Prevalence and Risk of Mild Cognitive Impairment (MCI) in Low and Middle-Income Countries: A Systematic Review

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ABSTRACT

Introduction Mild Cognitive Impairment (MCI) is a cognitive state associated with increased risk of dementia. Little research on MCI exists from low-and middle-income countries (LMICs), despite high prevalence of dementia in these settings.

Objective This systematic review aimed to review epidemiological reports to determine the prevalence of MCI and its associated risk factors in LMICs.

Methods Medline, Embase and PsycINFO were searched from inception until November 2019. Eligible articles reported on MCI in population or community-based studies from LMICs. No restrictions on the definition of MCI used as long as it was clearly defined.

Results 4,621 articles were screened, and 78 retained. In total, n=23 different LMICs were represented; mostly from China (n=55 studies). Few studies from countries defined as lower-middle income (n=14), low income (n=4), or from population representative samples (n=4). There was large heterogeneity in how MCI was diagnosed; with Petersen criteria the most commonly applied (n=26). Prevalence of aMCI (Petersen criteria) ranged from 0.6% to 22.3%. Similar variability existed across studies using the International Working Group Criteria for aMCI (range 4.5% to 18.3%) and all-MCI (range 6.1% to 30.4%). Risk of MCI was associated with demographic (e.g. age), health (e.g. cardio-metabolic disease) and lifestyle (e.g. social isolation, smoking, diet and physical activity) factors.

Conclusion Outside of China, few MCI studies have been conducted in LMIC settings. There is an urgent need for population representative epidemiological studies to determine MCI prevalence in LMICs. MCI diagnostic methodology also needs to be standardised. This will allow for cross-study comparison and future resource planning.

Key words: Epidemiology, Low-and Middle-Income Country (LMIC), Mild Cognitive Impairment (MCI), Prevalence, Risk Factors, Systematic Review
INTRODUCTION

Mild Cognitive Impairment (MCI) defines an intermediate state of cognitive function between normal ageing and dementia. Numerous definitions for MCI exist and prevalence estimates vary (range <1% up to 56% across different studies and definitions) depending on population sampling (age, clinical vs population), MCI case definition and operationalisation of the component criterion for an MCI case diagnosis [1-7]. However, the majority of MCI research has been undertaken in high-income countries, namely North America, Europe and Australia. This raising questions of generalisability of findings to low-and middle-income countries (LMIC) which vary by wealth, culture, ethnicity, research capacity and infrastructure to support ageing populations.

Studies examining MCI prevalence in LMICs have produced conflicting results. For example, the 10/66 study reported a range of estimates (0.8 to 4.3%) of Petersen defined amnestic MCI (aMCI) [8] across sites in Cuba, the Dominican Republic, Peru, Venezuela, Mexico, China, India and Puerto Rico [9]. Findings from the World Health Organization's Study on Global Ageing and Adult Health reported an overall MCI prevalence of 15.3% (95%CI: 14.4-16.3) when applying the National Institute of Ageing-Alzheimer’s Association (NIA-AA) criteria [10] across sites in China, Ghana, India, Mexico Russia, and South-Africa [11]; with the individual country prevalence estimates lower (e.g. 8.5% in South Africa [12]). It is not clear what is driving the differences. Within studies, the differences likely reflect variability in the profile of risk and protective factors across sites as well as cultural/ethnic perceptions of cognitive ageing and symptom reporting. Across studies, differences are likely due to heterogeneity in methodology e.g. differences in sample selection and the MCI criteria used for diagnosis.

While some have suggested that MCI as a mode of prodromal classification can have a limited role in clinical and epidemiological settings, others argue that MCI could be a pragmatic tool for identifying individuals who could benefit from risk reduction [13]. There is promising evidence to support dementia risk reduction interventions in HICs [14], with indications of similar opportunities in LMICs [15]. Determining how best to identify individuals with MCI and the prevalence of the condition in LMICs will have important implications for planning intervention trials, treatment strategies, budgeting and
public health surveillance. While several reviews on MCI have been conducted [1-7], to our knowledge none have focused specifically on LMIC settings. Therefore, the aim of this systematic review was to report on the population prevalence and risk factors for MCI in these settings. No restrictions were applied to the definition of MCI used as long as it was clearly defined.

MATERIALS AND METHODS

This review adhered to standard reporting guidelines [16] and full details of the MOOSE checklist [17] are in Appendix I. The review protocol can be made available by a member of the research team upon request.

Search Strategy

Medline, Embase and PsycINFO were searched from inception to the 10 January 2018, with updated searches run from 10 January 2018-6 November 2018 and from 6 November 2018-30 November 2019 (CR; See Supplementary Table 1 for the list of search terms).

Inclusion/Exclusion Criteria

Studies were included if: (1) the sample was from a LMIC, at the time of the study, as defined by The World Bank[18]; (2) the study reported population-level or community-based data; and, both cross-sectional and cohort study designs were included; (3) the study described how MCI had been mapped; (4) sample age was ≥50 years; and, (5) MCI prevalence was reported. No restrictions were placed on the definition of MCI used, language or publication date. Randomised controlled trials, case-control studies, unpublished studies, and conference abstracts were excluded. Studies were also excluded if, for analysis, cognitive groups (e.g. dementia and MCI groups) were combined or the sample restricted (e.g. studies investigating MCI in disease specific groups such as diabetics or in illiterate participants only). Reviews were also retained and the reference lists of these interrogated for any missed paper.

Data Analysis
Titles/abstracts were first screened, followed by the full text of any identified articles (CR and CVA). Where multiple publications using the same study were identified, these were retained for full text review and kept if they presented original findings. Disagreements were resolved by consensus or a third party (BCMS). Data including study characteristics, operationalisation of MCI criteria, and MCI prevalence estimates were independently extracted by four investigators (AMG [Chinese Studies], AS, BCMS and CVA).

Study quality (bias) was assessed using the tool developed by Hoy et al [19]. Nine items were selected related to representativeness of the study sample, methods for case definition, and the statistical calculation of MCI prevalence. Each risk of bias item was scored ‘0’ (low risk) or ‘1’ (high risk) of bias (total score range: 0 to 9).

Forest plots of the population prevalence estimates of MCI, defined using the most commonly applied criteria across the studies were created Prism-GraphPad 8 for Windows (GraphPad Software, San Diego, USA). This included plots for MCI defined using Petersen criteria (including all-MCI and aMCI; n=26 studies [9, 20-44]), International Working Group (IWG) criteria (n=14 studies [45-58]), or study specific criteria for Cognitive Impairment no Dementia (CIND; n=10 studies [59-68]). A meta-analysis was not possible due to large heterogeneity in methodology across the studies and the lack of key statistical information (i.e. confidence intervals for the MCI prevalence estimates) in most studies.

Role of the funding source
The review was completed as part of the NIHR Global Health Group: DePEC (Grant number: 16/137/62). AMG and BCMS have full access to the data and final responsibility to submit for publication.

RESULTS

Search Yields
The electronic search identified n=4,548 studies, with duplicates removed (See Figure 1). Following title/abstract screening, 162 studies were selected for full text review. This included a systemic review on MCI prevalence in China [7], where an additional n=48 studies in Mandarin were identified. These were added to the review giving a total of n=210 full text studies. From these, 73 studies were selected for inclusion. An updated electronic search in November 2019 yielded 972 studies, and an additional five were included (total n=78 studies). Two studies [66, 67] used the same dataset, but these were retained as they provided MCI prevalence estimates for different age groups.

**Study Characteristics**

Table 1 shows the characteristics of each study. Sample size ranged from n=120 [69] to n=32,715 [11]. Most studies included participants aged ≥60 years (n=46 studies [22, 25-30, 32, 35-42, 47, 52-56, 58, 60, 61, 65, 67, 68, 70-87]) or ≥65 years (n=16 studies [9, 23, 33, 44, 46, 48, 50, 51, 57, 62-64, 69, 88-90]). The remaining studies included participants aged ≥50 years (n=6 studies [11, 21, 59, 91-93]), ≥55 years (n=7 studies [24, 31, 34, 43, 94-96]), ≥70 years (n=1 study [49]), and ≥80 years (n=2 studies [20, 66]). One study [92] included only women.

As shown in Table 1, four studies [9, 11, 50, 64] analysed MCI prevalence for multiple countries. The majority of studies have been conducted in China (n=55 studies [9, 11, 20, 24, 26-45, 48, 51, 52, 54, 56-58, 62, 66-68, 72-84, 86, 87, 89, 90, 94-96]), followed by India (n=6 studies [9, 11, 25, 85, 91, 92]), Mexico (n=4 studies [9, 11, 22, 65]), Brazil (n=2 studies [59, 60]), Malaysia (n=2 studies [47, 53]), the Philippines (n=2 studies [61, 69]), Central African Republic (n=2 studies [50, 64]), South Africa (n=2 studies [11, 93]), Republic of Congo (n=2 studies [50, 64]), and one each in Colombia [21], Nigeria [23], Cuba [9], Dominican Republic [9], Peru [9], Venezuela [9], Georgia [46], Kazakhstan [55], Tanzania [49], Bulgaria [88], Ghana [11], Russia [11], Egypt [70] and Benin West-Africa [63]. Therefore, most studies (n=67 studies [9, 11, 20-22, 24, 26-45, 47, 48, 51-60, 62, 65-68, 71-84, 86-90, 94-96]) were from sites in upper middle-income countries, 14 studies [9, 11, 23, 25, 46, 50, 55, 61, 64, 70, 85, 91-93] were from sites in lower middle-income countries, and four studies [49, 50, 63, 64] were from sites in low-income countries. One study [9] included data collected during 2003-2007 from eight
sites, one of which was Puerto Rico. This country was declared high-income by the World Bank in 2002. Therefore, the prevalence data for Puerto Rico has been excluded. Only four studies [11, 44, 65, 93] selected participants from a representative country-wide sample. The remaining studies included a sample of community residents from a specific region, city or district(s).

**Quality Assessment**

The detailed quality assessment is reported in Table 2 of the supplementary material. Two studies [44, 93] obtained a low risk of bias score across all nine domains assessed, with the majority of studies (n=66 studies) only having high risk scores in 1-3 domains [9, 11, 21-43, 46, 48-51, 53-57, 60, 61, 63, 65-68, 70-73, 75-78, 80-86, 88-91, 94-96]. These were mostly related to a lack of, or unclear use of, randomisation procedures and that the study sample was unlikely to be representative of the national population.

**MCI Criteria**

As shown in Table 1, numerous criteria were used to diagnose MCI including (1) Petersen’s criteria [8, 97-102] (n=26 studies [9, 20-44]); (2) IWG criteria [103] (n=14 studies [45-58]); (3) study specific criteria for CIND (n=10 studies [59-68]); (4) study specific criteria for MCI (n=13 studies [30, 70, 74-76, 79, 80, 84, 86, 89, 91, 94, 95]); (5) DSM-IV criteria [104] (n=8 studies [72, 77, 78, 81-83, 90, 96]); (6) MCI based on a score from a neuropsychological assessment tool (n=3 studies [69, 87, 92]); (7) NIA-AA criteria [10] (n=2 studies [11, 93]); or, (8) the European Consortium on Alzheimer’s Disease (ECAD) criteria [105] (n=2 studies [85, 88]). A full description of the different MCI criteria applied across the studies is in Supplementary Tables 3 and 4.

**Operationalising MCI criteria**

Full details of how MCI criteria were operationalised (and any modifications that were made to mapping the original diagnostic criteria) are detailed below and outlined in Supplementary Table 5. Overall, MCI was diagnosed using one or more of the following criteria (1) subjective/informant cognitive or memory complaint; (2) global cognitive performance; (3) domain specific cognitive performance; (4) physical

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functioning; (5) no dementia; and, (6) other factors (e.g. disease related co-mobility). Additional assessments were used in 7/78 studies [24, 27, 45, 47, 51, 62, 70]. In four studies a Clinical Dementia Rating (CDR) score between 0 and 0.5 [27], or a score of 0.5 was needed for diagnosis of MCI [24, 45, 51]. In four studies [24, 47, 62, 70] it was required that cognitive impairment was independent of other factors such as depression.

**Domain Specific MCI**

Based on the cognitive domain test scores, 17 studies [9, 20-24, 26, 43, 45-48, 51-53, 70, 91] stratified MCI into different subtypes. This included non-amnestic MCI (naMCI; n=8 studies [22, 23, 43, 45-48, 51]), aMCI single domain (aMCI-SD; n=4 studies [22, 23, 43, 48]), multi-domain aMCI (aMCI-MD) (n=5 studies [22, 23, 43, 46, 48]), multi-domain non-amnestic MCI (naMCI-MD; n=4 studies) [22, 23, 46, 48], and single domain naMCI (naMCI-SD; n=3 studies [22, 23, 48]).

**Subjective Cognitive/Memory Complaint**

Cognitive/memory complaints were included as part of the MCI diagnosis in 57/78 studies [9, 11, 20-24, 26-29, 31-34, 36-43, 45, 47-56, 58-60, 62, 70, 72-76, 78-83, 85, 88, 90, 91, 93-95]. Complaint was typically required to be subjective and focused on memory (n=43 studies [9, 11, 20-22, 24, 26-28, 31-34, 36-43, 47, 48, 52, 53, 58-60, 62, 70, 72-74, 76, 78, 79, 81-83, 90, 95]) or cognition in general (n=11 studies [23, 45, 49-51, 54, 56, 75, 80, 85, 88]). In 25 studies, complaints could also be reported by an informant [22, 23, 27, 28, 44, 45, 47, 48, 51, 52, 54-56, 60, 62, 70, 72, 73, 75, 76, 80, 85, 91, 94, 95]. Thirty studies did not specify how cognitive/memory complaints were assessed or the information was not reported [20, 24-26, 29, 30, 43, 44, 46, 49, 50, 55, 57, 61, 63-69, 77, 84, 87-89, 92, 93, 96].

**Global Cognitive Function**

Global cognitive function was assessed in 61/78 studies [21-23, 25-34, 36-44, 46, 47, 50, 52-54, 57-70, 72-76, 78-83, 88-92, 95, 96]. In 33 studies [23, 25, 29, 32, 39-41, 50, 57-70, 74, 75, 79-83, 88, 90, 92, 95], global cognitive function was required to be impaired, while in 28 studies [21, 22, 26-28, 30, 31, 33, 34, 36-38, 42-44, 46, 47, 52-54, 72, 73, 76, 78, 89, 91, 94, 96] it was required to be preserved or
within normal limits. In total, 10 different neuropsychological assessment tools were used to assess global cognitive function including the Mini Mental State Examination (MMSE; n=40 studies [20, 22, 25-27, 30, 31, 33, 34, 36, 43, 47, 52-54, 57, 59, 60, 62, 66-69, 72, 74-76, 78, 80-83, 88-92, 95, 96]), the Montreal Cognitive Assessment (MoCA; n=10 studies [27, 29, 32, 39-41, 46, 58, 79, 89]), the Clinical Dementia Rating scale (CDR; n=5 studies [44, 61, 66, 67, 70]), the Community Screening Instrument for Dementia (CSI-D; n=3 studies [50, 63, 64]), the Consortium to Establish a Registry for Alzheimer’s Disease battery (CERAD; n=2 studies [21, 91]), the Five Word Test (FWT; n=2 studies [63, 64]), the Cambridge Examination for Mental Disorders-Revised (CAMDEX-R; n=1 study [20]), the Identification and Intervention for Dementia in Elderly Africans (IDEA) cognitive screen (n=1 study [23]), The Memory Impairment Screen (MIS; n=1 study [88]), and the Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE; n=1 study [65]). Of the studies using the MMSE, and with reported cut-off scores, 22 studies [26, 27, 30, 31, 33, 57, 59, 60, 62, 67, 72, 73, 75, 80-83, 89, 90, 94-96] used education specific cut-off scores, and 16 studies used a mixture of the following:

1. To demonstrate normal cognitive function: MMSE≥24 (n=4 studies [43, 54, 76, 78]), MMSE one standard deviation (1SD) from norm (n=1 study [68]), MMSE≥19 (n=2 studies [47, 53]), MMSE≥23 (n=1 study [22]) and MMSE range 24-26 (n=1 study [36]); and,

2. To demonstrate cognitive impairment: MMSE≤24 (n=2 studies [25, 92]), MMSE≤26 (n=2 studies [34, 74]), MMSE≤25 (n=1 study [88]), MMSE≤27 (n=1 study [66]), and MMSE range 20-25 (n=1 study [69]).

**Domain Specific Cognitive Function: Memory**

Memory was individually assessed for impairment in 41 studies [9, 11, 20-24, 26-29, 37-53, 55, 56, 59, 60, 62, 65, 70, 73, 78, 88, 90, 91, 93]. Some studies used neuropsychological assessment tools to assess memory impairment. The MMSE (n=3 studies [20, 26, 52]), and the Wechsler Memory Scale (WMS; n=3 studies [27, 48, 62]) were the most frequently used, followed by the MIS (n=2 studies [22, 88]), the CSI-D (n=1 study [9]), the Cross-Cultural Cognitive Examination (CCCE; n=1 study [65]), and the Cambridge Mental Disorders of the Elderly Examination (CAMDEX) (n=1 study [20]). The remaining studies used individual memory tests, of which the Auditory-Verbal Learning Test (AVLT; n=6 studies
was most often used followed by the CERAD 10 word learning test (n=5 studies [9, 11, 21, 49, 93]), the digit span test (n=4 studies [11, 12, 47, 53]), the Brief Cognitive Screening Battery (BCSB) delayed recall task (n=2 studies [59, 60]), the Fuld Object Memory Evaluation (FOME; n=1 study [45]), the stick test (n=1 study [45]), the Renminbi test (n=1 study [45]), the IDEA 10 word learning test (n=1 study [23]), the MoCA free delayed recall test (n=1 study [46]), the Rey-Osterrieth complex figure test (n=1 study [43]), RAVLT total learning (n=1 study [47]), RAVLT delayed recall (n=1 study [47]), the MMSE memory subtask (n=1 study [48]), WMS-III local memory test (n=1 study [70]), CDR memory score (n=1 study [70]), CCCE verbal memory (n=1 study [65]), and the free and cued selective reminding test (n=1 study [50]). Eighteen studies describe cut-off scores for impairment including: <1.5 SDs adjusted for age and education (n=8 studies [9, 21, 22, 43, 45, 48, 51, 78]), <1.5 SDs below norms (n=6 studies [27, 44, 46, 53, 62, 91]), <1 SD below norms (n=2 studies [47, 70]), <-1 SD adjusted for age, education and country (n=2 studies [11, 93]), and, 1.5-2 SDs below the overall mean adjusted for age and education (n=1 study [56]).

**Domain Specific Cognitive Function: Other Domains**

Non-memory cognitive test performance was assessed in 26 studies [11, 22, 23, 25, 27, 43-51, 55, 56, 59, 60, 62, 65, 79, 85, 88, 91, 93]. Eight different test batteries were used including: the Wechsler Adult Intelligence Scale (WAIS; n=3 studies [27, 48, 62]), CERAD (n=1 study [88]), CSI-D (n=1 study [49]), the Alzheimer's Disease Assessment Scale Cognitive Subscale (ADAS-COG; n=1 study [22]), IDEA cognitive screen (n=1 study [23]), CAMCOG (n=1 study [25]), MOCA (n=1 study [46]), Malayalam version of Addenbrooke’s Cognitive examination (m-ACE; n=1 study [85]), and the CCCE (n=1 study [65]). In addition, domain-specific tests (e.g. attention and executive function) were used, with the four most common being the verbal fluency test (n=10 studies [11, 43, 44, 50, 51, 59, 60, 62, 91, 93]), the Trail Making Test (TMT; n=7 studies [27, 43-46, 51, 62]), the Clock Drawing Test (CDT; n=5 studies [43, 44, 46, 47, 51]), and the Boston Naming Test (n=2 studies [43, 62]). Two studies [56, 79] stated that non-memory domains were assessed, however they did not describe which tests were used.

**Dementia**
Criteria used to exclude dementia included the DSM-IV (n=27 studies [20, 23, 25, 27, 34, 37, 44-46, 48-51, 55, 59, 61-64, 66-68, 70, 85, 88, 91, 92]), performance on a neuropsychological assessment battery (n=8 studies [22, 43, 47, 52, 56, 69, 87, 89]), a combination of cognitive test performance and evaluation of Activities of Daily Living (ADL)/Instrumental Activities of Daily Living (IADL; n=4 studies [11, 21, 65, 93]), NINCDS-ADRDA criteria (n=3 studies [23, 37, 62]), ICD-10 criteria (n=1 study [25]), the 10/66 dementia algorithm (n=1 study [9]), diagnoses by a doctor (n=1 study [53]) or NIA-AA criteria (n=1 study [60]).

**Functional Performance**

Fifty-six studies reported that physical functioning, including ADL/IADL, were part of the assessment for MCI [9, 11, 20-28, 31-33, 36-38, 42-56, 59, 60, 62, 65-67, 72-76, 79-83, 85, 88, 90, 91, 93-95]. However, 26 of these studies did not report the method used to determine physical functioning status [24-26, 28, 32, 34, 36-38, 42, 43, 46, 48, 49, 56, 72, 73, 75, 76, 79-83, 94, 95]. Thirty-six studies [9, 11, 20, 21, 24-27, 31-33, 37, 38, 42, 45-50, 52-54, 62, 65-67, 73, 74, 88, 90, 95] exclusively assessed either ADL or IADL. The majority of studies required persevered ADL/IADL for a diagnosis of MCI, with only 13 studies [9, 11, 22, 41, 46, 53, 72, 75, 80-83, 91] allowing for subtle changes/mild functional impairment. In 26 studies, impairment in ADL/IADL was assessed using previous developed tools, of which the Katz ADL scale was the most often used (n=8 studies [11, 20, 22, 27, 47, 52, 53, 93]), followed by the Lawton and Brody scale (n=5 studies [21, 45, 47, 52, 53]), the Functional Activities Questionnaire (FAQ; n=4 studies [44, 51, 55, 60]), the CDR (n=2 studies [45, 51]), the CSI-D informant interview (n=2 studies [9, 50]), the Everyday Ability Scale for India (n=2 studies [85, 91]), the Barthel scale (n=1 study [21]), the Clinician Home Based Interview to assess Function (CHIF test; n=1 study [23]), and the IQCODE (n=1 study) [60].

**MCI prevalence**

The prevalence estimates reported in this review were all determined at the time of the study. However, one study [86] reported MCI prevalence at two time points (2010 and 2015). Across the different definitions used, 31 studies [11, 22, 23, 25, 27, 30, 31, 43-51, 55, 57, 69, 71, 75, 80, 84-89, 91, 93, 96]
calculated overall MCI prevalence, 47 studies [9, 20-24, 26, 28, 29, 32, 34-43, 45-48, 51-53, 56, 58, 70, 72-74, 76, 78, 79, 81-83, 90, 91, 94, 95] calculated aMCI prevalence, eight studies [22, 23, 43, 45-48, 51] calculated naMCI prevalence and 10 studies [59-68] calculated CIND prevalence. Two studies [44, 86] subtyped MCI by aetiology as defined by: MCI caused by prodromal Alzheimer’s disease [44], MCI resulting from cerebrovascular disease [44], MCI with vascular risk factors [44], MCI with significant memory impairment [86], MCI with significant executive function impairment and relationship with cerebral vascular disease [86] and MCI caused by other factors [86]. As shown in Table 1, MCI prevalence ranged from 0.3% (95% CI: 0.1-0.5) in a sample from Mexico (n=2,944; ≥60 years; naMCI multiple domain, Petersen criteria) [22] to 63.3% in a sample from the Philippines (n=120; ≥65 years; MCI defined as an MMSE score 20-25 out of 30) [69]. Specifically, for Petersen criteria, prevalence of aMCI ranged from 0.6% (95% CI: 0.3-0.9) [9] to 22.3% [26]. Similar variability was seen across studies using the IWG Criteria for aMCI (range 4.5% [48] to 18.3% [58]; n=9 studies); IWG criteria for all-MCI (range 6.1% [50] to 30.4% [55]; n=10 studies); studies using CIND criteria (range 6.1% [59] to 47.4% [66]; n=10 studies), studies using study specific criteria to diagnose MCI (range 1.6% [86] to 27.7% [80]; n=13 studies); DSM-IV criteria (range 9.8% [83] to 33.0% [77]; n=8 studies); studies using neuropsychological tests (range 9.7% [87] to 63.3% [69]; n=3 studies); NIA-AA criteria (range 8.5% [93] to 15.3% [106]; n=2 studies) and European Consortium of AD criteria (range 6.7% [88] to 26.1% [85]; n=2 studies).

The forest plots in Figure 2 show the MCI prevalence estimates for Petersen defined all-MCI (Figure 2A) and aMCI (Figure 2B), the IWG criteria (Figure 2C) and criteria for CIND (Figure 2D). The plots show there is large variability in MCI prevalence across studies even when the same criteria are applied in the same country albeit in different samples. In contrast, prevalence estimates are generally, although not always, more consistent across countries in multi-site studies (n=4 studies [9, 11, 50, 64]) when the same methods are used (0.6%-4.6% [9]; 6.1%-7.2% [50]; 18.8%-25.0% [64]).

**Associated Risk Factors**
Risk factors for prevalent MCI were investigated in 64/78 studies [20-24, 26-45, 47, 48, 51-60, 62, 67-69, 72-76, 78-87, 89-93, 95, 96]. Two studies [53, 67] did not report risk factor information in the original article, however, risk factor data for the same cohort were later published in a separate article [107, 108]. In this scenario, we have added the risk factor information as documented in the most recent publication. One paper [27] reported additional vascular risk factor information in a separate article [109] and we have also included this data. Significant risk factors for MCI included increased age (n=46/64 studies [22, 23, 26-42, 44, 45, 48, 51, 54-58, 62, 67, 72-76, 78-82, 84, 89, 90, 92, 94, 96]), sex (n=41/64 studies; in 37 studies [22-24, 26, 28-30, 33, 34, 36, 38-42, 45, 48, 51, 54, 58, 62, 67-69, 72, 73, 76, 78, 81, 84, 86, 89, 90, 93-96] women had higher risk and in four studies [21, 27, 44, 87] men had higher risk), and low level of education (n=44/64 studies [20-23, 27-37, 39-45, 48, 51, 54-57, 62, 67, 72-76, 78-82, 84, 89, 90, 94]). Other significant risk factors included the presence of disease related co-morbidities (e.g. hypertension, stroke, coronary heart disease) [12, 20, 22, 34, 41-44, 48, 56, 60, 67, 84, 86, 89-91, 94], low monthly income/lower economic status [27-29, 33, 36, 39-42, 62, 79, 90, 92], marital status (without spouse) [28, 33, 34, 41, 54, 62, 68, 75, 76, 78, 80, 84, 87, 90, 92], occupation (physical labour) [27, 28, 34, 37, 41, 44, 58, 74-76, 78, 81, 83], geographic area (rural location) [37, 51, 68], diabetes [34, 41-44, 48, 84, 86, 90, 91], alcohol consumption [20, 39, 72, 81, 85, 93, 94], high body mass index [22, 48, 86, 89, 94], living alone [28, 29, 32, 34, 36, 38, 72, 78, 79, 81], APOE E4 carrier [32, 94], low physical activity [28, 38, 39, 41, 54, 84], current or a history of smoking [26, 34, 39, 48, 72, 75, 84, 90, 91], sleep (poor) [26, 28, 38, 84], depression [22, 41, 90], and an introverted personality [29, 40, 58]. Protective factors included maintaining social contact with others [29, 43, 58, 76, 78] and following a healthy diet/consuming healthy dietary components [35, 40, 43, 81] or specifically drinking tea [26, 35, 43, 89]. See supplementary Table 6 for full details of all risk factors reported across the different studies.

DISCUSSION

This is the first systematic review, to our knowledge, focused on MCI prevalence and its risk factors specifically in LMICs. The results highlight that MCI research in LMICs is largely restricted to upper-middle income countries, namely China. Further, MCI research is characterised by wide variation in
population sampling, the case definition used for an MCI diagnosis, operationalisation of the component criterion and prevalence estimates. These differences make cross-study comparison extremely difficult and highlight the urgent need for consensus in how MCI is defined across different settings.

MCI prevalence ranged from 0.3% [22] to 63.3% [69]. This variability was not reduced when grouping prevalence estimates by case definition. However, as shown in Figure 2, there was a general pattern. Similar to what is observed in high income countries [110] we found that diagnostic criteria that are more restrictive and capture a single impairment (e.g. Petersen aMCI criteria; range 0.6% (95%CI: 0.3-0.9) [9] to 22.3% [26]) have generally lower prevalence estimates compared to more general criteria that capture broader dysfunction (e.g. CIND where the majority of studies n=7/10 reported a prevalence >15%). Although it is important to note that estimated prevalence for specific criteria did vary considerably. In relation to age, across all definitions, MCI appears to be rare in the very young, i.e. people <50 years. Furthermore, aMCI (Petersen Criteria) and IWG generally have a lower prevalence in studies where people are aged ≥65 vs people aged ≥60 with the opposite trend observed for all MCI (Petersen Criteria) and CIND.

Regarding definition, across studies, the most widely applied criteria were Petersen defined aMCI (n=26 studies [9, 20-44]) requiring subjective/informant memory complaint, normal global cognitive function, impaired memory, preserved (or relatively preserved in later definitions) physical function and no dementia. Prevalence of aMCI ranged from 0.6% (95%CI: 0.3-0.9) [9] to 22.3% [26]. Similar variability was seen across studies using the IWG Criteria for aMCI (range 4.5% [48] to 18.3% [58]) and IWG criteria for all-MCI (range 30.4% [55] to 6.1% [50]). These results are in line with previous systematic reviews of MCI incorporating studies predominately from high-income countries [111]. Variability in prevalence is likely due to differences in sample characteristics (e.g. age, educational attainment and distribution of risk and protective factors) and methodology (e.g. test batteries used to assess cognitive and physical function, cut-off scores for impairment and whether the analyses were adjusted for factors such as age, sex and education) across studies. Indeed, of the studies that included multiple sites all
demonstrated that when the same methods were used to diagnose MCI, prevalence estimates were generally (although not always) more comparable across countries [9, 11, 50, 64].

Similar to findings in high-income countries, both modifiable and non-modifiable risks factors were identified for MCI. Key socio-demographic risk factors included increased age, sex (usually, but not always female) and low educational attainment. Modifiable health and lifestyle risk factors included, but were not limited to, smoking, presence of cardiovascular related diseases, social contact, occupation, physical activity and dietary related factors. These findings support the development of novel public health interventions to reduce risk of cognitive impairment targeting education, cardio-metabolic health and lifestyle factors that are applicable to the specific context of LMIC settings. However, a key knowledge gap highlighted by the review is the lack of research into context specific risk factors. Indeed, compared to high-income countries factors such as lifelong disadvantage, food insecurity, poverty, and absence of robust health and social care services might also be important in increasing risk of MCI and dementia in these settings.

Of note, is the scarcity of studies on MCI from countries classified as low-income (only n=4 studies [49, 50, 63, 64]). Further, no studies were identified from LMICs in the Middle East, with the exception of one study from Egypt [70]. As shown in Figure 3, most MCI research in LMICs has come from cohorts in the Far East (e.g. China and parts of Asia and South-Asia including Malaysia, Philippines and India), South America and the Caribbean (including Cuba, Dominican Republic, Mexico) and an increase in research in Africa (Tanzania, Nigeria, Central African Republic, Republic of Congo) only in the last five years (i.e. from 2015 onwards). Few studies have also been conducted in European LMICs with the exception of Bulgaria [88], Russia [106] and Georgia [46]. This lack of research into MCI could reflect the more recent demographic transition and population ageing in LMICs, highlighted by an increase in dementia-specific research in the past 10 years [112]. Also, across different LMIC settings there are high levels of low educational attainment/illiteracy in older people and there are often no norms for cognitive testing making MCI diagnosis challenging. Furthermore, there are typically very
few specialist clinicians able to supervise this type of work in LMIC settings, with the exception of some countries like China.

**Strengths and Weaknesses**

The study has a number of strengths. We undertook a wide literature search capturing many of the different definitions of MCI. This allowed for a more comprehensive synthesis of the types of criteria used to diagnose MCI across the many different LMICs. Some studies however could still have been missed if they defined MCI outside the scope of the search. There are some weaknesses. First, the electronic search was undertaken in English and therefore studies published in other languages, including those common in LMICs such as Spanish, Portuguese and French could have been missed if they were not recoded in EMBASE, Pubmed or PsycInfo. We minimised the risk of not capturing Chinese articles by including findings from a recent systematic review on MCI prevalence in China[7]. Structuring the search this way could possibly explain the large number of MCI studies captured from China compared to other LMICs. This difference could also be due to variability in research investment into ageing and dementia. Second, we focused only on cross-sectional studies that reported MCI prevalence estimates. Therefore, we did not investigate whether MCI is predictive of future dementia in LMICs or what the risk factors for incident MCI are. As such, we are unable to make recommendations as to which criteria are the most “useful”. This was beyond the scope of the review. Last, given the paucity of research into ageing and dementia in LMIC settings we included any population-based study in the review; and, only four were population-representative [11, 44, 65, 93]. MCI prevalence results in non-representative samples must be viewed with caution as they may be biased for example by sampling (e.g. difference in location such as urban vs. rural) and differences in the profile of risk/protective factors (e.g. demographic, health and socio-economic status).

**Conclusion**

Numerous definitions of MCI have been proposed [113]. Determining which, if any, are suitable for application in LMICs will require an in-depth evaluation of not only how well they capture people with
cognitive impairment, but also whether the condition is predictive of future dementia in these settings. To achieve this will require consensus on how MCI is defined particularly in settings with varying educational levels and amongst older people and varying cultural milieu and expectations resulting in challenges in MCI case identification. Nevertheless, given the high burden of dementia now seen in LMICs, identification of these higher risk individuals at a stage where intervention could take place is likely to have a high impact on the burden of disease associated with cognitive impairment and dementia in these settings. Thus, to further understand MCI prevalence in these settings there is an urgent need for more high quality, population representative MCI prevalence studies, particularly in countries classified as low income.

Conflict of Interests / Disclosure Statement
The authors have no conflict of interest to report.

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Contributor Statement
BCM conceptualised the study. CVA, CR, and YZ screened and selected the studies. AMG, AS, BCMS and CVA extracted the data. CVA and BCM drafted the initial manuscript, with a critical review by AMG. MS developed the forest plots. SMP, DM, YCS, MP, LR, MS, CR, SC, AS provided feedback and further revised the manuscript. All authors read and approved the final manuscript.
References


## Table 1 Study characteristics and MCI prevalence arranged by definition (ordered by age [lowest to highest])

<table>
<thead>
<tr>
<th>Author</th>
<th>Location</th>
<th>Income Class</th>
<th>Age (years)</th>
<th>Summary population characteristics</th>
<th>Mild cognitive impairment (MCI)</th>
<th>Total sample size</th>
<th>Cases</th>
<th>Prevalence % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henao-Arboleda, 2008 [21]</td>
<td>Columbia</td>
<td>UMIC</td>
<td>≥50</td>
<td>Residents of metropolitan area of Medellin</td>
<td>aMCI</td>
<td>848</td>
<td>82</td>
<td>9.7 (7.6 - 11.7)</td>
</tr>
<tr>
<td>Lao, 2011[31]</td>
<td>China</td>
<td>UMIC</td>
<td>≥ 55</td>
<td>Non-demented residents of Hainan province</td>
<td>MCI</td>
<td>7665</td>
<td>326</td>
<td>4.25 (3.80-4.68)</td>
</tr>
<tr>
<td>Li, 2013 [43]</td>
<td>China</td>
<td>UMIC</td>
<td>≥55</td>
<td>Non-demented residents of Beijing with an MMSE≥24 (The Beijing Ageing Brain Rejuvenation Initiative: BABRI)</td>
<td>aMCI-SD</td>
<td>1,020</td>
<td>65</td>
<td>6.4</td>
</tr>
<tr>
<td>Qin, 2014[34]</td>
<td>China</td>
<td>UMIC</td>
<td>≥ 55</td>
<td>Non-demented residents of Shanghai</td>
<td>aMCI</td>
<td>4086</td>
<td>612</td>
<td>14.98 (13.88-16.02)</td>
</tr>
<tr>
<td>Huang, 2008[73]</td>
<td>China</td>
<td>UMIC</td>
<td>≥ 60</td>
<td>Non-demented residents of Guangzhou</td>
<td>aMCI</td>
<td>4697</td>
<td>257</td>
<td>5.47(4.82-6.09)</td>
</tr>
<tr>
<td>Juarez-Cedillo, 2013 [22]</td>
<td>Mexico</td>
<td>UMIC</td>
<td>≥60</td>
<td>Residents, registered with family medicine units (IMSS), of Mexico City</td>
<td>All MCI</td>
<td>2,944</td>
<td>190</td>
<td>6.5 (5.6 - 7.4)</td>
</tr>
<tr>
<td>Liao , 2012[32]</td>
<td>China</td>
<td>UMIC</td>
<td>≥ 60</td>
<td>Non-demented residents of Ychun</td>
<td>aMCI</td>
<td>399</td>
<td>41</td>
<td>10.28 (7.30-13.10)</td>
</tr>
<tr>
<td>Pan, 2012 [28]</td>
<td>China</td>
<td>UMIC</td>
<td>≥ 60</td>
<td>Non-demented residents of Jinhu</td>
<td>aMCI</td>
<td>897</td>
<td>154</td>
<td>17.17 (14.7-19.51)</td>
</tr>
<tr>
<td>Su, 2013[36]</td>
<td>China</td>
<td>UMIC</td>
<td>≥ 60</td>
<td>Non-demented residents of Xian</td>
<td>aMCI</td>
<td>796</td>
<td>145</td>
<td>18.22(15.53-20.76)</td>
</tr>
<tr>
<td>Tang, 2007[37]</td>
<td>China</td>
<td>UMIC</td>
<td>≥ 60</td>
<td>Non-demented residents of Beijing</td>
<td>aMCI</td>
<td>1865</td>
<td>217</td>
<td>11.60(10.18-13.02)</td>
</tr>
<tr>
<td>Tiwari, 2013[25]</td>
<td>India</td>
<td>LMIC</td>
<td>≥60</td>
<td>Residents of Malihabad and Bakshi Ka Talab of Lucknow district of the State of Uttar Pradesh</td>
<td>All MCI</td>
<td>2,146</td>
<td>98</td>
<td>4.6 (3.7 - 5.5)</td>
</tr>
<tr>
<td>Tong, 2013[38]</td>
<td>China</td>
<td>UMIC</td>
<td>≥ 60</td>
<td>Non-demented residents of Tangshan</td>
<td>aMCI</td>
<td>1575</td>
<td>200</td>
<td>12.7</td>
</tr>
<tr>
<td>Wang, 2012[42]</td>
<td>China</td>
<td>UMIC</td>
<td>≥ 60</td>
<td>Non-demented residents of Tianjin</td>
<td>aMCI</td>
<td>3678</td>
<td>408</td>
<td>11.1</td>
</tr>
<tr>
<td>Wang, 2017[26]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Residents of rural and urban areas in Shanghai</td>
<td>aMCI</td>
<td>1,065</td>
<td>224</td>
<td>22.3</td>
</tr>
<tr>
<td>Xu, 2014[27]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of the Hebei province</td>
<td>All MCI</td>
<td>2,426</td>
<td>526</td>
<td>21.3 (19.2 - 23.1)</td>
</tr>
<tr>
<td>Zhang, 2011[41]</td>
<td>China</td>
<td>UMIC</td>
<td>≥ 60</td>
<td>Non-demented residents of Suzhou</td>
<td>aMCI</td>
<td>5388</td>
<td>691</td>
<td>12.8</td>
</tr>
<tr>
<td>Zhu and Li, 2015[40]</td>
<td>China</td>
<td>UMIC</td>
<td>≥ 60</td>
<td>Non-demented residents of some communities of Xinyang</td>
<td>aMCI</td>
<td>1755</td>
<td>245</td>
<td>13.96 (12.34-15.50)</td>
</tr>
<tr>
<td>Jia, 2014[114]</td>
<td>China</td>
<td>UMIC</td>
<td>≥ 65</td>
<td>Non-demented residents of 5 city of China</td>
<td>All MCI</td>
<td>10,276</td>
<td>630</td>
<td>19.5 (18.8-20.3)</td>
</tr>
<tr>
<td>Sosa, 2012[9]</td>
<td>Cuba</td>
<td>DR</td>
<td>≥65</td>
<td>Residents of urban and rural settings</td>
<td>aMCI</td>
<td>2,620</td>
<td>47</td>
<td>1.5 (1.0-1.9)</td>
</tr>
<tr>
<td>Ogguniyi, 2016 [23]</td>
<td>Nigeria</td>
<td>UMIC</td>
<td>≥65</td>
<td>Residents of rural and urban settings</td>
<td>aMCI</td>
<td>1,767</td>
<td>25</td>
<td>1.3 (0.7-1.8)</td>
</tr>
</tbody>
</table>

* Indicates significant difference from other studies.
<table>
<thead>
<tr>
<th>Author</th>
<th>Location</th>
<th>Income Class</th>
<th>Age (years)</th>
<th>Summary population characteristics</th>
<th>MCI definition</th>
<th>Total sample size</th>
<th>Cases</th>
<th>Prevalence % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hai, 2012 [20]</td>
<td>China</td>
<td>UMIC</td>
<td>≥80</td>
<td>Non-demented residents of Chengdu</td>
<td>aMCI</td>
<td>613</td>
<td>45</td>
<td>n/a</td>
</tr>
<tr>
<td>Ding, 2015 [45]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented community residents of Shanghai</td>
<td>aMCI</td>
<td>2,985</td>
<td>601</td>
<td>20.1 (18.7 - 21.5)</td>
</tr>
<tr>
<td>Fang, 2015 [56]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of a community of Shanghai</td>
<td>aMCI</td>
<td>1059</td>
<td>137</td>
<td>12.90 (10.9-14.9)</td>
</tr>
<tr>
<td>Fang, 2009 [54]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of Hangzhou</td>
<td>MCI</td>
<td>925</td>
<td>195</td>
<td>21.10 (18.45-23.58)</td>
</tr>
<tr>
<td>Tsoy, 2019 [55]</td>
<td>Kazakhstan</td>
<td>UMIC</td>
<td>≥60</td>
<td>Residents from Almaty, Kazakhstan</td>
<td>MCI</td>
<td>662</td>
<td>201</td>
<td>30.4 (26.9-33.9)</td>
</tr>
<tr>
<td>Vanoh, 2016 [53]</td>
<td>Malaysia</td>
<td>LMIC</td>
<td>≥60</td>
<td>Residents of four different states: Perak, Selangor, Kelantan and Johor (Towards Useful Ageing Study)</td>
<td>aMCI</td>
<td>1,993</td>
<td>315</td>
<td>15.8</td>
</tr>
<tr>
<td>Zhang, 2013 [58]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of Taicang</td>
<td>aMCI</td>
<td>2460</td>
<td>450</td>
<td>18.29 (16.76-19.74)</td>
</tr>
<tr>
<td>Su, 2013 [52]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Elderly of rural and urban areas in Xian</td>
<td>aMCI</td>
<td>796</td>
<td>145</td>
<td>18.2</td>
</tr>
<tr>
<td>Janelidze, 2018 [46]</td>
<td>Georgia</td>
<td>LMIC</td>
<td>≥65</td>
<td>Residents, without moderate to severe cognitive impairment, from urban (Tbilisi) and two rural areas (Kakheti and Imereti)</td>
<td>aMCI</td>
<td>238</td>
<td>66</td>
<td>27.7</td>
</tr>
<tr>
<td>Ma, 2016 [48]</td>
<td>China</td>
<td>UMIC</td>
<td>≥65</td>
<td>Non-demented residents of sixteen districts within the Tianjin urban boundary</td>
<td>aMCI</td>
<td>5,067</td>
<td>574</td>
<td>11.3 (8.2 - 14.4)</td>
</tr>
<tr>
<td>Pilleron, 2015 [50]</td>
<td>CAR</td>
<td>LIC</td>
<td>≥65</td>
<td>Residents of Bangui and Nola</td>
<td>All MCI</td>
<td>9860</td>
<td>62</td>
<td>7.2</td>
</tr>
<tr>
<td>Rao, 2018 [51]</td>
<td>China</td>
<td>UMIC</td>
<td>≥65</td>
<td>Residents of Guangzhou</td>
<td>aMCI</td>
<td>2,111</td>
<td>299</td>
<td>14.2</td>
</tr>
<tr>
<td>Sun, 2016 [57]</td>
<td>China</td>
<td>UMIC</td>
<td>≥65</td>
<td>Non-demented residents of Baotou</td>
<td>MCI</td>
<td>384</td>
<td>40</td>
<td>10.42 (7.36-13.32)</td>
</tr>
<tr>
<td>Paddock, 2015 [49]</td>
<td>Tanzania</td>
<td>LIC</td>
<td>≥70</td>
<td>Residents of the Hai district</td>
<td>All MCI</td>
<td>296</td>
<td>46</td>
<td>6.3 (2.9 – 9.7)</td>
</tr>
<tr>
<td>Mohan, 2019 [85]</td>
<td>India</td>
<td>LMIC</td>
<td>≥60</td>
<td>Residents from Thiruvananthapuram, Kerala</td>
<td>All MCI</td>
<td>426</td>
<td>111</td>
<td>26.1 (22.1-30.4)</td>
</tr>
<tr>
<td>Dimitrov, 2012 [88]</td>
<td>Bulgaria</td>
<td>UMIC</td>
<td>≥65</td>
<td>Residents from the city of Varna</td>
<td>All MCI</td>
<td>540</td>
<td>36</td>
<td>6.7 (4.6 - 8.8)</td>
</tr>
<tr>
<td>Koyanagi, 2019 [93]</td>
<td>South Africa</td>
<td>UMIC</td>
<td>≥50</td>
<td>Nationally representative sample from nine provinces across South Africa</td>
<td>All MCI</td>
<td>3672</td>
<td>312</td>
<td>8.5 (6.9-10.3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Author</th>
<th>Location</th>
<th>Income Class</th>
<th>Age (years)</th>
<th>Summary population characteristics</th>
<th>MCI definition</th>
<th>Total sample size</th>
<th>Cases</th>
<th>Prevalence % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STUDY SPECIFIC CRITERIA FOR MCI (n= 13 studies)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Das, 2007[91]</td>
<td>India</td>
<td>LMIC</td>
<td>≥50</td>
<td>Non-demented/non-depressed residents of Kolkata</td>
<td>All MCI aMCI (with/without complainers) aMCI (complainers only) (\text{mdMCI})</td>
<td>745</td>
<td>111</td>
<td>14.9 (12.2 - 18.0)</td>
</tr>
<tr>
<td>Wang, 2016[94]</td>
<td>China</td>
<td>UMIC</td>
<td>≥55</td>
<td>Non-demented residents of Ningxia province</td>
<td>aMCI</td>
<td>2168</td>
<td>457</td>
<td>21.08 (19.4-22.7)</td>
</tr>
<tr>
<td>Huang, 2007[30]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of Shenzhen</td>
<td>MCI</td>
<td>410</td>
<td>88</td>
<td>21.46 (17.49-25.23)</td>
</tr>
<tr>
<td>Khedr, 2015[70]</td>
<td>Egypt</td>
<td>LMIC</td>
<td>≥60</td>
<td>Residents of Qena governorates in Southern Egypt</td>
<td>aMCI</td>
<td>691</td>
<td>12</td>
<td>1.7 (0.8 - 2.7)</td>
</tr>
<tr>
<td>Li, 2013 [74]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of Jinan</td>
<td>aMCI</td>
<td>1226</td>
<td>115</td>
<td>9.38 (7.75-10.93)</td>
</tr>
<tr>
<td>Lu, 2019[86]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Residents of Ji County</td>
<td>In 2010 All MCI MCI-A MCI-VD MCI-O In 2015 All MCI MCI-A MCI-VD MCI-O</td>
<td>5581</td>
<td>5542</td>
<td>22.9 (16.60-28.87)</td>
</tr>
<tr>
<td>Wang, 2014[75]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of Zoushan</td>
<td>MCI</td>
<td>1906</td>
<td>318</td>
<td>16.68 (15.01-18.27)</td>
</tr>
<tr>
<td>Wu, 2012[76]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of Xian</td>
<td>aMCI</td>
<td>1583</td>
<td>396</td>
<td>25.02 (22.88-27.04)</td>
</tr>
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<td>Zhao, 2015[79]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of Jilin province</td>
<td>aMCI</td>
<td>976</td>
<td>171</td>
<td>17.60 (15.14-19.78)</td>
</tr>
<tr>
<td>Zhou, 2016[80]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of Changji</td>
<td>MCI</td>
<td>804</td>
<td>223</td>
<td>27.74 (24.64-30.67)</td>
</tr>
<tr>
<td>Zhu, 2013[84]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of Zhejiang province</td>
<td>MCI</td>
<td>1211</td>
<td>251</td>
<td>20.70 (18.44-22.89)</td>
</tr>
<tr>
<td>Chu, 2015[89]</td>
<td>China</td>
<td>UMIC</td>
<td>≥65</td>
<td>Non-demented residents of a community of Shanghai</td>
<td>MCI</td>
<td>842</td>
<td>180</td>
<td>21.4 (18.6-24.0)</td>
</tr>
<tr>
<td><strong>STUDY SPECIFIC CRITERIA FOR CIND/COGNITIVE IMPAIRMENT (n=10 studies)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cesar, 2016[60]</td>
<td>Brazil</td>
<td>UMIC</td>
<td>≥60</td>
<td>Residents of rural and urban areas in the Tremembe area, State of Sao Paulo</td>
<td>CIND</td>
<td>630</td>
<td>135</td>
<td>19.5 (16.6 - 22.8)</td>
</tr>
<tr>
<td>Dominguez, 2018[61]</td>
<td>Philippines</td>
<td>LMIC</td>
<td>≥60</td>
<td>Residents of Marikina City</td>
<td>CIND</td>
<td>1,367</td>
<td>317</td>
<td>23.2</td>
</tr>
<tr>
<td>Lei, 2008[68]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Normal cognitive and MCI residents from urban and rural areas of Guizhou province</td>
<td>CIND</td>
<td>4,323</td>
<td>665</td>
<td>15.4</td>
</tr>
<tr>
<td>Mejia-Arango, 2011[65]</td>
<td>Mexico</td>
<td>UMIC</td>
<td>≥60</td>
<td>Representative sample of elderly in Mexico (Mexican Health and Ageing Study)</td>
<td>CIND</td>
<td>6,847</td>
<td>1,719</td>
<td>28.7 ‡‡</td>
</tr>
<tr>
<td>Zhang, 2014 [67]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Residents of rural Ji County</td>
<td>CIND</td>
<td>5,550</td>
<td>1,295</td>
<td>23.3</td>
</tr>
<tr>
<td>Fei, 2009 [62]</td>
<td>China</td>
<td>UMIC</td>
<td>≥55</td>
<td>Residents of Taiyuan city</td>
<td>CIND</td>
<td>6,192</td>
<td>600</td>
<td>9.7 (9.6 - 9.8) ††</td>
</tr>
<tr>
<td>Guerchet, 2009[63]</td>
<td>Benin, West Africa</td>
<td>LIC</td>
<td>≥55</td>
<td>Residents in the rural commune of Djida centre</td>
<td>CIND</td>
<td>502</td>
<td>34</td>
<td>6.8</td>
</tr>
<tr>
<td>Guerchet, 2010[64]</td>
<td>CAR</td>
<td>LIC</td>
<td>≥55</td>
<td>Older age residents of Bangui</td>
<td>CIND</td>
<td>496</td>
<td>124</td>
<td>25.0 (21.2 - 29.0)</td>
</tr>
<tr>
<td>ROC</td>
<td>LMIC</td>
<td>≥55</td>
<td>Older aged residents of Brazzaville</td>
<td>CIND</td>
<td>520</td>
<td>98</td>
<td>18.8 (15.6 – 22.5)</td>
<td></td>
</tr>
<tr>
<td>Shi, 2013[66]</td>
<td>China</td>
<td>UMIC</td>
<td>≥80</td>
<td>Residents of rural Ji County</td>
<td>CIND</td>
<td>626</td>
<td>297</td>
<td>47.4 (43.5 - 51.4)</td>
</tr>
</tbody>
</table>

**CUT-OFF SCORE OF NEUROPSYCHOLOGICAL ASSESSMENT TOOL (n=3 studies)**
<table>
<thead>
<tr>
<th>Author</th>
<th>Location</th>
<th>Income Class</th>
<th>Age (years)</th>
<th>Summary population characteristics</th>
<th>MCI definition</th>
<th>Total sample size</th>
<th>Cases</th>
<th>Prevalence % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saha, 2010[92]</td>
<td>India</td>
<td>LMIC</td>
<td>≥50</td>
<td>Non-demented women, without history of neurological disorders, from a village of Singur block of Hoogly district, Kolkata</td>
<td>Cognitive impairment</td>
<td>179</td>
<td>76</td>
<td>42.4</td>
</tr>
<tr>
<td>Ruan, 2019[87]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Residents from 20 communities in the Zhoujiaqiao Primary Health Service Area in Changning district, Shanghai,</td>
<td>MCI</td>
<td>5328</td>
<td>500</td>
<td>9.67</td>
</tr>
<tr>
<td>Inocian, 2016[69]</td>
<td>Philippines</td>
<td>LMIC</td>
<td>≥55</td>
<td>Elderly, with no diagnosed mental health conditions, from Cebu City</td>
<td>All MCI</td>
<td>120</td>
<td>76</td>
<td>63.3</td>
</tr>
</tbody>
</table>

**DSM-IV CRITERIA** [104] (n=8 studies)

<table>
<thead>
<tr>
<th>Author</th>
<th>Location</th>
<th>Income Class</th>
<th>Age (years)</th>
<th>Summary population characteristics</th>
<th>MCI definition</th>
<th>Total sample size</th>
<th>Cases</th>
<th>Prevalence % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guo, 2013[72]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of six towns of rural area of Hunan</td>
<td>aMCI</td>
<td>1367</td>
<td>139</td>
<td>10.17 (8.57-11.69)</td>
</tr>
<tr>
<td>Zhang, 2015[77]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of Taian</td>
<td>MCI</td>
<td>1971</td>
<td>651</td>
<td>33.03</td>
</tr>
<tr>
<td>Zhang and Zeng, 2014[78]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of Changsha</td>
<td>aMCI</td>
<td>1764</td>
<td>229</td>
<td>16.27 (11.41-14.47)</td>
</tr>
<tr>
<td>Zhou, 2009[82]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of Xinjiang</td>
<td>aMCI</td>
<td>2986</td>
<td>205</td>
<td>10.21 (5.96-7.73)</td>
</tr>
<tr>
<td>Zhou, 2011[81]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of Ningbo</td>
<td>aMCI</td>
<td>1227</td>
<td>107</td>
<td>10.68 (7.14-10.22)</td>
</tr>
<tr>
<td>Zha, 2009[83]</td>
<td>China</td>
<td>UMIC</td>
<td>≥60</td>
<td>Non-demented residents of Wulumuqi</td>
<td>aMCI</td>
<td>1511</td>
<td>148</td>
<td>9.79 (8.3-11.22)</td>
</tr>
<tr>
<td>Xiong, 2013[90]</td>
<td>China</td>
<td>UMIC</td>
<td>≥65</td>
<td>Non-demented residents of Tianjin</td>
<td>aMCI</td>
<td>2798</td>
<td>339</td>
<td>11.38 (10.91-13.26)</td>
</tr>
</tbody>
</table>

**Notes**

* Weighted prevalence for age using the World Health Organization world population estimates 2015. † Weighted prevalence for age, gender, and education level. ‡ Weighted prevalence calculated using reciprocal probability weighting based on the Sixth Nationwide Population Census in China, 2010. § Participants with ‘all MCI’ could be categorized in more than one MCI subtype. ¶ Weighted prevalence using the direct standardization method adjusted by age and sex to the total Chinese population (according to the census conducted in 2005). †† Weighted prevalence for stratification and age according to the WHO standard population. §§ The study from Shi, 2013 and Zhang, 2014 used data from the same cohort study.

**Key**

95%CI Confidence Interval
alzMCI MCI caused by prodromal Alzheimer’s disease
aMCI Amnestic MCI
CAR Central African Republic
CIND Cognitive Impairment No Dementia
cvdMCI MCI resulting from cerebrovascular disease
DR Dominican Republic
LIC Low Income Country
LMIC Lower Middle Income Country
MCI Mild Cognitive Impairment
MCI-A Mild Cognitive Impairment with significant memory impairment
MCI-MD Multi Domain MCI
MCI-O non memory / nonvascular related types of mild cognitive impairment
MCI-SD Single Domain MCI
MCI-VD significant executive function impairment and relationship with cerebral vascular disease
naMCI Non-Amnestic MCI
NIA-AA National Institute on Aging and Alzheimer's Association
otherMCI MCI caused by other diseases
ROC Republic of Congo
UMIC Upper Middle Income Country
vrfMCI MCI with vascular risk factors
Figure 1 Study selection
Figure 2A Forest plot of MCI prevalence from studies using Petersen’s criteria for Amnestic MCI (ordered by age). Note: red dotted line indicates 10% prevalence. Key 95%CI 95% Confidence Interval; aMCI Amnesic Mild Cognitive Impairment; DR Dominican Republic
Figure 2B Forest plot of MCI prevalence from studies using Petersen’s criteria for All MCI (ordered by age). Note: red dotted line indicates 10% prevalence. Key 95% CI 95% Confidence Interval; MCI Mild Cognitive Impairment;
Figure 2C Forest plot of MCI prevalence from studies using the International Working Group criteria (ordered by age). Note: red dotted line indicates 10% prevalence. Key 95%CI 95% Confidence Interval; IWG International Working Group; CAR Central African Republic; ROC Republic of Congo.
Figure 2D Forest plot of MCI prevalence from studies using definition of Cognitive Impairment No Dementia criteria (ordered by age). Note: red dotted line indicates 10% prevalence.

Key 95%CI 95% Confidence Interval; CAR Central African Republic; ROC Republic of Congo; CIND Cognitive Impairment No Dementia.
Figure 3 World Map showing each study site, number of studies in each site (n) and the reported MCI prevalence estimate(s)