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Outcome of Magnetic Resonance Imaging (MRI) Technique on Vascular Cognitive Impairment (VCI): Meta-Analysis

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Abstract

Background: The significant justification for why vascular cognitive impairment (VCI) happens is because of cerebrovascular disease. If not recognized early, this will prompt vascular dementia. To have the option to analyze VCI the assessment procedure ought to be foremost, in order to assist with effective treatment strategy to forestall extra vascular harm.

Objective: The purpose of this meta-analysis is to evaluate the scoring system used to assess VCI after magnetic resonance imaging (MRI) technique.

Methods: A PRISMA selection protocol was used to identify neuroimaging studies across electronic database such as PubMed, Google scholar, Embase and web of science from May 13, 2011 to October 10, 2022. A total of 26 studies evaluating neuropsychological assessment such as Educational experience, Mini-mental state examination (MMSE), Montreal cognitive assessment (MoCA), Fazekas perivascular (PV) Score, Hamilton depression rating scale (HAMD), Hamilton anxiety scale (HAMA) and Activities daily living scale(ADL) for VCI after MRI method. Meta-analysis was performed by Rev-Man 5.4.

Results: The meta-analysis included 26 MRI studies on VCI patients and control. The studies included a total number of 2,253 individuals, 1,192 were in the control group and 1,061 patients in VCI group. The cognitive function assessed by the meta-analysis revealed VCI with lesser MMSE scores (Heterogeneity: Tau^2 = 6.75; Chi^2 = 879.81, df = 19 (P < 0.00001); I^2 = 98%) and MoCA scores (Heterogeneity: Tau^2 = 12.76; Chi^2 = 736.56, df = 15 (P < 0.00001); I^2 = 98%) respectively. The analysis showed that, educational level is positively related with cognitive function in VCI patients (Heterogeneity: Chi^2 = 39.68, df = 20 (P = 0.005); I^2 = 50%). The control group observed a lesser HAMA and Fazekas PV score compared to VCI. But there was no significant difference for HAMD and ADL between the two groups.

Conclusion: Cognitive performance in subjects with VCI can be evaluated using neuropsychological scoring system following MRI technique. Furthermore, MMSE and MoCA scores following education increases positive cognitive function.

Abbreviations

MRI: Magnetic Resonance Imaging; VCI: Vascular Impairment; VaD: Vascular Dementia; MMSE: Mini-Mental State Examination; MoCA: Montreal Cognitive Assessment; HAMA: Hamilton Anxiety scale; HAMD: Hamilton Depression rating scale; Fazekas PV: Fazekas Perivascular; ADL: Activities Daily Living scale; I^2: Inconsistency Statistic; CI: Confidence Interval; SIVD: Subcortical Ischemic Vascular Disease; VCIND: Vascular Cognitive Impairment, No Dementia; WMH: White Matter Hypersensitivity; CT: Computed Tomography; FAB: Frontal Assessment Battery

Introduction

The definition of vascular cognitive impairment (VCI) is when the whole vascular brain pathologies play a role in any level of cognitive impairment, that ranges from subjective cognitive decline to dementia [1-3]. A neuropathological study revealed that pure vascular disease (8-10%), Alzheimers disease (60-70%) and dementia with lewy bodies (10-25%) play a greater role in dementia cases [4]. There are three categories of VCI which include vascular dementia (VaD), Alzheimer's disease (AD) with a vascular component and vascular cognitive impairment with no dementia (VCIND) [5].

Studies by O'Brien, et al. suggested that people with VCI have a particular cognitive reports which includes conservation of memory and executive function is reduced which differs from AD [2]. Studies on VCI mechanism is still under research and also subcortical ischemic vascular disease (SIVD) which is a type of cerebral vascular disease is considered to be chief cause of VCI [6]. VCI is still important to doctors and researchers due to probable prevention, expense and its incidence [7]. The pathologies (cerebrovascular) of VCI are white matter hyperintensities (WMH) and infarct which occurs due to ischemia [8,9]. The severity of white matter damage is usually as a results of obstruction of small blood vessels and this can be assessed by the Fazekas scale [10].

To measure the severity and ascertain the state of vascular brain injury, imaging of the brain becomes paramount. Detection of small brain lesions, WMH, microbleed and superficial siderosis, MRI is selected over computed tomography due its sensitivity [11,12]. Patient's age should be considered when weighing the burden of brain atrophy and vascular brain lesions, because the occurrence of WMH increase from 50% to 95% at 45 and 80 years respectively in the overall populace [13,14]. Usually patients who do not show any symptoms also present with silent brain infarcts, lacunes, microbleeds, evident perivascular space and brain atrophy [11-14].

Individuals with VCI show heterogeneous cognitive manifestation. Conventionally, VCI is represented by mental deceleration and poor executive function in combination with gait loss and urinary incontinence.

But the cognitive impairment can be affected depending on the area of vascular brain injury [15]. Intellectual or cognitive assessment can be achieved by simple bed side test or use of screening tools such as the Montreal Cognitive Assessment (MoCA) which has been developed to this end [16]. The administration of mini-mental state examination (MMSE) can also be used to uncover executive dysfunction but this tool needs probing with supportive tests such as frontal assessment battery (FAB) [16,17]. Other screening tests such HAMA and HAMD also use questionnaire to indicate depression and also as a guide to evaluate recovery [18,19]. In addition ADL profile measures everyday activities for individuals with VCI [20]. To gain further insight into the neuropsychological assessment, the meta- analysis aims to evaluate the scoring system for VCI following an MRI examination.

Materials and Method

Literature search strategy

The current meta-analysis followed the PRISMA guidelines [21]. This search was executed to identify literature concerning MRI examination in relation with scoring system evaluation for patients with vascular cognitive impairment (VCI). Electronic database such as PubMed, Google scholar, Embase and web of science from May 13, 2011 to October 10, 2022 were queried using the keywords such as; Vascular cognitive impairment; MRI; Cognitive impairment; Neuroimaging; and Scoring system. All articles were checked by title and abstract to decide their importance to the study question. Relevant articles in relations with the study question were successively added (Figure 1).

Figure 1: Prisma flow diagram.
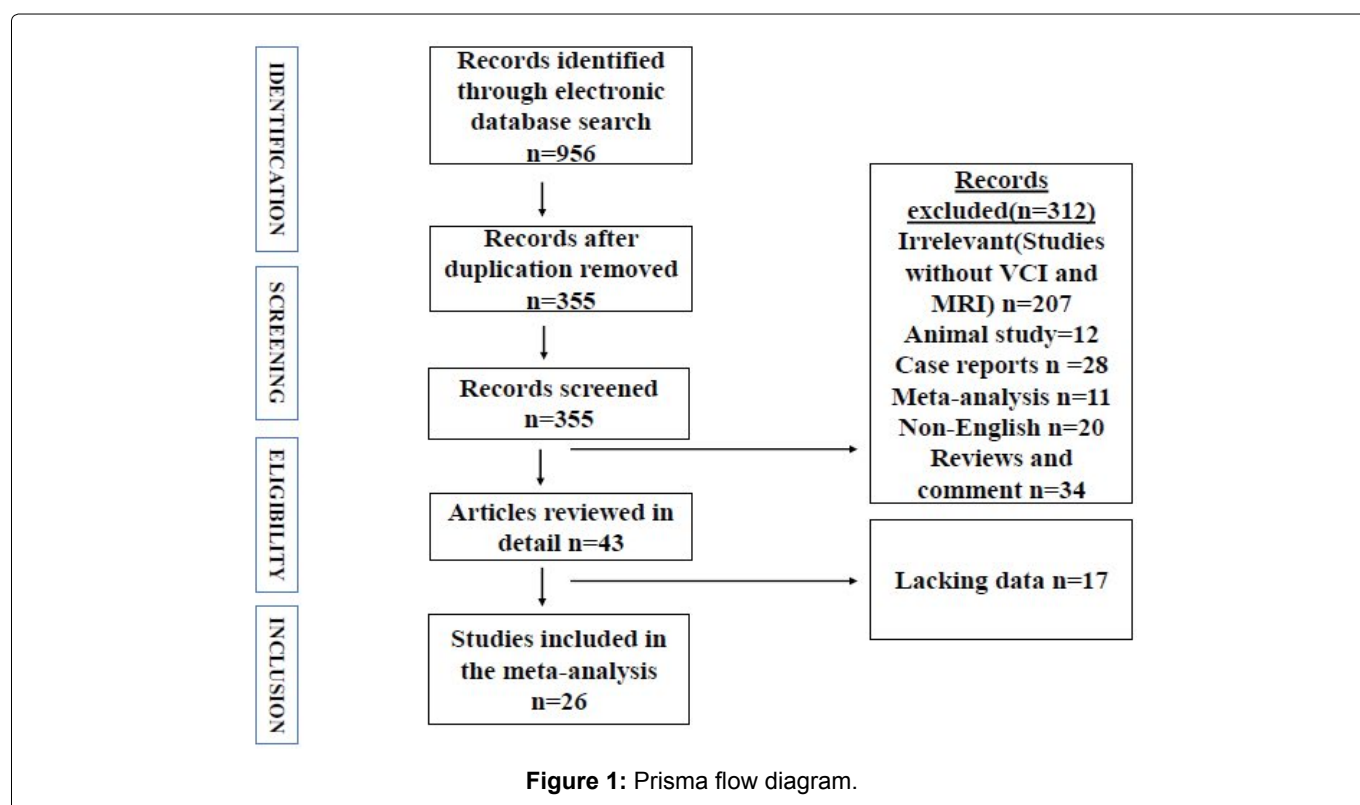
Inclusion criteria

- Cerebral vascular abnormality (hemorrhage, infarction and ischemia)
- Patients with Cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy.
- Patients with white matter hyperintensities (WMH)
- MRI and sub-types (resting state functional MRI)
- Assessment of all enrolled patients within the range of cognitive impairment
- Studies with stages of VCI (SVCI and MCI)

Exclusion criteria

Table 1: General characteristics of included studies.

Author name	Publication year	Nationality	Age	Patients Number(total)	Control/VCI
Lei Yu, et al. [22]	2014	China	40.2 + 7.2/40.2 + 11.2	33	22/11
Chuanming Li, et al. [23]	2014	China	68.0 (5.8)/69.0 (7.8)	65	35/30
Jingjing Su, et al. [24]	2019	China	48.5±13.7/49.0±14.2	66	44/22
Liye Yi, et al. [25]	2012	China	65.3 + 8.1/66.7 + 9.5	54	26/28
Xia Zhou, et al. [26]	2016	China	68.87 + 7.05/0.008.26	9+55	23/32
Weina Ding, et al. [27]	2015	China	67.78 ± 6.7 5/71. 07 ± 6.72	51	22/29
Ya-wen Sun, et al. [28]	2011	China	66.2 ± 7.7/69.1 ± 7.8	34	18/16
Xiaoshuang Liu, et al. [29]	2019	China	67.63 ± 8.19/70.48 ± 4.81	56	27/29
Qing Ye, et al. [30]	2019	China	62.03 ± 7.53/66.00 ± 5.13	47	33/14
Meimei Zuo, et al. [31]	2019	China	62.72 ± 8.22/63.84 ± 14.1	63	32/31
Min-Chien Tu, et al. [32]	2020	Taiwan	65.1 (6.97)/75.8 (7.67)	43	23/20
Ling Ni, et al. [33]	2016	China	70 ± 9 + 79 ± 6	50	28/22
Zhanxiong Wu, et al. [34]	2022	China	69.11 ± 7.87 /72.00 ± 5.89	36	18/18
Kai du, et al. [35]	2021	China	66.93 ± 6.83 /68.56 ± 8.91	514	257/257
Shuai Han, et al. [36]	2022	China	31.0 ± 6.0 /30.2 ± 4.5	91	47/44
Bo Liu, et al. [37]	2022	China	62.9 ± 7.7 /63.6 ± 9.4	116	76/40
Rong Zhao, et al. [38]	2022	China	74.41 ± 8.227/75.89 ± 8.554	153	100/53
Huiping Chen, et al. [39]	2021	China	55.04 ± 3.51 /67.26 ± 6.77	116	47/69
Qing Ye, et al. [40]	2022	China	60.78 ± 7.36 /65.52 ± 7.97	172	95/77
Amr.A.M.T, et al. [41]	2020	Egypt	62.02 ± 3.70 /64.61 ± 3 .85	68	24/44

Yuanyuan Liu, et al. [42]	2022	China	60.58 ± 5.98/65.04 ± 6.90	64	36/28
Yujun Gao, et al. [43]	2022	China	68.80 ± 4.951 /69.07 ± 4.932	121	68/53
Xuanyu Li, et al. [44]	2018	China	67.61 ± 8.86 /70.33 ± 8.27	58	31/27
Stefano Orsolini, et al. [45]	2020	Italy	47.0 ± 11.1 /43.6 ± 11.7	39	16/23
Ming Qi, et al. [46]	2018	China	69.1 ± 8.1 /70.6 ± 6.2	32	16/16
Jinfang Wang, et al. [47]	2019	China	58.35 ± 6.82/59.28 ± 6.12	56	28/28

Table 2: Outcomes after cognitive testing.

Author name	Education years (Control versus VCI)	MMSE (Control versus VCI)	MOCA (Control versus VCI)	Fazekas PV Score (Control versus VCI)	HAMD (Control versus VCI)	HAMA (Control versus VCI)	ADL (Control versus VCI)
Lei Yu, et al. [22]	9.4 ± 4.2/6.1 ± 5.0	29.9 ± 1.2/ 19.6 ± 4.3	-	-	-	-	-
Chuanming Li, et al. [23]	9.2 ± 3.3 /7.5 ± 4 .7	28.4 ± 1.1 /16.1 ± 5.1	27.2 ± 1.5 /9.4 ± 3.8	-	-	-	-
Jingjing Su, et al. [24]	-	28.6 ± 1.1 /23.3 ± 6.3	27.9 ± 1.4 /20.7 ± 7.9	-	4.0 ± 1.8 /7.0 ± 7.1	3.7 ± 1.6 /5.9 ± 6.0	-
Liye Yi, et al. [25]	12.3 ± 5.0 /9.9 ± 4.4	29.1 ± 1.2/ 25.7 ± 2.7	-	-	-	-	-
Xia Zhou, et al. [26]	10.09 ± 2.98 /8.47 ± 3.16	27.96 ± 0.98 /23.78 ± 2.66	-	-	-	-	20.22 ± 0.70 /25.47 ± 7.42
Weina Ding, et al. [27]	10.74 ±3.03/1 0.40 ± 3.42	28.61 ±1.23/2 5.90 ± 3.09	25.48 + 2.68/ 20.14 + 5.84	1.52 ± 0.75 /2.31 ± 0.5	-	-	-
Ya-wen Sun, et al [28]	11.6 ± 2.9 /10.2 ± 3.3	28.9 ± 1.3 /28.1 ± 1.4	-	-	-	-	14.1 ± 0.5 /15.3 ± 3.1
Xiaoshuang Liu, et al. [29]	10.22 ± 2.15 /9.35 ± 1.65	-	-	-	-	-	-
Qing Ye, et al. [30]	10.88 ± 3.49 /9.93 ± 2.89	28.47 ± 1.49 /26.86 ± 2.66	26.41 ± 2.30 /20.43 ± 2.71	-	-	-	-
Meimei Zuo, et al. [31]	10.25 ± 2.33 /9.32 ± 2.12	28.75 ± 1.39 /26.32 ± 2.06	27.75 ± 1.72/23.32 ± 1.33	-	1.37 ± 3.18/2.61 ± 3.59	1.69 ± 3.08/3.16 ± 3.66	-
Min-Chien Tu, et al. [32]	10.2 ± 3.32 / 7.5 ± 2.81	27.9 ± 1.60 / 20.1 ± 5.88	-	0.5 ± 0.59/1.9 ± 0.39	-	-	-

Ling Ni, et al. [33]	15 ± 1.41 / 12 ± 2.78	29 ± 1.09 / 25 ± 2.05	28 ± 0.98 / 21 ± 1.94	-	2.8 ± 2.2/2.6 ± 1.6	-	20 ± 0.8/ 23 ± 1.7
Zhanxiong Wu, et al. [34]	-	29.1 ±1.0 /27.0 ± 1.8	-	-	-	-	-
Kai du, et al. [35]	-	28.52 ± 1.64 /25.14 ± 3.39	-	-	-	-	-
Shuai Han, et al. [36]	15.0 ± 3.0 /15.2 ± 2.3	-	-	-	-	-	-
Bo Liu, et al. [37]	9.4 ± 4.0 /9.1 ± 4.3	28.1 ± 1.5 /24.6 ± 3.0	27.1 ± 2. 1 /18.6 ± 5.0	-	-	-	-
Rong Zhao, et al. [38]	14.32 ± 1.757 /14.75 ± 3.204	28.86 ±1.318 /22.08 ± 4.057	-	-	-	-	-
Huiping Chen, et al. [39]	-	27.90 ± 2.74 /28.54 ± 1.50	23.81 ± 4.12/25.35 ± 2.75	-	-	-	-
Qing Ye, et al. [40]	11.65 ± 4.75 /11.23 ± 3.20	29 ± 0.5 / 29 ± 0.5	25 ± 1. 25 /22 ± 1.0	-	-	-	-
Amr.A.M.T, et al. [41]	-	-	25.50 ± 1.06 /24.77 ± 1.44	-	-	-	28.70 ± 3.35 /24.57 ± 4.25
Yuanyuan Liu, et al. [42]	9.31 ± 3.32 /7.75 ± 3.88	-	22.33 ± 3.09 /17.81 ± 4.91	-	-	-	-
Yujun Gao, et al. [43]	9.75 ± 3.414 /10.04 ± 3.321	-	26.265 ± 1.671 /22.814 ± 4.150	-	-	-	14.059 ± 0.237/14.243 ± 0.824
Xuanyu Li, et al. [44]	11.77 ± 6.25 /10.74 ± 4.97	28.26 ± 3.02 /23.69 ± 4.71	25.61± 3.77/1 9.22 ± 5.15	-	-	-	-
Stefano Orsolini, et al. [45]	14.0 ± 5.9 /13.1 ± 3.6	-	22.1 ± 2.1 /22.9 ± 2.9	-	-	-	-
Ming Qi, et al. [46]	9.7 ± 2.7 /10.4 ± 2.6	27.1 ± 1.2 /27.3 ± 1.3	22.9 ± 1.7 /22.6 ± 2.1	-	-	-	-
Jinfang Wang, et al. [47]	13.43 ± 2.76 /13.43 ± 2.27	29.46 ± 1.07 /24.96 ± 1.48	28.64 ± 1.66 /21.68 ± 2.74	-	-	-	

- Disease of the brain such as poisoning, immune abnormalities etc.
- Intercranial tumors
- Patients with visual impairment
- Patients who Fail to cooperate
- Non-English papers
- Reviews
- Case reports

Data extraction

Data were collected for selected literature. Firstly, data about author, publication year, nationality, age, total number of patients, VCI and control was recorded as shown in Table 1. Educational experience, MMSE scores, MoCA scores, HAMA scores, HAMD scores, Fazekas PV scores and ADL scores as shown in Table 2.

Characteristics of included studies

A total of 956 studies were retrieved by database search. 355 articles were remaining after duplicate articles were removed. The remaining 355 articles were screen thoroughly after reading the title and abstracts. After screening, 312 were excluded because it did not meet the requirements. This led to 43 articles remaining which were reviewed in detail and finally 26 articles were included in

the meta-analysis as shown in Figure 1. The total number of patients recorded in 26 included studies were 2,253. Out of these patients, 1,192 were in the control group and 1,061 patients in VCI group. 23 of the included studies were conducted in China, 1 in Taiwan, 1 in Egypt and 1 in Italy as shown in Table 1. Studies reported neuropsychological assessment such as educational experience, MMSE, MoCA, Fazekas PV, HAMA, HAMD and ADL as shown in Table 2.

Statistical analysis

Statistical analysis was accomplished using the Review Manager (RevMan) software, version 5.4 presented by the Cochrane collaboration. Continuous variables were pooled using mean difference with a 95% CI. Random effect and fixed effect models were computed under statistical methods of Mantel-Haenszel for OR. Heterogeneity among studies was evaluated using the inconsistency statistic (I^2). If I^2 was < 50%, the eligible studies were considered to be homogenous; hence, the fixed effect model was used. In contrast, if I was > 50%, the pooled results were said to be significant, heterogeneous, and the random effect model was used in its place. For studies that present with median and range, Hozo, et al. [48] was used to calculate for mean and standard deviation.

Results of Neuropsychological Evaluation Meta-analysis Results

MMSE score

MMSE score is by and large utilized for screening patients with dementia and the score ranges between 0-30. Higher MMSE scores show better mental capability's score of 24 following educational correction is suggested for patients with VCI [49]. Twenty studies [22-28,30-35,37-40,44,46,47] collected MMSE scores. There was a statistically significant difference between the two groups. The VCI (n = 840) saw a lesser MMSE score as compared to the control (n = 974). Heterogeneity: Tau^2 = 6.75; Chi^2 = 879.81, df = 19 (P < 0.00001); I^2 = 98%. Test for overall effect: Z = 6.28 (P < 0.00001) (Figure 2a).

MOCA score

The MOCA is utilized for VCI and mild dementia which has been uncovered in examinations to have high responsiveness and particularity for separating individuals with VCI and the people who do not [50]. MoCA scores range from 0-30. Higher MoCA score represents good cognitive function and a cut off of 26 following education is need for people with cognitive disorders. The MOCA score was recorded in sixteen studies [23,24,27,30,31,33,37,39,40-47]. The meta-analysis showed a statistically significant difference between the two groups. Patient with VCI (n = 553) had a lesser MoCA score than those in the control group (n = 631). Heterogeneity: Tau^2 = 12.76; Chi^2 = 736.56, df = 15 (P < 0.00001); I^2 = 98%. Test for overall effect: Z = 5.39 (P < 0.00001) (Figure 2b).

Educational experience

Twenty-one studies [22,23,25-33,36-37,40,42-47] recorded number of subjects that underwent education. The results discovered a significant difference between the control (n = 793) and VCI (n = 651). The educational years was decrease in the VCI group than control group. Heterogeneity: Chi^2 = 39.68, df = 20 (P = 0.005); I^2 = 50%. Test for overall effect: Z = 4.18 (P < 0.0001) (Figure 2c).

Fazekas PV score

The Fazekas score suggests that the entire brain's white matter is hypersensitive. Additionally, this score may be used to predict future disability [10]. Two studies [27,46] recorded Fazekas PV scores. The result revealed a statistically significant difference. The control group (n = 45) observed a lesser Fazekas PV score than the VCI (n = 49). Heterogeneity: Tau^2 = 0.16; Chi^2 = 6.54, df = 1 (P = 0.01); I^2 = 85%. Test for overall effect: Z = 3.62 (P = 0.0003) (Figure 2d).

HAMD and HAMA score

Both scores are used to measure difference in anxiety and depression in individuals. it ranges from 21-29. A score of 29 indicated severe anxiety and depression, 21-29 (obvious anxiety and depression), 14-21 (anxiety and depression), 7-14 (indicates anxiety and depression may exist but not serious) and less than 7 shows good living conditions [51]. HAMD score was collected in three studies [24,31,33], with control with 104 and VCI 75 patients respectively. But there was no significant difference among the control (n = 104) and VCI (n = 75) Heterogeneity: Tau^2 = 1.19; Chi^2 = 5.06, df = 2 (P = 0.08); I^2 = 60%. Test for overall effect: Z = 1. 11 (P = 0.27) (Figure 2e).

The two studies [24,31] retrieved for HAMA score showed a significant difference. The control (n = 76) had lesser HAMA score than VCI (n = 53). Heterogeneity: Chi^2 = 0.22, df = 1 (P = 0.64); I^2 = 0%. Test for overall effect: Z = 2.37 (P = 0.02) (Figure 2f).

ADL

The meta-analysis executed on five studies [26,28,33,41,43] showed no significant difference between control (n = 161) and VCI (n = 167). Heterogeneity: Tau^2 = 4.53; Chi^2 = 85.17, df = 4 (P < 0.00001); I^2 = 95%. Test for overall effect: Z = 1.00 (P = 0.32) (Figure 2g).

Publication bias (Education experience)

The funnel plot on educational years (control vs. VCI) is shown in Figure 3. Because most studies placed inside the 95% CI limits, no evidence of publications bias was noted. Egger test was performed to provide statistical evidence regarding funnel plot symmetry. Result still did not reveal any evidence of publication bias in mortality (Heterogeneity: Chi^2 = 39.68, df = 20 (P = 0.005); I^2 = 50%).

Study or Subgroup	control Mean	SD	Total	VCI Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Bo Liu et al 2022	28.1	1.5	76	24.6	3	40	5.2%	3.50 [2.51, 4.49]
Chuanming Li et al 2014	28.4	1.1	35	16.1	5.1	30	4.7%	12.30 [10.44, 14.16]
Huiping Chen et al 2021	27.9	2.74	47	28.54	1.5	69	5.2%	-0.64 [-1.50, 0.22]
Jinfang Wang et al 2019	29.46	1.07	28	24.96	1.48	28	5.3%	4.50 [3.82, 5.18]
Jingjing Su et al 2019	28.6	1.1	44	23.3	6.3	22	4.2%	5.30 [2.65, 7.95]
Kai du et al 2021	28.52	1.64	257	25.14	3.39	257	5.3%	3.38 [2.92, 3.84]
Lei Yu et al 2014	29.9	1.2	22	19.6	4.3	11	4.3%	10.30 [7.71, 12.89]
Ling Ni et al 2016	29	1.09	28	25	2.05	22	5.2%	4.00 [3.05, 4.95]
Liye Yi et al 2012	29.1	1.2	26	25.7	2.7	28	5.1%	3.40 [2.30, 4.50]
Meimei Zuo et al 2019	28.75	1.39	32	26.32	2.06	31	5.2%	2.43 [1.56, 3.30]
Min-Chien Tu et al 2020	27.9	1.6	23	20.1	5.88	20	4.2%	7.80 [5.14, 10.46]
Ming Qi et al 2018	27.1	1.2	16	27.3	1.3	16	5.2%	-0.20 [-1.07, 0.67]
Qing Ye et al 2019	28.47	1.49	33	26.86	2.66	14	5.0%	1.61 [0.13, 3.09]
Qing Ye et al 2022	29	0.5	95	29	0.5	77	5.4%	0.00 [-0.15, 0.15]
Rong Zhao et al 2022	28.86	1.318	100	22.08	4.057	53	5.1%	6.78 [5.66, 7.90]
Weina Ding et al 2015	28.61	1.23	22	25.9	3.09	29	5.1%	2.71 [1.47, 3.95]
Xia Zhou et al 2016	27.96	0.98	23	23.78	2.66	32	5.2%	4.18 [3.18, 5.18]
Xuanyu Li et al 2018	28.26	3.02	31	23.69	4.71	27	4.6%	4.57 [2.50, 6.64]
Ya-wen Sun et al 2011	28.9	1.3	18	28.1	1.4	16	5.2%	0.80 [-0.11, 1.71]
Zhanxiong Wu et al 2022	29.1	1	18	27	1.8	18	5.2%	2.10 [1.15, 3.05]
Total (95% CI)			**974**			**840**	**100.0%**	**3.78 [2.60, 4.97]**

Heterogeneity: Tau² = 6.75; Chi² = 879.81, df = 19 (P < 0.00001); I² = 98%
Test for overall effect: Z = 6.28 (P < 0.00001)

2a. MMSE

Study or Subgroup	Control Mean	SD	Total	VCI Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Amr.A.M.T et al 2020	25.5	1.06	24	24.77	1.44	44	6.5%	0.73 [0.13, 1.33]
Bo Liu et al 2022	27.1	2.1	76	18	5	40	6.3%	9.10 [7.48, 10.72]
Chuanming Li et al 2014	27.2	1.5	35	9.4	3.8	30	6.3%	17.80 [16.35, 19.25]
Huiping Chen et al 2021	23.81	4.12	47	25.35	2.75	69	6.4%	-1.54 [-2.88, -0.20]
Jinfang Wang et al 2019	28.64	1.66	28	21.68	2.74	28	6.4%	6.96 [5.77, 8.15]
Jingjing Su et al 2019	27.9	1.4	44	20.7	7.9	22	5.4%	7.20 [3.87, 10.53]
Ling Ni et al 2016	28	0.98	28	21	1.94	22	6.5%	7.00 [6.11, 7.89]
Meimei Zuo et al 2019	27.75	1.72	32	23.32	1.33	31	6.5%	4.43 [3.67, 5.19]
Ming Qi et al 2018	22.9	1.7	16	22.6	2.1	16	6.4%	0.30 [-1.02, 1.62]
Qing Ye et al 2019	26.41	2.3	33	20.43	2.71	14	6.3%	5.98 [4.36, 7.60]
Qing Ye et al 2022	25	1.25	95	22	1	77	6.6%	3.00 [2.66, 3.34]
Stefano Orsolini et al 2020	22.1	2.1	16	22.9	2.9	23	6.3%	-0.80 [-2.37, 0.77]
Weina Ding et al 2015	25.48	2.68	22	20.14	5.84	29	5.9%	5.34 [2.94, 7.74]
Xuanyu Li et al 2018	25.61	3.77	31	19.22	5.15	27	5.9%	6.39 [4.04, 8.74]
Yuanyuan Liu et al 2022	22.33	3.09	36	17.81	4.91	28	6.1%	4.52 [2.44, 6.60]
Yujun Gao et al 2022	26.265	1.671	68	22.814	4.15	53	6.4%	3.45 [2.27, 4.64]
Total (95% CI)			**631**			**553**	**100.0%**	**4.95 [3.15, 6.75]**

Heterogeneity: Tau² = 12.76; Chi² = 736.56, df = 15 (P < 0.00001); I² = 98%
Test for overall effect: Z = 5.39 (P < 0.00001)

2b. MOCA

Study or Subgroup	Control Mean	SD	Total	VCI Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
Bo Liu et al 2022	9.4	4	76	9.1	4.3	40	4.1%	0.30 [-1.31, 1.91]
Chuanming Li et al 2014	9.2	3.3	35	7.5	4.7	30	2.6%	1.70 [-0.31, 3.71]
Jinfang Wang et al 2019	13.43	2.76	28	13.43	2.27	28	6.1%	0.00 [-1.32, 1.32]
Lei Yu et al 2014	9.4	4.2	22	6.1	5	11	0.9%	3.30 [-0.14, 6.74]
Ling Ni et al 2016	15	1.41	28	12	2.78	22	6.5%	3.00 [1.73, 4.27]
Liye Yi et al 2012	12.3	5	26	9.9	4.4	28	1.7%	2.40 [-0.12, 4.92]
Meimei Zuo et al 2019	10.25	2.33	23	9.32	2.12	31	7.3%	0.93 [-0.28, 2.14]
Min-Chien Tu et al 2020	10.2	3.32	23	7.5	2.81	20	3.2%	2.70 [0.87, 4.53]
Ming Qi et al 2018	9.7	2.7	16	10.4	2.6	16	3.1%	-0.70 [-2.54, 1.14]
Qing Ye et al 2019	10.88	3.49	33	9.93	2.89	14	2.9%	0.95 [-0.98, 2.88]
Qing Ye et al 2022	11.65	4.75	95	11.23	3.2	77	7.5%	0.42 [-0.77, 1.61]
Rong Zhao et al 2022	14.32	1.757	100	14.75	3.204	53	12.3%	-0.43 [-1.36, 0.50]
Shuai Han et al 2022	15	3	47	15.2	2.3	44	8.9%	-0.20 [-1.29, 0.89]
Stefano Orsolini et al 2020	14	5.9	16	13.1	3.6	23	1.0%	0.90 [-2.34, 4.14]
Weina Ding et al 2015	10.74	3.03	22	10.4	3.42	29	3.4%	0.34 [-1.44, 2.12]
Xiaoshuang Liu et al 2019	10.22	2.15	27	9.35	1.65	29	10.4%	0.87 [-0.14, 1.88]
Xia Zhou et al 2016	10.09	2.98	23	8.47	3.16	32	4.0%	1.62 [-0.02, 3.26]
Xuanyu Li et al 2018	11.77	6.25	31	10.74	4.97	27	1.3%	1.03 [-1.86, 3.92]
Ya-wen Sun et al 2011	11.6	2.9	18	10.2	3.3	16	2.4%	1.40 [-0.70, 3.50]
Yuanyuan Liu et al 2022	9.31	3.32	36	7.75	3.88	28	3.3%	1.56 [-0.24, 3.36]
Yujun Gao et al 2022	9.75	3.414	68	10.04	3.321	53	7.3%	-0.29 [-1.50, 0.92]
Total (95% CI)			**793**			**651**	**100.0%**	**0.69 [0.37, 1.02]**

Heterogeneity: Chi² = 39.68, df = 20 (P = 0.005); I² = 50%
Test for overall effect: Z = 4.18 (P < 0.0001)

2c. Education

Study or Subgroup	Control Mean	SD	Total	VCI Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Ming Qi et al 2018	0.5	0.59	23	1.9	0.39	20	51.5%	-1.40 [-1.70, -1.10]
Weina Ding et al 2015	1.52	0.75	22	2.31	0.5	29	48.5%	-0.79 [-1.15, -0.43]
Total (95% CI)			**45**			**49**	**100.0%**	**-1.10 [-1.70, -0.51]**

Heterogeneity: Tau² = 0.16; Chi² = 6.54, df = 1 (P = 0.01); I² = 85%
Test for overall effect: Z = 3.62 (P = 0.0003)

2d. Fazekas PV

Study or Subgroup	Control Mean	SD	Total	VCI Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Jingjing Su et al 2019	4	1.8	44	7	7.1	22	19.0%	-3.00 [-6.01, 0.01]
Ling Ni et al 2016	2.8	2.2	28	2.6	1.6	22	45.8%	0.20 [-0.85, 1.25]
Meimei Zuo et al 2019	1.37	3.18	32	2.61	3.59	31	35.2%	-1.24 [-2.92, 0.44]
Total (95% CI)			**104**			**75**	**100.0%**	**-0.92 [-2.53, 0.70]**

Heterogeneity: Tau² = 1.19; Chi² = 5.06, df = 2 (P = 0.08); I² = 60%
Test for overall effect: Z = 1.11 (P = 0.27)

Heterogeneity: Tau² = 1.19; Chi² = 5.06, df = 2 (P = 0.08); I² = 60%Test for overall effect: Z = 1.11 (P = 0.27)

2e. HAMD

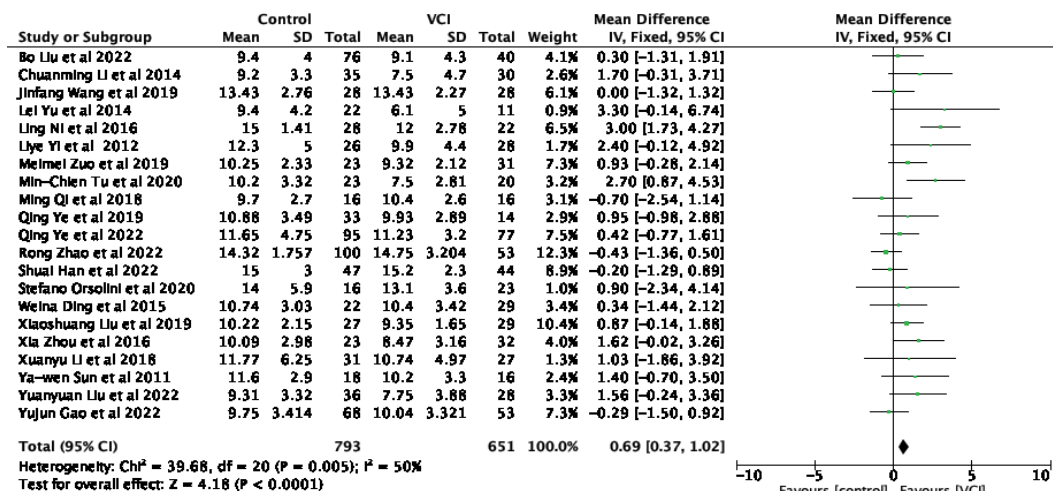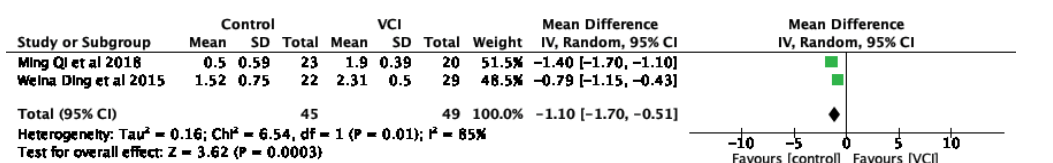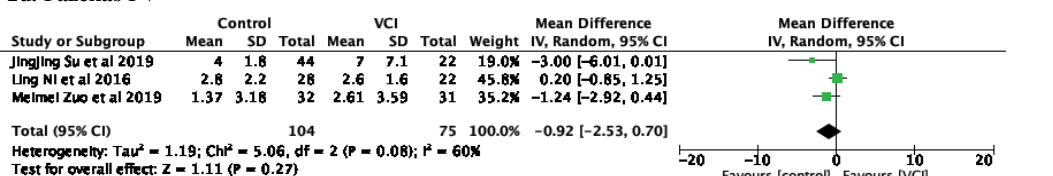Heterogeneity: Chi² = 0.22, df = 1 (P = 0.64); I² = 0%Test for overall effect: Z = 2.37 (P = 0.02)

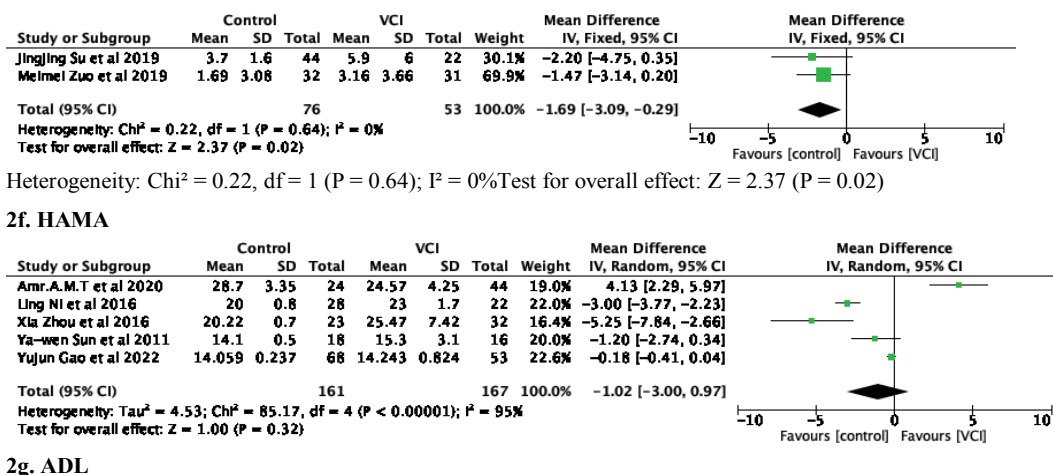**2f. HAMA**

2g. ADL

Figure 2: Forest plot of Control versus VCI: (a) MMSE; (b) MOCA; (c) Education year; (d) Fazekas PV; (e) HAMD; (f) HAMA; (g) ADL.
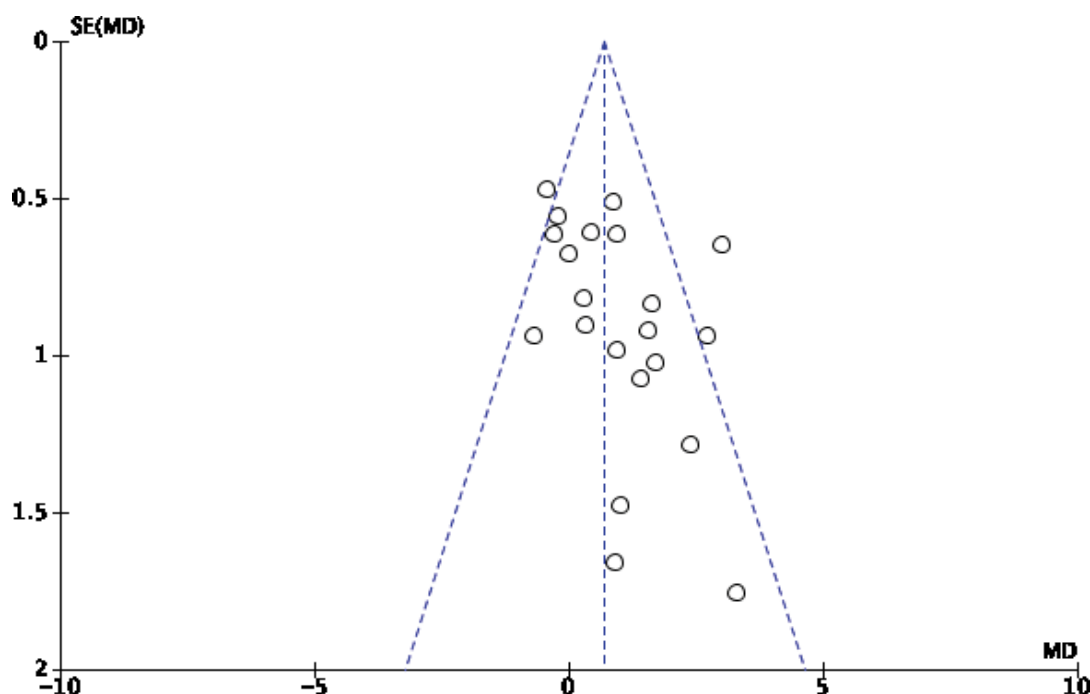

Figure 3: Funnel plot of educational years between control and VCI.

Discussion

The present meta-analysis was conducted to investigate the scoring tools for VCI after MRI examination. Vascular cognitive impairment may be the initial stage of dementia. During the past decade, neuroimaging has gained increasing interest as a tool used for predicting mental disorders [52]. Precise screening of the beginning phases of VaD expects outrageous significance, taking into account the high commonness paces of vascular cognitive impairment and the accessible essential and auxiliary counteraction procedures.

The result of the meta-analysis exhibited that MMSE, MoCA and educational experience is legitimate psychometrically dependable device for mental screening of patients with VCI. Furthermore, the significant and fine correlations between the MoCA scores and the MMSE scores are indicative of convergent validity. On the other hand, the significant and positive correlations between each MoCA's cognitive domain and the MoCA total score are suggestive of construct-related validity [53]. The study showed a significant difference of MMSE and MoCA between VCI and control. The VCI saw a lesser MMSE (Heterogeneity: Tau² = 6.75; Chi² = 879.81, df = 19 (P < 0.00001); I² = 98%) and MoCA (Heterogeneity: Tau² = 12.76; Chi² = 736.56, df = 15 (P < 0.00001); I² = 98%) scores. Both patients with VCI and healthy individuals were used in a study on MoCA discriminant capability analysis (control). Age, orientation, and educational background were matched for this particular cohort. To guarantee comparable degrees of cognitive deterioration, the
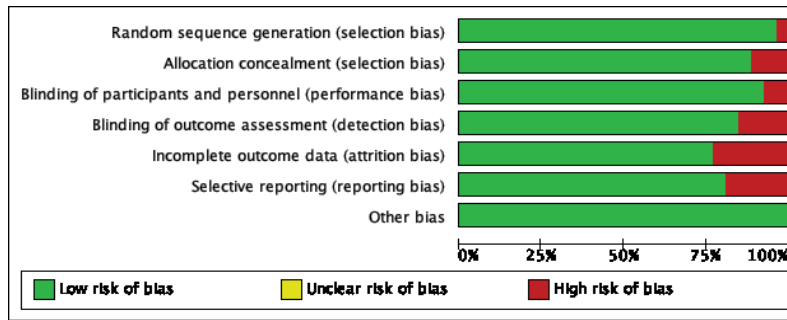
Figure 4: (a) Risk of bias graph: Review authors' judgements about each risk of bias item presented as percentages across all included studies; (b) Risk of bias summary: Review authors' judgements about each risk of bias item for each included study.

same clinical groups were matched for MMSE scores. Although this may have an impact on the correlation coefficient between the two tests, it is thought to be crucial for reliable comparison analysis. The outcomes showed that both the full and short forms of the MoCA productively segregate the cognitively adults from both clinical groups. MoCA scores in healthy patients was higher as compared to those in the clinical groups. But, between VaD and AD, the MoCA scores did not reveal any significant difference [53]. The present study revealed a significant difference for educational experience between VCI and control, where the VCI saw a low educational level than the control (Heterogeneity: $Chi^2 = 39.68$, df = 20 (P = 0.005); $I^2 = 50\%$). Two groups made up of healthy control (HC) and VaMCI. examined in earlier studies documented education, MoCA, HAMA and HAMD. The outcome of the studies resulted in VaMCI having low education (p = 0.017) and decrease MoCA score (p < 0.001), HAMA (p = 0.009) and HAMD scores (p = 0.006) were also high for VaMCI than HC [54]. However, the meta-analysis disclosed no significant difference for HAMD score between VCI and control (Heterogeneity: $Tau^2 = 1.19$; $Chi^2 = 5.06$, df = 2 (P = 0.08); $I^2 = 60\%$). Also, there was a significant difference for HAMA scores, whereby VCI saw a low HAMA scores as compared to control. Although there was no significant difference for ADL between the two groups. ADLs should be well thought out in regards with age of person and the state of impaired cognition [55]. Additionally, the study also showed a lesser Fazekas PV scores (Heterogeneity: $Tau^2 = 0.16$; $Chi^2 = 6.54$, df = 1 (P = 0.01); $I^2 = 85\%$) for control group as compared to the VCI. Fazekas PV scores in other studies were recorded to be high in the sVCI group [27]. Other reports disclosed that patients who have been diagnosed with stroke with cognitive impairment presented with high periventricular white matter hypersensitivities [56]. Studies by Sudo, et al. proved the relationship between mild VCI and the gravity of WMH recorded by the Fazekas scale which reveals high grades are mostly associated with cognitive impairment as compared to low grades [57].

There are some limitations to this review. First, there are several diseases under VCI with the same pathogenesis and this could raise some limitations due to that studies that did not discuss VCI were omitted due disparity in terminology. This is because cognitive impairment related to vascular disease could not have continuously being called VCI, MCI and SVCI. Second, the small number of studies made it difficult to study a detailed unified categorization. This is because it may affect the statistical power and interpretation of the final results. In addition, the heterogeneity of the papers could not be denied because the domains of cognitive impairment in the included papers were different. Third, full texts of some articles are difficult to obtain.

Conclusion

Cognitive performance of VCI subjects can be assessed using a neuropsychological scoring system following MRI technology. Moreover, MMSE and MoCA scores after education enhance positive cognitive function. This may also provide a basis for new neuropsychological assessment approaches.

Availability of Data and Material

The studies included were retrieved from PubMed, Cochrane, Embase and Google scholar databases.

Authors Contributions

Rabarijaona Tony Manjato Ratiaray was the main contributor in data collection, statistical analysis, interpretation of data and text writing. Haibo Xu was involved in data check, critical revision of draft and data analysis. All authors approved and contributed to the research and writing of this manuscript.

Ethics Approval and Consent to Participate

Not applicable.

Consent for Publication

Not applicable.

Competing Interests

The authors declare they have no competing interest.

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