Neuropsychiatric Disease and Treatment

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REVIEW

Leisure Activity Interventions on Cognition in Mild Cognitive Impairment Patients: A Meta-Analysis

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Abstract: Cognitive impairment has gradually become a serious social problem that endangers the normal life of elderly individuals. Traditional cognitive rehabilitation training (TCRT) is limited by family economic and medical insurance policies, making it difficult to sustain long-term rehabilitation training for patients with cognitive impairments. Leisure activities, as simple, efficient, and convenient intervention therapies, have been used for the rehabilitation of patients with cognitive impairment, but specific effects have not been reported. This meta-analysis of randomized controlled trials evaluated the efficacy of leisure activity intervention versus TCRT control on cognitive function in patients with varying degrees of cognitive impairment. As of December 10, 2024, literature searches were conducted on PubMed, Embase, the Cochrane Controlled Trials Registry, and related databases. The PEDro scale was used to assess the risk of bias. A total of 20 randomized controlled trials (n = 1126) used mahjong, poker, VR, or other games. The results revealed that leisure activity intervention improved overall cognitive function (MOCA, $P = 0.012$; MMSE, $P = 0.013$), memory function (DSB, $P < 0.0001$; DSF, $P = 0.015$), and quality of life (ADL, $P < 0001$). In summary, leisure activities can serve as a complementary and alternative therapy to traditional cognitive rehabilitation training to improve some cognitive domains of patients with cognitive impairments (PROSPERO registration: CRD42025639157).

Keywords: leisure activities, mild cognitive impairment, alzheimer's disease, complementary therapy, cognitive dysfunction, neuropsychological tests

Introduction

In recent years, the proportion of people aged 60 years and above has been increasing.[1] In 2019, there were 1 billion people aged 60 years or older. By 2030, this number is expected to reach 1.4 billion, and by 2050, it is expected to reach 2.1 billion.[2] Cognitive impairment is a stage between normal aging and Alzheimer's disease. It is a primary symptom of age-related diseases such as Alzheimer's disease.[3–5] Researchers have reported that the overall prevalence of mild cognitive impairment (MCI) is 20.8%, indicating that approximately 23.86 million people aged 65 years or older in China suffer from MCI.[6] Without early, active, and effective interventions, MCI can easily progress to dementia. Additionally, cognitive impairment burdens patients, reducing their ability to live independently, increasing hospitalization risk, and increasing medical costs.[7]

The pathogenesis of MCI has not been fully elucidated, and it may be related to multiple factors, all of which ultimately lead to cognitive impairment.[8] Genetic mutations can cause abnormal protein aggregation. Mutations in genes such as amyloid beta precursor protein, presenilin-1, and presenilin-2 promote the increased production, aggregation, and deposition of Aβ amyloid peptides.[9] Abnormalities in genes such as ApolipoproteinE affect their metabolic clearance, thereby leading to neuronal death and learning and memory impairments.[10] Tau gene mutations cause abnormal phosphorylation of tau protein, loss of normal activity, and neuronal damage, resulting in cognitive impairment.[11] The reduction or degeneration of cholinergic neurons in the basal forebrain reduces the content of acetylcholine, affects signal transmission, accelerates Aβ and tau pathology, and exacerbates cognitive deterioration.[12] In neuroinflammation, the initial activation of microglia is beneficial, but chronic activation promotes the pathological process.[13] Oxidative stress

Received: 1 May 2025
Accepted: 22 July 2025
Published: 13 August 2025

and mitochondrial dysfunction interact with each other, exacerbating Aβ toxicity and apoptosis, and thus participating in the pathogenesis.[14]

Traditional cognitive rehabilitation training (TCRT) is commonly used to treat elderly patients with cognitive impairments. TCRT positively boosts cognitive and memory functions.[15] However, TCRT usually requires professional guidance in medical settings. Patient participation is restricted by factors such as socioeconomic status and health insurance, resulting in a small number of participants.[16] Research also demonstrates that while some patients experience short-term improvements after training, these effects often fade over time, and this decline is not solely due to disease progression.[17,18] Consequently, there is an urgent demand for a convenient and inexpensive alternative to enhance the cognition and memory of cognitively impaired patients.

Because maintaining the sustainability of brain activity is crucial for the recovery of cognition and memory functions in cognitively impaired patients, leisure activities centered on cognitive and memory training have become more popular in recent years as rehab methods.[19] Leisure activities are broadly defined.[20] Within the context of this study, leisure activities are defined as non-professional, voluntary, and enjoyable activities primarily designed to improve cognitive function through engagement in structured, non-clinical tasks. Specifically, they include three categories:Virtual reality (VR) games: Computer-generated immersive environments that require interactive cognitive tasks (eg, memory puzzles); Board games: Tabletop games involving strategic thinking, rule-based decision-making, and memory (eg, mahjong); Interactive games: Motion-based or rhythm-based activities using dynamic feedback (eg, Xbox Kinect games). This definition emphasizes activities that combine entertainment with cognitive stimulation, distinguishing them from formal cognitive rehabilitation training. VR technology uses computers and other devices to create a lifelike 3D virtual world with visual, tactile, and olfactory experiences, giving users an immersive feeling. VR-based games are used to train and improve cognitive impairment in elderly individuals.[21] Studies have shown that VR games enhance cognitive skills in older adults,[22,23] although it is unclear whether they are better than TCRT games are. Board games have been in use for thousands of years[24] and include games such as mahjong, poker, chess, and Go. Many studies have shown their significance in enhancing elderly individuals' cognitive function.[19,25–27] Interactive games use human motion and dynamic feedback. Players can control in-game characters or operations through physical movements, increasing immersion and interactivity.[28] Neuroimaging research has indicated that regular engagement in interactive games for cognitive training can increase resting-state activity in the frontal and temporal lobes, supporting memory and enhancing overall cognition.[29,30]

Taking part in appropriate leisure activities has numerous advantages. Leisure activities can enhance cognitive function and memory, strengthen executive skills, and increase overall quality of life.[31] In fact, these activities are becoming increasingly popular worldwide. They are not just fun hobbies for middle-aged and elderly people but also useful rehabilitation training for those with cognitive impairment.[32] Leisure activities are now commonly used in complementary and alternative medicine to improve cognition and memory function.[33] Many prospective studies suggest that regularly engaging in leisure activities such as gaming might reduce the risk of dementia and even depression.[34,35] Additionally, some cross-sectional studies have revealed a connection between playing games and a lower dementia incidence rate.[36] Yates et al reported that people with MCI had better capacity for activity, instrumental daily living skills, and basic motor functions after they participated in leisure activities.[37]

With leisure activities becoming increasingly popular for improving the health, mobility, and cognitive skills of older adults and the need for comparative assessment and clinical guidance, we conducted a systematic review and meta-analysis of the available evidence. Our aim was to assess how leisure activities affect the cognitive and memory functions of patients with cognitive impairment.

Methods

This study followed the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[38] The protocol for this systematic review has been registered with PROSPERO (number CRD42024563951). This study conducted a meta-analysis by systematically searching and integrating published research data, all of which were sourced from publicly available academic literature and did not involve the collection of raw clinical data or studies on human subjects. Therefore, according to the ethical regulations of Heilongjiang Academy of Chinese Medicine, this study does not require approval from the ethics committee or informed consent from patients.

Search Strategy

The comprehensive search was conducted in the PubMed, Embase, Cochrane Library, Scopus, Web of Science, China National Knowledge Infrastructure, Wanfang, VIP, and Chinese Biomedical Literature Service System databases, with the search time set from the establishment of the databases until October 10, 2024. The search strategies are primarily composed of diseases ("cognitive impairment", "memory impairment"), interventions ("leisure activities", "Mahjong", "poker", "cards", "chess", "Chinese chess", "digital games", "jigsaw puzzles", "virtual reality"), and type of research ("randomized controlled trials"). See Appendix 1. for the detailed search.

Inclusion and Exclusion Criteria

We limited our evidence to studies published in peer-reviewed journals, and we applied the PICOS principles to establish the inclusion and exclusion criteria for this study. Additionally, manuscripts published exclusively online were also included in our review.

P (participant): The subjects in the study met the diagnostic criteria for cognitive impairment and were at least 18 years old. There were no restrictions on the sex or race of the subjects.

I (intervention): The subjects included in the study will receive leisure activity interventions, with the primary rehabilitation treatment methods including Go, poker, mahjong, VR games, and interactive games. There will be no restrictions on the stimulation site, duration, or frequency.

C (control): The control group received a nonleisure activity intervention or a lower frequency leisure activity intervention.

O (outcome): Efficacy of intervention on (1) the Montreal Cognitive Assessment (MoCA) and Mini-Mental State Examination (MMSE), (3) the digit span forward (DSB), (4) the digit span backward (DSF), (5) the trail-making test-A (TMT-A), (6) the trail-making test-B (TMT-B), and (7) activities of daily living (ADL).

S (Study Design): All the included studies were randomized controlled trials.

The exclusion criteria included duplicate studies, animal studies, reviews, conference papers, and studies with incomplete data. Due to resource constraints, non-Chinese or English studies (eg, Korean) were excluded. While attempts were made to retrieve data via author contact, language barriers may have resulted in potential omissions. In order to maintain consistency in the measurement results, studies using alternative tests that are inconsistent with our predefined diagnostic framework were excluded. This study only included studies using specific tests such as MMSE, MoCA, DSF, DSB, TMT-A, TMT-B, and ADL to diagnose cognitive impairment.

Data Extraction

Two assessors (HXM and LCM) extracted data from the eligible articles, covering details such as publication year, data source, participant demographics (gender, age, education level), intervention methods, and outcome measures. For any missing or inaccessible data, we contacted the authors via phone or email. The outcomes from each study are reported as the means with standard deviations (means ± SDss). In cases where data were presented in different formats (eg, quartiles, means ± standard errors, or confidence intervals), we converted them according to the guidelines in the Cochrane Handbook while noting any potential errors that might result from this conversion process. All included studies declared ethical approval by institutional review boards and adherence to the Declaration of Helsinki. During data extraction, we verified ethical compliance.

Risk of Bias Assessment

Two review authors (HEM and LCM) independently evaluated the risk of bias in the selected studies using the Physical Therapy Evidence Database (PEDro) scale.[39,40] This scale comprises 11 criteria, with each criterion being awarded a score of 1 (note that the first criterion, related to eligibility, is not scored). The total score ranges from 0 to 10, where higher scores reflect better experimental quality. Any disagreements were resolved through discussions with a third author (LZY).

Statistical Analyses

All meta-analyses were performed using R studio. For continuous outcome data, we used the mean ± standard deviation (SD) or standardized mean difference (SMD) along with the 95% confidence interval (CI) for analysis. The I^2 statistic was used to assess the degree of heterogeneity, with I^2 values of 25%, 50%, and 75% indicating low, moderate, and high heterogeneity, respectively. In cases of significant heterogeneity, we identified its source through sensitivity analysis, which was conducted on the basis of the type of intervention. If the I^2 value exceeds 50%, a random effects model will be applied; otherwise, a fixed effects model will be used for data evaluation. Publication bias was assessed using Egger's regression test.[41]

Results

Results of the Database Search

As shown in Figure 1, a total of 8,185 articles were retrieved from 9 different databases. Following the application of the inclusion and exclusion criteria, 4,310 references were initially screened. Among these, 343 articles were selected for full-text analysis, but 323 were subsequently excluded. In the end, this study included a total of 20 randomized controlled trials (RCTs), which were analyzed to evaluate the relevant outcomes.

Characteristics of the Included Studies

Table 1 offers a comprehensive summary of the studies included in this analysis. Among the 20 studies, 19 were RCTs, and 1 was a cluster RCT. The studies were geographically diverse, with 13 originating from China (including 2 from Taiwan, China), 3 from Korea, and 1 each from Pakistan, Türkiye, Iran, and Japan.

The sample size ranged from 17 to 119 elderly people with cognitive impairment, with a total of 1126 elderly people with cognitive impairment participating in these studies. In all the studies, 565 elderly individuals with cognitive

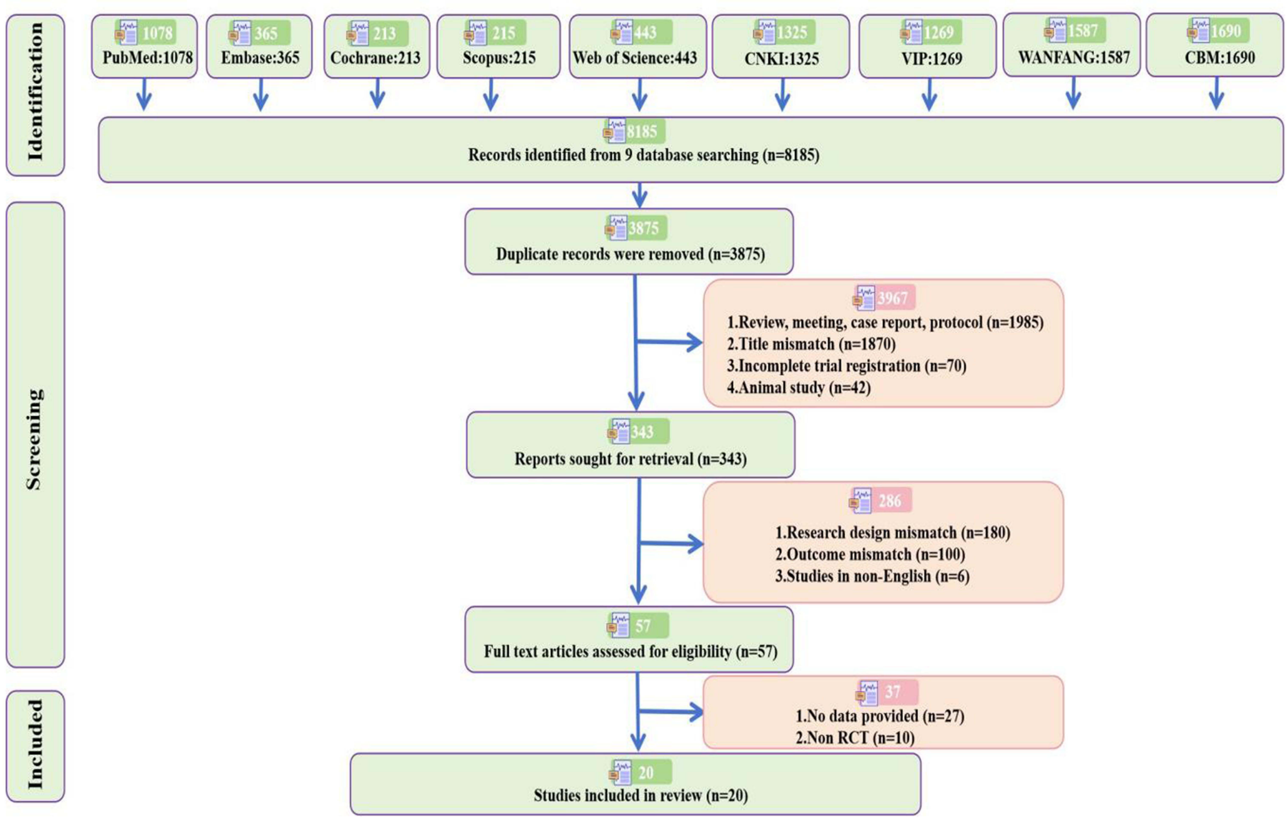

Figure 1 PRISMA flowchart of the literature search and screening.

 https://doi.org/10.2147/NDT.S536627

Table 1 Characteristics of the Included Studies

Reference	Country	Study Type	Leisure Activities	Sample	Age (Y)	Sex (M/F)	Setting	History of Education	Intervention	Control	Duration	F-up	Outcomes
Amjad et al, 2019[42]	Pakistan	RCT	Cognitive games	C: 18 I: 20	NR	NR	H	NR	Cognitive games (Xbox 360 Kinect) 40 min x5/week	Range of motion exercises 40 min x5/week	1.5	1.5	MOCA, MMSE, TMT-A, TMT-B
Çetin et al, 2024[43]	Turkey	RCT	Exergames	C: 10 I: 10	C: 68.1 ± 12.70 I: 66.90 ± 6.10	C: 7/3 I: 6/4	H	C:≥JHS 9 I:≥JHS 9	Exergames 1 h x3/week	Routine physiotherapy 1 h x3/week	2	2	MOCA
Cao et al, 2023[44]	China	RCT	VR	C: 42 I: 42	C: 69.53 ± 6.28 I: 68.94 ± 6.35	C: 15/27 I: 14/28	H	NR	rTMS 10 sessions + VR 30 min x5/week	rTMS 10 sessions x5/week	1	1	MOCA, MMSE, ADL
Cheng et al, 2022[45]	China Taiwan	RCT	VR	C: 11 I: 13	C: 71.60 ± 5.10 I: 74.10 ± 8.05	C: 6/5 I: 7/6	H	NR	rTMS 10 sessions + VR 40 min x 10/weekdays	rTMS x 10/ weekdays	3	3	MOCA
Cheng et al, 2014[15]	China	Cluster-RCT	Mahjong	C: 35 I: 36	C: 80.90 ± 7.20 I: 81.90 ± 6.20	C: 12/23 I: 13/23	NH	C:≥JHS 12 I:≥JHS 25	Mahjong 1 h x3/week	Handicrafts 1 h x3/ week	3	9	MMSE, DSF, DSB
Fei et al, 2020[46]	China	RCT	Dance games	C: 41 I: 41	NR	NR	G + CO	NR	Dance games (Amuse World) 1 h x3/week	Health lectures 1 h x1/week	6	6	MOCA, MMSE, TMT-A, TMT-B
Iizuka et al, 2018[47]	Japan	RCT	Go	C: 8 I: 9	C: 89.10 ± 6.60 I: 89.10 ± 4.10	C: 1/7 I: 1/8	NH	C:11.60 ± 2.50 (Y) I:11.30 ± 2.70 (Y)	Go 1 h x1/week	Nothing	3.75	3.75	MOCA, DSB, DSF
Jin et al, 2023[48]	China	RCT	Mahjong	C: 20 I: 20	C: 60.25 ± 3.21 I: 60.95 ± 4.10	C: 9/11 I: 10/10	CO	C:≥JHS 14 I:≥JHS 12	Mahjong 2 h x1/week + Donepezil	Donepezil	4	4	MOCA, MMSE
Park et al, 2020 a[49]	Korea	RCT	VR	C: 11 I: 10	C: 69.45 ± 7.45 I: 71.80 ± 6.61	C: 4/7 I: 3/7	H	C:8.00 ± 2.90 (Y) I:7.20 ± 3.61 (Y)	VR 30 min x2/week	Normal daily activities 30 min x1/week	3	3	MMSE, DSB, DSF
Park et al, 2020 b[50]	Korea	RCT	VR	C: 17 I: 18	C: 77.20 ± 7.20 I: 75.80 ± 8.50	C: 7/10 I: 10/8	H	C:≥JHS 3 I:≥JHS 3	VR 30 min x5/week	CCT 30 min x5/ week	1.5	1.5	MOCA, TMT-A, TMT-B, DSB, DSF
Ren et al, 2023[51]	China	RCT	VR	C: 40 I: 40	C: 58.75 ± 5.62 I: 59.24 ± 6.23	C: 22/18 I: 24/16	H	C:>JHS 26 I:>JHS 28	rTMS + VR 20 min x5/week	rTMS + CCT 20 min x5/week	2	2	MOCA, MMSE, ADL
Sasaninezhad et al, 2024[52]	Iran	RCT	VR	C: 20 I: 20	C: 69.10 ± 5.05 I: 70.30 ± 6.59	C: 9/11 I: 10/10	H	C:≥JHS 20 I:≥JHS 20	VR 30 min x10/week	Nothing	3	3	DSF, DSB
Thapa et al, 2020[53]	Korea	RCT	VR	C: 33 I: 33	C: 72.70 ± 5.60 I: 72.60 ± 5.40	C: 10/24 I: 6/28	H	C:8.40 ± 3.50 (Y) I:9.30 ± 4.00 (Y)	VR 100 min x3/week	Educational program 50 min x1/week	2	2	MMSE, TMT-A, TMT-B
Wang et al, 2016[54]	China	RCT	VR	C: 30 I: 30	T: 59.61 ± 8.73	T: 38/22	H	NR	Anokan-VR + AC 40 min x5/week	AC 40 min x5/ week	2	2	MOCA, MMSE

(*Continued*)

https://doi.org/10.2147/NDT.S536627

Table 1 (Continued).

Reference	Country	Study Type	Leisure Activities	Sample	Age (Y)	Sex (M/F)	Setting	History of Education	Intervention	Control	Duration	F-up	Outcomes
Wang et al, 2023[55]	China	RCT	Mahjong	C: 39 I: 38	C: 67.87 ± 5.18 I: 66.38 ± 4.68	C: 24/15 I: 23/15	H	C:≥JHS 28 I:≥JHS 25	Butylphthalide Soft Capsules 0.2 g tid + Majong 3 h x5/week	Butylphthalide Soft Capsules 0.2 g tid	3	3	MOCA, MMSE
Xue et al, 2021[2]	China	RCT	Chess and card games	C: 36I: 36	C: 73.44 ± 4.89I: 75.42 ± 4.58	C: 13/23I: 11/25	NH	C:≥JHS 22I:≥JHS 22	Board game x3/week	Usual nursing care	2	2	MOCA
Yuan et al, 2024[56]	China	RCT	Pokers	C: 60 I: 59	C: 41.29 ± 11.55 I: 39.01 ± 10.85	C: 31/29 I: 27/32	H	NR	Pokers 2 h x7/week + Agomelatine 25 mg qd	Agomelatine 25 mg qd	2	2	MOCA
Zhang et al, 2023[57]	China	RCT	VR	C: 32 I: 32	C: 64.03 ± 5.28 I: 63.87 ± 5.60	C: 17/15 I: 19/13	H	C:≥JHS 11 I:≥JHS 10	VR 20 min x5/week	CCT 30 min x5/week	2	2	MOCA, MMSE,
Zhao et al, 2021[58]	China	RCT	VR	C: 30 I: 30	C: 58.70 ± 13.40 I: 58.4= ± 14.90	C: 15/15 I: 10/20	H	NR	VR 30 min x7/week	CCT x7/week	1.5	1.5	MOCA, MMSE, ADL
Zhang et al, 2020[59]	China	RCT	Mahjong	C: 28 I: 28	C: 74.20 ± 4.80 I: 74.40 ± 3.90	C: 9/19 I: 6/22	NH	C:5.90 ± 4.20 (Y) I:5.60 ± 3.70 (Y)	Mahjong 1 h x3/week	Normal daily activities 1 h x3/week	3	3	MOCA

Note: Duration of the intervention and total follow-up are in months.

Abbreviations: AD, Alzheimer's disease; T, totality; Y, year; M, male; F, female; H, hospital; NH, nursing home; G, gym; CO, community; DC, day care; NR, not reported; I, intervention; C, control; VR, virtual reality; JHS, junior high school; qd: quaque die; tid: ter in die; AC, acupuncture; rTMS, repetitive transcranial magnetic stimulation; CCT, conventional cognitive training; DS, digit span; DSB, digit span backward; DSF, digit span forward; DST, digit span test; MMSE, mini-mental state examination; MOCA, Montreal cognitive assessment; RCT, randomized controlled trial; TMT-A/B, trail making test-A/B; ADL, activities of daily living.

https://doi.org/10.2147/NDT.S536627

impairments were assigned to leisure activities (intervention group), whereas 561 elderly individuals with cognitive impairments participated in traditional nursing routine training (control group). After 3 surveys that did not indicate the gender ratio of participants were excluded, the overall gender ratio in this study was comparable, with 51.9% of males in the intervention group and 55.4% in the control group. Seven studies did not report the education level of the participants. Nine studies categorized education level as a categorical variable, whereas the remaining studies treated it as a continuous variable. All participants in the studies exhibited some form of cognitive impairment. Specifically, MCI was identified in fourteen studies, cognitive problems following stroke in one study, severe depression with cognitive impairment in one study, vascular cognitive impairment in one study, dementia in another study, and MCI associated with Parkinson's disease in two studies.

Intervention Characteristics

The frequency of interventions ranged from once to ten times per week, with the overall treatment duration varying between 4 and 24 weeks. Each intervention session lasted from 20 to 120 minutes. The intervention group utilized several methods, including VR games (used in 10 studies), board games (used in 7 studies), and interactive games (used in 3 studies). The VR game interventions involved immersive VR experiences or games. The interactive game interventions included various rhythmic activities, such as cognitive games, exergames, and dance-based games. In contrast, the control group used nonleisure activities, including conventional cognitive training, health lectures, acupuncture, medication treatment, and other methods.

Risk of Bias

In this review, we employed the Cochrane risk assessment tool to comprehensively evaluate the risk levels of the studies included in our analysis. According to,[60] studies that achieve a PEDro score of 6 or higher are considered high-quality or excellent-quality studies, reflecting their reliability and rigor. On the basis of these criteria, the 23 studies included in our analysis were all rated as high quality, with PEDro scores ranging from 6 to 9 (Table 2). We conducted Egger tests and generated funnel plots for studies with more than 10 entries (Supplementary Figures 1 and 2). The results revealed MOCA ($t = 1.95$, $df = 14$, $P = 0.072$) and MMSE ($t = 1.76$, $df = 10$, $P = 0.108$) scores. Overall, these studies were assessed as having low risk in terms of intergroup performance differences at baseline, evaluator blinding, dropout rates, and reporting of intergroup differences.

Cognitive Function

Compared with the control group, the experimental group exhibited significantly higher MOCA scores (k = 16; SMD [95% CI] = 1.15 [0.24–2.07], P = 0.012) (Figure 2) and MMSE scores (k = 12; SMD [95% CI] = 1.10 [0.28–1.92], P = 0.013) (Figure 3). There was significant heterogeneity (MOCA: P < 0.0001, I2 = 86.2%; MMSE: P < 0.0001, I2 = 90.9%).

In the subgroup analysis, there was no significant difference in MOCA results among the subgroups, but the MMSE results were different (MOCA: P = 0.114; MMSE: P < 0.0001). Subgroup analysis revealed that the VR game subgroup (MMSE: SMD [95% CI] = 0.54 [0.04–1.04], I2 = 72.9%), board game subgroup (MMSE: SMD [95% CI] = 0.93 [−0.82–2.67], I2 = 86.7%), and interactive game subgroup (MMSE: SMD [95% CI] = 3.61 [−5.06–12.28], I2 = 74%) differed significantly from the control group. When studies using MOCA (k = 16) and MMSE (k = 12) were removed one by one, the effect sizes and heterogeneity remained largely unchanged (Supplementary Figures 3 and 4).

Memory Function

A positive effect on memory function was observed in the experimental group compared with the control group for DSB (k = 5) (SMD [95% CI] = 0.78 [0.48 to 1.09], $P < 0.0001$) (Figure 4) and DSF (k = 5) (SMD [95% CI] = 0.83 [0.27 to 1.39], $P = 0.015$) (Figure 5). There was no significant heterogeneity in either DSB or DSF (DSB: $I^2 = 27\%$, $P = 0.241$; DSF: $I^2 = 44\%$, $P = 0.126$).

Subgroup analyses were conducted according to the memory function evaluation tool (DSB or DSF). There was no significant difference between the DSB subgroups, whereas the opposite results were observed for the DSF subgroup (DSB:

 https://doi.org/10.2147/NDT.S536627

Table 2 Risks of Bias of the Included Studies

Study	Eligibility Criteria Specified	Random Allocation	Allocation Concealment	Groups Similar at Baseline	Participant Blinding	Therapist Blinding	Assessor Blinding	< 15% Dropout	Intention-to Treat Analysis	Between-Group Differences Reported	Point Measure and Variability Reported	Score (1–10)
Amjad et al, 2019[42]	Y	Y	N	Y	N	N	N	Y	Y	N	Y	6
Çetin et al, 2024[43]	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	8
Cao et al, 2023[44]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	7
Cheng et al, 2022[45]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	7
Cheng et al, 2014[15]	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	8
Fei et al, 2020[46]	Y	Y	N	Y	N	N	N	Y	Y	Y	N	6
Iizuka et al, 2018[47]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	7
Jin et al, 2023[48]	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	9
Park et al, 2020 a[49]	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	9
Park et al, 2020 b[50]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	7
Ren et al, 2023[51]	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	8
Sasaninezhad et al, 2024[52]	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	9
Thapa et al, 2020[53]	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	8
Wang et al, 2016[54]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	7
Wang et al, 2023[55]	Y	Y	Y	Y	N	N	N	Y	Y	Y	N	7
Xue et al, 2021[2]	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	8
Yuan et al, 2024[56]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	7
Zhang et al, 2023[57]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	7
Zhao et al, 2021[58]	Y	Y	Y	Y	N	N	N	Y	Y	Y	N	7
Zhang et al, 2020[59]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	7

Notes: Y = Yes, N = No. The total score is equal to the number of Ys, excluding the first criterion (eligibility criteria specified).

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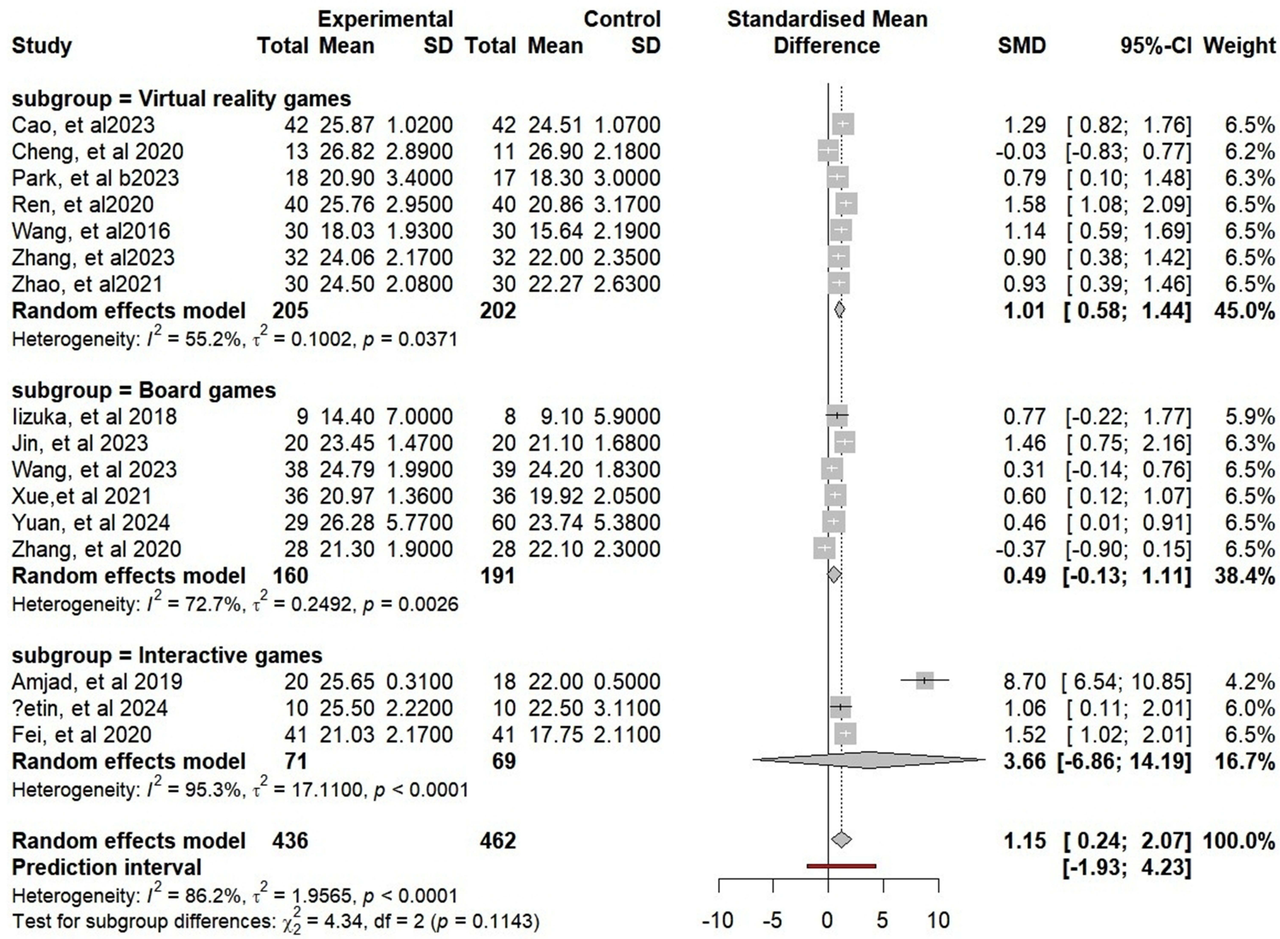

Figure 2 Forest plot of the impact of leisure activity intervention on MOCA.
Abbreviation: MOCA, Montreal Cognitive Assessment.

P = 0.373; DSF: P = 0.038). Subgroup analysis revealed that the VR game subgroup (MMSE: SMD [95% CI] = 0.54 [0.04 to 1.04], I^2 = 72.9%), board game subgroup (MMSE: SMD [95% CI] = 0.93 [−0.82 to 2.67], I^2 = 86.7%), and interactive game subgroup (MMSE: SMD [95% CI] = 3.61 [−5.06 to 12.28], I^2 = 74%) were significantly different from the control group.

In the subgroup analysis, compared with the control group, the VR game subgroup (DSF: SMD [95% CI] = 0.60 [−0.34 to 1.53], I^2 = 7.9%) and Board game subgroup (DSF: SMD [95% CI] = 1.24 [−1.58 to 4.07], I^2 = 0%) presented significant differences in the DSF. The studies that were included were removed one by one. Excluding,[52] combined effect size (DSF: SMD, [95% CI] = 0.77, [−0.44 to 1.58], P = 0.056) was used. The results are presented in Supplementary Figures 5 and 6.

Executive Function

The TMT-A and TMT-B serve as the primary instruments for assessing executive ability. After the leisure activity intervention, there was no significant difference in the TMT-A (k = 4) (SMD [95% CI] = −1.31 [−3.20 to 0.58], P = 0.115) (Figure 6) or TMT-B (k = 4) scores (SMD [95% CI] = −2.09 [−6.95 to 2.77], P = 0.265) (Figure 7) relative to the control group, and significant heterogeneity was observed (TMT-A: $P < 0.0001$, I^2 = 87%; TMT-B: $P < 0.0001$, I^2 = 93%).

There were no notable differences between the subgroups (TMT-A: P = 0.159; TMT-B: P = 0.326). Subgroup analysis revealed that the VR subgroup (TMT-A: SMD [95% CI] = −0.58 [−1.62 to 0.46], I^2 = 0%; TMT-B: SMD [95% CI] = −0.58 [−2.60 to 1.43], I^2 = 0%) and the interactive games subgroup (TMT-A: SMD [95% CI] = −2.07 [−15.43 to 11.30], I^2 = 93%; TMT-B: SMD [95% CI] = −3.66, [−43.43 to 36.10], I^2 = 97%) exhibited decreased TMT scores.

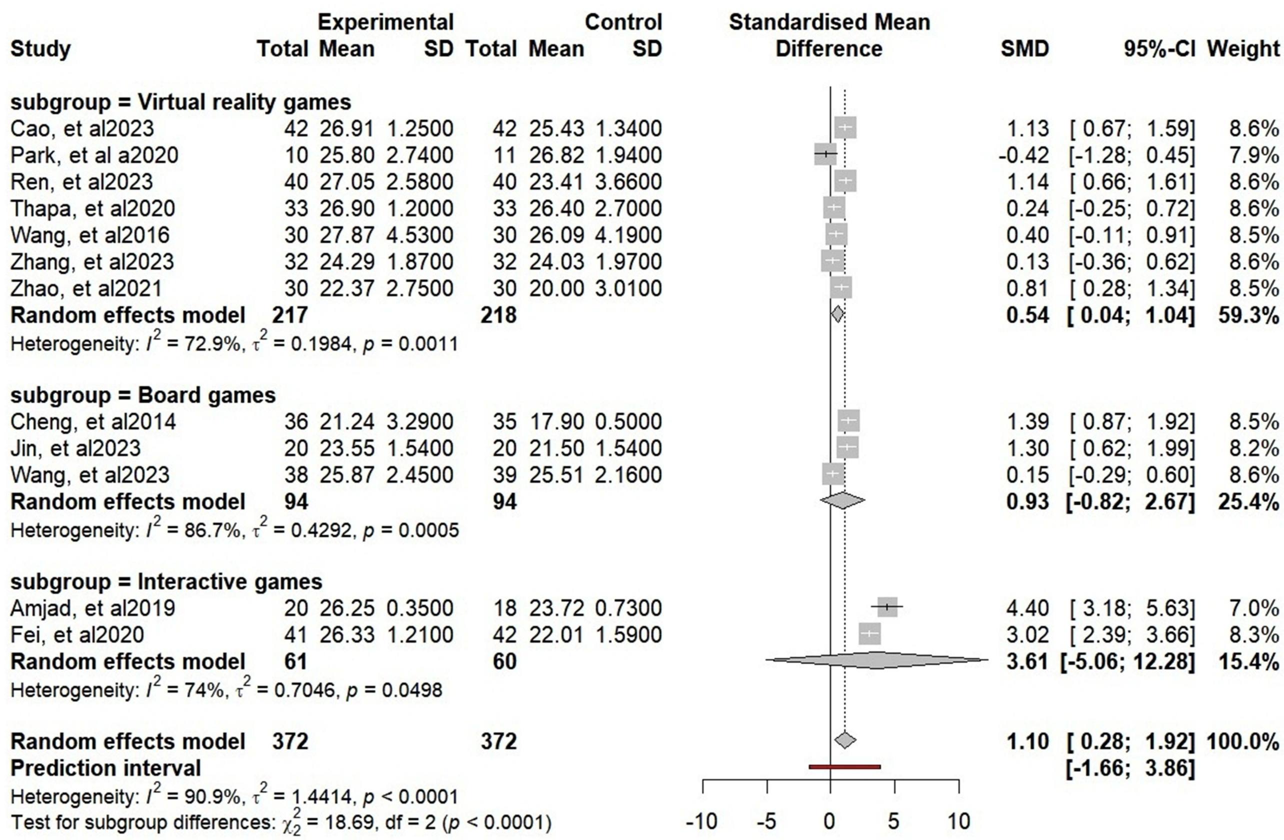

Figure 3 Forest plot of the impact of leisure activity intervention on MMSE scores.
Abbreviation: MMSE, Minimum Mental State Examination.

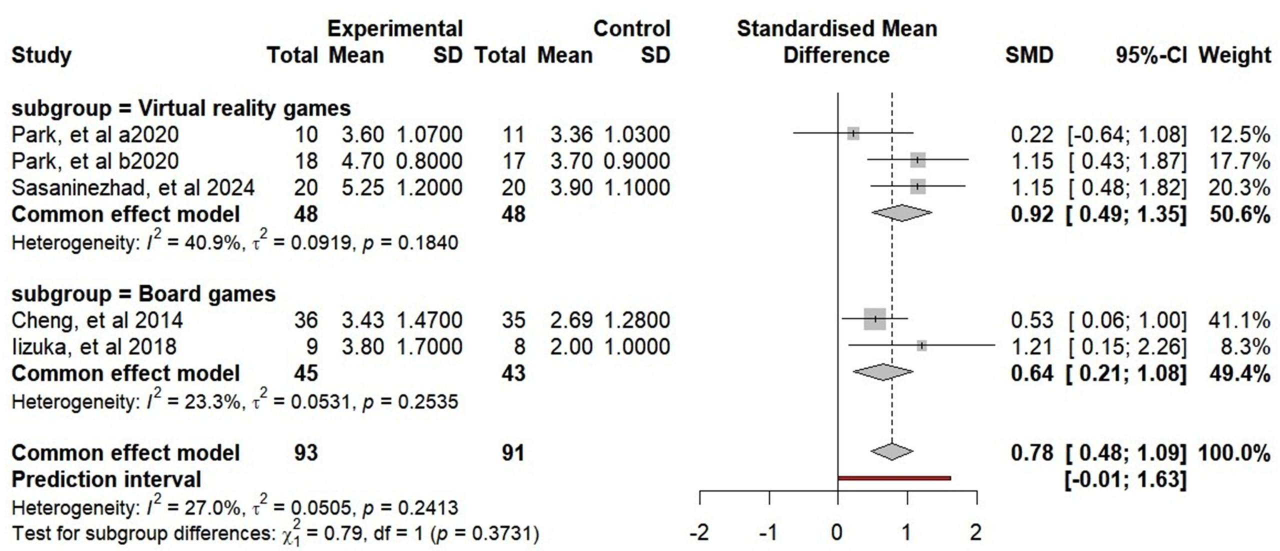

Figure 4 Forest plot of the impact of leisure activity intervention on DSB.
Abbreviation: DSB, Digit Span.

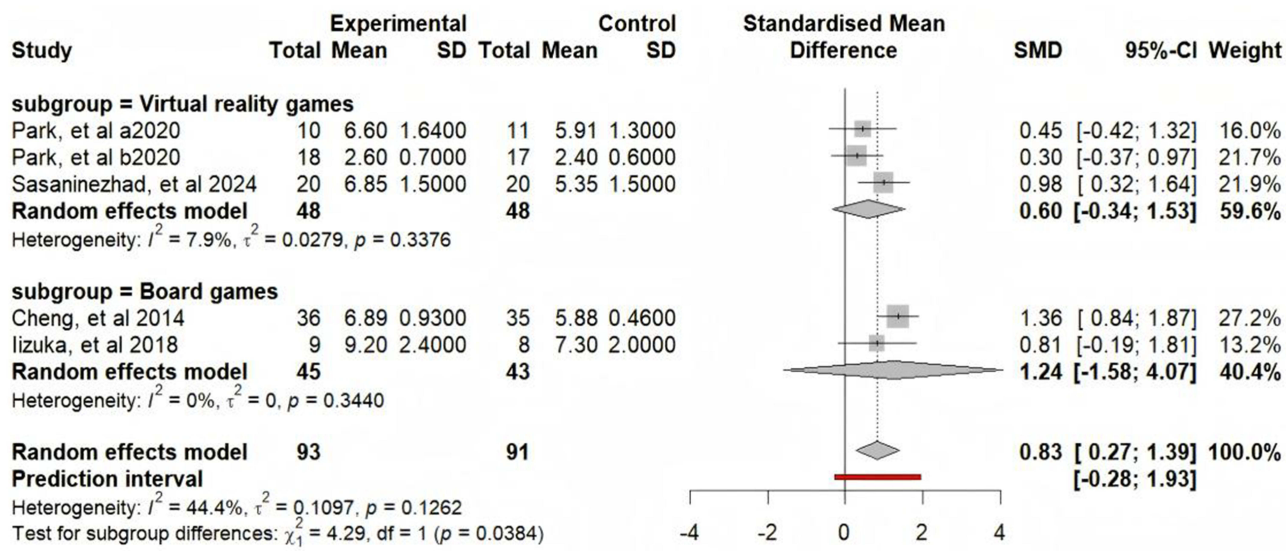

Figure 5 Forest plot of the impact of leisure activity interventions on the DSF.
Abbreviation: DSF, Digit span forward.

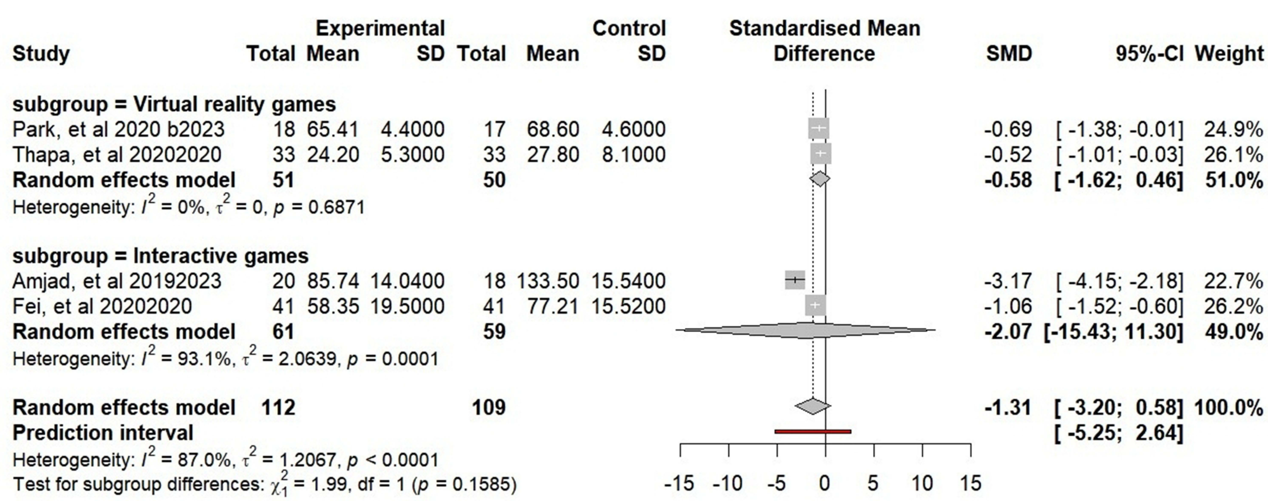

Figure 6 Forest plot of the impact of leisure activity intervention on TMT-A.
Abbreviation: TMT-A, Trail making test-A.

Excluding,[42] the combined effect size was as follows: TMT-A: SMD, [95% CI] = −0.78, [−1.51 to −0.04], *P* = 0.0452; TMT-B: SMD, [95% CI] = −0.59, [−0.94 to −0.23], *P* = 0.0195. This finding indicates that the combined results may not be robust. For more information, please refer to Supplementary Figures 7 and 8.

Quality of Life

In the experimental group, the ADL scores (k = 3) (SMD [95% CI] = 0.81 [0.53 to 1.08], *P* < 0.0001) (Figure 8) were significantly higher than those in the control group. This finding indicates substantial heterogeneity in the results (ADL: *P* = 0.307, I^2 = 15%).

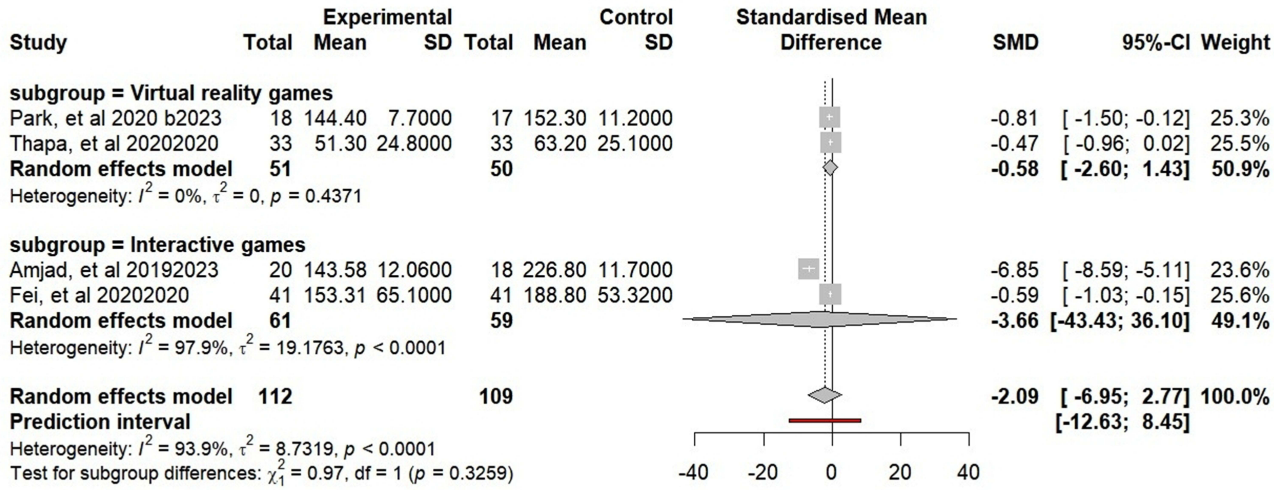

Figure 7 Forest plot of the impact of leisure activity intervention on TMT-B.
Abbreviation: TMT-B, Trail making test-B.

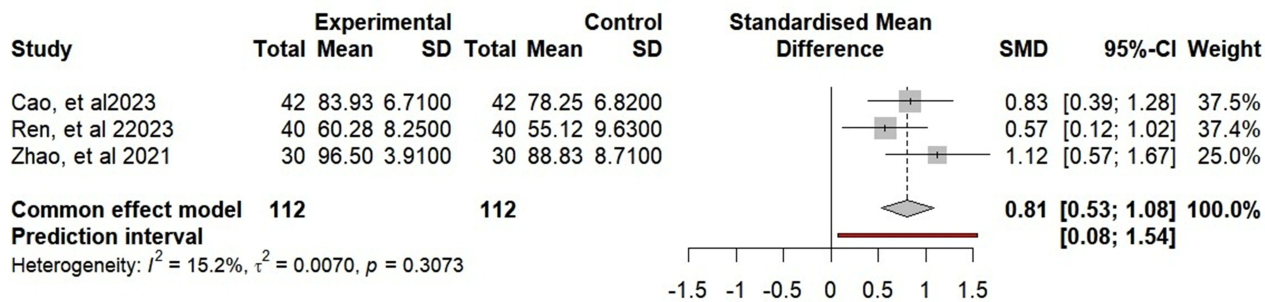

Figure 8 Forest plot of the impact of leisure activity intervention on ADLs.
Abbreviation: ADL, Activities of Daily Living.

Discussion

The benefits of leisure activities on cognitive function have been confirmed, but whether leisure activities can improve cognition and memory in patients with cognitive impairment remains unknown. Our study is the first to analyze the effectiveness of leisure activities on cognition and memory in patients with cognitive impairment. Overall, after leisure activity interventions, patients' overall cognition, memory, executive ability, and quality of life improved.

Virtual Reality Games

VR games are a new rehab technique. VR games use computers to create virtual environments that mimic real objects and space.[61] With sensing devices, patients can immerse themselves in these virtual cognitive settings and interact naturally.[62] In 10 VR game studies, the VR game subgroup exhibited excellent consistency across cognitive tests such as the MOCA and MMSE. This approach minimized the degree of clinical heterogeneity. Subgroup analysis revealed that VR game interventions positively affected patients' cognitive and memory function. The immersive, multisensory nature of VR games engages players, boosting immersion and memory in virtual worlds.

VR technology affects neural plasticity in multiple ways. VR technology can balance the cholinergic and dopamine systems (Kim et al, 2011) and release neurotrophic factors for nerve health.[63] Research has shown that VR cognitive training can change neuronal plasticity through forced learning.[64] During VR training, players may activate neural systems related to cognitive pathways by observing their movements, enhancing consciousness and cognitive function.[65,66] This review revealed that VR game interventions are effective for cognitively impaired patients. VR games improve cognitive, memory, and quality of life. However, no statistical differences were observed in the execution of functions (TMT-A/B). This may be due to the complexity of the task, such as TMT-B requiring simultaneous visual tracking and cognitive transformation, which places high demands on executive function and may exceed the scope of current interventions. Therefore, VR games are recommended as alternatives to traditional cognitive rehabilitation for better cognitive and memory enhancement.

Board Games

This meta-analysis explores how board games can boost cognitive function in elderly, cognitively impaired patients. Among the seven studies included in the analysis, four focused on mahjong, whereas the rest focused on Go, poker, chess, and card games.

Subgroup analysis revealed that board game interventions significantly improved patients' MOCA and MMSE scores. This aligns with recent research on mahjong's ability to enhance cognitive skills and attention in the elderly. Iizuka et al reported that playing Go increases fluorodeoxyglucose uptake in the left temporal gyrus, improving memory task performance.[47,67] Another study revealed that long-term Go players have more white matter connections in key brain areas, suggesting enhanced cognitive function and neural communication.[68]

However, in the included studies, the board game subgroup did not have a significant effect on memory function (DSF). This might be because Go's simple black and white pieces limit certain cognitive improvements. Additionally, the intervention intensity and duration might not be enough to sustain relevant biological effects in executive function-related brain regions.

Overall, this meta-analysis indicates that board game interventions could be a potential treatment for improving cognitive function in cognitively impaired patients. However, more high-quality research is needed to confirm the overall results.

Interactive Games

Interactive games allow players to directly interact with their surroundings via body movements, and no complex controllers are needed. They are widely used in the rehabilitation of individuals with cognitive impairment. Common platforms are "Nintendo Wii" and "Microsoft Xbox 360 Kinect".[69] This study included only 3 relevant interactive game studies. During screening, we found little research on DSB and DSF applications, possibly due to different memory function evaluation criteria.

Interactive games follow task-oriented exercise principles, with repetition and high intensity as keys.[70,71] Shepherd et al suggested that when neurons are damaged, repeated, strong activation of neural networks can reactivate brain pathways and improve function.[72] In addition, a previous study suggested that interactive games can improve cognitive function in MCI patients. One possible reason for the improvement in cognition is that these games require participants to integrate attention resources,[73,74] visual motor skills,[75,76] processing speed,[77,78] visual spatial ability,[79,80] and executive function.[81] However, in our study, there was no significant improvement in patients' cognitive function, which may be due to some interactive games may prioritize attention or memory training over executive function. In conclusion, interactive games seem to enhance cognitive function. However, more in-depth research is needed to assess their reliability and long-term effects more completely.

The Relationship Between Intervention Duration, Frequency, and Cognitive Effects

Compared to TCRT (where effects may fade within 6–12 months), our analysis suggests that long-term leisure activities ($\geq$6 months) show more persistent cognitive benefits, possibly due to their integration into daily life. However, short-term interventions ($<$3 months) showed inconsistent results, indicating potential decay of effects over time. The overall analysis showed that the correlation coefficient between the total intervention duration and the improvement of MOCA score was $r=0.38$ ($p=0.02$), and the correlation coefficient with the improvement of MMSE score was $r=0.35$ ($p=0.03$), indicating that a longer intervention period (such as 24 weeks vs 4 weeks) is more conducive to cognitive function improvement. Frequency analysis showed that the correlation coefficient between the number of interventions per week (1–10 times) and cognitive score improvement was $r=0.15$ ($p=0.21$), indicating that there was no statistically significant difference in the effect between "high-frequency short cycles" (such as 10 times per week x 4 weeks) and "low-frequency long cycles.

Strengths and Limitations

This meta-analysis offers the first, latest, and most comprehensive summary of how leisure activities can improve cognitive function in patients with various cognitive impairment etiologies. However, this study has limitations. First, blind method implementation in areas such as mahjong, poker, Go, and VR game interventions is difficult because of their unique nature. Second, the lack of quantitative indicators of exercise intensity in these studies makes direct cross-sectional comparisons difficult. Third, most board game intervention literature is from China, which may lead to regional bias. Fourth, this study excluded non English research, which may introduce selection bias. High-quality research from non-English countries (eg, Korean, Japan) might exist but was inaccessible due to language restrictions, potentially affecting the comprehensiveness of our findings. Future reviews should prioritize multilingual inclusion or professional translation support to mitigate this bias. This will help us better understand how effective leisure activities are in enhancing cognitive function among elderly, cognitively impaired people. Finally, a potential limitation is the variability in neuropsychological tests across included studies, which may affect the comparability of results.

Conclusion

Leisure activities could be a viable cognitive intervention for patients with cognitive impairment. Such activities can enhance cognitive function, memory, executive function, and quality of life, with effects on par with or even better than those of TCRT. Given the promising results of this review and the clinical challenges of TCRT, there is a substantial evidence to promote the integration of leisure activities as a supplement or alternative to evidence-based cognitive rehabilitation in treatment plans. This change is likely to yield positive results.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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