Communities' has been particularly popular[22]. The UK Prime Minister's Challenge on Dementia* emphasises the central role of people with dementia;

> "We would like people living with dementia to be able to say that they know what they can do to help themselves and who else can help them, and that their community is working to help them to live well with dementia."

The term "dementia friendly" has been applied both to physical environments and communities. It addresses in particular the lived experience of people with dementia, seeking among other things, a change in attitudes and behaviours towards dementia, for people with dementia and their carers to be treated with dignity and respect, for an end to stigma, and for communities to be enabled to support people affected by dementia so they can 'live well with dementia'. A key example is that of the Japanese 'Dementia Friends' model (copied in the UK) where a remarkable 6 million friends (4.6% of the population), lightly trained by 105,000 dementia champions, are driving innovative community programs across the country†. The US National Dementia Plan focuses more upon the concept of 'dementia capable' workforces, programs, services, and systems, with a practical focus upon building knowledge, capacity and skills in key services to better meet the needs of people with dementia and their caregivers[22].

In a thoughtful review, Lin and Lewis have highlighted the complementary nature of the two approaches, which both encourage inclusion and acceptance. At the same time, they argue the need for a third component, 'dementia positivity'[22];

> "At first glance, this society (dementia capable and dementia friendly) seems to have everything to ensure a good life for people with dementia and their families. However, without dementia positivity, it is merely a society that tolerates and respects differences. It is merely a society that supports or takes care of its members. It is not a society that truly sees people with dementia as equal contributors. The desires of people with dementia to make contributions to society and be seen as persons with strengths and abilities have been documented in books written by people

* Delivering major improvements in dementia care and research by 2015 (Department of Health, 2012) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/215101/dh_133176.pdf

† See Dr Mayumi Hayashi's recent blog at https://ageingissues.wordpress.com/2015/03/20/dementia-care-in-japan-is-being-solved-through-volunteer-schemes-not-government/

with dementia and their advocates alike, such as Christine Bryden's (2012) Who Will I Be When I Die, John Zeisel's (2010) I'm Still Here, and Anne Davis Basting's (2009) Forget Memory, to name a few. People with dementia want society to accept their disabilities. They also want society to see their strengths and abilities. Without dementia positivity, regardless of how well the society provides resources, accommodations, services, activities, and opportunities for people with dementia and their families to stay engaged, it is merely a pseudo social inclusion."

Accessible services

At the United Nations Second World Assembly on Ageing (Madrid, 2002), governments of 159 nations adopted the Madrid International Plan of Action on Ageing (MIPAA), to respond to the challenges of population ageing [23]. The plan stressed the need for equitable, affordable access to age-appropriate healthcare, reflecting also the universal right to health and access to medical care enshrined in the Universal Declaration of Human Rights (1948), and the UN Convention on the Rights of Persons with Disabilities (2006), and consistent with the concept of universal coverage that is likely to be at the heart of the UN's new Sustainable Development Goals. Unfortunately, in 2012, a 32 country case study conducted for a UNFPA 10 year review of MIPAA[24] found that very little progress has been made towards the achievement of these objectives, particularly in LMIC and other resource poor settings.

Problems of access to services are complex, and include low awareness linked to limited help-seeking, and financial barriers, when the need for care is continuing, and reimbursement for health or social care is either means-tested, or subject to insurance for which coverage is less than complete, and where older people have insufficient personal incomes to meet out-of-pocket payments[4;6;25].

For low and middle income countries, a lack of coverage of services is an even more pressing problem. There are simply too few specialists (geriatricians, psychiatrists, neurologists, psychologists, specialist nurses, occupational and physical therapists, and nutritionists) to provide services for more than a tiny proportion of people with dementia, mainly restricted to urban centres. Similar resource limitations have been identified for other chronic disease domains including global mental health[26], palliative care[27], and global surgery[28]. The challenge for dementia care is particularly acute, given that the demand for services will increase sharply, and likely outstrip any efforts to expand the specialist workforce. An important part of the solution must be a move towards a 'task-shifting' or, more appropriately, a 'task-sharing' approach, where much of the onus for delivering care is placed upon non-specialist primary care and community services, trained and supported by more experienced specialists. This approach has been championed in the global mental health field[10;27;29]. Scaling up such services is a complex process, requiring changed roles and responsibilities, additional resources, and new models for the delivery of care. Specialists need to focus as much upon service management, training and supervision, as on the delivery of frontline care (reserved for complex cases). In essence, they need to become agents of public health, and attend as much to the coverage of services, as to the quality of care provided to their limited caseload.

Global problems require global solutions, and it is likely that the 'task-sharing' solution will have applications in high income as well as low and middle income country settings. It is becoming abundantly clear that, in the face of the current dementia epidemic, all health and social care systems should be considered to be 'resource-poor'. Given that half or more of all people with dementia have not received a dementia diagnosis, there are, arguably, insufficient specialist services in high income countries to perform this task in a timely fashion. The coordination or case management of health and social care for people with dementia across the evolving journey of care is both critically important, and neglected[4]. These roles are probably best embedded in integrated community health and social care services[30], and at the level of primary care, where staff are best acquainted with the person with dementia and their family, and best placed to deliver person-centred care based on individual values and preferences. Task-sharing models aim for allocative efficiency, either by extending the coverage of services at a similar cost, or providing the same level of care output at a lower cost[31]. These are highly relevant objectives for health and social care systems around the world. Rich developed nations do not have a monopoly on solutions, and may have developed an over-specialised model of care. There is potential here for 'south-north' as well as 'north-south' learning and knowledge translation.

Prevention

On the basis of the reviews conducted for the World Alzheimer Report 2014, 'An analysis of modifiable risk factors for dementia' we concluded that the strongest evidence for possible causal associations with dementia (plausible, consistent, strong associations, relatively free of bias and confounding) are those of low education in early life, hypertension in midlife, and smoking and diabetes across the life course[32]. While there was consistent evidence from several studies for an inverse association between both physical and cognitive activity and dementia incidence, more research is necessary to confirm a causal relationship. The pattern of association suggests two important general mechanisms; a) cognitive or brain reserve (education and occupational attainment enhancing brain structure or function, modifying the impact of neurodegenerative brain damage in late-life[33]) and;

b) vascular pathology, through which the effects of midlife hypertension, smoking and diabetes may be mediated. The report has added to a growing consensus that risk reduction may, indeed be possible, and that further research, and health promotion actions are indicated[34;35]. The first necessary step is a wider acknowledgement and understanding that dementia may, at least to some extent, be a preventable condition.

Our best hope of ascertaining the likely impact of increasing levels of education and improvements in cardiovascular health may be to observe populations in which such trends are prominent, to see whether these are associated with a decline over time in the age-specific incidence of dementia. The review carried out for this report, of secular trends in dementia prevalence and incidence, provides equivocal evidence some of which is consistent with the notion that the disease frequency may already have started to decline in some high income countries. However:

a) More robust research is required, in more settings, and over longer periods into the future to determine trends with more precision and their variation between regions, countries and sub-populations.

b) It is perfectly possible that reductions in risk factor exposures, linked to improvements in public health, may reduce the incidence of dementia, but prolong survival, with an uncertain, but possibly neutral effect on age-specific prevalence.

c) While levels of education have increased all around the world, cardiovascular health is becoming increasingly compromised in many low and middle income countries. Even with priority action to address this problem[36], trends in dementia incidence and prevalence in these settings may therefore be in the adverse direction, at least in the short- to medium-term.

We have not yet found sufficient evidence to alter our assumption, for future projections, that the age-specific prevalence of dementia will remain constant over time. For the time-being, prudent policymakers should adopt a similar perspective. That should not, however, deter them from vigorous attempts to reduce the incidence of dementia by acting on the evidence regarding modifiable risk factors. Detection and treatment of diabetes and hypertension, reduction in levels of obesity, smoking cessation, increased physical activity, and better education are already public health priorities for most countries worldwide. Nevertheless, the message that dementia, alongside heart disease, stroke and cancer, may be prevented through increased adoption and more effective implementation of these public health strategies is one that policymakers and public need to hear. Failure to act risks missed opportunities to mitigate the scale of the future epidemic, or even allowing it to advance more rapidly than we are currently predicting.

7.4.4 Equity and rights

There is much that is fundamentally unfair about dementia and its impact upon individuals and societies. It selectively impacts upon the old and frail, women, those with less education, and fewer assets. It rarely, but very significantly, blights the hopes and expectations of those in the prime of their lives. It dims the voices of those affected, just when they might have most to tell us about their experiences of living with the condition, and how they would wish their rights to be respected. Given different global rates of population ageing, the future epidemic will be concentrated in low and middle income countries, where there are currently the lowest levels of awareness, and the fewest resources to meet the coming demand.

Equity is different. The basic principle is that all people affected by the condition should be acknowledged as having equal status and value, and should be accorded equal access to diagnosis, and evidence-based treatment, care and support, regardless of age, gender, socioeconomic status, ethnicity, or (at a global level) country of residence. Evidently, from the evidence presented in this report, and summarised in this chapter, we are a very long way from achieving this objective.

It is very encouraging that the WHO ‘call for action’ makes frequent reference to the inalienable human rights of those affected, and to the need to give special and focused attention to low and middle income countries, and, above all emphasises;

> “a universal health coverage and an equity-based approach in all aspects of dementia efforts, including facilitation of equitable access to health and social care for people living with dementia and their caregivers.”

Unless these problems are addressed, equity, particularly for the majority of people with dementia living in the world’s poorer countries will not be achieved. With the focus on therapeutic innovations (a disease-course altering treatment by 2025), there is a danger that the lessons of the AIDS epidemic will be forgotten. Nowadays, those living in Los Angeles and Lusaka, Birmingham and Blantyre, and Phnom Penh or Paris have an approximately equal opportunity, in principle, to access an affordable HIV diagnosis and life-changing treatment. However, the journey to this point since the advent of antiretroviral therapy has been far too long, with millions of lives lost. The rate limiting step, after the affordability of medications was addressed, was the weakness of healthcare delivery systems. The belated achievement is, nevertheless, a triumph for global health, and demonstrates that with political galvanised by advocacy, and with global collaboration, equity is attainable.

We would like, in this year’s World Alzheimer Report, to draw attention to two further important equity issues. One, gender, was highlighted in an ADI report

issued earlier this year[37]. The other, younger-onset dementia, has been perennially neglected, including in this report, due to a relative lack of high quality data, and an accurate perception that, being a rare condition it contributes relatively little to the overall burden. However, this has resulted in a neglect of the heightened individual impact, and the special needs of those affected, which are poorly met.

Gendering

As highlighted earlier this year in an Alzheimer's Disease International global research review on women and dementia, too little attention has been given to the gendered aspects of the epidemic[37]. Women predominate amongst older people with dementia. This is mainly because of women's greater life expectancy. However, as highlighted earlier in this report (Chapters 2 and 3), age-specific prevalence and incidence of dementia are also higher among women, particularly at older ages. The reasons for this are not clearly established, and more research would be justified, seeking options for prevention and treatment. The ADI report also revealed that there has been surprisingly little research into the effect of gender upon care needs and preferences from the perspective of the person with dementia.

Care for people with dementia is also overwhelmingly provided by women. Men and women approach the caring role, cope, and seek support in different ways. However, very little work has been carried out to determine how health and social care professionals should incorporate gender awareness into the support that they provide to people with dementia and their informal carers. The paid professional health and social care workforce is, probably, even more overwhelmingly female. In the UK, it has been estimated that 87% of the dementia care workforce is female, a greater proportion than the care workforce overall[38]. Dementia care workers were more likely to be female, temporary agency staff and from an ethnic minority group. As highlighted in the World Alzheimer Report 2013, there are widespread problems across high income countries with the low status, low pay and lack of professional development opportunities for the care workforce, all of which pose considerable challenges for maintaining and improving care quality[4]. Paid or unpaid, the fact that most carers across most if not all cultures are women, needs to be carefully considered from an equity standpoint. Women are already likely to be relatively disadvantaged with respect to education, career opportunities across the life course, income, assets and (in older age) pension entitlements. Taking on caring responsibilities for a person with dementia can lead to social isolation, cutting back or stopping work, and risks to physical and mental health[4].

Needs of younger people with dementia

Younger onset dementia (sometimes referred to as early-onset) is typically defined as onset before the age of 65 years. This is a rare condition[12], which, unlike late-onset dementia, will not be apt to increase in terms of numbers affected over time. However, people with younger onset dementia and their caregivers have specific age-related needs. The low prevalence, unusual presenting features (particularly neuropsychiatric symptoms) and broader differential diagnosis may all contribute to a substantial delay in obtaining a diagnosis (4.4 vs 2.8 years for late-onset dementia in one Dutch study)[39], which is likely to have led to a substantial underestimate of true prevalence[12]. Younger-onset dementia is particularly likely to have a genetic cause, and depending upon the type of dementia and the family history, genetic counselling and testing may be indicated[40]. Few studies have compared carer strain between younger-onset and late-onset dementia, but it is plain from a comprehensive review of the literature that levels of strain, anxiety and depression are very high among carers (usually spouses and children), and family conflict is often reported[41]. There are likely to be multiple contributory factors. People experiencing dementia at a younger age may still be employed and bringing up children; they are faced, while physically robust, with the prospect of losing their active roles and needing fundamentally to reappraise their future hopes and plans. Carers, as well as the people living with dementia, are more likely to be employed than spouses of late-onset dementia patients, and often need to take early retirement or reduce their working hours. Financial difficulties were common[40], exacerbated by health and social care systems in some countries that do not provide the same range of benefits and reimbursements for younger as for older families[42]. In most countries there are few or no designated services for people with younger onset dementia, and there are real challenges in meeting this need, given the small numbers and geographic dispersion of those affected[42]. This was a significant cause of distress for caregivers, who can be left feeling angry and guilty when offered no option other than to accept services designed for older people[41].

Many of these issues are addressed authentically and sensitively in the novel 'Still Alice' by Lisa Genova*, and the film of the same name, for which Julianne Moore was awarded the Academy Award (Oscar) for Best Actress in 2014.

There is a clear need, enunciated by people living with young onset dementia at several recent meetings, for supported employment initiatives for people living with younger onset dementia. As retirement ages increase worldwide beyond the age of 65 years, this will be an issue for late-onset dementia also. Carers, as well as people with dementia, would benefit from more flexible work arrangements.

* Gallery Books/ ISBN 9781439102817/ January 2009 - http://books.simonandschuster.com/Still-Alice/Lisa-Genova/9781439102817#sthash.SRRJJALd.dpuf

Workplaces should be highlighted not only as a unique place to support people living with dementia and their carers, but also to encourage lifestyle changes to reduce the risk of dementia.

7.4.6 Research prioritisation

Dementia research is currently grossly underfunded with respect to the burden of disease, and the societal economic cost. ADI, in conjunction with 42 other international and national non-governmental organisations, has called for nation states to contribute 1% of their respective societal economic costs to dementia research funding. This modest proposal, if initiated, would result in research investment being increased to over US$ 8 billion per annum. Currently, the USA, by far the largest national contributor to research, invests some US$731 million annually through Federally-funded National Institutes of Health programs. The $8.4 billion contribution would be distributed pro rata, with US$6.9 billion from high income countries, US$1.4 billion from middle income countries, and US$19 million from low income countries. This would amount to only around 0.003% of GDP in low income countries, and 0.014% of GDP in high income countries. A proportion of this fund could be hypothecated to a 'Global Fund' to address major cross-national questions, and to give a much needed focus to service development in low and middle income countries.

The key question remains; to which priorities should this research funding be directed? ADI and its INGO partners have recommended that in addition to search after a treatment or cure, governments should 'increase efforts in other areas of research, such as research into effective care models; prevalence, incidence and mortality, prevention and risk reduction to a comparable level, and increase the focus on translating research into practice'. This chimes with the recommendation from a Lancet Editorial that;

> "Little research is carried out on scaling up of cost-effective care strategies and integrated models of care. Little is known about, for example, alternatives to antipsychotic treatment, non-drug approaches, or the place of cognitive stimulation. The dementia research agenda should include studies of disease mechanisms, epidemiology, early diagnosis, prevention, risks and social determinants, nondrug based approaches, and quality of life. The quest for new drugs must not overshadow improving today's care and patients' lives."[2]

There is clearly a move towards a more balanced research agenda. The WHO has led a research prioritisation exercise, using well established Child Health and Nutrition Research Initiative (CHNRI) methodology, that essentially seeks to use the 'wisdom of crowds' to establish key priorities on the basis of feasibility, answerability, potential to reduce disease burden, and equity of impact[43]. The results of this exercise will be updated following expansion of the consultation to include a broader base of stakeholders and world regions, and then published in full and final form. However, preliminary findings presented at the WHO Ministerial Conference indicated that six of the top 10 overall priorities were orientated to the delivery of prevention and care (Table 7.1), whereas ratings on the basis of 'potential for conceptual breakthrough'

Table 7.1
Preliminary findings from the WHO research prioritisation exercise – overall priorities (presented at WHO Ministerial Conference, March 2015)

1	Identify clinical practice and health system-based interventions that would promote a timely and accurate diagnosis of dementia in primary health care practices.
2	Develop and validate biomarkers – including biological, genetic, behavioral and cognitive markers – for neurodegenerative brain diseases causing dementia, to identify similarities and differences between diseases and dementia subtypes, and assess progression from pre-manifest (pre-symptomatic) to late stage diseases.
3	Identify strategies to anticipate and deliver effective and cost-effective late life and end of life care for people with dementia, including advance care planning.
4	Determine the most effective interventions for educating, training and supporting formal and informal carer(s) of people with dementia.
5	Identify, validate and apply better outcome measures for clinical trials of cognition, function and other biomarkers for neurodegenerative diseases causing dementia.
6	Understand the contributions of vascular conditions to neurodegenerative diseases causing dementia.
7	Explore single and multi-domain approaches for primary and secondary prevention of dementias based on evidence on risk/protective factors and the relationship with other chronic diseases.
8	Establish norms and standards for the highest quality of care in residential and nursing homes and approaches to assist families of people with dementia to determine the optimal time to consider placement.
9	Evaluate the relative effectiveness and identify the optimal models of care and support for people with dementia and their carers in the community (e.g. collaborative care, integrated health and social care, case management) across the disease course.
10	Establish norms/standardize clinical trial methodology and ethics of conducting research with new pharmacological agents, and non-pharmacologic interventions for diseases causing dementia.

Table 7.2
Preliminary findings from the WHO research prioritization exercise – potential for conceptual breakthrough (presented at WHO Ministerial Conference, March 2015)

1	Understand the basic biological mechanisms of neuronal cell death involved in the initiation/onset and progression of neurodegenerative diseases causing dementia.
2	Understand the basic biological mechanisms of dysfunction of cellular metabolism, and their regulation in the initiation/onset and progression of neurodegenerative diseases that lead to dementia.
3	Understand the role of inflammation and of the immune system in the initiation/onset and progression of neurodegenerative diseases that lead to dementia.
4	Determine the roles of non-neuronal brain cells (such as microglia, astrocytes and macrophages) in pathogenesis and progression of neurodegenerative diseases that cause dementia.
5	Identify underlying mechanisms of resilience to neurodegenerative diseases causing dementia at all stages (such as cognitive reserve, protective genotypes, and neuroprotection).
6	Understand the impact of the neurodegenerative diseases causing dementia upon the structure and function of neural systems and networks with the aim of identifying new therapeutic targets.
7	Understand protein misfolding and propagation in the brain and their role in the initiation/onset and progression of neurodegenerative diseases causing dementia.
8	Investigate how intrinsic biological ageing processes may contribute to the neurodegenerative diseases causing dementia.
9	Understand the contributions of vascular conditions to neurodegenerative diseases causing dementia.
10	Understand the contribution of environmental factors to neurodegenerative diseases causing dementia and their interactions with other pathophysiological processes at the epigenetic, molecular and systems levels.

favoured more basic research into disease mechanisms.

In reality, both approaches are required, and the only question is the relative balance of research investment into each area.

Given the focus for this report, we must also highlight the need, worldwide, but especially in high income countries, to re-engage with the neglected task of monitoring the prevalence of dementia worldwide, accompanied, ideally, with observation of any secular trends in incidence and mortality, where longitudinal research is feasible. Such studies should, ideally, be conducted on nationally representative samples, and could conveniently be performed nested within national surveys of health and ageing. This would facilitate secondary aims including a) monitoring changes in dementia diagnostic coverage, access to and receipt of dementia-specific services, b) changes in the exposure to hypothesised modifiable risk factors for dementia, and relating these to changes in dementia prevalence and incidence, c) changes in formal and informal care arrangements, and healthcare for people with dementia, and their attendant societal costs.

7.5 Final conclusions and recommendations

Alzheimer's Disease International;

- Applauds the action taken by the G7 in launching a 'Global Action Against Dementia' and recognises the considerable efforts of the Global Dementia Envoy, the World Dementia Council, and the G7 governments over the past 18 months
- Hopes and expects that this initiative will now be continued, with a broader agenda and a wider representation of countries and regions most affected by the ongoing epidemic
- Would support and advocate for a transfer of political leadership to the G20 group of nations, assuming continued commitment and engagement of the G7 nations to the cause
- Wholeheartedly endorses all aspects of the 'call for action' issued at the WHO first Ministerial Conference for Dementia
- Welcomes the leadership role outlined for WHO in the 'call for action' and will continue to work closely with this body and its member states to ensure that people with dementia and their families are put at the centre of all policies, in pursuit of equitable access to comprehensive services for all people with dementia worldwide, and the realisation of the full potential for living well with dementia.
- Believes work on the quality of care should be a priority and applauds OECD's commitment to evaluate dementia care models and make outcomes measurable and transparent

Call to action

Alzheimer's Disease International;

1. Recognises the need for the 'call for action' to be translated into an operationalised 'Global Dementia Action Plan', with clear targets and deliverables, and will both advocate for and support interested Member States to propose motions to the World Health Assembly
2. Proposes that the elements of planning for dementia at the global and country level that has the objective

of supporting the person with dementia to stay in the community for as long as possible include;

a) Awareness raising of dementia

b) Creation of dementia friendly communities that reduce stigma associated with the disease

c) Promotion of risk reduction measures

d) Measures to improve diagnosis and reduce the average length of diagnosis

e) Support for family carers including through information, social support, respite and counselling

f) Access to long term community and residential dementia care services and to enhanced care for people dementia in hospitals

g) A commitment to person centred care and to care that minimises the use of medical and physical restraint

h) Workforce strategies including training

i) The use of technology to assist the person with dementia in the home and to extend service reach in rural areas

j) Recognition that people with dementia deserve good quality end-of-life care with respect to their dignity and personal wishes

3. Calls for a focus on strengthening primary health care as the key part of the health system to respond to the dementia challenge

4. Calls for risk reduction for dementia to be made an explicit priority with linked actions, including setting of some targets and indicators, in the general work stream on non-communicable diseases that is led by the World Health Organization

5. Calls for a significant upscaling of research investment, proportionate to the societal cost of the disease, and for a balanced investment in research into prevention, treatment, care and cure, with a specific work stream for lower and middle-income countries, developing programmes to raise awareness and improve health system responses with the inclusion of partners from those countries.

6. Supports the need for a Global Dementia Observatory, coordinated by WHO to; support and monitor policy development; monitor the scale of the epidemic; assess opportunities for prevention, their implementation and impact; and monitor progress towards increasing the available resources for treatment and care, and their coverage worldwide.

7. Recommends that every country should develop its own national dementia plan or strategy as a framework for action across government sectors; and monitor the results and renew the plan on a regular basis.

References

1 Alzheimer's Disease International. Policy Brief for G8 Heads of Government. The Global Impact of Dementia 2013-2050. London, UK: Alzheimer's Disease International; 2013.

2 Addressing global dementia. Lancet 2014 June 28;383(9936):2185-6736.

3 Dementia: a false promise. Lancet 2014 September; 384(9948):1072-6736.

4 Prince, M., Prina, M., and Guerchet, M. World Alzheimer Report 2013. Journey of Caring. An analysis of long-term care for dementia. London: Alzheimer's Disease International; 2013.

5 Beaglehole R, Epping-Jordan J, Patel V, Chopra M, Ebrahim S, Kidd M et al. Improving the prevention and management of chronic disease in low-income and middle-income countries: a priority for primary health care. Lancet 2008 September 13;372(9642):940-9.

6 Albanese E, Liu Z, Acosta D, Guerra M, Huang Y, Jacob K et al. Equity in the delivery of community healthcare to older people: findings from 10/66 Dementia Research Group cross-sectional surveys in Latin America, China, India and Nigeria. BMC Health Serv Res 2011;11:153.

7 Patel V, Prince M. Ageing and mental health in a developing country: who cares? Qualitative studies from Goa, India. Psychological Medicine 2001;31(1):29-38.

8 Prince M, Acosta D, Albanese E, Arizaga R, Ferri CP, Guerra M et al. Ageing and dementia in low and middle income countries-Using research to engage with public and policy makers. Int Rev Psychiatry 2008 August;20(4):332-43.

9 Standard & Poor's. Global Aging 2010: An Irreversible Truth. Standard & Poor's Financial Services LLC (S&P), a subsidiary of The McGraw-Hill Companies, Inc. All rights reserved; 2010.

10 Dua T, Barbui C, Clark N, Fleischmann A, Poznyak V, Van OM et al. Evidence-based guidelines for mental, neurological, and substance use disorders in low- and middle-income countries: summary of WHO recommendations. PLoS Med 2011 November;8(11):e1001122.

11 Prince MJ, Acosta D, Castro-Costa E, Jackson J, Shaji KS. Packages of care for dementia in low- and middle-income countries. PLoS Med 2009 November;6(11):e1000176.

12 World Health Organization. Dementia: a public health priority. Geneva: World Health Organization; 2012.

13 Saxena S, Funk M, Chisholm D. World Health Assembly adopts Comprehensive Mental Health Action Plan 2013-2020. Lancet 2013 June 8;381(9882):1970-1.

14 Jitapunkul S, Chansirikanjana S, Thamarpirat J. Undiagnosed dementia and value of serial cognitive impairment screening in developing countries: a population-based study. Geriatr Gerontol Int 2009 March;9(1):47-53.

15 Prince M., Bryce, R., and Ferri, C. World Alzheimer Report 2011: The benefits of early diagnosis and intervention. London: Alzheimer's Disease International; 2011.

16 Nakamura AE, Opaleye D, Tani G, Ferri CP. Dementia underdiagnosis in Brazil. Lancet 2015 January 31;385(9966): 418-9.

17 Dias A, Patel V. Closing the treatment gap for dementia in India. Indian Journal of Psychiatry 2009;51(5):93-7.

18 Olazaran J, Reisberg B, Clare L, Cruz I, Pena-Casanova J, Del ST et al. Nonpharmacological therapies in Alzheimer's disease: a systematic review of efficacy. Dement Geriatr Cogn Disord 2010;30(2):161-78.

19 Mittelman MS, Ferris SH, Shulman E, Steinberg G, Levin B. A family intervention to delay nursing home placement of patients with Alzheimer disease. A randomized controlled trial. JAMA 1996 December 4;276(21):1725-31.

20 Prince M, Brodaty H, Uwakwe R, Acosta D, Ferri CP, Guerra M et al. Strain and its correlates among carers of people with dementia in low-income and middle-income countries. A 10/66 Dementia Research Group population-based survey. Int J Geriatr Psychiatry 2012 July;27(7):670-82.

21 Alzheimer's Disease International. World Alzheimer Report 2009. London: Alzheimer's Disease International; 2009.

22 Lin SY, Lewis FM. Dementia friendly, dementia capable, and dementia positive: concepts to prepare for the future. Gerontologist 2015 April;55(2):237-44.

23 United Nations. Report of the Second World Assembly on Ageing, Madrid 8-12 April 2002. New York: United Nations; 2002. Report No.: A/CONF.197/9.

24 United Nations Population Fund and HelpAge International. Ageing in the Twenty-First Century: A Celebration and A Challenge. New York: UNFPA/ HelpAge International; 2012.

25 Prince MJ, Wu F, Guo Y, Gutierrez Robledo LM, O'Donnell M, Sullivan R et al. The burden of disease in older people and implications for health policy and practice. Lancet 2015 February 7;385(9967):549-62.

26 Saxena S, Thornicroft G, Knapp M, Whiteford H. Resources for mental health: scarcity, inequity, and inefficiency. Lancet 2007 September 8;370(9590):878-89.

27 Downing J, Grant L, Leng M, Namukwaya E. Understanding Models of Palliative Care Delivery in Sub-Saharan Africa: Learning From Programs in Kenya and Malawi. J Pain Symptom Manage 2015 April 30;(15):10.

28 Meara JG, Leather AJ, Hagander L, Alkire BC, Alonso N, Ameh EA et al. Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development. Lancet 2015 April 21;(15):10-6736.

29 Lund C, Tomlinson M, De SM, Fekadu A, Shidhaye R, Jordans M et al. PRIME: a programme to reduce the treatment gap for mental disorders in five low- and middle-income countries. PLoS Med 2012;9(12):e1001359.

30 Hebert R, Raiche M, Dubois MF, Gueye NR, Dubuc N, Tousignant M. Impact of PRISMA, a coordination-type integrated service delivery system for frail older people in Quebec (Canada): A quasi-experimental study. J Gerontol B Psychol Sci Soc Sci 2010 January;65B(1):107-18.

31 Fulton BD, Scheffler RM, Sparkes SP, Auh EY, Vujicic M, Soucat A. Health workforce skill mix and task shifting in low income countries: a review of recent evidence. Hum Resour Health 2011 January 11;9:1. doi: 10.1186/1478-4491-9-1.:1-9.

32 Prince, M., Albanese, E., Guerchet, M., and Prina, M. World Alzheimer Report 2014. Dementia and Risk Reduction. An analysis of Protective and Modifiable Risk Factors. London: Alzheimer's Disease International; 2014.

33 Jones RN, Manly J, Glymour MM, Rentz DM, Jefferson AL, Stern Y. Conceptual and Measurement Challenges in Research on Cognitive Reserve. J Int Neuropsychol Soc 2011 March 17;1-9.

34 Lincoln P, Fenton K, Alessi C, Prince M, Brayne C, Wortmann M et al. The Blackfriars Consensus on brain health and dementia. Lancet 2014 May 24;383(9931):1805-6.

35 Norton S, Matthews FE, Barnes DE, Yaffe K, Brayne C. Potential for primary prevention of Alzheimer's disease: an analysis of population-based data. Lancet Neurol 2014 August;13(8):788-94.

36 Beaglehole R, Bonita R, Horton R, Ezzati M, Bhala N, Amuyunzu-Nyamongo M et al. Measuring progress on NCDs: one goal and five targets. Lancet 2012 October 13;380(9850):1283-5.

37 Erol, R., Brooker, D., and Peel, E. Women and Dementia: A Global Research Review. London, UK: Alzheimer's Disease International; 2015.

38 Hussein S, Manthorpe J. The dementia social care workforce in England: secondary analysis of a national workforce dataset. Aging Ment Health 2012;16(1):110-8.

39 van VD, de Vugt ME, Bakker C, Pijnenburg YA, Vernooij-Dassen MJ, Koopmans RT et al. Time to diagnosis in young-onset dementia as compared with late-onset dementia. Psychol Med 2013 February;43(2):423-32.

40 Goldman JS. Genetic testing and counseling in the diagnosis and management of young-onset dementias. Psychiatr Clin North Am 2015 June;38(2):295-308.

41 van VD, de Vugt ME, Bakker C, Koopmans RT, Verhey FR. Impact of early onset dementia on caregivers: a review. Int J Geriatr Psychiatry 2010 November;25(11):1091-100.

42 Shnall A. Public advocacy and community engagement: interventions for individuals with young-onset dementia and their families. Psychiatr Clin North Am 2015 June;38(2):353-62.

43 Rudan I, Gibson J, Kapiriri L, Lansang MA, Hyder AA, Lawn J et al. Setting priorities in global child health research investments: assessment of principles and practice. Croat Med J 2007 October;48(5):595-604.

Appendix A: Global Burden of Disease (GBD) Regions

Table A.1
GBD regions for which meta-analysis could be conducted

GBD Region	Countries (those with one or more studies underlined)	Relationship to WHO regions used for ADI/ Lancet estimates	Approach used to generate regional prevalence and numbers
ASIA			
Australasia	Australia, New Zealand	WPRO A	Apply estimates from meta-analysis.
Asia Pacific, High Income	Brunei-Darussalam, Japan, Republic of Korea, Singapore	WPRO A except for Korea (WPRO B)	Apply estimates from meta-analysis.
Asia, East	China, Democratic People's Republic of Korea, Hong Kong SAR, Taiwan, Macao SAR	WPRO B except for Democratic People's Republic of Korea (SEARO D)	Apply estimates from meta-analysis.
Asia, South	Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan	SEARO D except for Afghanistan and Pakistan (EMRO D)	Apply estimates from meta-analysis.
Asia, Southeast	Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Maldives, Mauritius, Mayotte, Myanmar, Philippines, Reunion, Seychelles, Sri Lanka, Thailand, Timor-Leste, Viet Nam	Mainly SEARO B and WPRO B	Apply estimates from meta-analysis.
EUROPE			
Europe, Central	Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Serbia, Montenegro, Slovakia, Slovenia, The Former Yugoslav Republic of Macedonia	EURO B, except for Croatia, Czech Republic and Slovenia (EURO A)	Apply estimates from meta-analysis.
Europe, Western	Austria, Belgium, Channel Islands, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, San Marino, Spain, Sweden, Switzerland, United Kingdom	EURO A	Apply estimates from meta-analysis.
THE AMERICAS			
North America	Canada, United States of America	AMRO A	Conduct meta-analysis for USA. Apply CSHA data for Canada, then aggregate
Latin America, Andean	Bolivia (Plurinational State of), Ecuador, Peru	AMRO D	Apply estimates from meta-analysis conducted across all four regions
Latin America, Central	Colombia, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Venezuela (Bolivarian Republic of)	AMRO B except for Guatemala and Nicaragua (AMRO D)	
Latin America, Southern	Argentina, Chile, Uruguay	AMRO B	
Latin America, Tropical	Brazil, Paraguay	AMRO B	
AFRICA			
Sub-Saharan Africa, Central	Angola, Central African Republic, Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon	A mixture of AFRO D and AFRO E	Apply estimates from meta-analysis in sub-Saharan Africa conducted across all four regions
Sub-Saharan Africa, East	Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mozambique, Rwanda, Somalia, South Sudan, Sudan, Uganda, United Republic of Tanzania, Zambia	AFRO E except for Comoros (AFRO D) and Somalia and Sudan (EMRO D)	
Sub-Saharan Africa, Southern	Botswana, Lesotho, Namibia, South Africa, Swaziland, Zimbabwe	AFRO E	
Sub-Saharan Africa, West	Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Sao Tome and Principe, Senegal, Sierra Leone, Togo	AFRO D	

Table A.2
GBD regions for which meta-analysis could not be conducted

Region	Countries (those with one or more studies underlined)	Relationship to WHO regions used in ADI/ Lancet	Approach
ASIA			
Asia, Central	Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Mongolia, Tajikistan, Turkmenistan, Uzbekistan	EURO B, except for Kazakhstan (EURO C)	Apply relevant Lancet/ ADI estimates to each country and aggregate
Oceania	Fiji, French Polynesia, Guam, Kiribati, Micronesia (Federated States of), New Caledonia, Papua New Guinea, Samoa, Solomon Islands, Tonga, Vanuatu	WPRO B	Data from one study in Guam only (indigenous Chamorros islanders. Therefore use Lancet/ ADI WPRO B for all countries
EUROPE			
Europe, Eastern	Belarus, Estonia, Latvia, Lithuania, Republic of Moldova, Russian Federation, Ukraine	EURO C	Apply Lancet/ ADI EURO C estimates
THE AMERICAS			
Caribbean	Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Cuba, Curacao, Dominican Republic, French Guiana, Grenada, Guadaloupe, Guyana, Haiti, Jamaica, Martinique, Puerto Rico, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, United States Virgin Islands	AMRO B, other than Haiti (AMRO D) and Cuba (AMRO A)	Use meta-analysed estimates for Cuba, 10/66 estimates for Dominican Republic and Puerto Rico for those countries. Jamaica prevalence for this country. Apply relevant Lancet/ ADI estimates to other countries and aggregate
AFRICA			
North Africa / Middle East	Algeria, Bahrain, Egypt, Iran (Islamic Republic of), Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, State of Palestine, Syrian Arab Republic, Tunisia, Turkey, United Arab Emirates, Western Sahara, Yemen	EMRO B, except for Egypt, Iraq, Morocco and Yemen (EMRO D), Algeria (AFRO D) and Turkey (EURO B)	Apply meta-analysed Turkey estimates to Turkey. Apply Egypt meta-analysed estimates to Egypt and other EMRO D and AFRO D countries. Apply relevant Lancet/ ADI estimates to other countries and aggregate

Alzheimer's Disease International

About ADI

Alzheimer's Disease International (ADI) is the international federation of Alzheimer associations throughout the world. Each of our 83 members is a non-profit Alzheimer association supporting people with dementia and their families.

ADI's vision is an improved quality of life for people with dementia and their families throughout the world. ADI aims to make dementia a global health priority, to build and strengthen Alzheimer associations, and to raise awareness about dementia worldwide. Stronger Alzheimer associations are better able to meet the needs of people with dementia and their carers.

What we do

- Support the development and activities of our member associations around the world.
- Encourage the creation of new Alzheimer associations in countries where there is no organization.
- Bring Alzheimer organizations together to share and learn from each other.
- Raise public and political awareness of dementia.
- Stimulate research into the prevalence and impact of Alzheimer's disease and dementia around the world.
- Represent people with dementia and families in international platforms at the UN and WHO

Key activities

- Raising global awareness through World Alzheimer's Month™ (September every year).
- Providing Alzheimer associations with training in running a non-profit organization through our Alzheimer University programme.
- Hosting an international conference where staff and volunteers from Alzheimer associations meet each other as well as medical and care professionals, researchers, people with dementia and their carers.
- Disseminating reliable and accurate information through our website and publications.
- Supporting the 10/66 Dementia Research Group's work on the prevalence and impact of dementia in developing countries.
- Supporting global advocacy by providing facts and figures about dementia, and monitoring as well as influencing dementia policies.

ADI is based in London and is registered as a non-profit organization in the USA. ADI was founded in 1984 and has been in official relations with the World Health Organization since 1996. You can find out more about ADI at www.alz.co.uk.

Bupa

About Bupa

Bupa's purpose is longer, healthier, happier lives.

As a leading global health and care company, we offer health insurance, medical subscription and other health and care funding products; we run care homes, retirement and care villages, primary care, diagnostic and wellness centres, hospitals and dental clinics. We also provide workplace health services, home healthcare, health assessments and long-term condition management services.

We have 29m customers in 190 countries. With no shareholders, we reinvest our profits to provide more and better healthcare and fulfil our purpose.

We employ almost 80,000 people, principally in the UK, Australia, Spain, Poland, New Zealand and Chile, as well as Saudi Arabia, Hong Kong, India, Thailand and the USA.

For more information, visit bupa.com.

About Bupa's social care services around the world

Bupa is committed to tackling the toughest challenges in healthcare, including dementia. We want to set the standard for person-centred care and be recognised as a global leader in helping people live well with dementia and Alzheimer's disease.

Bupa has significant expertise and networks, with approximately three-quarters of residents in our care homes living with dementia, making us the leading international provider of specialist dementia care. During a given year, we care for more than 65,000 people in over 450 care homes and retirement villages in the UK, Spain, Australia, New Zealand and Poland.

We combine experience and expertise to care for our residents living with dementia. Our philosophy of care is based on a 'person first' approach which revolves around each person's background, experiences, values, hobbies and what makes them happy, and seeks to understand who they are and the reality in which they are living.

We are committed to shaping a world where people can live well with dementia today, and reduce the risk of dementia for future generations. That is why we are proud to partner with ADI, and together we have outlined for the first time what we believe are the rights of people living with dementia, wherever they are in the world. Our joint Global Dementia Charter 'I can live well with dementia' has been endorsed by people living with dementia, and together with ADI we intend to make it a reality.

To download the charter and find out more, visit www.bupa.com/dementia

Alzheimer's Disease International:
The International Federation
of Alzheimer's Disease and
Related Disorders Societies, Inc.
is incorporated in Illinois, USA,
and is a 501(c)(3) not-for-profit
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