ELSEVIER

Alzheimer's & Dementia 9 (2013) 63–75

Alzheimer's & Dementia

Review Articles

The global prevalence of dementia: A systematic review and metaanalysis

Martin Prince[a,*], Renata Bryce[a], Emiliano Albanese[a,b], Anders Wimo[c,d], Wagner Ribeiro[a,e], Cleusa P. Ferri[a,e]

[a]*Institute of Psychiatry, King's College London, London, UK*
[b]*Laboratory of Epidemiology, Demography, and Biometry, National Institute of Aging, National Institutes of Health, Bethesda, Maryland, USA*
[c]*KI–Alzheimer Disease Research Centre, Karolinska Institutet, Stockholm, Sweden*
[d]*Aging Research Center, Karolinska Institutet, Stockholm, Sweden*
[e]*Department of Psychiatry, Federal University of Sao Paulo, Sao Paulo, Brazil*

Abstract

Background: The evidence base on the prevalence of dementia is expanding rapidly, particularly in countries with low and middle incomes. A reappraisal of global prevalence and numbers is due, given the significant implications for social and public policy and planning.

Methods: In this study we provide a systematic review of the global literature on the prevalence of dementia (1980–2009) and metaanalysis to estimate the prevalence and numbers of those affected, aged ≥60 years in 21 Global Burden of Disease regions.

Results: Age-standardized prevalence for those aged ≥60 years varied in a narrow band, 5%–7% in most world regions, with a higher prevalence in Latin America (8.5%), and a distinctively lower prevalence in the four sub-Saharan African regions (2%–4%). It was estimated that 35.6 million people lived with dementia worldwide in 2010, with numbers expected to almost double every 20 years, to 65.7 million in 2030 and 115.4 million in 2050. In 2010, 58% of all people with dementia lived in countries with low or middle incomes, with this proportion anticipated to rise to 63% in 2030 and 71% in 2050.

Conclusion: The detailed estimates in this study constitute the best current basis for policy-making, planning, and allocation of health and welfare resources in dementia care. The age-specific prevalence of dementia varies little between world regions, and may converge further. Future projections of numbers of people with dementia may be modified substantially by preventive interventions (lowering incidence), improvements in treatment and care (prolonging survival), and disease-modifying interventions (preventing or slowing progression). All countries need to commission nationally representative surveys that are repeated regularly to monitor trends.

Keywords: Dementia; Prevalence; Epidemiology; Projection; WHO Global Burden of Disease regions; Worldwide; Systematic review; Metaanalysis

Disclosures: Anders Wimo has been acting as consultant to drug companies (e.g., Pfizer, Janssen-Cilag, Astra-Zeneca, Novartis, Merz, Lundbeck, Forest, GSK, Wyeth, Sanofi, Elan, Neurochem, Lilly, BMS) purchasing or developing drugs for treatment of Alzheimer's disease or other dementias, but this has not influenced work associated with this study nor has there been any financing from these companies of this work. This systematic review was supported by a small grant from Alzheimer's Disease International (ADI) to King's College London. ADI has acknowledged support for the production and dissemination of the *World Alzheimer Report 2009* from the Vradenburg Foundation, Geoffrey Beene Foundation, Alzheimer's Association, Alzheimer's Australia, Alzheimer's Australia WA, Alzheimer Scotland, Alzheimer's Society, Association Alzheimer Suisse, Alzheimerföreningen i Sverige, Deutsche Alzheimer Gesellschaft, and Stichting Alzheimer Nederland. The sponsors had no role in study design, data collection, data analysis, data interpretation, or the writing of this review.

*Corresponding author.
E-mail address: Martin.Prince@kcl.ac.uk

1552-5260/$ - see front matter
http://dx.doi.org/10.1016/j.jalz.2012.11.007

1. Introduction

Dementia is a clinical syndrome caused by neurodegeneration (Alzheimer's disease, vascular dementia, Lewy body, and frontotemporal dementia being the most common underlying pathologies) and characterized by inexorably progressive deterioration in cognitive ability and capacity for independent living. It is a health- and social-care priority for many high-income countries. Governments in the UK, France, Norway, USA, and South Korea have recently developed specific plans or strategies. Population aging is having a profound impact on the emergence of the dementia epidemic, and is driving government responses. Although young-onset cases are increasingly recognized, dementia is typically a condition that affects older people, among whom it is a leading contributor to disability and dependence [1,2]. Particularly rapid increases in the numbers and proportion of older people are forecast for China, India, and Latin America [3]. By 2050, the number of people aged ≥60 years will have increased by 1.25 billion, accounting for 22% of the world's population, with 79% living in the world's less developed regions. As yet, awareness of dementia and health system preparedness is much more limited in these regions. It is therefore important to track the global prevalence of this burdensome condition, and its regional distribution in the context of the rapidly unfolding demographic and health transitions.

In 2005, Alzheimer's Disease International [ADI] commissioned a panel of experts, coordinated by our group from King's College London, to review all available epidemiologic data and reach a consensus estimate of prevalence in each of the 14 WHO regions [4]. The panel estimated 24.3 million people with dementia in 2001, with 60% living in low- and middle-income countries (LMIC). Each year, 4.6 million new cases of dementia were predicted, with numbers affected nearly doubling every 20 years to reach 81.1 million by 2040. These estimates were described as "provisional," given that prevalence data were lacking in many world regions, and patchy in others [4]. Coverage was good in Europe, North America, and in developed Asia–Pacific countries. Several studies were done in India and China, but estimates were too few or too variable to provide a consistent overview for these very large countries. There was a dearth of published epidemiologic studies in Latin America [5–7], Africa [8], Russia, the Middle East, and Indonesia, and a consequent reliance upon the consensus judgment of the international expert panel. The panel's consensus largely supported a tendency noted in the relatively few LMIC studies available at that time, for the age-specific prevalence of dementia to be lower in those regions than in the developed north [8–10].

Our group reappraised the global prevalence of dementia for the forthcoming revision of the report of the Global Burden of Disease (GBD, which provides information for the global health community on the relative burden contributed by different diseases to years lived with disability and premature mortality), with findings summarized in ADI's *World Alzheimer Report 2009* [11]. By this time, the global evidence base had expanded considerably with more studies from low- and middle-income countries (defined according to the World Bank classification), based on gross national income per capita, and other regions and groups previously underrepresented in the literature. These included prevalence studies conducted by the 10/66 Dementia Research Group in Brazil, Cuba, Dominican Republic, Peru, Mexico, Venezuela, India, and China [12,13], and further new prevalence studies from Brazil [14], Peru [15], Cuba [16], Venezuela [17], China [18], Korea [19], India [20], Thailand [21], Australia (indigenous people [22]), Guam [23], Poland [24], and Turkey [25]. Enhancements from the previous exercise included: a fully systematic review of the world literature on the prevalence of dementia; a critical appraisal of study quality; and an attempt, where possible, to generate regional estimates from quantitative metaanalyses. A reappraisal was timely, not only because of improvements in the evidence base, but also given the very high policy relevance of such data.

2. Methods

The differences in approach between the current study and the generation of the earlier ADI/*Lancet* estimates [4] are summarized in Table E1. We conducted a systematic review of the world literature on the prevalence of dementia with PubMed/Medline up to March 2009 using the search terms ("Dementia"[Mesh] AND (("Prevalence"[Mesh]) OR "Epidemiology"[Mesh])). We sought and included population-based studies of the prevalence of dementia among people aged ≥60 years of age (according to the Diagnostic and *Statistical Manual of Mental Disorders, fourth edition* [DSM-IV] or the *International Classification of Diseases, tenth edition* [ICD-10] criteria, or similar clinical criteria), for which the fieldwork started on or after January 1, 1980. The exclusion criteria were related to sampling, case ascertainment procedures, and outcome definitions:

(A) *Sampling design:*
   1. Studies of prevalence from the follow-up phase (rather than the inception phase) of a population cohort.
   2. Studies sampling from an out-of-date population register (prepared >3 years prior to the survey).
   3. Studies of nursing home or residential care populations, primary care attendees, or other unrepresentative service-user populations.

B. *Ascertainment/outcome definition:*
   1. Studies in which the ascertainment of dementia depended upon help-seeking and/or receipt of dementia care services.
   2. Studies in which "dementia" was diagnosed purely on the basis of cognitive impairment, such as according to a cutpoint on the MMSE.

3. Two-phase studies, in which screening procedures were clearly inadequate and two-phase methodology was not properly applied.
4. Studies of the prevalence of Alzheimer's disease or other subtypes of dementia, or restricted to young-onset dementia.

2.1. Procedures

M.P. and C.F. read the abstracts of all publications identified on the electronic databases, excluding only those that clearly did not meet the aforementioned criteria. In the next stage, printed copies of the remaining publications were read by either M.P., C.F., R.S., W.R., or E.A., and a consensus was made on those that met all criteria. We read studies published in English, French, Spanish, Italian, Portuguese, and German, and recruited outside assistance for studies published in Japanese and Polish. For China, we relied on a recently published systematic review and metaanalysis that included both English language and Chinese publications from 1980 to 2004 [26], supplemented with recent studies published in English and not included in that meta-analysis [12,18,27].

All eligible studies were systematically coded for their study design and quality. An overall quality score was derived by summing scores for the following elements:

Sample size: <500, 0.5 point; 500–1499, 1 point; 1500–2999, 1.5 points; ≥3000, 2 points.

Study 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. Data extraction

For studies reporting unweighted prevalence, we extracted either numerator and denominator, or prevalence and denominator, or prevalence and standard error, or prevalence and 95% confidence intervals. Numerator and denominator could then be calculated from any of these combinations. For studies reporting weighted prevalence we extracted either weighted prevalence and weighted standard error or weighted 95% confidence intervals. Effective numerators and denominators (taking account of the design effect) could then be calculated. Prevalence estimates were stratified differently in different publications. Those that lacked age stratification could not be used in our metaanalyses, because the main aim was to model the effect of age on dementia prevalence. Age-specific prevalence data could generally be calculated from age- and gender-specific estimates. Therefore, we could 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.

2.3. Metaanalytical methods for estimating dementia prevalence within regions

Within each GBD region, where there were sufficient data to conduct a metaanalysis, we used a random effect exponential (Poisson) model to assess the effects of age and gender on the prevalence of dementia. Random effects are assumed to have a gamma distribution—the α coefficient is an estimate of overdispersion and an index of between-study heterogeneity. Age was coded as the mean for each age group reported. For high-income countries, this was calculated from the U.S. Census, whereas for low- and middle-income countries we estimated this as the mean observed in the relevant 10/66 Dementia Research Group population-based studies [12]. For each region we ran two models, one for the effect of age and one for the main effects of age and gender, and an interaction between age and gender. We then applied the relevant mean ages and gender codings to the coefficients estimated from the models, to estimate prevalence in 5-year age bands from 60 to 89 years, and for those aged ≥90 years, for both genders combined (from the age only model), and for men and women separately (from the age and gender model).

3. Results

3.1. Evidence base

The search yielded abstracts for 2017 publications. After reading the abstracts, 1764 publications were excluded as clearly ineligible, leaving 253 for further review. Where possible, we obtained copies of the full published version of each study, which were then carefully assessed against inclusion/exclusion criteria. A further 98 publications were excluded at this stage, leaving 155 publications (describing 167 studies) that were provisionally eligible. For 20 of these publications, we were either unable to confirm eligibility with the information available, or could not use the data in the form in which it was provided. Finally, 135 publications (describing 147 studies) were fully eligible for inclusion in the review. A full list of included and excluded publications is provided in an online Appendix to the *World Dementia Report 2012* [28] at: http://www.who.int/mental_health/publications/dementia_report_2012/en/. The number of studies identified in each GBD world region are summarized in Figure E1. Good to reasonable coverage was identified for 11 of the 21 GBD regions. Western Europe (61 studies) and East Asia (34 studies) accounted for the majority of the world's studies. The next best represented region was Asia Pacific High Income (22 studies), followed by North America (13 studies), and Latin America (11 studies). Other regions with reasonable coverage were South Asia

(7 studies), South East Asia (5 studies), and Australasia (4 studies). Sparse coverage was achieved in five regions: the Caribbean (4 studies); Central Europe (4 studies); North Africa/Middle East (2 studies); Eastern Europe (1 study); and Western (2 studies) and Southern (1 study) Sub-Saharan Africa. No eligible studies were identified for the remaining three GBD world regions: Central and Eastern Sub-Saharan Africa and Central Asia. Figure E2 shows the annual number of prevalence studies according to the median year in which data were collected. This indicates a large and sustained increase in studies conducted in LMIC since the mid-1990s, whereas studies in high-income countries peaked in the early 1990s and declined sharply thereafter; 27% of high-income country studies (chiefly Europe and North America) were conducted in the 1980s, 63% in the 1990s, and just 10% in the 2000s.

3.2. Quality of included studies

The principal characteristics of the included studies are described in Table 1, by region.

(a) Study design. The major quality issue concerns the use of surveys with two or more phases. Such multiphase survey designs are popular in dementia research (70% of dementia prevalence studies used this design) because of perceived efficiencies in interviewer time and cost. Unfortunately, most

Table 1
Study characteristics, by region (for those regions within which meta-analyses were conducted), and by country income level

	Europe	North America	Latin America and Caribbean	Asia Pacific High Income	Australasia	East Asia	South Asia	South East Asia	HIC	LMIC	All regions
Number of studies*	51	13	15	20	4	34	7	5	93	64	157
Year of research											
1980–1989	13 (26%)	3 (23%)	0	7 (35%)	2 (50%)	5 (15%)	0	1 (20%)	25 (27%)	8 (13%)	33 (21%)
1990–1999	34 (67%)	9 (69%)	3 (20%)	10 (50%)	1 (25%)	25 (74%)	4 (57%)	2 (40%)	59 (63%)	32 (50%)	91 (58%)
After 2000	4 (8%)	1 (8%)	12 (80%)	3 (15%)	1 (25%)	4 (12%)	3 (43%)	2 (40%)	9 (10%)	24 (38%)	33 (21%)
Sample size											
<500	16 (31%)	0	0	3 (16%)	2 (50%)	0	1 (14%)	1 (20%)	21 (23%)	3 (5%)	24 (16%)
500–1499	19 (37%)	4 (31%)	5 (36%)	7 (37%)	2 (50%)	10 (29%)	3 (43%)	4 (80%)	34 (37%)	24 (38%)	58 (37%)
1500–2999	9 (18%)	5 (39%)	8 (57%)	5 (26%)	0	10 (29%)	2 (29%)	0	21 (23%)	22 (34%)	43 (28%)
≥3000	7 (14%)	4 (31%)	1 (7%)	4 (21%)	0	14 (41%)	1 (14%)	0	16 (17%)	15 (23%)	31 (20%)
Outcome											
ICD-10	1 (2%)	0 (0%)	0	1 (5%)	0	1 (7%)	1 (14%)	0	3 (3%)	2 (5%)	5 (4%)
DSM-IV/IIIR	37 (73%)	9 (69%)	8 (53%)	17 (85%)	2 (67%)	10 (71%)	4 (57%)	4 (80%)	69 (75%)	25 (60%)	94 (70%)
GMS/AGECAT	2 (4%)	1 (8%)	0	0 (0%)	0	0	0 (0%)	1 (20%)	3 (3%)	1 (2%)	4 (3%)
CAMDEX	6 (12%)	0 (0%)	0	0 (0%)	0	0	0	0	6 (7%)	1 (2%)	7 (5%)
Other	5 (10%)	3 (23%)	7 (47%)	2 (10%)	1 (33%)	3 (21%)	2 (29%)	0	11 (12%)	13 (31%)	24 (18%)
Design											
One phase	16 (31%)	2 (15%)	10 (67%)	3 (15%)	3 (75%)	3 (21%)	3 (43%)	0	25 (27%)	16 (36%)	41 (30%)
Two or more phases	36 (69%)	11 (85%)	5 (33%)	17 (85%)	1 (25%)	11 (89%)	4 (57%)	5 (100%)	69 (73.%)	20 (46%)	97 (70%)
Multiphase design applied and analyzed correctly†	22%	55%	20%	12%	100%	9%	0%	0%	25%	11%	21%
Response proportion											
<60%	5 (10%)	0	0	0	0	0	0	0	5 (5.3%)	1 (2%)	6 (4%)
60%–79%	16 (31%)	6 (46%)	2 (13%)	3 (15%)	2 (50%)	4 (29%)	1 (14%)	1 (20%)	29 (31%)	8 (18%)	37 (27%)
80%–100%	28 (54%)	5 (39%)	10 (67%)	10 (50%)	2 (50%)	10 (71%)	5 (71%)	1 (20%)	48 (51%)	26 (59%)	74 (54%)
Not specified	3 (6%)	2 (15%)	3 (20%)	7 (35%)	0	0	1 (14%)	3 (60%)	12 (13%)	9 (21%)	21 (15%)
Assessment quality											
Comprehensive diagnostic assessment‡	28 (55%)	5 (39%)	11 (73%)	2 (10%)	0	4 (31%)	3 (43%)	1 (20%)	36 (39%)	21 (51%)	57 (43%)
Overall quality score§											
Mean (SD)	8.2 (1.8)	8.2 (1.7)	9.7 (2.0)	6.6 (1.6)	8.3 (0.9)	8.0 (1.9)	8.4 (2.2)	5.5 (0.7)	7.8 (1.8)	8.3 (2.5)	7.9 (2.0)

*These numbers differ from the totals listed elsewhere, as we were not able to ascertain some or all of the study characteristics for some of the "pending" studies, about which we were seeking further information from authors. Also, full details on methodology were not available from several of the Chinese language publications, as summarized in a previous published metaanalysis [26].

†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 subsample based on screening score).

‡Defined as a multidomain cognitive battery, an informant interview, a formal assessment of disability, and a clinical interview.

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

investigators using a multiphase design did not sample screen negatives, and those who did often did not weight back appropriately. For 79% of multiphase studies (49% of all studies) the design was not correctly applied and/or analyzed appropriately.

(b) Scope of definitive diagnostic assessment. Dementia diagnosis requires cognitive impairment (and decline from a previous level of functioning) in memory and other domains of intellectual function, and consequent social or occupational impairment. Other causes, including functional psychosis, depression, and delirium, should be excluded. A diagnostic assessment should therefore include multidomain cognitive testing, disability assessment, clinical interview, and informant interview. Overall, only 43% of studies met this requirement. Informant interviews were most frequently omitted.

(c) Sample size. A sample 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 of 3000. Just over a half of the studies had sample sizes of <1500. Nearly a third of Western European studies had sample sizes <500. East Asia (China and Chinese Taipei) contributed a relatively high proportion of large studies. In general, sample sizes tended to be larger in LMIC studies.

(d) Response proportion. Participation in studies of dementia prevalence was generally adequate to good; only six studies (4%) reported <60% of eligible participants responding, whereas more than half reported ≥80% responding. However, 15% of studies provided no information on the proportion responding.

(e) Overall quality. Mean scores for the ad hoc quality index varied significantly between regions. Overall study quality was high for the Latin American region, and particularly poor for Asia Pacific High Income (mainly attributable to the Japanese studies) and South East Asia studies. Study quality did not differ significantly between high-income and low/middle-income countries. There was a pronounced tendency for study quality to have improved over time—from a mean of 7.3 for studies conducted in the 1980s, to 7.8 for the 1990s, to 9.0 for studies conducted in this century.

3.3. Metaanalysis of dementia prevalence within GBD regions

The evidence base was sufficient, in terms of number and quality of studies and coverage, to conduct metaanalyses for 11 of the 21 GBD regions: Western Europe; North America; Latin America (combining the Latin American Andean, central, southern, and tropical regions); Asia Pacific High Income; Australasia; East Asia; South East Asia; and South Asia. Given that the North American region included just two countries, Canada and the USA, and that Canada was represented by a large and well-conducted survey on a nationally representative sample [29], we used a different approach for this region, applying the prevalence figures from that study to Canada, and metaanalyzing USA studies to generate estimates for USA.

3.4. Modeling the prevalence of dementia

Prevalence of dementia increased exponentially with age in each region, doubling with every 5.5-year increment in age in North America, Latin America, and Asia Pacific, with every 5.6-year increment in East Asia, every 6.3 years in Western Europe and South Asia, and every 6.7 years in South East Asia and Australasia. We also noted an independent effect of gender in all regions other than North America and Asia Pacific, with the predicted prevalence for men being between 19% and 29% lower than that for women. An interaction was noted between age and gender, with a tendency in all regions for the divergence in prevalence between men and women to increase with increasing age; however, this was statistically significant only for the Asia Pacific region. There was statistically significant overdispersion in all of the models other than that for South East Asia, indicating significant heterogeneity in age-specific or age- and gender-specific prevalence among studies, within regions. Heterogeneity was most marked for South Asia ($\alpha = 0.39$), Western Europe ($\alpha = 0.19$), and Asia Pacific ($\alpha = 0.18$). We carried out a more detailed assessment of sources of heterogeneity within Western Europe, the region with the largest number of studies (Table E2). The base model (not shown) included the effects of age, gender, and an interaction between age and gender, with an α of 0.19. Excluding the two studies from Israel (one of which reported an unusually high prevalence [30]) reduced the α to 0.16. Adding methodological factors and year of study (Model 1) reduced the α to 0.10. Adding country further reduced α to 0.07. Thus, much of the variation in prevalence between Western European studies could be explained by the study design (a higher prevalence in two phase studies, particularly when incorrectly applied), year of study (a nonlinear effect, with a higher prevalence from studies carried out in the 1990s compared with those carried out before or after that decade), and method of dementia ascertainment (a higher prevalence in studies that included informant interview). The country in which the survey was carried out accounted for a smaller degree of heterogeneity, with the highest prevalence seen in France, followed by Belgium, Norway, Denmark, Italy, Spain, Germany, UK, San Marino, Switzerland, The Netherlands, Sweden, and Finland.

Age-specific and age- and gender-specific metaanalyzed dementia prevalence estimates are described for each region in Table 2. We prioritized the age- and gender-specific estimates to provide the most precise prediction of regional prevalence. However, we could not calculate age- and

Table 2
Metaanalyzed estimates of dementia prevalence, generated from Poisson random effects models, by GBD region

Global Burden of Disease Region	Number of studies: Potentially eligible studies	Number of studies: Used in metaanalysis (age-specific, age- and gender- specific)	Gender	Age group: 60–64	65–69	70–74	75–79	80–84	85–89	90+	Standardized prevalence[1], for those ≥60 years
Asia											
Australasia	4	3, 0	All	1.8	2.8	4.5	7.5	12.5	20.3	38.3	6.91*
Asia–Pacific, High Income	22	14, 10	M	1.4	2.3	3.8	6.4	10.9	18	34.9	6.30*
			F	0.9	1.7	3.1	6.0	11.7	21.7	49.2	
			All	1.0	1.7	2.9	5.5	10.3	18.5	40.1	5.57
East Asia	34	34, 31	M	0.8	1.3	2.2	4.0	7.3	16.7	26.4	4.98*
			F	0.9	1.6	2.9	5.3	10.0	17.9	38.7	
			All	0.7	1.2	3.1	4.0	7.4	13.3	28.7	4.19
South Asia	8	7, 6	M	1.0	1.7	2.9	5.3	9.4	16.4	33.7	5.65*
			F	1.5	2.3	3.8	6.5	11	18.1	35.1	
			All	1.3	2.1	3.5	6.1	10.6	17.8	35.4	5.78
South East Asia	6	5, 2	M	1.7	2.6	4.0	6.2	9.8	15	26.4	7.63
			F	1.8	3.0	5.1	9.0	15.9	27.2	54.9	
			All	1.6	2.6	4.2	6.9	11.6	18.7	35.4	6.38*
Europe											
Western Europe	56	52, 46	M	1.4	2.3	3.7	6.3	10.6	17.4	33.4	7.29*
			F	1.9	3.0	5.0	8.6	14.8	24.7	48.3	
			All	1.6	2.6	4.3	7.4	12.9	21.7	43.1	6.92
The Americas											
North America (USA only)	11	8, 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	1.1	1.9	3.4	6.3	11.9	21.7	47.5	6.46
Latin America	11	11, 10	M	1.0	1.9	3.7	7.0	13.0	24.3	55.0	8.50*
			F	1.0	2.0	4.2	8.4	16.4	32.5	79.5	
			All	1.3	2.4	4.5	8.4	15.4	28.6	63.9	8.48

[1]Direct standardization for age, or for age, or for age and gender, using the Western European population structure as the standard population. Estimates that have been standardized for age and gender are indicated with *. Other estimates are standarized for age only.

gender-specific prevalence for Australasia, because no studies reported prevalence in this way, and in South East Asia only two studies could be used for this purpose. Therefore, for these two regions, we used age-specific prevalence instead.

3.5. Generation of prevalence estimates for other GBD regions

Where it was not possible to conduct a metaanalysis, due to lack of available data, our default option was to apply the relevant estimates from the Delphi consensus from 2005, representing the best available estimates of likely dementia prevalence in those regions [4]. This was complicated by the mismatch between the 14 WHO world regions (based on geography and patterns of mortality) and the 21 GBD regions (based on geography alone). Therefore, we applied the relevant ADI 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 thought that recent good quality studies arguably provided better estimates for that country (and in some instances for some of its neighbors) than the Delphi consensus regional estimate. Thus, for the Caribbean region we applied country-specific estimates for Cuba [31] and the Dominican Republic [12]; for North Africa/Middle East we applied estimates for Egypt [32] to Egypt, Iraq, Morocco, and Yemen; and for West Sub-Saharan Africa we applied estimates for Nigeria [8] to all other countries in the region. The resulting age-specific aggregated dementia prevalence estimates for each region are presented in Table 3.

3.6. Final summary of estimated prevalence

Estimated prevalence for all those aged ≥60 years, age-standardized to the Western European population structure, can be compared directly between the 21 GBD regions (Tables 2 and 3 and Figure 1). There is a fourfold variation in prevalence overall, from 2.07% (West Sub-Saharan Africa) to 8.50% (Latin America). However, most of the estimated age-standardized prevalence figures lie in a band between 5% and 7%. The major source of variation is clearly the very low estimated prevalence for the four Sub-Saharan Africa regions.

3.7. Estimation of numbers of people with dementia

Having applied the age-specific or age- and gender-specific prevalence estimates to the UN population projections, we estimated 35.6 million people worldwide living with dementia in 2010 (Table 4). Western Europe is the

Table 3
Estimates of dementia prevalence (%) for GBD regions where it was not possible to carry out a quantitative metaanalysis

	Sources of prevalence data used to calculate regional weighted average	60–64	65–69	70–74	75–79	80–84	85^{+}	Age-standardized prevalence for all those aged ≥60 years
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								
Central	EURO A, EURO B	0.9	1.3	3.3	5.8	12.2	24.7	5.78
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 [12,31], Dominican Republic [12]	1.3	2.6	4.9	8.5	16.0	33.2	8.12
Africa								
North Africa/Middle East	EMRO B, AFRO D, Egypt [32]	1.0	1.6	3.5	6.0	12.9	23.0	5.85
Sub-Saharan Africa, Central	AFRO D, AFRO E	0.5	0.9	1.8	3.5	6.4	13.8	3.25
Sub-Saharan Africa, East	AFRO E, AFRO D, EMRO D	0.6	1.2	2.3	4.3	8.2	16.3	4.00
Sub-Saharan Africa, Southern		0.5	1.0	1.9	3.8	7.0	14.9	3.51
Sub-Saharan Africa, West	Nigeria [8]	0.3	0.9		2.7		9.6	2.07

GBD region with the largest number of people with dementia (7.0 million), closely followed by East Asia with 5.5 million, South Asia with 4.5 million, and North America with 4.4 million. At the country level, the nine countries with the largest number of people with dementia in 2010 (one million or more) were: China (5.4 million); USA (3.9 million); India (3.7 million); Japan (2.5 million); Germany (1.5 million); Russia (1.2 million); France (1.1 million); Italy (1.1 million); and Brazil (1.0 million).

The total number of people with dementia is projected nearly to double every 20 years, to 65.7 million in 2030 and 115.4 million in 2050. Much of the increase is attributable to increases in the numbers of people with dementia in LMIC (Figure 2)—in 2010, 57.7% of all people with dementia lived in LMIC, rising to 63.4% in 2030 and 70.5% in 2050.

Projections for growth in numbers of people with dementia are driven by population growth and demographic aging

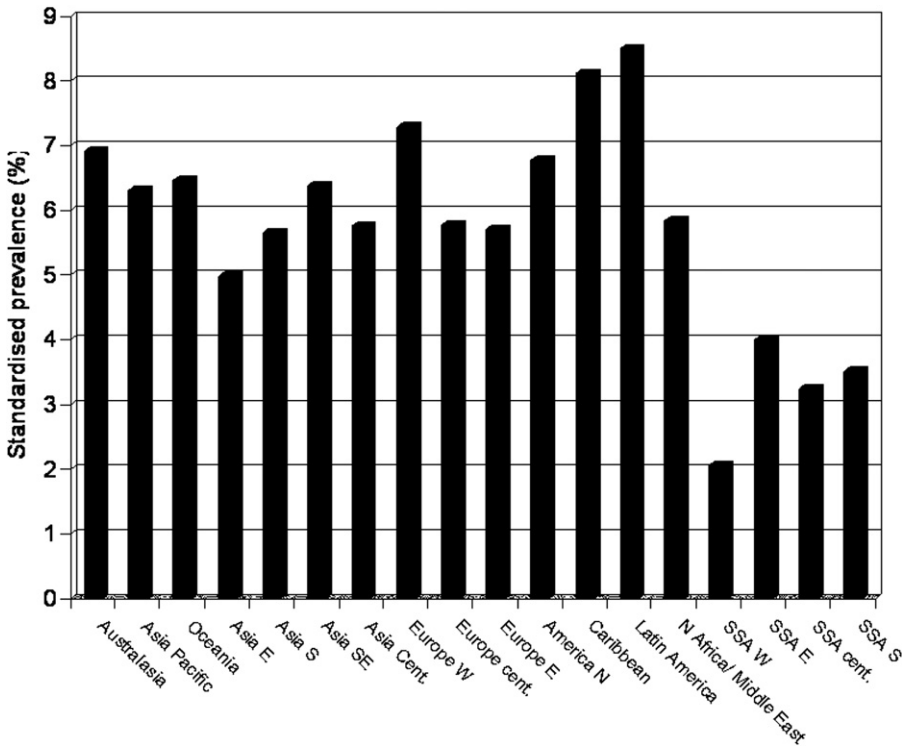

Fig. 1. Estimated prevalence of dementia for those aged ≥60 years, standardized to the Western Europe population, by Global Burden of Disease region.

Table 4
Total population >60, crude estimated prevalence of dementia (2010), estimated number of people with dementia (2010, 2030 and 2050) and proportionate increases (2010–2030 and 2010–2050) by GBD world region

GBD region	Over 60 population (millions, 2010)	Crude estimated prevalence (%, 2010)	Number of people with dementia (millions)			Proportionate increases (%)	
			2010	2030	2050	2010–2030	2010–2050
Asia	406.55	3.9	15.94	33.04	60.92	107	282
Australasia	4.82	6.4	0.31	0.53	0.79	71	157
Asia Pacific	46.63	6.1	2.83	5.36	7.03	89	148
Oceania	0.49	4.0	0.02	0.04	0.10	100	400
Central Asia	7.16	4.6	0.33	0.56	1.19	70	261
East Asia	171.61	3.2	5.49	11.93	22.54	117	311
South Asia	124.61	3.6	4.48	9.31	18.12	108	304
South East Asia	51.22	4.8	2.48	5.30	11.13	114	349
Europe	160.18	6.2	9.95	13.95	18.65	40	87
Western Europe	97.27	7.2	6.98	10.03	13.44	44	93
Central Europe	23.61	4.7	1.10	1.57	2.10	43	91
Eastern Europe	39.30	4.8	1.87	2.36	3.10	26	66
The Americas	120.74	6.5	7.82	14.78	27.08	89	246
North America	63.67	6.9	4.38	7.13	11.01	63	151
Caribbean	5.06	6.5	0.33	0.62	1.04	88	215
Andean LA	4.51	5.6	0.25	0.59	1.29	136	416
Central LA	19.54	6.1	1.19	2.79	6.37	134	435
Southern LA	8.74	7.0	0.61	1.08	1.83	77	200
Tropical LA	19.23	5.5	1.05	2.58	5.54	146	428
Africa	71.07	2.6	1.86	3.92	8.74	111	370
North Africa/Middle East	31.11	3.7	1.15	2.59	6.19	125	438
Central SSA	3.93	1.8	0.07	0.12	0.24	71	243
East SSA	16.03	2.3	0.36	0.69	1.38	92	283
Southern SSA	4.66	2.1	0.10	0.17	0.20	70	100
West SSA	15.33	1.2	0.18	0.35	0.72	94	300
World	758.54	4.7	35.56	65.69	115.38	85	225

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

(Table 4). World regions fall into three broad groups. More developed regions start from a high base, but would experience only a moderate proportionate increase: 40% increase in Europe; 63% in North America; 77% in the southern Latin American cone; and 89% in the developed Asia–Pacific countries. Other parts of Latin America and North Africa and the Middle East started from a low base but would experience a particularly rapid increase in numbers: 134%–146% in the rest of Latin America and 125% in North Africa and the Middle East. India, China, and their South Asian and Western Pacific neighbors started from a high base and would also experience a relatively rapid growth: 107% in South Asia and 117% in East Asia. Predictions of growth for Sub-Saharan Africa (70%–94%) are modest, consistent with projections for demographic aging in the light of persistently high child mortality and the effects of the human immunodeficiency virus (HIV) epidemic.

4. Discussion

With a large increase in the numbers of prevalence studies, particularly from LMIC, it is now possible to rely less on expert opinion guided by scant research, and more on the direct evidence of the accumulated prevalence data. Having reviewed systematically the research evidence from community surveys and applying strict inclusion and exclusion criteria, we were able to identify sufficient studies to carry out quantitative regional metaanalyses in 11 of 21 WHO GBD regions. We were also able to supplement our previous consensus estimates [1] with data from well-conducted studies, which could be applied to the country concerned and, where appropriate, to some of its regional neighbors. We confirm a near exponential increase of

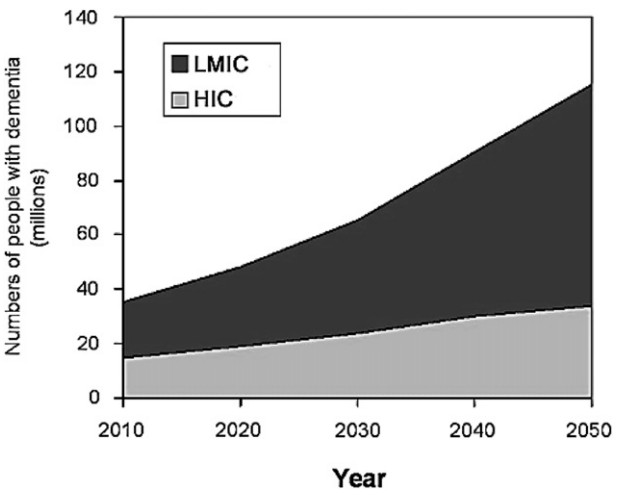

Fig. 2. The growth in numbers of people with dementia in high-income (HIC) and low- and middle-income countries (LMIC).

dementia prevalence with age, and a higher prevalence in women than in men, particularly at older ages. The gender effect on prevalence may be explained partly by a higher incidence among older women [33] and partly by differential survival; survival with dementia, particularly AD, seems to be longer in women than men [34], although years of life lost may be similar or greater [35].

4.1. Comparison with previous estimates

Our new estimates for 2020 (48.1 million) and 2040 (90.3 million) can be compared directly with those from the earlier ADI consensus [1] (42.7 million for 2020 and 82.0 million for 2040). The new estimates are therefore approximately 10% higher. The differences between the two sets of estimates are accounted for principally by:

1. A sizeable increase (5.65% vs. 3.40%) in the estimated age-standardized prevalence for South Asia, a region that includes India, Pakistan, and Bangladesh, and an estimated 125 million older people (aged ≥60 years) in 2010.
2. A notable increase (7.29% vs. 5.92%) in the estimated prevalence for Western Europe (97 million older people).
3. A modest increase (8.50% vs. 7.25%) in the estimated prevalence for the Latin American regions (52 million older people).

These increases were partly offset by the reduction (4.98% vs. 6.46%) in the estimated prevalence for East Asia, which includes China (172 million older people). The new estimates for these regions are likely to represent an improvement on those provided earlier, given the large increase in the evidence base from low and, particularly, middle-income countries. We were able to include 7 studies from South Asia, 52 from Western Europe, 34 from East Asia, and 11 from Latin America in the regional metaanalyses. At the time of our earlier estimates there was just one prevalence study available from Latin America [5]. The evidence base from China has been extended considerably by a recent systematic review that included data from a large number of publications previously only available in Chinese journals [26]. The previous ADI estimates for South Asia were heavily, perhaps disproportionately, influenced by one large study, from rural Ballabgarh, in northern India, in which the prevalence was strikingly low [10]. The new evidence base challenges the previous consensus that the prevalence of dementia was lower in LMIC [9], strikingly so in some studies [8,10].

Estimates of incidence were also exceptionally low in the USA–Nigeria and USA–India studies, suggesting that differences in survival could only have been part of the explanation [36,37]. Differences in levels of exposure to environmental risk factors may also have contributed—for example, the healthy cardiovascular status of older Nigerians [38,39]. Differing patterns of mortality in early life could also be implicated; older people in very poor countries are exceptional survivors, and some of the factors that confer survival advantage may also protect against dementia onset in late life. More recently, methodological explanations have been proposed. In the 10/66 dementia Research Group studies, the group's 10/66 dementia diagnosis (developed, calibrated, and validated in a 26-site pilot study [40]) was both more prevalent than that according to DSM-IV criteria, and more consistent between sites; the prevalence of DSM-IV dementia was particularly low in rural and less developed sites [12]. It may be that milder dementia is underdetected in developing countries because of low awareness, high levels of support routinely provided to older people, and reluctance to report failings to outsiders, all contributing to difficulties in establishing the DSM-IV criterion of social and occupational impairment [10,12]. In the 10/66 Cuban center, the 10/66 dementia diagnosis corresponded more closely to local clinician Dementia diagnoses than did DSM-IV dementia, which selectively missed mild and moderate cases [41]; a similar finding was reported in the Canadian Study of Health and Ageing [42].

In a predictive validation of the 10/66 dementia diagnosis in urban Chennai, after 3 years of follow-up, 10/66 dementia cases showed a high mortality, with survivors showing expected progression of cognitive impairment, disability, and needs for care [43]. This suggested that the true prevalence at baseline was closer to the 7.5% of 10/66 dementia than the 0.9% prevalence according to DSM-IV criteria. Our previous Delphi consensus estimates for Europe [4] were strongly influenced by the results of two previous EURODEM reviews, with their pooled analyses covering the periods 1980–1990 [44] and 1990–2000 [45]. Our current systematic review is much more comprehensive, and our new estimates for Europe coincide with those derived from a recent systematic review of the European literature, limited to studies published since 1990, carried out by the European Collaboration on Dementia (EuroCoDe) group for Alzheimer Europe; the age- and gender-standardized prevalence for EuroCoDe was 7.1%, effectively identical to the 7.3% that we have estimated using a different methodology. EuroCoDe estimated 7.3 million people with dementia in the 25 European Union states [46].

4.2. Limitations

The main limitations of this investigation are: (a) the poor coverage of the evidence base in many world regions; (b) the poor quality of many of the studies included in the review; and (c) the heterogeneity of prevalence estimates between studies within regions. These issues are now considered in detail. Our projections for future growth in the numbers of people with dementia should be interpreted with caution. First, the findings relied on demographic statistics, which might not be accurate for many parts of the world, especially for older age groups. Second, we assumed that age-specific

prevalence in each region would remain constant over time. Changes in risk exposure might increase or decrease incidence. Conversely, specific therapies and better social and medical care may reduce case mortality and increase prevalence. Disease-modifying therapies that delay onset even to a modest extent would have considerable potential for reducing age-specific prevalence.

4.2.1. Coverage

The recent expansion of population-based research into dementia in China, Latin America, and the Caribbean means that the coverage of the evidence base for these regions is now as good as that for Western Europe and North America. However, our systematic review has highlighted continued deficiencies in research evidence. 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. The best approach would be a survey of a nationally representative sample, but to our knowledge such studies have only been carried out in the USA (yet on a very small sample) [47] and Canada [29]. By the same token, studies carried out in just one or two countries may not safely be generalized to a large number of other countries in the same GBD region. Limits to generalizability are particularly marked when the few or only available studies are small, conducted some time ago, and/or of poor methodological quality, such as with the one study from southern sub-Saharan Africa [48]. The low estimated prevalence in sub-Saharan Africa was greatly influenced by the one good quality study from that continent when the review was conducted in 2009 [8]. This evidence base has since been extended by studies from francophone countries in western and central Africa [49–51] and one further study from northern Nigeria [52]. These suggest a more variable distribution of prevalence, higher in urban than in rural sites, and in central compared with western Africa. The Nigerian study recorded a low prevalence consistent with findings from the earlier USA–Nigeria study (2.4% for those aged $\geq$65 years age-standardized to Western Europe, with an age-standardized prevalence of 1.9% for those aged $\geq$60 years, assuming that the prevalence for those aged 60–64 years, which was not assessed, was half that of those aged 65–74 years) [52]. Prevalence was similarly low in rural Benin (2.4% age-standardized for 65^+ and 2.0% for 60^+ years similarly estimated) [49]. The prevalence in an urban location in Benin was somewhat higher (4.3% and 3.5%) [51], and that recorded in cities in the Republic of Central Africa (10.1% and 8.2%) and Congo (7.2% and 6.0%) substantially higher [50]. The North Africa and Middle East region includes as many older people as the whole of Sub-Saharan Africa combined, and with a much steeper projected increase in numbers; as yet, only one study from Egypt [32] and one from Turkey [25] were eligible for inclusion in the review. Eastern Europe (including Russia) and Central Asia remain essentially uncovered by research, and again our estimates remain highly tentative. South East Asia is represented by five studies, but none from Indonesia, whose 21 million older people account for two-fifths of the total for the whole region.

A key finding from this review has been that descriptive population-based research into dementia in high-income countries peaked in the 1990s, and dropped off sharply since then. This is regrettable, and very short-sighted. Prevalence can change over time, either because of changes in disease incidence (e.g., because of improvements in cardiovascular health) or disease duration (reductions in dementia mortality associated with improved long-term care). Future policy-making and planning requires accurate up-to-date figures, and these are no longer available for most high-income countries.

4.2.2. Study quality

The quality of prevalence studies, as assessed in this review, is a cause for concern, most particularly as the problems identified can all lead to biased, inaccurate estimates of prevalence and numbers. There are two main issues. Dementia diagnosis requires a multidomain cognitive test battery, an informant interview, a structured disability assessment, and a clinical interview to exclude other causes of cognitive impairment. Fewer than half of all studies met these standards, with the informant interview being most frequently omitted. The effect of applying more limited ascertainment procedures on dementia prevalence is uncertain. In principle, it could lead either to under- or overestimation of true prevalence.

Misapplication of study designs involving two or more phases was even more widespread. The correct procedures for designing, conducting, and analyzing such studies are well established [53]. However, awareness among dementia researchers remains limited. Research funders, peer reviewers, and journal editors need to address this problem. Misapplication of multiphase methods will always tend toward an underestimation of true dementia prevalence and an overestimation of precision. Multiphase studies are also complicated by the high levels of loss to follow-up that occur between the screening and diagnostic assessment [9]; bias could be toward over- or underestimation of true prevalence [54].

4.2.3. Heterogeneity

A fundamental assumption, implicit in the modeling 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. In fact, and contrary to some previous suggestions [55], we observed statistically significant heterogeneity of age- and gender-specific prevalence in almost all regions. This is not surprising given the varied languages, cultures, levels of development, and demographic compositions of the national and subnational units that make up a GBD world region. Arguably one should be more impressed by the similarity rather than the differences in prevalence between studies. Our analysis of Western European

studies has indicated that, for that region, methodological factors may have accounted for more of the observed variability than country or region effects. Methodological variability can be reduced through standardization 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. DSM-IV criteria, the most widely applied dementia diagnosis, is not, in fact, fully operationalized, although it can be [41]. An international consensus regarding what constitutes cognitive impairment, what constitutes social and occupational impairment, and how these should be measured would be desirable. Due allowance would have to be made for cultural differences. Clinicians resist the degree of straitjacketing that full operationalization imposes. A parallel set of more specific research diagnostic criteria would therefore be helpful—recent proposals for DSM-V neurocognitive disorder may meet some of these requirements [56].

4.3. Implications for future public health and social policy

The detailed estimates in this study constitute the best currently available basis for policymaking, planning, and allocation of health and welfare resources. In high-income countries, numbers of people with dementia will continue to grow, particularly among the oldest old. The provision and financing of measures to meet their long-term care needs, including support for their family carers, will inevitably become an increasingly urgent political priority. The health and social care needs of the large and rapidly growing numbers of frail, dependent older persons should also be a matter of great concern for policymakers in LMIC. If government policies are well formulated and planned with the projections described in this study in mind, the inevitable shift of resource expenditure toward older people can be predicted and its consequences mitigated. If, as seems likely, early and late-life patterns of morbidity and mortality converge with those of the developed West, then dementia prevalence levels will do likewise. The implication is that our projections of rates of growth in the numbers of people with dementia in developing regions (based on an assumption of constant prevalence) may be conservative.

Currently, most people with dementia do not receive a diagnosis or, if they do, this happens late in the disease course. The benefits of earlier diagnosis are now quite clearly established [57], including the societal benefit that investing in earlier diagnosis and intervention may lead to net savings from delayed institutionalization [58–60]. Efforts to improve the quality and availability of care, and to seek after cure, should be coupled with urgent investment in primary prevention measures. More research is required to identify modifiable risk factors. In the meantime, primary prevention should focus on targets suggested by current evidence; improving access to education; and countering risk factors for vascular disease, including diabetes, midlife hypertension, midlife obesity, smoking, and physical inactivity. In a modeling exercise, based on observational data, it was recently estimated that a modest 10% reduction in risk exposure levels could reduce the prevalence of Alzheimer's disease by up to 1.1 million cases worldwide [61]. Having said this, there is a lack of direct experimental evidence to support the effectiveness of such primary [62] or secondary [63] prevention strategies in later life. Cardiovascular risk profiles may need to be targeted in early to midlife. In comparison with the situation in most high-income countries, efforts to prevent and control the coming epidemic of cardiovascular and other chronic diseases in low- and middle-income countries are in their infancy [64]. Advocated measures include implementation of tobacco-free policies, comprehensive bans on advertising and taxation of tobacco products, salt reduction through voluntary agreements with the food industry, and combination drug therapy for those at high risk of cardiovascular disease [64]. The detection and control of hypertension, hyperlipidemia, diabetes, and metabolic syndrome is poorly implemented by overstretched primary care services that struggle to cope with the double burden of historic priorities (maternal, child, and communicable diseases) and the rising tide of chronic disease in adults. Health systems are not trained, equipped, or structured to deal with the latter. Given the strong evidence for cardiovascular disease and cardiovascular risk factors as risk factors for dementia, the success or otherwise of these initiatives should have an important impact on the future prevalence and incidence of dementia worldwide [4].

4.4. Future directions

Efforts need to be made in all regions to monitor secular trends in incidence and prevalence of dementia associated with the epidemiologic transition, and with changes in medical and social care. The current evidence base provides us with a strong baseline, which will yet be improved as more evidence accumulates from currently underrepresented regions. Most importantly, we will be able to monitor the progress of the dementia epidemic in all world regions.

Acknowledgments

The authors acknowledge the contribution of other members of the expert consensus group for the ADI/*Lancet* estimates, which were used in whole or in part in the current study for some world regions where no updated evidence was available; these contributors include: Carol Brayne, Henry Brodaty, Laura Fratiglioni, Mary Ganguli, Kathleen Hall, Kazuo Hasegawa, Hugh Hendrie, Yueqin Huang, Anthony Jorm, Paulo R. Menezes, and Marcia Scazufca.

References

[1] 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;374:1821–30.
[2] 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;10:53.
[3] World Population Prospects: The 2002 revision—Highlights. New York: United Nations; 2003.
[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;366:2112–7.
[5] Herrera E Jr, Caramelli P, Silveira AS, Nitrini R. Epidemiologic survey of dementia in a community-dwelling Brazilian population. Alzheimer Dis Assoc Disord 2002;16:103–8.
[6] Nitrini R, Caramelli P, Herrera E Jr, Bahia VS, Caixeta LF, Radanovic M, et al. Incidence of dementia in a community-dwelling Brazilian population. Alzheimer Dis Assoc Disord 2004; 18:241–6.
[7] Rosselli D, Ardila A, Pradilla G, Morillo L, Bautista L, Rey O, et al. The Mini-Mental State Examination as a selected diagnostic test for dementia: A Colombian population study. GENECO [in Spanish]. Rev Neurol 2000;30:428–32.
[8] Hendrie HC, Osuntokun BO, Hall KS, Ogunniyi AO, Hui SL, Unverzagt FW, et al. Prevalence of Alzheimer's disease and dementia in two communities: Nigerian Africans and African Americans. Am J Psychiatry 1995;152:1485–92.
[9] 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. Int J Geriatr Psychiatry 2000;15:21–30.
[10] Chandra V, Ganguli M, Pandav R, Johnston J, Belle S, DeKosky ST. Prevalence of Alzheimer's disease and other dementias in rural India. The Indo–US study. Neurology 1998;51:1000–8.
[11] Alzheimer's Disease International. World Alzheimer Report 2009. London: Alzheimer's Disease International; 2009.
[12] Llibre Rodriguez JJ, Ferri CP, Acosta D, Guerra M, Huang Y, Jacob KS, et al. Prevalence of dementia in Latin America, India, and China: A population-based cross-sectional survey. Lancet 2008; 372:464–74.
[13] Scazufca M, Menezes PR, Vallada HP, Crepaldi AL, Pastor-Valero M, Coutinho LM, et al. High prevalence of dementia among older adults from poor socioeconomic backgrounds in Sao Paulo, Brazil. Int Psychogeriatr 2008;20:394–405.
[14] Bottino CM, Azevedo D Jr, Tatsch M, Hototian SR, Moscoso MA, Folquitto J, et al. Estimate of dementia prevalence in a community sample from Sao Paulo, Brazil. Dement Geriatr Cogn Disord 2008; 26:291–9.
[15] Custodio N. Prevalencia de demencia en una comunidad urbana de Lima: Un estudio puerta a puerta [abstract]. Santo Domingo, Republica Dominicana, XII Congreso Panamericano de Neurologia; 2007.
[16] Llibre JJ, Fernández Y, Marcheco B, Contreras N, López AM, Ote M. Prevalence of dementia and Alzheimer's disease in a Havana municipality: A community-based study among elderly residents. MEDICC Rev 2009;11:29–35.
[17] Molero AE, Pino-Ramirez G, Maestre GE. High prevalence of dementia in a Caribbean population. Neuroepidemiology 2007;29:107–12.
[18] Zhang ZX, Zahner GE, Roman GC, Liu XH, Wu CB, Hong Z, et al. Socio-demographic variation of dementia subtypes in china: Methodology and results of a prevalence study in Beijing, Chengdu, Shanghai, and Xian. Neuroepidemiology 2006;27:177–87.
[19] Jhoo JH, Kim KW, Huh Y, Lee SB, Park JH, Lee JJ, et al. Prevalence of dementia and its subtypes in an elderly urban Korean population: results from the Korean Longitudinal Study on Health and Aging (KLoSHA). Dement Geriatr Cogn Disord 2008;26:270–6.
[20] Shaji S, Bose S, Verghese A. Prevalence of dementia in an urban population in Kerala, India. Br J Psychiatry 2005;186:136–40.
[21] Wangtongkum S, Sucharitkul P, Silprasert N, Inthrachak R. Prevalence of dementia among population age over 45 years in Chiang Mai, Thailand. J Med Assoc Thai 2008;91:1685–90.
[22] Smith K, Flicker L, Lautenschlager NT, Almeida OP, Atkinson D, Dwyer A, et al. High prevalence of dementia and cognitive impairment in indigenous Australians. Neurology 2008;71:1470–3.
[23] Galasko D, Salmon D, Gamst A, Olichney J, Thal LJ, Silbert L, et al. Prevalence of dementia in Chamorros on Guam: Relationship to age, gender, education, and APOE. Neurology 2007;68: 1772–81.
[24] Bdzan LB, Turczynski J, Szabert K. Prevalence of dementia in a rural population [in Polish]. Psychiatr Pol 2007;41:181–8.
[25] 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;;23:67–76.
[26] 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;36:619–24.
[27] Wang W, Wu S, Cheng X, Dai H, Ross K, Du X, et al. Prevalence of Alzheimer's disease and other dementing disorders in an urban community of Beijing, China. Neuroepidemiology 2000;19:194–200.
[28] World Health Organization. Dementia: A public health priority. Geneva: World Health Organization; 2012.
[29] Canadian Study of Health and Ageing. Canadian study of health and aging: study methods and prevalence of dementia. CMAJ 1994; 150:899–913.
[30] Bowirrat A, Treves TA, Friedland RP, Korczyn AD. Prevalence of Alzheimer's type dementia in an elderly Arab population. Eur J Neurol 2001;8:119–23.
[31] 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;31:243–51.
[32] Farrag A, Farwiz HM, Khedr EH, Mahfouz RM, Omran SM. Prevalence of Alzheimer's disease and other dementing disorders: Assiut–Upper Egypt study. Dement Geriatr Cogn Disord 1998;9:323–8.
[33] Fratiglioni L, Launer LJ, Andersen K, Breteler MM, Copeland JR, Dartigues JF, et al. Incidence of dementia and major subtypes in Europe: A collaborative study of population-based cohorts. Neurology 2000;54(Suppl 5):S10–5.
[34] Helmer C, Joly P, Letenneur L, Commenges D, Dartigues JF. Mortality with dementia: Results from a French prospective community-based cohort. Am J Epidemiol 2001;154:642–8.
[35] Brodaty H, Seeher K, Gibson L. Dementia time to death: A systematic literature review on survival time and years of life lost in people with dementia. Int Psychogeriatr 2012 July;24:1034–45.
[36] Hendrie HC, Ogunniyi A, Hall KS, Baiyewu O, Unverzagt FW, Gureje O, et al. Incidence of dementia and Alzheimer disease in 2 communities: Yoruba residing in Ibadan, Nigeria, and African Americans residing in Indianapolis, Indiana. JAMA 2001;285:739–47.
[37] Chandra V, Pandav R, Dodge HH, Johnston JM, Belle SH, DeKosky ST, et al. Incidence of Alzheimer's disease in a rural community in India: the Indo-US study. Neurology 2001;57:985–9.
[38] Hendrie HC, Hall KS, Ogunniyi A, Gao S. Alzheimer's disease, genes, and environment: The value of international studies. Can J Psychiatry 2004;49:92–9.
[39] Deeg M, Baiyewu O, Gao S, Ogunniyi A, Shen J, Gureje O, et al. A comparison of cardiovascular disease risk factor biomarkers in African Americans and Yoruba Nigerians. Ethn Dis 2008;18:427–33.
[40] Prince M, Acosta D, Chiu H, Scazufca M, Varghese M. Dementia diagnosis in developing countries: A cross-cultural validation study. Lancet 2003;361:909–17.
[41] Prince M, 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.
[42] Erkinjuntti T, Ostbye T, Steenhuis R, Hachinski V. The effect of different diagnostic criteria on the prevalence of dementia. N Engl J Med 1997;337:1667–74.
[43] Jotheeswaran AT, Williams JD, Prince MJ. The predictive validity of the 10/66 dementia diagnosis in Chennai, India: A 3-year follow-up study of cases identified at baseline. Alzheimer Dis Assoc Disord 2010;24:296–302.
[44] 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. Int J Epidemiol 1991;20:736–48.
[45] Lobo A, Launer LJ, Fratiglioni L, Andersen K, Di Carlo A, Breteler MM. Prevalence of dementia and major subtypes in Europe: A collaborative study of population-based cohorts. Neurology 2000; 54(Suppl 5):S4–9.
[46] Reynish E, Fratiglioni L, Prince M, Bickel H, Kiejna A, Georges J. EUROCODE: Report of WP7 2006. Prevalence of Dementia in Europe. Alzheimer Europe; 2006. Available at: http://ec.europa.eu/health/archive/ph_information/dissemination/diseases/docs/eurocode.pdf. Accessed August 16, 2012.
[47] 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; 29:125–32.
[48] 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. S Afr Med J 1983; 64:1056–61.
[49] 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. Dement Geriatr Cogn Disord 2009;27:34–41.
[50] 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. Dement Geriatr Cogn Disord 2010;30:261–8.
[51] 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;36:245–51.
[52] Yusuf AJ, Baiyewu O, Sheikh TL, Shehu AU. Prevalence of dementia and dementia subtypes among community-dwelling elderly people in northern Nigeria. Int Psychogeriatr 2011;23:379–86.
[53] Dunn G, Pickles A, Tansella M, Vazquez-Barquero JL. Two-phase epidemiological surveys in psychiatric research. Br J Psychiatry 1999; 174:95–100.
[54] Prince M. Commentary: Two-phase surveys. A death is announced; no flowers please. Int J Epidemiol 2003;32:1078–80.
[55] Rocca WA, Hofman A, Brayne C, Breteler MM, Clarke M, Copeland JR, et al. Frequency and distribution of Alzheimer's disease in Europe: A collaborative study of 1980–1990 prevalence findings. Ann Neurol 1991;30:381–90.
[56] Ganguli M, Blacker D, Blazer DG, Grant I, Jeste DV, Paulsen JS, et al. Classification of neurocognitive disorders in DSM-5: A work in progress. Am J Geriatr Psychiatry 2011;19:205–10.
[57] Prince M, Bryce R, Ferri C. World Alzheimer Report 2011: The benefits of early diagnosis and intervention. London: Alzheimer's Disease International; 2011.
[58] Weimer DL, Sager MA. Early identification and treatment of Alzheimer's disease: Social and fiscal outcomes. Alzheimers Dement 2009;5:215–26.
[59] Getsios D, Blume S, Ishak KJ, Maclaine G, Hernandez L. An economic evaluation of early assessment for Alzheimer's disease in the United Kingdom. Alzheimers Dement 2012;8:22–30.
[60] Banerjee S, Wittenberg R. Clinical and cost effectiveness of services for early diagnosis and intervention in dementia. Int J Geriatr Psychiatry 2009;24:748–54.
[61] Barnes DE, Yaffe K. The projected effect of risk factor reduction on Alzheimer's disease prevalence. Lancet Neurol 2011;10:819–28.
[62] Daviglus ML, Plassman BL, Pirzada A, Bell CC, Bowen PE, Burke JR, et al. Risk factors and preventive interventions for Alzheimer disease: State of the science. Arch Neurol 2011;68:1185–90.
[63] Richard E, Kuiper R, Dijkgraaf MG, van Gool WA. Vascular care in patients with Alzheimer's disease with cerebrovascular lesions—a randomized clinical trial. J Am Geriatr Soc 2009;57:797–805.
[64] Epping-Jordan JE, Galea G, Tukuitonga C, Beaglehole R. Preventing chronic diseases: taking stepwise action. Lancet 2005;366:1667–71.

Table E1
Main differences in approach between previous ADI/*Lancet* estimates of global prevalence of dementia, and current estimates

	ADI/*Lancet* [4]	Current review
Search strategy	Limited time and resources did not permit fully systematic review	Fully systematic review, with inclusion/exclusion criteria, specified search terms, multiple databases
Regional subdivisions	Estimates provided for 14 WHO world regions	Estimates provided for 21 WHO Global Burden of Disease world regions
Method for generating regional estimates	Regional estimates generated from expert Delphi consensus guided by all the available evidence	Regional estimates generated, where possible, from quantitative metaanalysis
Stratification for prevalence estimates	Age-specific prevalence in 5-year age bands to ≥85 years of age	Age- and gender-specific prevalence in 5-year age bands to ≥90 years of age
Base year	2001	2010
Future projections	2020/2040	2020/ 2030/ 2040/2050

Table E2
Modeling the effects of study characteristics on observed prevalence in Western Europe (46 studies)

Study characteristic	Model 1	Model 2
Design		
Two-phase survey incorrectly applied	1 (ref)	
Two-phase survey correctly applied	0.81 (0.61–1.09)	0.98 (0.70–1.36)
One-phase survey	0.68 (0.53–0.85)	0.91 (0.65–1.27)
Year		
1980–1989	1 (ref)	
1990–1999	1.36 (1.06–1.75)	1.15 (0.83–1.59)
2000–	0.74 (0.48–1.13)	0.69 (0.43–1.10)
Dementia ascertainment		
Informant interview included	1.13 (0.91–1.41)	1.27 (0.98–1.65)
Country		
Italy		1 (ref)
France		1.77 (1.00–3.14)
Netherlands		0.65 (0.42–1.01)
Sweden		0.64 (0.40–1.03)
Germany		0.83 (0,52–1.34)
Finland		0.67 (0.34–1.29)
Denmark		1.16 (0.65–2.06)
Spain		0.99 (0.71–1.38)
Belgium		1.32 (0.74–2.36)
Norway		1.22 (0.64–2.32)
San Marino		0.73 (0.35–1.50)
UK		0.80 (0.52–1.24)
Switzerland		0.70 (0.35–1.43)
Heterogeneity		
α	0.10 (0.60–0.16)	0.07 (0.04–0.11)

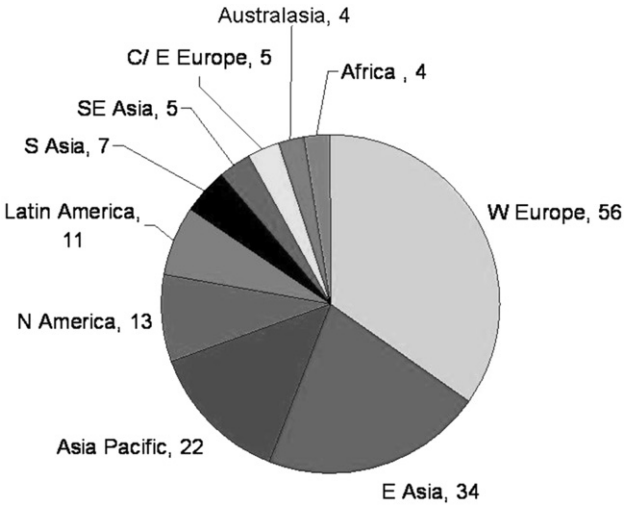

Fig. E1. Number of studies by Global Burden of Disease world region.

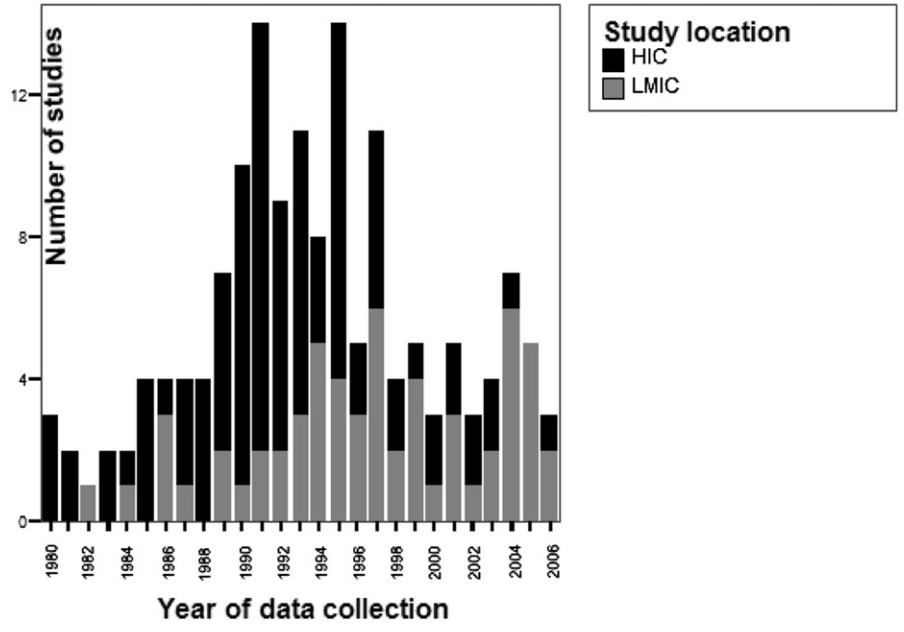

Fig. E2. Numbers of prevalence studies by year of data collection and income level of the country where the research was carried out.