Prevalence of dementia in Latin America, India, and China: a population-based cross-sectional survey

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Summary

Background Studies have suggested that the prevalence of dementia is lower in developing than in developed regions. We investigated the prevalence and severity of dementia in sites in low-income and middle-income countries according to two definitions of dementia diagnosis.

Methods We undertook one-phase cross-sectional surveys of all residents aged 65 years and older (n=14 960) in 11 sites in seven low-income and middle-income countries (China, India, Cuba, Dominican Republic, Venezuela, Mexico, and Peru). Dementia diagnosis was made according to the culturally and educationally sensitive 10/66 dementia diagnostic algorithm, which had been prevalidated in 25 Latin American, Asian, and African centres; and by computerised application of the dementia criterion from the Diagnostic and Statistical Manual of Mental Disorders (DSM IV). We also compared prevalence of DSM-IV dementia in each of the study sites with that from estimates in European studies.

Findings The prevalence of DSM-IV dementia varied widely, from 0·3% (95% CI 0·1–0·5) in rural India to 6·3% (5·0–7·7) in Cuba. After standardisation for age and sex, DSM-IV prevalence in urban Latin American sites was four-fifths of that in Europe (standardised morbidity ratio 80 [95% CI 70–91]), but in China the prevalence was only half (56 [32–91] in rural China), and in India and rural Latin America a quarter or less of the European prevalence (18 [5–34] in rural India). 10/66 dementia prevalence was higher than that of DSM-IV dementia, and more consistent across sites, varying between 5·6% (95% CI 4·2–7·0) in rural China and 11·7% (10·3–13·1) in the Dominican Republic. The validity of the 847 of 1345 cases of 10/66 dementia not confirmed by DSM-IV was supported by high levels of associated disability (mean WHO Disability Assessment Schedule II score 33·7 [SD 28·6]).

Interpretation As compared with the 10/66 dementia algorithm, the DSM-IV dementia criterion might underestimate dementia prevalence, especially in regions with low awareness of this emerging public-health problem.

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Background

In the 1990s, with demographic ageing proceeding rapidly in all regions worldwide, interest began to focus on the previously neglected topic of dementia in low-income and middle-income countries (LMIC). Two-thirds of all people aged 65 years and older, and a similar proportion of people with dementia, were living in LMIC, with rapid increases predicted.[1] However, two studies funded by the National Institute of Aging from that period—the US-Nigeria study[2] and the Indo-US study[3]—suggested an age-specific prevalence of dementia that was only between a quarter and a fifth of that typically recorded in developed countries. Longitudinal data from the same centres suggested that these findings were because of a decreased incidence of disease, rather than reduced survival alone.[4,5]

In 2005, Alzheimer's Disease International (ADI) commissioned an international group of experts to review all available data and to reach a consensus on dementia prevalence in 14 WHO regions. The results suggested that 24·2 million people live with dementia worldwide, with 4·6 million new cases every year.[6] The trend towards a lower prevalence in less-developed regions than in developed settings was endorsed, at least for sub-Saharan Africa and south Asia. Nonetheless, the figures indicated that most people with dementia lived in LMIC: 60% in 2001 rising to a forecast 71% by 2040. Numbers were predicted to double every 20 years to more than 80 million people by 2040, with more rapid increases in developing than in developed regions. However, the quality and coverage of the evidence-base is poor, with very few published studies from Latin America, Africa, the Middle East, eastern Europe, and Russia, and patchy and inconsistent estimates in other less developed regions.[6] Some new studies have been published,[7–11] but dementia in LMIC remains under-researched.

In 1999, the 10/66 Dementia Research Group launched a large-scale pilot study in 25 centres in LMIC, developing and validating the 10/66 dementia diagnosis as a tool especially suited for studies based in low education populations in the developing world, or those designed to make valid comparisons across countries and cultures.[12] Our subsequent programme of

population-based cross-sectional surveys in 17 sites in 12 developing countries (India, China, Nigeria, South Africa, Cuba, Dominican Republic, Brazil, Venezuela, Mexico, Peru, Argentina, and Puerto Rico) will provide a unique resource for comparative descriptive research of prevalence, effect, and cost of this disease.[13] An incidence phase, which is now in progress, focuses on aetiology, examining the roles of racial admixture, micronutrient deficiency, cardiovascular disease, and its risk factors.

We now report the prevalence of dementia in the first group of 10/66 sites (India, China, Cuba, Dominican Republic, Venezuela, Mexico, and Peru). Results from the Brazilian site have already been published,[11] and data from the remaining sites should become available in 2009. We aimed to address the following four questions: first, how do the prevalences and severity of dementia, defined by the 10/66 group and the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV), vary between sites and regions when estimated with the same cross-culturally validated methods, and how much of that variation can be explained by compositional (demographic ageing, education, and socioeconomic status) and methodological factors? Second, how does the 10/66 diagnosis of dementia compare with the DSM-IV dementia criterion that was used in many previous LMIC studies, and what is their construct validity with respect to concurrent associations with disability? Third, how do our findings for DSM-IV dementia prevalence compare with the consistent prevalence of dementia in Europe?[14] Finally, how consistent are our new findings with the regional estimates from the ADI and *Lancet* consensus study?[6]

Methods

Settings and study design

The full 10/66 population-based study protocols have already been published elsewhere.[13] This study was undertaken in 11 geographically defined catchment area sites in seven LMIC (India, China, Cuba, Dominican Republic, Venezuela, Mexico, and Peru). We undertook cross-sectional comprehensive one-phase surveys of all residents aged 65 years and older. After visiting people's homes to establish eligibility, all those consenting to participate received the full assessment lasting 2–3 h, consisting of participant and informant interviews, physical examination, and phlebotomy. Interviews were done in participants' homes. Participants provided written consent. Next of kin provided written agreement in the event of lack of capacity to consent. Illiterate participants provided oral consent that was witnessed in writing by a literate person.

The target sample size for every country was 2000–3000 participants (table 1). Recruitment in China, India, Peru, and Mexico was split between urban and rural sites; all other countries included urban sites only. A sample size of 2000 would allow estimation of a typical dementia prevalence of 4·5% (standard error 0·9%).[14] Rural and urban samples of 1000 each would provide a standard error of 1·2%. All studies were approved by local ethics committees and the King's College London (UK) ethics committee.

Protocols and procedures

Every site had a project coordinator and between four and ten interviewers who were generally non-specialist graduates, although Cuba and China used medical doctors. Assessments were translated into Ibero-American Spanish (with country-specific adaptations when necessary), Tamil (India), and Mandarin (China). Personnel at all centres had already been extensively trained in the main diagnostic assessments for the dementia diagnostic pilot study.[12] An extra 1 week of project planning meetings were held for all principal investigators before starting fieldwork. Group meetings for investigators from all sites were held roughly every 6 months throughout the project. All researchers were retrained in study protocol and procedures and structured interviewing techniques, and were supported by a standardised operating procedures manual. All interviews were checked by the project coordinator for completeness and coherence before data entry. Every interviewer was supervised in the field until the coordinator was satisfied with interview quality. Random checks were made every few months thereafter. The London-based coordinators (CPF and MP) visited every centre at least twice during the fieldwork phase. In Cuba, data were collected directly onto laptop computers with computerised questionnaires driven by EpiData (version 2.0) software, incorporating conditional skips and range checks. In other sites, data were first collected onto paper. Data were extracted into SPSS (version 15.0), and cleaning, processing of derived variables, and diagnostic algorithms were done with SPSS syntax files. Data were checked in London after the first 100 interviews had been completed, and on three to four occasions subsequently.

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	Site	Setting	Achieved sample (completed interviews)	Response proportion
Cuba (JLR)	Havana/Matanzas	Urban	2944	94%
Dominican Republic (DA)	Santo Domingo	Urban	2011	95%
Peru (MG)	Lima	Urban	1381	80%
	Canete	Rural	552	88%
Venezuela (AS)	Caracas	Urban	1904	80%
Mexico (ALS)	Mexico City	Urban	1002	84%
	Morelos	Rural	1000	86%
China (SL, YH)	Xicheng, Beijing	Urban	1160	74%
	Daxing	Rural	1002	96%
India (ESK, KSJ)	Chennai	Urban	1005	72%
	Vellore	Rural	999	98%
Overall	11 sites	7 urban, 4 rural	14 960	

Initials of the principal investigator are shown in parentheses.

Table 1: **Summary of the sites and samples**

	Cuba (N=2944)	Dominican Republic (N=2011)	Peru (urban) (N=1381)	Peru (rural) (N=552)	Venezuela (N=1904)	Mexico (urban) (N=1002)	Mexico (rural) (N=1000)	China (urban) (N=1160)	China (rural) (N=1002)	India (urban) (N=1005)	India (rural) (N=999)
Demographic variables											
Age (years)											
65–69	760 (25·9%)	533 (26·5%)	375 (27·2%)	179 (32·4%)	813 (42·7%)	245 (24·4%)	299 (29·9%)	316 (27·2%)	383 (38·2%)	415 (41·5%)	331 (33·1%)
70–74	789 (26·9%)	520 (25·9%)	25·5(52·7%)	141 (25·5%)	461 (24·2%)	329 (32·8%)	252 (25·2%)	362 (31·2%)	296 (29·5%)	318 (31·8%)	350 (35·0%)
75–79	639 (21·8%)	397 (19·7%)	298 (21·6%)	101 (18·3%)	340 (17·9%)	205 (20·5%)	221 (22·1%)	254 (21·9%)	202 (20·2%)	144 (14·4%)	177 (17·7%)
≥80	749 (25·5%)	561 (27·9%)	355 (25·7%)	131 (23·7%)	290 (15·2%)	223 (22·3%)	228 (22·8%)	228 (19·7%)	121 (12·1%)	124 (12·4%)	141 (14·1%)
Missing	7	0	1	0	0	1	0	0	0	4	0
Women	1913 (65·0%)	1325 (66·0%)	888 (64·3%)	295 (53·4%)	1215 (63·8%)	666 (66·4%)	602 (60·2%)	661 (57·0%)	556 (55·5%)	571 (57·7%)	545 (54·5%)
Missing values	0	2	0	0	0	0	0	0	0	15	0
Marital status											
Never married	275 (9·4%)	139 (7·0%)	145 (10·6%)	68 (12·3%)	188 (9·9%)	63 (6·3%)	42 (4·2%)	3 (0·3%)	22 (2·2%)	21 (2·1%)	5 (0·5%)
Married/cohabiting	1271 (43·3%)	586 (29·4%)	784 (57·2%)	308 (55·9%)	903 (47·7%)	470 (46·9%)	538 (53·8%)	829 (71·7%)	585 (58·4%)	523 (52·2%)	481 (48·2%)
Widowed	928 (31·6%)	806 (40·4%)	367 (26·8%)	157 (28·5%)	544 (28·8%)	395 (39·4%)	371 (37·1%)	326 (28·1%)	394 (39·3%)	426 (42·5%)	497 (49·7%)
Divorced/separated	462 (15·7%)	465 (23·3%)	75 (5·5%)	18 (3·3%)	257 (13·6%)	75 (7·5%)	48 (4·8%)	2 (0·2%)	1 (0·1%)	32 (3·2%)	16 (1·6%)
Missing values	8	15	10	15	12	0	1	0	0	3	0
Education											
None	75 (2·5%)	392 (19·7%)	37 (2·7%)	84 (15·4%)	154 (8·1%)	227 (22·6%)	327 (32·7%)	232 (20·0%)	579 (57·8%)	428 (42·7%)	660 (66·1%)
Minimal	655 (22·3%)	1022 (51·3%)	90 (6·5%)	141 (25·9%)	438 (23·1%)	354 (35·3%)	510 (51·0%)	153 (13·2%)	114 (11·4%)	234 (23·3%)	195 (19·5%)
Completed primary	979 (33·3%)	370 (18·6%)	460 (33·5%)	267 (49·1%)	950 (50·1%)	229 (22·8%)	122 (12·2%)	303 (26·1%)	259 (25·8%)	212 (21·1%)	116 (11·6%)
Completed secondary	728 (24·8%)	135 (6·8%)	481 (35·0%)	36 (6·6%)	263 (13·9%)	99 (9·9%)	25 (2·5%)	335 (28·9%)	45 (4·5%)	87 (8·7%)	26 (2·6%)
Tertiary	499 (17·0%)	73 (3·7%)	305 (22·2%)	16 (2·9%)	92 (4·8%)	94 (9·4%)	16 (1·6%)	137 (11·8%)	5 (0·5%)	42 (4·2%)	2 (0·2%)
Missing values	8	19	8	8	7	0	0	0	0	2	0
Socioeconomic position											
Government or occupational pension disclosed	2417 (82·1%)	611 (30·4%)	908 (65·7%)	357 (64·7%)	1128 (59·2%)	729 (72·7%)	254 (25·4%)	1050 (90·5%)	38 (3·8%)	117 (11·6%)	346 (34·6%)
Food insecurity	140 (4·8%)	240 (12·1%)	63 (4·6%)	(74 (13·5%)	109 (5·9%)	39 (3·9%)	85 (8·6%)	0	12 (1·2%)	207 (20·8%)	141 (14·1%)
Missing values	11	22	16	5	69	4	7	0	0	10	0
Number of assets											
0–2	29 (1·0%)	136 (6·8%)	5 (0·4%)	38 (6·9%)	4 (0·2%)	13 (1·3%)	213 (21·3%)	0 (0·0%)	15 (1·5%)	132 (13·2%)	444 (44·4%)
3–5	1008 (34·3%)	951 (47·4%)	61 (4·4%)	343 (62·1%)	9 (0·5%)	150 (15·0%)	518 (51·8%)	604 (52·1%)	374 (37·3%)	620 (61·9%)	512 (51·3%)
6	1899 (64·7%)	919 (45·8%)	1315 (95·2%)	171 (31·0%)	1860 (99·3%)	840 (83·7%)	269 (26·9%)	555 (47·9%)	613 (61·2%)	249 (24·9%)	43 (4·3%)
Missing values	8	5	0	0	31	0	0	1	0	4	0

Data are number (%).

Table 2: **Demographic and socioeconomic characteristics by study site**

Measures

The 10/66 population-based study interview generates information about dementia diagnosis, mental disorders, physical health, anthropometry, demographics, an extensive dementia and chronic diseases risk factor questionnaire, disability, health-service use, care arrangements, and caregiver strain.[13] In the Latin American sites, we analysed fasting blood samples for full blood count and differential glucose, cholesterol, triglyceride, and albumin measurements. Frozen serum was saved. DNA was extracted and will be analysed for apolipoprotein genotype and African/European ancestry admixture. We describe in detail here only the assessments relevant to the present descriptive analysis of dementia prevalence.

Age of the participant was formally established during interview from stated age, official documentation, informant report, and, in the case of discrepancy, age according to an event calendar. We also recorded sex and marital status. We obtained similar demographic information about informants.

We recorded the following socioeconomic variables: level of education (none/did not complete primary/completed primary/secondary/tertiary); sources and amount of income; household assets index (car, television, refrigerator, telephone, mains water, plumbed toilet); and food insecurity (assessed by the question "do you ever go hungry because there is not enough food to eat?").

We measured activity limitation and participation restriction by the WHO Disability Assessment Schedule

(WHODAS) II,[15] which was developed by WHO as a culture-fair assessment for cross-cultural research.

10/66 dementia diagnosis was given to participants scoring above a cutpoint of predicted probability for dementia, which was calculated with coefficients derived from a logistic regression equation that was developed, calibrated, and validated cross-culturally in the 10/66 pilot study undertaken in 25 centres.[12] The coefficients are linked to the outputs from a structured clinical mental-state interview: the Geriatric Mental State;[16] two cognitive tests: the Community Screening Instrument for Dementia (CSI'D') COGSCORE[17] and the modified CERAD ten-word list learning task with delayed recall;[18] and informant reports of cognitive and functional decline from the CSI'D' RELSCORE.[17] In the pilot study, this algorithm was developed on half the sample and tested on the other, and identified dementia with a sensitivity of 94% and specificity of 97% in controls with high-level education and a specificity of 94% in those with low-level education.[12]

DSM-IV dementia diagnosis was allocated to those meeting the relevant criteria:[19] impairment in memory and at least one other domain of cognitive function; impairment in social or occupational functioning, and representing a decrease from a previous level of functioning; not occurring exclusively during delirium; and not better accounted for by another mental disorder. Our fully operationalised computerised algorithm has been published elsewhere.[20] It addresses a key weakness of dementia diagnosis with the DSM systems—that insufficient operationalisation leads to poor reliability for specific elements,[21] more so between than within

	65–69 years	70–74 years	75–79 years	≥80 years	Crude prevalence (95% CI)	Standardised prevalence (95% CI)*
Cuba						
Men	2·9% (0·9–5·0)	5·9% (3·1–8·6)	6·6% (3·3–9·8)	23·2% (17·7–28·6)	10·8% (9·7–11·9)	12·6% (10·4–14·9)
Women	2·9% (1·4–4·4)	6·1% (4·0–8·2)	9·8% (6·9–12·7)	26·6% (22·8–30·5)		
Dominican Republic						
Men	4·8% (1·7–7·9)	6·2% (2·7–9·6)	14·4% (8·3–20·5)	17·2% (11·4–22·9)	11·7% (10·3–13·1)	9·8% (8·4–11·1)
Women	3·5% (1·5–5·4)	7·1% (4·3–9·9)	11·7% (7·8–15·6)	25·5% (21·2–29·8)		
Peru (urban)						
Men	3·6% (0·1–7·1)	3·0% (0·1–6·0)	8·3% (3·0–13·6)	19·3% (12·8–25·8)	9·3% (7·7–11·0)	8·5% (6·2–10·8)
Women	2·3% (0·04–4·1)	2·2% (0·0–4·3)	7·9% (4·0–11·8)	27·2% (21·0–33·5)		
Peru (rural)						
Men	1·3% (0·0–3·8)	3·5% (0·0–8·3)	8·3% (0·2–16·4)	6·9% (0·1–13·0)	6·5% (4·4–8·6)	7·6% (5·0–10·3)
Women	5·0% (0·6–9·3)	7·2% (1·5–12·9)	5·7% (0·0–12·1)	17·0% (7·1–26·8)		
Venezuela						
Men	3·0% (1·1–4·9)	2·3% (0·0–4·5)	6·5% (2·1–10·8)	17·2% (9·1–25·4)	5·7% (4·7–6·8)	6·2% (4·9–7·4)
Women	2·0% (0·8–3·2)	3·5% (1·4–5·6)	5·1% (2·1–8·1)	20·7% (15·1–26·3)		
Mexico (urban)						
Men	0	5·1% (1·1–9·1)	3·8% (0·0–8·1)	16·3% (7·5–25·0)	8·6% (6·8–10·4)	7·4% (5·9–8·9)
Women	0·5% (0·0–1·6)	4·3% (1·5–7·0)	13·5% (7·4–19·5)	25·2% (18·1–32·3)		
Mexico (rural)						
Men	0	2·9% (0·0–6·2)	6·9% (1·5–12·3)	20·7% (12·9–28·6)	8·5% (6·7–10·3)	7·3% (5·7–9·0)
Women	2·0% (0·1–4·0)	6·0% (2·2–9·9)	9·7% (4·6–14·8)	22·9% (15·3–30·6)		
China (urban)						
Men	0	3·7% (0·7–6·7)	6·0% (1·6–10·3)	14·7% (7·9–21·4)	7·0% (5·5–8·5)	8·0% (6·2–9·8)
Women	2·9% (0·6–5·3)	3·0% (0·6–5·3)	8·0% (3·4–12·6)	24·4% (16·5–32·2)		
China (rural)						
Men	1·6% (0·0–3·3)	3·1% (0·0–6·0)	9·1% (2·5–15·6)	19·6% (7·6–31·5)	5·6% (4·2–7·0)	4·8% (3·1–6·4)
Women	1·6% (0·0–3·3)	4·2% (1·1–7·3)	9·6% (4·4–14·8)	14·7% (6·5–22·9)		
India (urban)						
Men	2·9% (0·4–5·4)	5·5% (1·5–9·6)	4·5% (0·0–9·6)	25·0% (12·8–37·2)	7·5% (5·8–9·1)	8·2% (6·0–10·3)
Women	5·5% (2·5–8·4)	7·4% (3·6–11·2)	8·0% (1·7–14·3)	21·2% (11·0–31·4)		
India (rural)						
Men	4·3% (0·9–7·7)	5·8% (2·1–9·6)	5·7% (0·7–10·6)	11·0% (3·6–18·3)	10·6% (8·6–12·6)	8·7% (6·9–10·5)
Women	7·8% (4·0–11·6)	14·8% (9·8–19·8)	15·7% (8·0–23·5)	29·4% (18·3–40·5)		

Webtable 1 shows distribution of sample and 10/66 dementia cases by age and sex. *Standardised for age, sex, and education.

See Online for webtable 1

Table 3: **Prevalence (95% CI) of 10/66 dementia by age group, sex, and country**

international research teams.[22] We assessed the severity of dementia (classified as questionable, mild, moderate, or severe) in all participants according to the clinical dementia rating (CDR).[23] The full syntax files for the algorithms for 10/66 Dementia, DSM-IV dementia, and CDR can be accessed on the 10/66 website.

For the **10/66 website** see http://www.alz.co.uk/1066

Statistical analysis

We used the 10/66 data archive (release 1.5; February, 2008) and STATA (version 9.2) for all analyses. For every site we described the participants' characteristics: age, sex, marital status, educational level, receipt of government or occupational pension, and food security. We reported the prevalence of 10/66 dementia and DSM-IV dementia by age and sex, with robust 95% CIs adjusted for household clustering, and described the clinical severity (CDR) for dementia cases. Furthermore, we modelled the effects of age, sex, education, and household assets, providing mutually adjusted prevalence ratios derived from a Poisson working model. We used the fitted model to estimate the increment in age corresponding to a doubling of estimated prevalence. We fitted the model separately for every site and then used a fixed effects meta-analysis to combine them, with Higgins' I^2 to estimate the degree of heterogeneity[24] with approximate 95% CIs.

We used standardisation to make three comparisons. First, to compare the prevalence of 10/66 dementia and DSM-IV dementia between our study sites after adjustment for the compositional effects of age, sex, and education (direct standardisation, with the whole sample as the standard population). Second, to compare the

	65–69 years	70–74 years	75–79 years	≥80 years	Crude prevalence (95% CI)	Standardised prevalence (95% CI)*
Cuba						
Men	1·1% (0·0–2·3)	3·1% (1·1–5·1)	3·9% (1·4–6·4)	13·7% (9·3–18·2)	6·4% (5·5–7·3)	6·3% (5·0–7·7)
Women	1·8% (0·6–3·1)	3·6% (2·0–5·3)	5·9% (3·6–8·2)	16·5% (13·2–19·7)		
Dominican Republic						
Men	2·1% (0·0–4·2)	5·1% (2·0–8·3)	4·5% (0·9–8·1)	10·1% (5·5–14·6)	5·4% (4·4–6·4)	4·2% (3·3–5·1)
Women	0·9% (0·0–1·8)	3·1% (1·2–5·0)	4·9% (2·3–7·5)	11·7% (8·5–14·9)		
Peru (urban)						
Men	2·7% (0·0–5·7)	0	1·8% (0·0–4·4)	2·8% (0·0–5·6)	3·1% (2·2–4·0)	3·8% (1·9–5·8)
Women	1·5% (0·0–3·0)	1·4% (0·0–2·9)	2·6% (0·3–4·9)	9·8% (5·8–13·8)		
Peru (rural)						
Men	0	0	0	0	0·4% (0·1–0·9)	0·4% (0·0–1·0)
Women	0	0	0	3·4% (0·0–8·1)		
Venezuela						
Men	0·3% (0·0–1·0)	0	1·6% (0·0–3·9)	5·7% (0·7–10·7)	1·9% (1·3–2·6)	2·6% (1·6–3·5)
Women	0·9% (0·0–1·7)	1·0% (0·0–2·2)	2·8% (0·6–5·0)	7·9% (4·1–11·6)		
Mexico (urban)						
Men	0	3·4% (0·1–6·7)	2·5% (0·0–6·1)	8·7% (2·4–15·1)	4·1% (2·8–5·3)	3·2% (2·2–4·2)
Women	0·5% (0·0–1·6)	1·4% (0·0–3·0)	4·0% (0·5–0·7)	12·6% (7·1–18·1)		
Mexico (rural)						
Men	1·0% (0·0–2·9)	0	1·2% (0·0–3·4)	6·6% (1·8–11·4)	2·2% (1·3–3·1)	2·4% (1·2–3·6)
Women	1·0% (0·4–2·4)	2·0% (0·0–4·3)	2·2% (0·0–4·8)	4·1% (0·5–7·7)		
China (urban)						
Men	0·9% (0·0–2·7)	2·5% (0·1–4·9)	3·4% (0·1–6·8)	5·5% (1·2–9·8)	3·0% (2·0–4·0)	3·1% (2·0–4·2)
Women	2·0% (0·0–3·9)	0·5% (0·0–1·5)	2·2% (0·0–4·7)	10·1% (4·6–15·6)		
China (rural)						
Men	0·1% (0·0–1·5)	2·3% (0·0–4·9)	2·6% (0·0–6·2)	8·7% (0·2–17·1)	2·4% (1·4–3·3)	2·0% (0·8–3·1)
Women	1·6% (0·0–3·3)	1·8% (0·0–3·9)	4·8% (1·0–8·6)	2·7% (0·0–6·4)		
India (urban)						
Men	0·6% (0·0–1·7)	1·6% (0·0–3·8)	0	0	0·9% (0·3–1·5)	0·9% (0·3–1·6)
Women	0·8% (0·0–2·0)	1·1% (0·0–2·5)	0	3·0% (0·0–7·3)		
India (rural)						
Men	0·7% (0·0–2·1)	1·3% (0·0–3·1)	0	1·4% (0·0–4·1)	0·8% (0·2–1·3)	0·3% (0·1–0·5)
Women	0·5% (0·0–1·6)	1·0% (0·0–2·4)	0	1·5% (0·0–4·4)		

See Online for webtable 2

Webtable 2 shows distribution of sample and DSM-IV dementia cases by age and sex. *Standardised for age, sex, and education.

Table 4: **Prevalence (95% CI) of DSM-IV dementia by age group, sex, and country**

	Latin America (urban) (N=9242)	Latin America (rural) (N=1552)	China (urban) (N=1160)	China (rural) (N=1002)	India (urban) (N=1005)	India (rural) (N=999)
DSM-IV dementia						
Crude prevalence	4·6% (4·2–5·1)	1·5% (0·9–2·2)	3·0% (2·0–4·0)	2·4% (1·4–3·3)	0·9% (0·3–1·5)	0·8% (0·2–1·3)
Standardised prevalence*	4·4% (3·9–4·8)	1·8% (0·9–2·8)	3·1% (2·0–4·2)	2·0% (0·8–3·1)	0·9% (0·3–1·6)	0·3% (0·1–0·5)
SMR† (EURODEM)‡	80 (70–91)	27 (16–41)	57 (36–86)	56 (32–91)	22 (7–41)	18 (5–34)
SMR (ADI/*Lancet*)§	55 (49–62)	19 (11–28)	44 (28–64)	44 (25–69)	33 (11–66)	27 (8–54)
DSM-IV dementia severity						
Number of cases	432	24	35	24	9	8
Questionable	8 (1·9%)	2 (8·3%)	0	0	0	0
Mild	213 (49·3%)	16 (66·7%)	15 (42·9%)	10 (41·7%)	4 (44·4%)	4 (50·0%)
Moderate	135 (31·3%)	5 (20·8%)	19 (54·3%)	13 (54·2%)	4 (44·4%)	4 (50·0%)
Severe	76 (17·6%)	1 (4·2%)	1 (2·9%)	1 (4·2%)	1 (11·1%)	0
10/66 dementia						
Crude prevalence	9·7% (9·1–10·4)	7·8% (6·4–9·2)	7·0% (5·5–8·5)	5·6% (4·2–7·0)	7·5% (5·8–9·1)	10·6%(8·6–12·6)
Standardised prevalence*	9·7% (9·0–10·3)	7·4% (5·9–9·0)	8·0% (6·2–9·8)	4·8% (3·1–6·4)	8·2%(6·0–10·3)	8·7%(6·9–10·5)
SMR (ADI/*Lancet*)§	116 (105–128)	97 (75–125)	102 (74–140)	102 (70–150)	278 (184–464)	358 (246–577)
10/66 dementia severity						
Number of cases	906	121	81	56	75	106
No dementia	7 (0·8%)	6 (5·0%)	0	2 (3·6%)	6 (8·0%)	6 (5·7%)
Questionable	221 (24·4%)	56 (46·3%)	15 (18·5%)	16 (28·6%)	49 (65·3%)	67 (63·2%)
Mild	389 (42·9%)	46 (38·0%)	36 (44·4%)	24 (42·9%)	15 (20·0%)	27 (25·5%)
Moderate	197 (21·7%)	10 (8·3%)	28 (34·6%)	13 (23·2%)	4 (5·3%)	4 (3·8%)
Severe	92 (10·2%)	3 (2·5%)	2 (2·5%)	1 (1·8%)	1 (1·3%)	2 (1·9%)
10/66 dementia, restricted to CDR mild/moderate/severe						
Crude prevalence	7·3% (6·8–7·8)	3·8% (2·9–4·7)	5·7% (4·4–7·0)	3·8% (2·6–5·0)	2·0% (1·1–2·9)	3·3% (2·2–4·4)
Standardised prevalence*	6·9% (6·2–7·3)	4·3% (2·9–5·6)	6·3% (4·7–7·8)	3·5% (2·0–4·9)	2·1% (1·1–3·0)	1·4% (0·9–1·9)
SMR (ADI/*Lancet*)§	87 (78–96)	47 (34–63)	83 (59–115)	69 (44–104)	74 (38–134)	111 (66–189)

Webtable 3 shows standardised morbidity ratios for comparisons. SMR=standardised morbidity ratio. CDR=clinical dementia rating.[23] *Direct standardisation for age, sex, and education. †SMR is a ratio of the observed to expected number of dementia cases. The observed figures come from the 10/66 study samples, and the expected figures from applying the age-specific and sex-specific prevalence (EURODEM)[14] or age-specific prevalence (*Lancet*/ADI regional consensus estimates)[6] from the reference population to the age, or age and sex distribution of the 10/66 study samples. An SMR of 100 implies that the dementia prevalence in the 10/66 study sample is similar to that in the reference population, an SMR less than 100 implies that the prevalence in the 10/66 sample is lower than that in the reference population, and an SMR greater than 100 implies that the prevalence is higher than that in the reference population. ‡Indirect standardisation for age and sex. §Indirect standardisation for age.

Table 5: **Prevalence (95% CI) of 10/66 dementia and DSM-IV dementia, by region and clinical severity, to compare prevalence from 10/66 studies with EURODEM DSM-IV prevalence and prevalence estimates from the ADI and *Lancet* consensus study**

See Online for webtable 3

prevalence of DSM-IV dementia in each of the study sites with that from the EURODEM meta-analysis of 12 European studies[14] (indirect standardisation for age; sex-standardised morbidity ratios [SMR] and Fieller 95% CIs were calculated with an SMR of 100 for the reference population). Third, to compare the prevalence of DSM-IV dementia and 10/66 dementia (restricted and not restricted to CDR mild, moderate, and severe cases) in each of the study sites and regions with that from the ADI and *Lancet* consensus study for the relevant region[6] (indirect standardisation for age).

We assessed the concurrent validity of dementia diagnoses with the DSM-IV and 10/66 criteria by comparing the distribution of WHODAS disability scores between participants with no dementia (group 1), those with 10/66 dementia not confirmed by DSM-IV (group 2), and those with DSM-IV dementia (group 3). We used zero inflated-negative binomial regression to model the main effect of 10/66 dementia and 10/66 dementia by DSM-IV dementia interaction term on disability scores, after adjustment for other relevant covariates. These two parameters provided a test of differences for group 2 versus group 1, and group 3 versus group 2.

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The sponsors of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. All authors had full access to all the data in the study, and the corresponding author had final responsibility for the decision to submit for publication.

Results

Overall, 14960 interviews were completed (table 1). Response proportions varied between 72% and 98%, and were 80% or higher in all but two sites (urban China and urban India; table 1).

Demographic ageing was more advanced in the Latin American centres and urban China than in rural China

and India (table 2). Educational levels were highest in the urban sites in Cuba, Peru, and Venezuela. In the Dominican Republic, rural Peru, and Mexico, between 15% and 33% of participants had no education, whereas having no education in rural China and India was common. Women predominated over men in all sites. Pension coverage was especially low in the Dominican Republic, rural Mexico, rural China, and India; food insecurity was prevalent in these sites (table 2).

The prevalence of 10/66 dementia varied between 5·6% and 11·7% by site (table 3), whereas that of DSM-IV dementia varied between 0·4% and 6·4% (table 4). The prevalence of 10/66 dementia was higher in every site, and was generally around double that of DSM-IV dementia. However, in urban India (0·9%), rural India (0·8%), and in rural Peru (0·4%), the prevalence of DSM-IV dementia was much lower than the 10/66 dementia prevalence in the same site (7·5%, 10·6%, and 6·5%, respectively). The distribution of CDR clinical severity was generally less severe for patients with 10/66 dementia than for those with DSM-IV dementia (table 5). Those with 10/66 dementia had a lower CDR severity profile in rural Latin America and India than in other regions. However, even after restricting 10/66 dementia to CDR mild, moderate, and severe cases, the prevalence exceeded that of DSM-IV dementia in all sites (table 5).

The prevalence of dementia was strongly age-dependent for both criteria, with pooled estimates suggesting a doubling with every 7·5-year increment in age (table 6). The prevalence of dementia was consistently lower in men than in women, with a pooled adjusted prevalence ratio of 0·84 (95% CI 0·75–0·93) for 10/66 dementia and 0·88 (0·73–1·05) for DSM-IV dementia. The effect of education (an inverse association) predominated over that of assets, although assets, rather than education, were independently inversely associated with 10/66 dementia prevalence in rural Mexico and in urban India. Direct standardisation for age, sex, and education had little effect on prevalence differences between sites. The standardised prevalence of 10/66 dementia was somewhat higher in Cuba (12·6%) and the Dominican Republic (9·8%), and somewhat lower in rural China (4·8%) than in other sites, where prevalence ranged between 6%

	10/66 dementia					DSM-IV dementia				
	Age (5-year groups)	Increment in age for a doubling of estimated prevalence (years)	Sex	Education	Assets	Age (5-year groups)	Increment in age for a doubling of estimated prevalence (years)	Sex	Education	Assets
Individual sites										
Cuba	1·99 (1·76–2·26)	7·1 (6·3–8·3)	0·89 (0·71–1·11)	0·81 (0·73–0·91)	0·99 (0·89–1·10)	2·11 (1·79–2·49)	6·7 (5·8–8·0)	0·79 (0·59–1·08)	0·86 (0·75–0·99)	1·02 (0·88–1·18)
Dominican Republic	1·76 (1·55–1·98)	9·1 (7·8–11·2)	0·91 (0·70–1·19)	0·83 (0·71–0·98)	0·89 (0·79–1·01)	1·82 (1·51–2·21)	8·3 (6·5–11·0)	1·13 (0·76–1·70)	0·89 (0·67–1·10)	0·97 (0·81–1·18)
Peru (urban)	2·48 (1·99–3·10)	6·0 (5·2–7·1)	0·89 (0·62–1·26)	0·90 (0·77–1·07)	1·12 (0·93–1·34)	1·87 (1·26–2·76)	7·9 (5·5–13·6)	0·54 (0·26–1·15)	0·73 (0·54–1·00)	1·37 (1·01–1·86)
Peru (rural)	1·37 (1·03–1·83)	16·1 (8·1–infinity)	0·53 (0·25–1·11)	0·69 (0·47–1·01)	0·86 (0·62–1·21)	Too few cases (two) to estimate parameters				
Venezuela	2·00 (1·65–2·42)	7·5 (6·2–9·2)	1·02 (0·70–1·50)	0·79 (0·66–0·94)	0·94 (0·77–1·16)	2·19 (1·41–3·40)	8·1 (5·8–13·6)	0·61 (0·28–1·33)	0·68 (0·47–0·97)	0·88 (0·60–1·28)
Mexico (urban)	2·29 (1·81–2·89)	6·4 (5·3–8·4)	0·69 (0·44–1·07)	0·61 (0·46–0·80)	0·98 (0·82–1·16)	2·25 (1·57–3·22)	6·9 (5·1–10·3)	0·96 (0·51–1·80)	0·46 (0·33–0·64)	1·15 (0·90–1·48)
Mexico (rural)	2·32 (1·86–2·89)	6·0 (5·0–7·5)	0·77 (0·52–1·13)	0·88 (0·61–1·27)	0·76 (0·63–0·92)	1·95 (1·26–3·02)	6·2 (4·2–11·6)	0·87 (0·39–1·96)	1·47 (0·91–2·38)	1·08 (0·72–1·61)
China (urban)	2·38 (1·87–3·02)	5·3 (4·4–6·9)	0·79 (0·48–1·28)	0·80 (0·67–0·97)	1·28 (0·93–1·75)	1·92 (1·34–2·75)	6·5 (4·4–12·1)	0·94 (0·43–2·04)	0·96 (0·71–1·30)	0·80 (0·50–1·27)
China (rural)	2·21 (1·73–2·84)	6·2 (5·0–8·5)	0·94 (0·57–1·56)	1·08 (0·80–1·46)	0·90 (0·72–1·12)	1·63 (1·11–2·41)	8·4 (5·3–20·4)	1·13 (0·52–2·51)	0·82 (0·48–1·39)	0·92 (0·63–1·34)
India (urban)	1·75 (1·44–2·13)	8·4 (6·4–11·8)	0·84 (0·55–1·28)	0·88 (0·69–1·13)	0·74 (0·58–0·96)	1·16 (0·64–2·13)	57·8 (7·5–infinity)	0·57 (0·17–1·80)	1·27 (0·66–2·45)	1·05 (0·48–2·28)
India (rural)	1·42 (1·21–1·66)	11·4 (8·2–18·2)	0·54 (0·34–0·86)	0·69 (0·45–1·05)	0·93 (0·80–1·09)	1·05 (0·51–2·18)	18·7 (4·4–infinity)	2·34 (0·57–9·66)	0·26 (0·05–1·40)	0·73 (0·38–1·38)
Pooled meta-analysis										
Meta-analysed estimate	1·92 (1·80–2·01)	7·3 (6·4–8·3)	0·84 (0·75–0·93)	0·82 (0·77–0·87)	0·93 (0·89–0·99)	1·92 (1·75–2·12)	7·5 (6·7–8·3)	0·88 (0·73–1·05)	0·83 (0·75–0·90)	1·02 (0·93–0·12)
χ^2 test for heterogeneity (degrees of freedom)	36·6 (10); p<0·0001		7·8 (10); p=0·65	11·2 (10); p=0·34	17·8 (10); p=0·06	8·7 (9); p=0·47		7·3 (9); p=0·61	23·9 (9); p=0·004	7·8 (9); p=0·56
Higgins I^2 (95% CI)	73% (50–85)		0% (0–60)	11% (0–51)	44% (0–72)	0% (0–62)		0% (0–60)	62% (25–81)	0% (0–62)

Table 6: **Prevalence ratios (95% CI) from a Poisson regression for the independent effects of age, sex, education, and assets on dementia prevalence**

and 9% (table 3). DSM-IV dementia prevalence was also somewhat higher in Cuba (6·3%) and the Dominican Republic (4·2%) and substantially lower in rural Peru (0·4%) and urban (0·9%) and rural India (0·3%) than in other sites, where the prevalence ranged between 2% and 4% (table 4).

When we compared the prevalence of DSM-IV dementia in 10/66 sites with the consistent, pooled estimate from the 12 European sites in the EURODEM meta-analysis[14] (indirectly standardising for age and sex), the prevalence in urban Latin American sites was about four-fifths of that in Europe, that in the Chinese sites was just over half, and that in rural Latin American and Indian sites only between a quarter and a fifth (table 5). We then compared the prevalence estimates from our studies with the relevant region-specific prevalence estimates from the ADI and *Lancet* consensus study,[6] indirectly standardising for age (table 5). The DSM-IV dementia prevalences from the 10/66 studies, especially for rural Latin America and India, were lower than were those from the ADI and *Lancet* consensus study. The 10/66 dementia prevalences, when patients with questionable CDR were excluded, were much closer to estimates from the ADI and *Lancet* consensus study for most regions, but still less than half that for rural Latin America (table 5). Inclusion of patients with 10/66 dementia classified as questionable provided the closest match for the prevalence from the ADI and *Lancet* consensus study for Latin America and China, but the 10/66 dementia prevalence in India was then three times higher for that region (table 5).

Across all sites, 498 (94%) of 532 patients with DSM-IV dementia were also classified as having 10/66 dementia. An additional 847 of 1345 cases of 10/66 dementia were not confirmed by DSM-IV criteria. The distribution of WHODAS disability scores in those with 10/66 dementia that was not confirmed by DSM-IV dementia criteria was intermediate, but scores were much closer to the high (more impaired) scores in those with DSM-IV dementia than to the low (less impaired) scores in those who did not meet either set of criteria (table 7). The interaction between 10/66 dementia and DSM-IV dementia was not significant in six of the 11 site-specific regressions to predict WHODAS disability score (table 7), indicating that the levels of disability in patients with 10/66 dementia not confirmed by DSM-IV criteria may be similar, at least in Peru, Venezuela, urban Mexico, and urban China.

In a post-hoc analysis, we explored further the discrepancies between the prevalence of 10/66 dementia and DSM-IV dementia. Although we recorded fairly small differences between sites and regions in the prevalence of objective memory impairment (impairment on two or more of three memory tests), we noted substantial regional variation in the proportion of patients meeting the cardinal DSM-IV A1 criteria (impairment in memory) who also met the B criterion (cognitive decline and social or occupational impairment): 501/893 (56·1%) in urban Latin American sites, 39/68 (57·4%) in urban China, and 25/44 (56·8%) in rural China, compared with only 29/98 (29·6%) in rural Latin America, 11/36 (30·6%) in urban India, and 11/86 (12·8%) in rural India. The CSI'D' informant interview RELSCORE is the main source of information that is used

	Mean (SD) WHODAS disability scores				Risk ratios (95% CI) from a zero inflated negative binomial regression*	
	Overall	Group 1: no dementia	Group 2: 10/66 dementia not confirmed by DSM-IV	Group 3: DSM-IV dementia	Group 2 *vs* group 1	Group 3 *vs* group 2
Cuba	13·4 (20·0) n=2920	9·7 (14·1) n=2600	36·0 (30·2) n=132	48·6 (32·0) n=188	2·34 (2·00–2·75)	1·38 (1·13–1·69)
Dominican Republic	16·5 (20·3) n=1996	13·9 (17·3) n=1757	28·9 (26·9) n=133	43·5 (29·5) n=106	1·60 (1·35–1·89)	1·39 (1·09–1·77)
Venezuela	10·8 (16·4) n=1852	9·2 (13·8) n=1740	32·0 (29·3) n=77	39·9 (30·4) n=35	2·33 (1·86–2·91)	1·13 (0·77–1·65)
Peru						
Urban	13·1 (20·6) n=1369	9·5 (15·2) n=1242	47·4 (31·9) n=84	48·5 (31·2) n=43	3·15 (2·54–3·90)	1·00 (0·70–1·42)
Rural	10·4 (14·6) n=550	9·0 (12·0) n=514	29·0 (26·6) n=34	62·5 (17·7) n=2	2·54 (1·84–3·51)	1·80 (0·55–5·86)
Mexico						
Urban	10·0 (17·3) n=1000	8·1 (14·3) n=907	25·4 (25·4) n=52	32·8 (33·0) n=41	1·92 (1·41–2·62)	1·23 (0·77–1·97)
Rural	11·1 (19·1) n=1000	9·1 (16·2) n=913	26·2 (29·9) n=65	47·7 (31·8) n=22	1·87 (1·41–2·46)	1·61 (0·98–2·64)
China						
Urban	8·1 (20·1) n=1150	4·6 (13·4) n=1071	46·4 (33·4) n=44	65·6 (30·8) n=35	2·26 (1·68–3·02)	1·36 (0·91–2·02)
Rural	8·0 (14·6) n=1000	6·0 (10·1) n=945	31·9 (24·8) n=32	55·9 (31·5) n=23	2·09 (1·67–2·61)	1·82 (1·30–2·55)
India						
Urban	10·5 (15·4) n=1001	9·5 (14·2) n=926	20·2 (18·9) n=66	46·6 (34·2) n=9	1·65 (1·29–2·11)	2·22 (1·17–4·21)
Rural	28·3 (18·3) n=999	26·4 (16·6) n=891	41·8 (21·5) n=100	72·2 (23·0) n=8	1·46 (1·30–1·65)	1·69 (1·06–2·69)

WHODAS=WHO Disability Assessment Schedule. *Model also includes the effects of sex and education (parameters not shown).

***Table 7*: Distribution of WHODAS disability scores by dementia status and site, and the effects of dementia (main effect of 10/66 dementia, modified by DSM-IV dementia) on WHODAS score**

	Relative risk (95% CI)	p value
Characteristics of informant		
Relation to participant (friend or neighbour *vs* other)	0·73 (0·65–0·81)	<0·0001
Male sex	0·81 (0·77–0·85)	<0·0001
Not living in same household	0·88 (0·83–0·94)	0·00014
Characteristics of participant		
Age (per 5-year age group)	1·22 (1·19–1·24)	<0·0001
Male sex	0·86 (0·82–0·91)	<0·0001
Educational level	0·89 (0·87–0·91)	<0·0001
Considered head of household	0·89 (0·84–0·93)	<0·0001
Main effect of number of memory tests impaired (per additional impaired test), in urban Latin America*	1·83 (1·78–1·88)	<0·0001
Main effect of site/region (when no memory tests impaired)		
Urban Latin America	1 (reference)	
Rural Latin America	0·79 (0·72–0·85)	<0·0001
Urban China	0·48 (0·43–0·54)	<0·0001
Rural China	0·17 (0·14–0·20)	<0·0001
Urban India	0·52 (0·46–0·58)	<0·0001
Rural India	0·61 (0·56–0·66)	<0·0001
Interaction of site/region with number of memory tests impaired		
Urban Latin America	1 (reference)	
Rural Latin America	0·83 (0·76–0·90)	<0·0001
Urban China	1·40 (1·28–1·53)	<0·0001
Rural China	1·46 (1·29–1·65)	<0·0001
Urban India	0·82 (0·72–0·93)	0·002
Rural India	0·66 (0·61–0·71)	<0·0001

Negative binomial regression; n=14 783. *To obtain the estimated relative risk for the effect of number of memory tests impaired for another site or region, multiply the main effect in urban Latin America by the relevant interaction term—eg, for rural India: 1·83×0·66=1·21.

Table 8: **Independent correlates of community screening instrument for dementia informant report of intellectual and functional decline (RELSCORE)**

to establish the DSM-IV dementia B criterion. We used a negative binomial regression model (table 8) to identify its correlates. We controlled for objective evidence of memory impairment (number of impaired memory tests), as well as participant and informant characteristics that could be sources of methodological bias, and fitted a site or region by objective memory impairment interaction term. In the absence of objective memory impairment, RELSCOREs were highest in urban Latin America (table 8). In these sites, we recorded a strong association between objective memory impairment and RELSCORE. Site or region by objective memory impairment interaction terms indicated that this association was strongest in China, but significantly weaker in rural Latin America, urban India and, particularly, rural India than in the urban Latin American sites (table 8). RELSCOREs were also lower for male participants, those considered to be head of household, or those who were better educated, and were higher for older participants (table 8). Male informants tended to report less impairment, as did those who did not live in the same household as the participant, and those who were friends or neighbours rather than relatives of the participant (table 8).

Discussion

We have shown that the prevalence of DSM-IV dementia in urban Latin America is similar to that previously recorded in Europe and other developed-country settings. However, consistent with other reports from less developed regions,[2,3] the prevalence of DSM-IV dementia in rural Latin America and in India was very low—a quarter or less than that typically seen in Europe.[14] The prevalence of 10/66 dementia, with use of our 10/66 cross-culturally validated and education-fair algorithm,[12] was more homogenous (although still somewhat higher in the urban Latin American sites), and much higher than that of DSM-IV dementia, especially in the least developed sites. For both dementia outcomes, the effect of age on prevalence (doubling with every 7·5-year increment in age) is attenuated with respect to the doubling with every 4–6 years that is typically seen in developed-country studies.[14,25] This finding could be explained by a higher associated mortality at advanced age in less-developed settings; studies from Nigeria[26] and Brazil[27] have suggested especially high mortality risks for people with dementia.

This is the first comparative paper from the 10/66 Dementia Research Group's continuing programme of population-based studies in Latin America, India, China, and Africa. As this work evolves, we hope to give a clearer understanding of the distribution, determinants, and public-health effect of the disorder, particularly in regions where little research has been published.

The whole catchment area sampling strategy enabled us to foster links with local communities, improving response and helping with follow-up; however, prevalence estimates might not be generalisable beyond these and similar districts. Our one-phase dementia diagnostic assessment has several advantages compared with the two-phase approach that is used in most previous studies.[28] Attrition is pronounced between the first and second phase;[29] participants with probable dementia are likely to refuse, move away, or die, leading to informative censoring. The problem is compounded when no random sample of screen negatives is selected for second-phase assessment with the tacit assumption of perfect sensitivity for the screening measure.[28,30] Our participant and informant assessments were generally well tolerated, as shown by high levels of participation; non-response bias should therefore be small, but we have little information about non-responders to clarify this notion. We are also relatively well-placed to make valid comparisons of prevalence between regions. All sites adopted the same core protocol and assessments. The 10/66 dementia algorithm was carefully validated in 25 LMIC sites,[12] including all those in this report. We have also fully operationalised and computerised the DSM-IV dementia criterion, and validated this and our 10/66 dementia diagnosis against clinician diagnosis in our Cuban centre.[20]

How can the discrepancy between the prevalence of 10/66 dementia and DSM-IV dementia be explained? In our 10/66 dementia validation,[12] sensitivity and specificity

were both excellent against the gold standard of a local clinician's DSM-IV diagnosis. However, the false positive rate, which varied between 1% and 10% across regions and levels of education, might be one factor accounting for the higher prevalence of 10/66 dementia. The higher severity profile of DSM-IV dementia cases that we recorded was expected, since the criteria prioritise reliability by restricting the diagnosis to more severe and incontrovertible cases; several domains of cognitive function must be affected, each with clear evidence of social or occupational impairment. DSM-IV dementia is thus the narrower and more specific criterion. The key question is whether DSM-IV dementia is also a sensitive criterion, or whether 10/66 dementia might be better at detecting those with milder and recent onset disease. In our Cuban centre, 10/66 dementia corresponded more closely with dementia diagnoses made by the Cuban clinical interviewer than did DSM-IV dementia, which selectively missed mild and moderate cases.[20] A similar finding was reported from the Canadian Study of Health and Ageing.[31]

DSM-IV criteria have been criticised for the primacy accorded to memory impairment (which is not an early feature in some dementia subtypes) and for the lack of specificity of the secondary cognitive criteria.[32] Our finding that those with a 10/66 dementia diagnosis that was not confirmed by the DSM-IV criterion were consistently disabled compared with those without disease, and that they could not be distinguished in that respect from patients with DSM-IV dementia in six of our 11 sites, is an important construct validation of the 10/66 dementia diagnosis; the WHODAS disability scale was not used to establish either dementia diagnostic outcome. Overall we believe that we have good empirical evidence that the DSM-IV dementia criterion might lack specificity, and hence underestimate true dementia prevalence.

Underestimation by the DSM-IV dementia criterion was a particular issue in rural and less-developed sites. Our data suggest that this underestimation might be attributable to cultural effects on informant reports of intellectual decline and social or occupational impairment, specifically a much weaker correlation between objective evidence of memory impairment and informant reports in less-developed settings. Several possible mechanisms might be implicated. First, our cognitive tests could be biased, overestimating cognitive impairment in these settings. However, this notion seems unlikely in view of the small regional effects on test performance in our pilot study, after controlling for the more prominent influences of age, education, and dementia.[12] For our DSM-IV algorithm, cognitive impairment is defined with reference to age-specific and education-specific test norms from the pilot study.[20] Second, objective cognitive impairment might be less likely to lead to noticeable impairment in the performance of normal social roles, because of the high levels of instrumental support that are routinely provided to all older people, especially in the early stages of dementia; more attention might need to be given to developing culturally relevant assessments to detect the results of early intellectual decline. Third, impairment or decline might have been noted by informants, but they could have been reluctant to disclose this information because of the culture of respect towards elderly people. This tenet accords with our finding of lower reported scores by informants for heads of household and male participants. Last, impairment or decline might have been noted, but attributed to a normal ageing process[33,34] and hence not worthy of mention in view of the implicit focus of the assessments on abnormality.

The merits of pathologising the last three of these scenarios could be debated. Is there a point to labelling someone as having dementia, if their relatives do not acknowledge a problem? However, our data suggest substantial associated disability, and the quality of life of the elderly person will probably be impaired. Our pilot studies also suggested high levels of caregiver strain which were exacerbated by little understanding of the nature of the underlying disorder.[33,35,36] Our post-hoc analysis suggests that the accuracy of reports from informants might be improved by selecting female informants (who are mostly responsible for providing care) who are related to and living with the participant. An important rationale for dementia diagnosis is that it alerts patients, clinicians, and carers to the likelihood of progression. The predictive validity of the 10/66 dementia diagnosis will be tested in the 10/66 incidence phase. Patients with true dementia would have progressed or died, whereas others will have been misclassified. Those that progress are likely to need assistance, but, at present are poorly served by health and social-care systems that fail to meet their needs.[37] Accurate estimation of the true population burden is the first important step in addressing this problem.

Our conclusion is that the DSM-IV dementia criterion might substantially underestimate the true prevalence of dementia, especially in least developed regions, because of difficulties in defining and ascertaining decline in intellectual function and its consequences. We believe that our methods have drawn attention to a substantial prevalence of dementia that might have been missed. Prevalence differences between developed and developing countries might not be as large as previously thought. Our new estimates are broadly consistent with recent expert consensus estimates of regional prevalence for Latin America and China, but numbers affected in India might have been substantially underestimated.[6]

Contributors

All authors worked collectively to develop the protocols and methods described in this paper. MP led the research group and CPF acted as research coordinator. JJLR (Cuba), DA (Dominican Republic), MG (Peru), AS (Venezuela), ALS (Mexico), KSJ (Vellore, India), ESK (Chennai, India), and YH (China) were principal investigators responsible for the fieldwork in their respective countries. MP wrote the first draft with the assistance of JJLR and CPF. These three authors also did the analyses, with statistical support from MD. Other authors reviewed the report, and provided further contributions and suggestions. All authors read and approved the final report.

Conflict of interest statement
We declare that we have no conflict of interest.

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