The Prevalence of Mild Cognitive Impairment among Chinese People: A Meta-Analysis

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Keywords

Mild cognitive impairment · Prevalence · Meta-analysis · China · Screening tool

Abstract

Background: Mild cognitive impairment (MCI) induced the majority number of dementia patients. The prevalence of MCI in China varied across studies with different screening tools and diagnostic criteria. **Objective:** A systematic review and meta-analysis was conducted to estimate the pooled MCI prevalence among the population aged 55 years and older in China. **Methods:** PubMed, EMBASE, CNKI, Wanfang, CQVIP, and CBMdisc were searched for studies on prevalence of MCI among Chinese elderly between January 1, 1980, and February 10, 2020. The quality assessment was conducted via external validity, internal validity, and informativity, the pooled prevalence was calculated through the random-effect model, and the homogeneity was evaluated by Cochran's Q test and I^2 . **Results:** Fifty-three studies with 123,766 subjects were included. The pooled prevalence of MCI among Chinese elderly was 15.4% (95% CI: 13.5–17.4%). Subgroup analyses indicated that the prevalence calculated with different screening tools was 20.2% (95% CI: 15.1–25.9%) for Montreal Cognitive Assessment (MoCA) and

13.0% (95% CI: 10.7–15.5%) for Mini-Mental State Examination (MMSE). According to different diagnostic criteria, the prevalence was 14.8% (95% CI: 12.2–17.6%) for Petersen criteria, 15.0% (95% CI: 12.7–17.5%) for DSM-IV, and 21.2% (95% CI: 17.5–25.2%) for Chinese Expert Consensus on Cognitive Impairment (CECCI). Besides, women, older adults, illiterate people, rural residents, and those who lived with unhealthy lifestyles and morbidity showed higher prevalence. **Conclusions:** The prevalence of MCI in China was 15.4%, which varied by demographics, lifestyles, morbidity, screening tools, and diagnostic criteria. In further studies, screening tools and diagnosis criteria should be considered when estimating MCI prevalence.

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Introduction

Dementia, as the leading cause of disability in older people, has become a major public health problem for its heavy economic and disease burden [1]. Mild cognitive impair-

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ment (MCI) is a transition stage between normal aging and dementia, and patients with MCI are more likely to suffer from dementia in the coming 2 years [2, 3]. A systematic review of 41 cohort studies showed that the conversion rate from MCI to dementia, Alzheimer's disease, and vascular dementia was 39.2, 33.6, and 6.2%, respectively [3, 4]. And, there was no effective medication for MCI. Paying attention to the MCI prevalence and taking available prevention strategies for risk factors will contribute to decrease the incidence of MCI and subsequent dementia. Therefore, a reliable estimate of MCI prevalence will play an indicative role in public health priority setting.

Facing a serious issue of population aging, China has a rapid increasing burden of MCI [5]. However, the representative epidemiological studies are scarce because of China's vast territory and complicated conditions, such as lifestyle, morbidity, different diagnostic criteria, and various screening tools. The published prevalence of MCI varies widely across studies ranging from 3.2 to 29.6% [6, 7], and accordingly the results are hard to be used in MCI prevention. Thus, in this study, we aimed to perform a timely meta-analysis basing on published population-based studies on the prevalence of MCI among Chinese elderly population.

Methods

Literature Search

Published studies were identified by systematically searching PubMed, Excerpta Medica Database (EMBASE), China National Knowledge Infrastructure (CNKI), Wanfang Database, Chongqing VIP (CQVIP) Database, and China Biology Medicine disc (CBMdisc). The search strategy used Mesh phrases and words such as "cognitive dysfunction, mild cognitive impairment, MCI, mild neurocognitive disorder, prevalence, epidemiology, China, and Chinese." In order to reflect the epidemiology of MCI comprehensively, we searched all relevant literatures with an update in February 10, 2020. The title and abstract of the articles were read firstly, and then the full-text article was read if it was not possible to identify the eligibility of a paper from the abstract. Moreover, references of relevant literatures were scanned carefully to determine any articles missed. Results were limited to papers published between January 1, 1980, and February 10, 2020, because the concept of MCI was proposed firstly between the early and mid-1980s [8].

Inclusion/Exclusion Criteria

All selected studies met the following criteria: (1) the case collection was based on cross-sectional investigation. (2) The studies were based on population samples and random sampling designs. (3) The age of participants included were 55 years and older. (4) The case collections were performed in 2 stages: screening and diagnostic phases, and the screening scale and diagnostic criteria were internationally recognized. (5) The prevalence of MCI was reported. (6) The papers were published in Chinese or English.

Articles based on community-dwelling adults were included, and those including individuals from hospital, nursing home, or military were excluded. Moreover, we excluded duplicated studies or results based on the same sample, and only the study with the most comprehensive results was accepted.

Data Extraction

Data from eligible studies were extracted independently by 2 reviewers and listed on Microsoft Excel worksheets. Specific information, such as first author's name, publication time, investigation time, province, sample size, demographic characteristics of participants, risk factors of MCI, morbidity status, screening tools, and diagnostic criteria, was extracted. Any disagreements between 2 individuals were resolved by discussing with a third reviewer.

Quality Assessment

Quality assessment was conducted according to the criteria for the methodological quality assessment of prevalence studies [9], which included the following items: 6 items on external validity (representativeness of the sample, description of eligibility criteria, participants and nonresponders, description of study period, and the characteristics of study population), 6 items on internal validity (the prospective data collection, the validation and specification of measurement instrument, the definition of diseases, the prevalence of specific age and gender, and the confounding diseases), and 3 items on informativity (the method of data collection, possible question and answer, and the reproducibility of the reported prevalence). Another 2 items added were (16) "Did researchers take measures to control quality?" (17) "Did researchers discuss the limitations of the study?" The answers of each question were "Yes" or "No," and 1 point for "Yes" and 0 point for "No." The total quality score of each article ranged from 0 to 17, of which 0–8 points were regarded as low quality and 9–17 points were high quality.

Statistical Analyses

Meta-analysis was conducted by using meta package in R-3.6.2 to evaluate accurate binomials and confidence intervals [10]. The procedure of Metaprop was used for handling proportions <20.0% by allowing Freeman-Tukey double arcsine transformation to stabilize the variances [11]. The pooled prevalence of MCI and 95% confidence intervals were calculated by the random-effect model. Heterogeneity was assessed by using Cochran's Q test and I^2 . The test is of statistical significance when $p < 0.05$. $I^2 > 50\%$ was considered to have statistically significant heterogeneity. Further subgroup analyses were conducted according to MCI type (amnesic MCI and nonamnesic MCI), research time, the demographic characteristics of participants (age, gender, living area, living status, occupation, and education), risk factors of MCI (drinking alcohol, tea, and sports), the morbidity status (hypertension, coronary heart disease, stroke, diabetes, and depression), screening tools (MMSE, MoCA, and both MMSE and MoCA), diagnostic criteria (Petersen, DSM-IV, Frisoni, CECI, and CGDM), and different screening groups with different education (illiterate population screened by MMSE, primary school population screened by MMSE, and so on) to explore the source of heterogeneity. The funnel plot and Egger's test were used to estimate the publication biases, with $p < 0.05$ indicating potential bias. The sensitivity analysis was performed by excluding articles one by one to determine the reliability of the analysis results.

Fig. 1. Flowchart of study selection process of MCI prevalence. By searching PubMed, EMBASE, CNKI, Wanfang, CQVIP, and CBMDisc databases, there were 10,205 potentially relevant studies. After removing the duplicated studies, there were 7,354 studies that might be relevant. By reading the abstracts and full-text articles, 53 studies that met the inclusion and exclusion criteria were included in this meta-analysis. MCI, mild cognitive impairment.

Results

Characteristics of the Included Studies

Among 10,205 studies retrieved from the Internet, 53 studies were included in this meta-analysis according to the inclusion and exclusion criteria (Fig. 1). The characteristics and quality score of these studies are reported in Table 1, of which 48 studies achieved a score of 13 or above ($n = 48$). The overall quality of included studies was high.

Prevalence of MCI

In this meta-analysis, we included 123,766 investigated participants from 23 provinces, of which 18,814 individuals were MCI. The overall prevalence of MCI calculated via the random-effect method was 15.4% (95% CI: 13.5–17.4%) (Fig. 2). The prevalence of MCI in 2000–2004, 2005–2009, 2010–2014, and 2015–2019 was 8.5%

(95% CI: 4.8–13.1%), 13.5% (95% CI: 10.9–16.2%), 15.5% (95% CI: 13.0–18.3%), and 21.8% (95% CI: 17.4–26.5%), respectively (Fig. 3).

Prevalence of MCI with respect to Characteristics of Population

Demographically, the prevalence of MCI increased with age, from 11.1% (95% CI: 9.1–13.3%) in those aged 60–69 years to 38.0% (95% CI: 14.9–64.0%) in those aged 90 and older. And, it was not only higher in women (18.3%, 95% CI: 15.6–21.2%) than in men (14.8%, 95% CI: 12.4–17.4%), but also higher in people recruited from rural (17.3%, 95% CI: 14.8–19.8%) than those from urban (13.3%, 95% CI: 11.5–15.2%). As for living status, participants who lived alone (22.9%, 95% CI: 18.9–27.3%) had a higher prevalence than those who lived with others (19.3%, 95% CI: 15.9–23.0%). When taking occupation into consideration, mental workers (12.3%, 95% CI: 8.8–

Table 1. Characteristics of included studies [7, 12, 13, 45–94]

Author	Published year (survey year)	Area (urban/rural)	Minimum age	Screening scale/ tools	Diagnostic criteria	Sample size	MCI	Quality score
Tang et al. [46]	2007 (2004)	Beijing (mixed)	60	MMSE	Petersen	1,865	217	14
Guan et al. [47]	2008 (2004)	Beijing (mixed)	60	MMSE	Petersen	1,750	203	16
Ge et al. [48]	2009 (2004)	Beijing (mixed)	60	MMSE	Petersen	1,716	212	15
Li et al. [49]	2013 (2009)	Beijing (mixed)	60	MMSE	Petersen	3,500	332	15
Guo et al. [50]	2013 (2011)	Hebei (mixed)	60	MoCA	Petersen	940	136	12
Huang et al. [51]	2008 (2001)	Guangdong (mixed)	60	MMSE	Petersen	4,697	257	14
Lei et al. [52]	2008 (2005)	Guizhou (mixed)	60	MMSE	Frison	4,323	665	15
Zhou et al. [53]	2011 (2009)	Zhejiang (mixed)	60	MMSE	DSM-IV	1,227	107	13
Zhang et al. [54]	2013 (2012)	Hunan (mixed)	60	MMSE/MoCA	Petersen	1,764	287	12
Hu et al. [55]	2012 (2008)	Inner Mongolia (rural)	55	MMSE	DSM-IV	9,146	1,782	13
Yin et al. [56]	2012 (2007)	Hebei (mixed)	65	MMSE/MoCA	Petersen	1,011	67	12
Qin et al. [57]	2014 (2011)	Shanghai (mixed)	55	MMSE	Petersen	4,086	612	15
Chen et al. [58]	2015 (2013)	Shanghai (mixed)	60	MoCA	Petersen	1,695	352	11
Peng et al. [59]	2012 (2011)	Shanghai (urban)	60	MMSE/MoCA	Petersen	300	67	13
Pan et al. [60]	2012 (2011)	Zhejiang (mixed)	60	MoCA	Petersen	897	154	13
Song et al. [61]	2012 (2010)	Guangdong (mixed)	60	MMSE	Petersen	2,279	167	13
Li et al. [62]	2013 (2013)	Shandong (mixed)	60	MMSE/MoCA	DSM-IV	1,462	260	14
Wu et al. [63]	2012 (2011)	Shanxi (mixed)	60	MMSE	CECCI	1,583	396	13
Xu et al. [64]	2014 (2012)	Hebei (mixed)	60	MMSE/MoCA	Petersen	2,426	526	14
Wang et al. [65]	2015 (2010)	Hebei (mixed)	60	MMSE/MoCA	Petersen	3,136	625	15
Su et al. [66]	2013 (2011)	Shanxi (mixed)	60	MMSE	Petersen	796	145	16
Li et al. [67]	2013 (2011)	Beijing (urban)	55	MMSE	Petersen	1,020	160	13
Ding et al. [68]	2014 (2009)	Shanghai (mixed)	60	MMSE	DSM-IV	3,141	601	15
Luo et al. [69]	2015 (2011)	Shanghai (urban)	60	MMSE	Petersen	3,060	554	14
Jia et al. [70]	2014 (2009)	Shanghai (mixed)	65	MMSE/MoCA	DSM-IV	10,276	2,004	16
Zhou et al. [71]	2016 (2015)	Xinjiang (mixed)	60	MMSE/MoCA	CGDM	804	221	15
Luo et al. [72]	2015 (2009)	Guangdong (mixed)	60	MMSE/MoCA	Petersen	1,981	299	16
Wu et al. [73]	2017 (2014)	Jiangsu (mixed)	60	MMSE	Petersen	1,846	317	15
Qiu et al. [74]	2003 (2000)	Sichuan (mixed)	55	MMSE	Petersen	3,910	92	13
Guo et al. [45]	2011 (2008)	Shanxi (mixed)	65	MMSE	Petersen	264	35	14
Ma et al. [75]	2016 (2012)	Tianjin (urban)	65	MMSE	Petersen	5,214	591	15
Wang et al. [76]	2016 (2012)	Ningxia (mixed)	55	MMSE	CECCI	2,168	457	14
Lao et al. [77]	2011 (2010)	Hainan (mixed)	55	MMSE	Petersen	7,665	326	15
Zhao et al. [78]	2015 (2013)	Jilin (rural)	60	MoCA	CECCI	976	171	13
Ren et al. [79]	2013 (2011)	Jiangxi (urban)	60	MoCA	DSM-IV	946	99	14
Guo et al. [80]	2013 (2011)	Hunan (rural)	60	MMSE	Petersen	1,367	139	13
Yuan et al. [81]	2013 (2010)	Shanghai (rural)	60	MMSE	DSM-IV	3,311	631	13
Xia et al. [82]	2006 (2004)	Shanghai (urban)	60	MMSE	Petersen	145	16	11
Jia et al. [83]	2011 (2010)	Hebei (mixed)	60	MMSE/MoCA	Petersen	1,300	205	13
Liao et al. [84]	2012 (2011)	Jiangxi (mixed)	60	MoCA	Petersen	399	41	13
Yang et al. [7]	2017 (2016)	Hubei (mixed)	60	MoCA	Petersen	1,000	296	15
Xiong et al. [85]	2013 (2011)	Tianjin (mixed)	65	MMSE	DSM-IV	2,978	339	15
Zhou et al. [86]	2009 (2007)	Xinjiang (mixed)	60	MMSE	DSM-IV	2,986	305	16
Wang et al. [87]	2018 (2016)	Chongqing (mixed)	60	MMSE	Petersen	1,781	209	15
Zhang et al. [12]	2018 (2017)	Shanghai (mixed)	55	MoCA	Petersen	1,033	430	16
Liu et al. [88]	2018 (2018)	Shanghai (mixed)	60	MMSE	DSM-IV	1,796	317	13
Rao et al. [13]	2018 (2009)	Guangzhou (mixed)	65	MMSE/MoCA	DSM-IV	2,111	299	15
Jiang et al. [89]	2019 (2017)	Nanning (mixed)	60	MoCA	Petersen	3,000	833	15
Dai et al. [90]	2019 (2019)	Qingdao (mixed)	60	MMSE/MoCA	CGDM	1,184	209	14
Liu et al. [91]	2019 (2018)	Shanghai (mixed)	60	MMSE/MoCA	CGDM	554	73	16
Yuan et al. [92]	2019 (2015)	Ningxia (urban)	55	MMSE	Petersen	1,032	199	13
Wu et al. [93]	2019 (2019)	Chengdu (urban)	65	MoCA	Petersen	876	164	15
Yuan et al. [94]	2019 (2016)	Xiamen (mixed)	60	MMSE/MoCA	Petersen	3,043	613	15

The basic information of 53 articles included was first author, published year, survey year, living area, minimum age, screening test, diagnostic criteria, sample size, MCI cases, and quality score. There were a total population of 123,766 subjects investigated and 18,814 MCI cases selected. MCI, mild cognitive impairment; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, 4th edition; CECCI, Chinese Expert Consensus on Cognitive Impairment; CGDM, Chinese guidelines for diagnosis and management of cognitive impairment and dementia.

16.3%) had a lower prevalence than manual workers (19.1%, 95% CI: 15.7–22.7%). And, participants with high education level had a lower prevalence of MCI, which is shown in Figure 4.

Prevalence of MCI with respect to Healthy Lifestyle

The prevalence of MCI was higher among drinkers (16.8%, 95% CI: 13.7–20.2%) than nondrinkers (15.6%, 95% CI: 12.9–18.4%). However, compared with those who hardly drunk tea (19.3%, 95% CI: 12.9–26.6%) or exercised (24.8%, 95% CI: 19.6–30.3%), participants who drunk tea (11.6%, 95% CI: 7.5–16.4%) and exercised regularly (15.2%, 95% CI: 9.8–21.6%) had a lower prevalence.

Prevalence of MCI with respect to Morbidity Status

The prevalence of MCI was higher in those who had hypertension, stroke, diabetes, or depression than those did not have these diseases (Table 2). But, there was no difference in MCI prevalence between people with coronary heart disease and without it ($\chi^2 = 1.53$, $p = 0.217$).

Prevalence of MCI with respect to Different Screening and Diagnostic Methods

The prevalence of MCI varied according to different screening tools. It was 20.2% (95% CI: 15.1–25.9%) in populations screened by Montreal Cognitive Assessment (MoCA), which was significantly higher than that by Mini-Mental State Examination (13.0%, 95% CI: 10.7–15.5%). A further subgroup analysis was conducted according to education level in different screening groups, and the prevalence was markedly higher in people interviewed by MoCA than that by MMSE in the same education level. For example, when using MoCA and MMSE to screen MCI, the prevalence was 29.9% (95% CI: 19.5–41.3%) versus 18.6% (95% CI: 14.0–23.7%) in the illiterate group, 24.6% (95% CI: 15.2–35.4%) versus 13.6% (95% CI: 9.8–17.9%) in the primary school group, 19.7% (95% CI: 9.4–32.5%) versus 11.3% (95% CI: 8.4–14.5%) in the middle school group, 14.2% (95% CI: 7.5–22.5%) versus 8.0% (95% CI: 5.9–10.4%) in the high school group, and 11.8% (95% CI: 6.8–17.9%) versus 7.2% (95% CI: 4.2–10.9%) in the college and above group (Table 3).

In terms of different diagnostic criteria, the prevalence was 14.8% (95% CI: 12.2–17.6%) for Petersen criteria, 15.0% (95% CI: 12.7–17.5%) for Diagnostic and Statistical Manual of Mental Disorders (DSM-IV), 15.4% (95% CI: 14.3–16.5%) for Frisoni criteria, 21.2% (95% CI: 17.5–25.2%) for CECI, and 19.1% (95% CI: 12.1–27.3%) for Chinese guidelines for diagnosis and management of cognitive impairment and dementia (CGDM).

Publication Bias

Publication bias was assessed by funnel plot and Egger's test. The result of Egger's test ($p = 0.247$, $p > 0.05$) suggested that there was no obvious publication bias for prevalence of MCI.

Sensitivity Analysis

Sensitivity analysis demonstrated that Qiu's study [6] and Zhang's study [12] had more influence on the pooled prevalence of MCI compared with others. After the Qiu's study was excluded, the pooled prevalence (15.8%, 95% CI: 14.0–17.7%) increased. When Zhang's study was omitted, the prevalence (15.0%, 95% CI: 13.2–17.0%) decreased. It might be that the former study was conducted in 2000, and the participants were screened by MMSE, so the prevalence was low. While in the latter study, the mean age of included participants was 69. It had already been proved that aging was the strongest risk factor of MCI [13]. Therefore, the older age led to higher MCI prevalence, which influenced the stability of pooled prevalence.

Discussion/Conclusion

This meta-analysis evaluated the prevalence of MCI across different age, gender, living status, occupation, education, risk factors, morbidity status, screening tools, and diagnostic methods among Chinese elderly aged 55 years and older. The major findings are as follows: (1) the overall prevalence of MCI was 15.4% (95% CI: 13.5–17.4%), and it increased with time. (2) The younger, the male, and participants with higher education, healthy lifestyle, and no morbidity had a lower prevalence. (3) The prevalence varied with different screening scale and diagnostic criteria.

The timely prevalence of MCI (15.4%, 95% CI: 13.5–17.4%) reported in the present study was not only higher than that of a previous meta-analysis (14.0%, 95% CI: 12.8–16.2%), which selected 25 studies involving 56,720 patients [14], but also higher than that reported in other countries. The MCI prevalence was reported under 10% in most developed countries, such as Mexico [15], Netherlands [16], USA [17, 18], Japan [19], France [20], Germany [21], Finland [22, 23], Sweden [24], and Italy [25]. However, in developing countries, the prevalence of MCI seemed to be higher than developed countries [26]. For example, a survey in India found the prevalence of MCI was 14.9% in adults aged 60 years or older [27]. And, results from the present study showed that the MCI preva-

(For legend see next page.)

Fig. 3. Prevalence of MCI considering the survey year. The prevalence of MCI was 8.5% (95% CI: 4.8–13.1%) in 2000–2004, 13.5% (95% CI: 10.9–16.2%) in 2005–2009, 15.5% (95% CI: 13.0–18.3%) in 2010–2014, and 21.8% (95% CI: 17.4–26.5%) in 2015–2019, increasing markedly from 8.5% in 2000–2004 to 21.8% in 2015–2019. MCI, mild cognitive impairment.

lence in China increased from 8.5 to 21.8% during 2000–2019. The rapid increase might be due to the aging and the increasing use of MoCA. For instance, the use frequency (8/11, 72.7%) for MoCA was far higher in 2015–2019 than those (0/6, 0.0%) in 2000–2004.

Subgroup analysis showed that younger age and higher education level were associated with lower prevalence of MCI [28], which had already been proved by a previous study [13]. Manual workers and those who lived in rural were more likely to develop MCI, possibly due to their lower education level. And, the prevalence in women was higher than in men partly because MCI was an age-related disease, and women tended to have more longevity [29]. As for healthy lifestyle, individuals who regularly drunk tea or exercised had lower prevalence. The mechanism might be that tea was rich in caffeine, catechins, and epigallocatechin gallate, which had neuroprotective effects for its antioxidant and anti-inflammatory abilities [30]. And, exercise could elevate levels of brain-derived

Fig. 2. Forest plot of prevalence studies of MCI in the elderly Chinese. $I^2 = 98.93\%$, $p < 0.001$; there was a significant heterogeneity among the 53 articles included in the meta-analysis. Therefore, the random-effect method was used to obtain the pooled prevalence of MCI. The overall prevalence was 15.4%, and the 95% confidence interval was 13.5–17.4%. MCI, mild cognitive impairment.

Fig. 4. Prevalence of MCI considering educational levels. The pooled prevalence of MCI was 23.6% (95% CI: 19.2–28.3%) in the illiterate elderly population, 17.5% (95% CI: 13.8–21.5%) in people with primary school education, 13.7% (95% CI: 10.7–17.0%) in people with middle school education, 10.5% (95% CI: 8.1–13.2%) in people with high school education, and 9.0% (95% CI: 6.5–11.9%) in people with college and above education. The elderly with low education level had a high prevalence of MCI. MCI, mild cognitive impairment.

neurotrophic factors, which contributed to neuronal regeneration and decreasing inflammatory in the brain [31]. Though we found that people drinking had higher prevalence, the relationship between alcohol and MCI remained controversial [32]. Most reviews pointed to a possible beneficial effect of light-to-moderate drinking on cognitive health, whereas moderate drinking had been consistently thought to damage brain structures [33, 34]. In terms of morbidity, a previous study had identified hypertension [35], stroke [36], diabetes, and depression [37] as risk factors of dementia, which was consistent with our study that those who had hypertension or stroke had a higher prevalence of MCI.

MMSE and MoCA were the most widely used screening tools for MCI diagnosis. In this study, the overall prevalence of MCI was 13.0% (95% CI: 10.7–15.5%) for MMSE and 20.2% (95% CI: 15.1–25.9%) for MoCA ($\chi^2 = 816.16$, $p = 0.000$), which was consistent with previous studies that MoCA had higher sensitivity and specificity in detecting MCI [38]. The reason might be that the MMSE, widely used in detecting dementia [39], paid more attention to the orientation and language function rather than memory and executive function, which might decrease the detecting sensitivity of impairment in these

Table 2. Prevalence estimates by subgroups

Subgroups	Case	Population	MCI prevalence, %	95% CI, %	χ^2	<i>p</i> value
MCI subtype						
Amnestic MCI	1,714	21,762	9.2	6.6–12.3	–	–
Nonamnestic MCI	2,057	21,762	6.1	2.3–11.7		
Age range						
60–69	4,978	38,265	11.1	9.1–13.3	1,254.93	0.000
70–79	5,172	28,430	17.9	15.3–20.6		
80–89	2,420	8,737	28.6	24.5–32.8		
90+	88	230	38.0	14.9–64.0		
Gender						
Male	5,486	41,104	14.8	12.4–17.4	186.19	0.000
Female	8,763	52,904	18.3	15.6–21.2		
Sample size						
≥2,000	12,611	86,456	14.1	11.1–17.5	8.70	0.003
<2,000	5,203	37,319	16.3	14.2–18.5		
Area						
Urban	3,874	27,995	13.3	11.5–15.2	178.13	0.000
Rural	4,711	26,125	17.3	14.8–19.8		
Living status						
Alone	1,229	5,754	22.9	18.9–27.3	17.17	0.000
Not alone	5,704	30,018	19.3	15.9–23.0		
Occupation						
Mental labor	1,315	9,021	12.3	8.8–16.3	11.28	0.001
Manual labor	3,069	19,019	19.1	15.7–22.7		
Education						
Illiterate	2,976	17,554	23.6	19.2–28.3	233.88	0.000
Primary school	3,356	24,222	17.5	13.8–21.5		
Middle school	2,497	17,478	13.7	10.7–17.0		
High school	1,139	10,183	10.5	8.1–13.2		
College and above	758	6,694	9.0	6.5–11.9		
Drinking alcohol						
Yes	1,318	7,975	16.8	13.7–20.2	263.87	0.000
No	5,995	23,600	15.6	12.9–18.4		
Drinking tea						
Yes	443	4,356	11.6	7.5–16.4	140.57	0.000
No	766	3,969	19.3	12.9–26.6		
Sports						
Yes	1,752	10,545	15.2	9.8–21.6	19.40	0.000
No	1,321	6,874	24.8	19.6–30.3		
Stroke						
Yes	998	5,220	22.5	17.9–27.6	140.57	0.000
No	1,511	12,321	13.7	11.6–15.9		
Diabetes						
Yes	1,062	4,859	22.0	19.0–25.3	92.87	0.000
No	4,739	29,178	17.2	14.1–20.5		
Hypertension						
Yes	2,960	15,864	19.1	19.0–25.3	273.89	0.000
No	2,671	21,446	13.3	14.1–20.5		
Coronary heart disease						
Yes	842	4,392	20.0	16.1–24.2	1.53	0.217
No	3,295	17,945	17.3	13.2–21.7		
Depression						
Yes	1,090	3,555	31.4	13.3–52.9	591.04	0.000
No	2,214	16,052	17.3	8.1–18.0		

Table 2 (continued)

Subgroups	Case	Population	MCI prevalence, %	95% CI, %	χ^2	<i>p</i> value
Diagnostic criteria						
Petersen	9,878	72,794	14.8	12.2–17.6	458.11	0.000
DSM-IV	6,744	39,380	15.0	12.7–17.5		
Frisoni	665	4,323	15.4	14.3–16.5		
CECCI	1,024	4,727	21.2	17.5–25.2		
CGDM	503	2,542	19.1	12.1–27.3		

The results of subgroup analyses based on MCI subtype, age range, gender, area, living status, occupation, education, sample size, and diagnostic criteria. The female, older adults, manual workers, illiterate people, rural residents, and those who lived with unhealthy lifestyles and morbidities showed higher prevalence. Moreover, the prevalence was 14.8% for Petersen, 15.0% for DSM-IV, 15.4% for Frisoni, 21.2% for CECCI, and 19.1% for CGDM, respectively. MCI, mild cognitive impairment; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, 4th edition; CECCI, Chinese Expert Consensus on Cognitive Impairment; CGDM, Chinese guidelines for diagnosis and management of cognitive impairment and dementia.

Table 3. Subgroup analyses of prevalence in different tool groups

Tools	Case	Population	MCI prevalence, %	95% CI, %
MMSE	10,448	80,891	13.0	10.7–15.5
Illiterate	1,860	13,077	18.6	14.0–23.7
Primary school	1,899	18,001	13.6	9.8–17.9
Middle school	1,370	12,291	11.3	8.4–14.5
High school	642	7,400	8.0	5.9–10.4
College school	411	4,363	7.2	4.2–10.9
MoCA	2,676	11,762	20.2	15.1–25.9
Illiterate	376	1,440	29.9	19.5–41.3
Primary school	584	2,345	24.6	15.2–35.4
Middle school	622	2,295	19.7	9.4–32.5
High school	291	1,547	14.2	7.5–22.5
College school	217	1,421	11.8	6.8–17.9
Both*	5,755	31,352	17.4	15.4–19.5
Illiterate	740	3,037	32.2	20.2–45.4
Primary school	873	3,876	21.8	16.6–27.5
Middle school	505	2,892	15.4	11.9–19.2
High school	206	1,236	13.8	7.6–21.4
College school	130	910	10.1	4.7–17.0

The prevalence was 13.0% for MMSE and 20.2% for MoCA. Further subgroup analyses according to education level showed that the prevalence was 18.6% for MMSE, 29.9% for MoCA, and 17.4% for both MoCA and MMSE among the illiterate. Similarly, the prevalence was higher for MoCA than for MMSE in other education levels. MMSE, Mini-Mental State Examination; MoCA, Montreal Cognitive Assessment; both* refers that MMSE and MoCA are all used in investigations; MCI, mild cognitive impairment.

cognitive domains. However, the MoCA, developed on the basis of MMSE, was designed as a specific tool to screen MCI [38]. In brief, it had added the evaluation of visual space and executive function, increased the number and difficulty of words, extended the time of delayed recall, and improved the score distribution in cognitive domains, making it an appropriate scale in reflecting the real status of the patient suffered from MCI [40]. In consideration of the applicable evaluation tools for MCI which depend strongly on educational level [41], further subgroup analyses stratified by education level were conducted in different tool groups. The similar result was found in our study that the MCI prevalence in older adults administered by MoCA was remarkably higher than that by MMSE when they had similar education level. It was consistent with the previous point that MoCA was more sensitive than MMSE and was able to detect the MCI patients among older adults with high education level. The ceiling effect for MMSE induced that MCI patients and cognitively normal subjects have relative scores, particularly in those with higher education level [42, 43]. Therefore, MoCA should be recommended when estimating the prevalence of MCI in further studies.

In our study, the prevalence of MCI varied greatly when using different diagnostic criteria. Petersen (35/53) and DSM-IV (11/53) criteria were used in most studies, and the prevalence of MCI according to the 2 criteria was close with 14.8 and 15.0%, respectively. However, the pooled prevalence according to several Chinese standards (CECCI and CGDM) for MCI was remarkably higher than those studies utilizing Petersen and DSM-IV crite-

ria. The main difference between Petersen criteria and CECCI and CGDM is memory impairment dominant [21]. If “the effect of memory complaints” in diagnostic criteria was excluded, the prevalence of MCI would increase significantly [44]. Therefore, the choice and operationalization of diagnostic criteria influenced greatly on MCI prevalence estimation, and the lack of specific, reliable, and validated operationalized criteria might partly explain the heterogeneity of MCI prevalence.

There are several strengths in our study. First, this meta-analysis included 53 studies, all of which were of high quality (score > 8), and collected the information of 123,766 individuals who were both screened and diagnosed by widely recognized criteria from 1980 to 2019. Second, we did Freeman-Tukey double arcsine transformation to stabilize the variances to deal with the within-study variability. Third, we did not only investigate the influence of age, sex, occupation, education level, living status, lifestyle, and morbidity, but also considered the impact of different diagnostic criteria and screening tools on the pooled prevalence of MCI. In addition to considering the internationally recognized diagnostic criteria (Petersen criteria and DSM-IV), we also considered the Chinese standards (CECCI and CGDM). Moreover, we further discussed the impact of education on the application of MCI screening tools, which had not been fully considered in previous studies.

There are some limitations of the study. First, the screening tools and diagnostic criteria for MCI varied in studies. Second, though the extracted data were analyzed by the subgroup analysis, the heterogeneity regarding MCI prevalence among the articles was not ruled out markedly. It might have something to do with family economic status and other illness. Third, some included studies with small sample size or limited information such as Xia’s study and Guo’s study [45] could not be selected for subgroup analysis, so large-sample and well-designed research studies are needed to verify these relationships. Another limitation is the inconsistency in stratification methods for some influencing factors of MCI, such as age. Some research studies divided total population into 4 age groups of 10 years each from 60 years old, while several research studies selected the population from 55 years old or divided age every 5 years. Consequently, these differences will lead to some required information loss and reduce the number of samples.

In conclusion, the prevalence of MCI in China was 15.4%. The female, manual workers, and people of older age, lower education, and living with unhealthy lifestyles and morbidity had a higher prevalence. More efficient

MCI prevention strategies should be provided in Chinese older adults. In addition, we found that the prevalence of MCI varied with different screening tools and diagnostic criteria used. Therefore, it is necessary to choose suitable screening tools and diagnostic criteria in further investigations of MCI.

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Conflict of Interest Statement

The authors have no conflicts of interest to declare. The opinions expressed in this publication are those of the authors and do not necessarily reflect the official views of the Chinese Ministry of Education.

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Author Contributions

Shuang Rong designed the study. Shuang Rong, Guangwen Cheng, and Wenfang Li contributed to the development of data extraction form. Siqi Zhao and Yan Deng conducted PubMed, EMBASE, CNKI, Wanfang, CQVIP, and CBMdisc search and completed study selection. Siqi Zhao, Yan Deng, Jiajia Yang, Benchao Li, Kai Xu, Pei Xiao, and Guangwen Cheng collected data from the included articles. Shuang Rong analyzed data and drafted the manuscript. Shuang Rong and Yan Deng revised the articles for important intellectual content. All authors commented on the manuscript.

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