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The Effect of Motor Imagery Training on Lower Limb Function in Older Adults: A Systematic Review

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Abstract

Background Population aging is a significant trend in China's development, and the decline in lower limb function in older adults is one of the primary health threats, often leading to falls or injuries. Several studies have applied motor imagery (MI) to improve lower limb function in older adults. However, the benefits of this intervention method for older adults remain to be further explored. **Objective** This paper systematically reviews the benefits of motor imagery in improving lower limb function in older adults using the International Classification of Functioning, Disability, and Health (ICF) framework. **Methods** Relevant literature on motor imagery interventions targeting balance ability in healthy older adults was retrieved from four English and three Chinese databases. The content of the literature was analyzed and coded based on the theoretical framework of the ICF. **Results** A total of 11 studies from 7 countries were included, comprising 11 randomized controlled trials (RCTs) with 758 older adult participants. Interventions included MI alone or combined with physical exercise, and intervention settings encompassed laboratories, communities, hospitals, and homes. Outcome measures included motor function, postural changes and maintenance, gait, and mobility. **Conclusion** Motor imagery interventions and their combination with other intervention methods can improve lower limb function and related motor abilities in older adults. However, compared to MI alone, the effects of combined MI interventions on lower limb function in older adults remain inconclusive.

Keywords Motor imagery; older adults; lower limb function; systematic review

Introduction

The aging of the global population is becoming an increasingly pressing issue. Individuals aged 60 and above account for over 10% of the world’s total population[1] and the number of those aged 80 and above is rising rapidly. According to United Nations projections, by 2050, the global elderly population is expected to comprise 20% of the total population[2]. To enhance the quality of life for older adults and promote their physical and mental health, encouraging active participation in physical activity has become a critical objective worldwide[3]. Lower limb function refers to the ability to perform and coordinate leg and foot movements, encompassing essential activities such as walking, running, jumping, squatting, and climbing stairs. Key factors influencing lower limb function include leg muscle strength, joint flexibility, and balance[4]。 However, with advancing age, lower limb function naturally deteriorates. This decline contributes to reduced balance and gait stability, limiting mobility and significantly increasing the risk of falls—some of which can have fatal consequences[5]。 For older adults, motor control and muscle strength are vital to maintaining independence in daily life. Targeted physical exercise has been shown to improve these abilities[6] effectively. Furthermore, recent research highlights the potential of innovative interventions in enhancing lower limb function among the elderly[7].

Motor imagery (MI) is a mental process that stimulates the brain’s motor regions through the internal simulation of movements[8], During motor imagery, individuals vividly imagine themselves performing specific actions without engaging in physical movement or activating muscles[9]. This dynamic mental state allows participants to simulate the visual and motor aspects of an action internally, without any physical execution[10]. In essence, motor imagery consciously activates brain regions responsible for motor planning and execution, while simultaneously suppressing actual movement[11]. Motor imagery training has shown considerable promise in interventions designed for older adults. It is a convenient and efficient method that uses verbal or auditory guidance to help participants mentally rehearse movements. Additionally, studies indicate that combining motor imagery with physical interventions can amplify their effectiveness and efficiency[12]. However, when developing motor imagery training programs for older adults, it is essential to carefully consider their physical health, cognitive capacity, and prior motor experiences to maximize the benefits[13].

This study aims to systematically review existing research on the effectiveness of motor imagery interventions in enhancing lower limb function among healthy older adults. Specifically, it will analyze the design of motor imagery programs to improve balance and evaluate their impact on balance and overall health outcomes in this population.

1 Research Methods

1.1 Research Framework

The United Nations' 2030 Agenda for Sustainable Development incorporates rehabilitation as a continuum of health services, encompassing physical functioning, activity, environment, and well-being. This spans prevention, treatment, rehabilitation, and health promotion across the entire population and life cycle[14]. The *International Classification of Functioning, Disability, and Health* (ICF) is a framework designed to describe and classify human functioning, disability, and health. It emphasizes the functional levels of individuals in their health and social environments, aiding professionals in better understanding and assessing individuals' health status and its impact on daily life. The ICF provides a theoretical foundation for formulating health policies, enabling the evaluation of the effectiveness and impact of health services. It also serves as an international standard with broad applicability across different countries and cultures[15]. This study, based on the ICF framework, analyzes motor imagery interventions for improving balance ability in healthy older adults. It focuses on motor function, postural changes, maintenance, walking, and mobility while examining intervention protocols, settings, comparisons, and outcomes. The study's PICO criteria are detailed in Table 1.

Table 1. PICO Strateg

PICO	Selection Criteria
Population	**Health Status:** Healthy older adults; No cognitive impairment; No major illnesses; No disabilities; No functional mobility impairments; May have a fear of falling **Age Group:** 65 years and older
Intervention	**Types:** MI intervention alone; Exercise + MI intervention; Music + MI intervention; Imagery (video) + MI intervention; Action observation + MI intervention **Intervention Settings:** Laboratory; Community; Hospital; Home
Comparison	Comparison Between the MI Group and the Control Group; Comparison Among Multiple Intervention Groups; Comparison of Different Intervention Methods
Outcome	**Motor Function:** Lower limb muscle power functions (b7303); Involuntary movement reaction functions (b755)；Gait pattern functions (b770) **Changing and Maintaining Body Position:** Maintaining a standing position (d4154); Moving oneself to a sitting position (d4200)

Walking and Moving: Walking short distances (d4500); Walking around obstacles (d4503)

1.2 Literature Search Strategy

The study employed a combination of subject terms and free-text keywords for the literature search. English databases searched included PubMed, Embase, Web of Science, and the Cochrane Library. The search spanned from database inception to November 2024 to ensure the inclusion of up-to-date literature. English search terms included: "Imagery," "motor imagery," "mental imagery," "postural balance," "balance," "walk," "Aged," "Older," and "Senior." The detailed search strategy is presented in Table 2.

1.3 Inclusion and Exclusion Criteria

Inclusion criteria: ①Study participants were healthy older adults aged 60 or above; ②Interventions included motor imagery; ③The study focused on the impact of motor imagery on the balance function of healthy older adults.; ④The study design was a randomized controlled trial (RCT).

Exclusion criteria: ①Participants had diseases, injuries, or disabilities affecting balance function; ②Studies involved acute or non-physical activity interventions; ③No balance test results were reported; ④Duplicate publications, general reviews, or unpublished works (e.g., conference abstracts, theses); ⑤Systematic reviews, meta-analyses, or other secondary studies; ⑥Studies without access to the full text.

1.4 Literature Screening and Data Extraction

Search results from different databases were merged, and duplicates were removed. Two researchers independently analyzed and extracted data based on the inclusion and exclusion criteria. Extracted information included the title, authors, country, publication date, research objective, study population, methodology, results, and conclusions. The process of literature search and screening is illustrated in Figure 1.

1.5 Quality Assessment of Included Studies

The methodological quality of the included studies was evaluated using the PEDro scale[16]. Among the 11 included studies, 6 were considered high-quality studies: one study scored 9 points, one scored 8 points, and four scored 7 points. Blinding, allocation concealment, and intention-to-treat analysis were the key areas most susceptible to bias in the included studies. Detailed results are presented in Table 3.

Table 2. English search form (using PubMed as an example)

Search Level	Query Term
#1	(Imagery[MeSH Terms]) OR ((((((((((((((motor imagery) OR (action observation)) OR (mental practice)) OR (mental training)) OR (mental rehearsal)) OR (mental imagery)) OR (guided imagery)) OR (exercise imagery)) OR (imagery based)) OR (verbally elicited imagery)) OR (movement imagery)) OR (visualization)) OR (psychoneuromuscular theory)) OR (movement observation)) OR (imagined))
#2	(postural balance[MeSH Terms]) OR ((((((((((((((((Posture Equilibrium) OR (Equilibrium, Posture)) OR (Posture Equilibriums)) OR (Balance, Postural)) OR (Postural Equilibrium)) OR (Equilibrium, Postural)) OR (Posture Balance)) OR (Balance, Posture)) OR (Posture Balances)) OR (Musculoskeletal Equilibrium)) OR (Equilibrium, Musculoskeletal)) OR (Postural Control)) OR (Control, Postural)) OR (Postural Controls)) OR (Posture Control)) OR (Control, Posture)) OR (Posture Controls)) OR (Walking[MeSH Terms]) OR (Ambulation) OR (Walking Speed[MeSH Terms]) OR ((((((((((Speed, Walking) OR (Speeds, Walking)) OR (Walking Speeds)) OR (Gait Speed)) OR (Gait Speeds)) OR (Speed, Gait)) OR (Speeds, Gait)) OR (Walking Pace)) OR (Pace, Walking)) OR (Paces, Walking)) OR (Walking Paces))

Search Level	Query Term
#3	(Aged[MeSH Terms]) OR ((((((Geriatric) OR (aged)) OR (Old)) OR (Older)) OR (Senior)) OR (elderly))
#4	#1 AND #2 AND #3

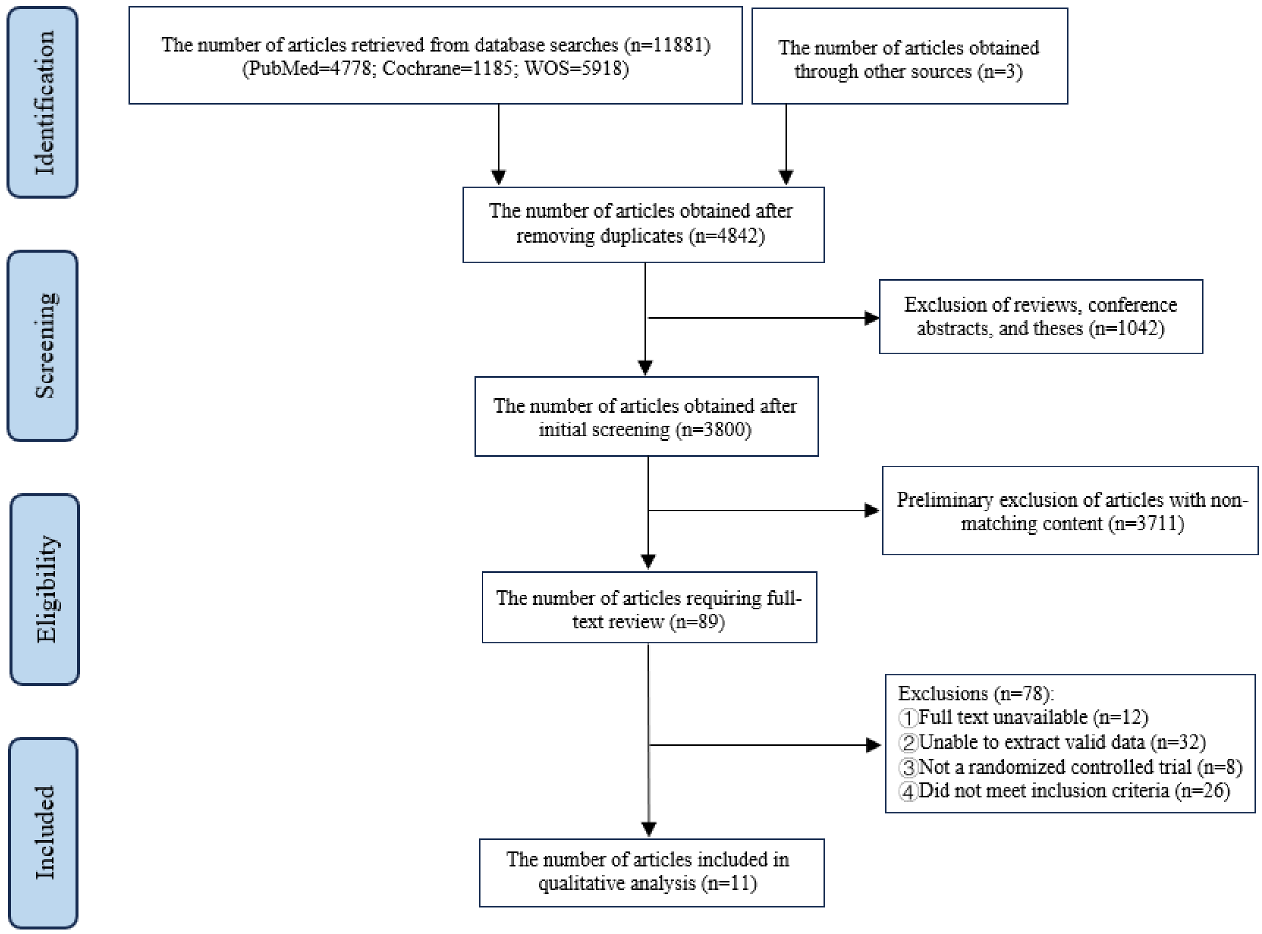

Figure 1. Flowchart of literature screening

Table 3: PEDro scale scores of the included literature

Study	1	2	3	4	5	6	7	8	9	10	11	Totals
Sakurai（2017）	√	√	√	√	-	-	-	√	√	√	√	7
Hilt（2023）	√	√	-	√	-	-	-	√	√	√	√	6
Blumen（2017）	√	√	-	√	-	-	-	-	√	√	√	5
Chiacchiero（2015）	√	√	-	√	-	√	-	√	√	√	√	7
Sakurai（2021）	√	√	√	√	-	-	-	√	√	√	√	7
Goudarzian（2017）	√	√	-	√	-	-	-	√	√	√	√	6
Oh（2021）	√	√	-	√	-	-	-	√	√	√	√	6
Batson（2007）	√	√	-	√	-	-	-	√	√	√	√	6
Temporiti（2024）	√	√	√	√	√	-	√	√	√	√	√	9

Nicholson（2018）	√	√	√	√	-	-	-	√	√	√	√	7
Kim（2022）	√	√	√	√	√	-	-	√	√	√	√	8

Note:1:Meets criteria (inclusion criteria clearly defined);2:Random allocation;3:Allocation concealment;4:Similar baseline characteristics;5:Blinding of participants;6:Blinding of therapists;7:Blinding of assessors;8:Adequate follow-up (over 85% of participants completed the trial);9:Intention-to-treat analysis;10:Between-group comparisons;11:Point estimates and variability.

2 Results

2.1 Basic Characteristics of Included Studies

A total of 11 studies[17–28]were included in the analysis, all published in English. These studies originated from seven countries: Japan, France, the United States, Iran, South Korea, Italy, and Australia. Collectively, they comprised 11 randomized controlled trials (RCTs) involving 758 older adult participants. The studies primarily spanned fields such as medicine, psychology, exercise intervention, and sports science, with publication dates concentrated between 2007 and 2014. The basic characteristics of the included studies are summarized in Table 4.

2.2 Intervention Subjects

According to the PICO framework, the included studies focused on healthy older adults without cognitive impairment, disabilities, mental illness, or injuries. However, older adults with a fear of falling (FoF) were included to facilitate a more comprehensive analysis. Across the 11 studies, participants were rigorously screened. For example, the studies by Hilt[27]and Chiacchiero[26]targeted very old adults, with an average age of around 85. In Sakurai’s two studies[28,25] the participants included healthy older adults and older adults with high physical functioning. However, through long-term follow-up, individuals at risk for FoF were identified and selected for intervention trials. Additionally, Goudarzian’s study[24]focused exclusively on older male participants, while Batson’s study[22]involved community-dwelling older adults. Other studies[23,20,19,18,17]generally included participants aged between 65 and 85.

2.3 Intervention Methods

The intervention protocols in the included studies encompassed various approaches, such as Motor imagery (MI) alone, Exercise combined with MI, Audio-guided MI, Image-based (video) MI, and Action observation (AO) combined with MI.

Among these, standalone motor imagery training appeared most frequently. For example, in Hilt’s study[27] the intervention group underwent MI training alone, which was then compared with the control group. In Blumen’s study[17]the intervention for the experimental group involved not only MI but also the inclusion of imagery. In this study, gait-related (AC) imagery interventions were conducted through phone communication. In the studies by Chiacchiero[26]and Kim[21], participants listened to recorded instructions or music to facilitate motor imagery as part of the intervention. In Oh’s study, the intervention group underwent task-oriented training after motor imagery exercises, integrating MI with physical activities. In Temporiti’s study[20]one intervention group combined MI with action observation (AO+MI). This group performed AO+MI exercises in the evening before sleep, while another intervention group performed the same exercises in the morning. Both intervention groups were then compared with a control group. In Goudarzian’s study[24]one intervention group performed MI alone, while another combined MI with whole-body vibration (MI+WBV), attempting to integrate motor imagery with vibration training.

Table 4 Basic characteristics of the included literature

nations	Design	Group	Population	MI Intervention	Comparison	Measures
Japan	RCT	T1（n=178）: FoF T2（n=107）: No FoF	Healthy elderly individuals without diseases (average age 73.1 years, 74.7% female)	①Not specified ②Not specified ③Not specified (4 trials in total) ④Small effect size ⑤Laboratory setting ⑥Participants in two groups were first asked to imagine the trial (iTUG) and estimate the time required, followed by performing the actual trial (aTUG), with the difference between iTUG and aTUG (ΔTUG) calculated.	In the FoF group, the aTUG test was significantly slower, but the iTUG test duration was nearly identical between the two groups. Older adults in the FoF group overestimated their TUG performance.	(d4503) (d4500)
France	RCT	T1（n=15）: MIT T2（n=15）: CG	Right-handed healthy older adults (age 86 ± 2 years)	①20min ②Not specified ③Conducted once every 24 hours ④Moderate effect size ⑤Laboratory ⑥30 older adults engaged in either 20 minutes of motor imagery training (T1) or watched a 20-minute documentary (T2). Before and after the session, participants performed a sequential stepping task as quickly as possible.	The control group maintained stable performance on the sequential stepping task after a 20-minute rest, while the mental imagery training (MIT) group showed improved performance on the sequential stepping task after 20 minutes of MIT.	(b7303) (b770) (b755)
United States	RCT	T1（n=24）MIT T2（n=24）: CG	Healthy older adults strictly screened according to eligibility criteria (aged 65–80 years)	①15min ②12weeks ③3 times per week ④Large effect size ⑤Laboratory ⑥The motor imagery of gait (AC) intervention was delivered via phone. The primary outcome was the change in gait speed during actual walking (W) and walking while thinking (WWT) before and after the intervention.	Compared to the control group, the MIT group exhibited a significant increase in gait speed and demonstrated stronger functional neuroplastic responses.	(b770) (b7303)
United States	RCT	T1（n=9）: MIT T2（n=11）: CG	Healthy older adults (average age 79.2 ± 6.35 years, including 3 men and 17	①20min ②4 weeks ③3 times per week ④Moderate effect size ⑤Not specified ⑥Participants in the control group were instructed not to listen to the audio recordings. In contrast, those in the experimental group actively focused on the audio instructions	Compared to the control group, older adults in the experimental group showed improvements in forward functional reach and reduced sway path length when standing with eyes open on a solid surface.	(d4154)

				women)	and imagined moving their bodies as directed. A balance test was conducted afterward.		
urai[28] 021）	Japan	RCT	T1（n=99）：FoF T2（n=85）：No FoF	Community-dwelling healthy older adults (average age = 73.5 years, 77.9% female)	①Not specified ②Not specified ③4 trials in total ④Small effect size ⑤Laboratory ⑥Participants in two groups first imagined performing the TUG task and estimated the time required (iTUG), followed by performing the actual trial (aTUG). The difference between the two trials was calculated.	For patients with FoF, the iTUG duration was significantly shorter than the aTUG duration, indicating an overestimation of their TUG performance.	(d4503) (d4500)
darzian [24] 017）	Iran	RCT	T1（n=11）：WBV T2（n=12）：MT T3（n=10）：WBV+MT T4（n=9）：CG	Healthy older men (average age = 68 ± 5.78 years)	①30min ②8 weeks ③3 times per week ④Small effect size ⑤Laboratory ⑥Whole-body vibration (WBV) exercises were performed on a vibration machine. During mental training (MT), participants were instructed to mentally imagine performing timed up-and-go exercises. Testing was conducted afterward.	Compared to baseline and the control group, WBV, MT, and WBV+MT interventions significantly improved postural stability, timed up and go, five-times sit-to-stand, 6-meter tandem walking, 10-meter walking, and leg strength.	(b7303) (d4154) (d4200) (b770) (d4500)
)h[23] 021）	South Korea	RCT	T1（n=11）：MIT T2（n=11）：TOTG T3（n=12）：CG	Healthy elderly individuals aged 65 and above	①40min ②6 weeks ③3 times per week ④Small effect size ⑤Laboratory ⑥The MITG group received motor imagery training followed by task-oriented training, the TOTG group only received task-oriented training, and the CG group received fall prevention and health education using audiovisual materials.	Post-intervention, compared to the CG group, the MITG and TOTG groups showed significant improvements in path length, BBS, TUG, speed, cadence, step length, and stride length. Additionally, the TOTG group exhibited significant improvements in BBS, TUG, and FES compared to the CG group.	(b770) (b7303) (d4500) (d4503)
son[22] 007）	United States	RCT	T1（n=3）：MIT T2（n=3）：CG	Older adults screened under eligibility criteria	①1h ②6weeks ③2 times per week ④Large effect size ⑤Library ⑥Two groups participated in motor imagery training or health education sessions, respectively. Pre- and post-intervention	A statistically significant decline in gait speed was observed across the entire group, but not within either group individually. All participants, except one whose scores	(b7303) (d4500) (d4503)

				and examinations (aged 65–80 years)	measurements included the Berg Balance Scale (BBS), Timed Up and Go (TUG), and the Activities-Specific Balance Confidence Scale (ABC).	remained unchanged, demonstrated an average improvement in gait speed.	
Temporiti[20] (2024)	Italy	RCT	T1（n=15）: AOMI-Sleep T2（n=15）: AOMI T3（n=15）: CG	Healthy older adults selected according to inclusion and exclusion criteria (aged 65–85 years)	①2h ②3weeks ③4 times per week ④Small effect size ⑤Laboratory ⑥The AOMI-sleep group and AOMI-control group engaged in gait and balance tasks involving action observation and motor imagery in the evening and morning, respectively, while the control group watched landscape video clips.	Compared to the AOMI-control group and the control group, early sleep following AOMI training improved gait and balance abilities in older adults.	(b7303) (b770)
Nicholson[19] (2018)	Australia	RCT	T1（n=10）: MIT T2（n=10）: TOTG T3（n=10）: CG	Community-dwelling older adults selected through screening (aged 65–85 years)	①Not specified ②Not specified ③Not specified ④Large effect size ⑤Laboratory ⑥The MIT group performed imagined repetitions, the physical training group completed physical repetitions, and the control group played cognitive games on an iPad. The time for imagined and physical performance was measured during each training session.	Compared to the training and control groups, a single session of motor imagery training facilitated motor learning in older adults. Motor imagery training of specific motor tasks also had a positive effect on related physical motor performance outcomes.	(b7303) (b755)
Kim[18] (2022)	South Korea	RCT	T1（n=12）: VR T2（n=10）: MIT T3（n=12）: CG	Older adults included based on strict inclusion criteria (aged 65 and above)	①20min ②6weeks ③3 times per week ④Moderate effect size ⑤Rehabilitation hospital ⑥The VR group received interventions through virtual games, the MIT group engaged in motor and visuospatial imagery training, and the control group received no intervention. Testing was conducted post-intervention.	Compared to the VR group, the MIT group did not show significant differences in balance scores with eyes open or closed. However, the MIT group outperformed the CG group in balance scores with eyes open.	(b7303)

Note: RCT: randomized controlled trial; MIT: motor imagery training; CG: control group; FoF: Fear of Falling; WBV: Whole-Body Vibration Training; TOTG: Time on the Ground Training; VR: Virtual Reality; AOMI:Action Observation combined with Motor Imagery; ①:Intervention duration; ②:Intervention period; ③:Intervention frequency; ④:Intervention intensity; ⑤:Intervention location; ⑥:Intervention content; (b7303):Lower limb muscle power functions; (b755):Involuntary movement reaction functions; (b770):Gait pattern functions; (d4154):Maintaining a standing position; (d4200): Moving oneself to a sitting position; (d4500):Walking short distances; (d4503): Walking around obstacles risk of falls in older adults with FoF when adapting to different environments.

3 Discussion

3.1 Mechanisms of MI's Impact on the Elderly

Motor imagery (MI) has been studied extensively, with several theoretical frameworks proposed to explain its mechanisms. Key theories include the Psychoneuromuscular Theory, Symbolic Learning Theory, and Bioinformational Theory[29]Mattay et al.[30]observed that elderly individuals develop bilateral neural networks in the brain when learning motor tasks based on visual information, a pattern less prominent in younger learners. The influence of MI on lower limb function in elderly individuals is best explained by the Functional Equivalence Hypothesis[31]. According to this hypothesis, MI is driven by a "simulator" controlled by the brain's central command. This simulator not only processes motor commands but also evaluates sensory feedback, mimicking the input-output functions of the brain's motor cortex. During MI, the brain sends neural signals to the simulator, creating patterns of neural activity. Training through MI involves repeatedly stimulating these patterns. When the elderly transition from imagery to physical movement, the simulator-trained neural currents activate the motor cortex, allowing muscles to perform actions such as walking or standing. This process is illustrated in Figure 2.

3.2 MI's Impact on Different Elderly Populations

The 11 reviewed studies included diverse elderly populations, such as the very elderly, community-dwelling seniors, and individuals with a fear of falling (FoF), with participants primarily aged 65 to 85. In Hilt's[27]study on very elderly individuals, performance improved after three MI sessions but returned to baseline following a 20-minute rest, suggesting potential age-related impairments in the motor cortex. However, the final test revealed that MI still produced positive effects, indicating its potential to reduce performance disparities between older and younger elderly groups. Nicholson's[19]study on healthy, community-dwelling seniors demonstrated significant improvements in obstacle negotiation tasks after MI. In contrast, Sakurai's[25,28]research found that elderly individuals with FoF often overestimated their abilities and struggled to accurately imagine their performance on the Timed Up and Go (TUG) test. These findings highlight the necessity of tailoring MI interventions to address the specific needs and limitations of different elderly populations. Future studies should carefully select participants, considering factors such as age, living environment, and the presence of FoF, while excluding individuals with severe illnesses or injuries.

3.3 MI Intervention Duration

Among the included studies, only eight specified the duration and frequency of MI interventions, with an average duration of three months. Other studies utilized short-term or immediate intervention designs. Batson [22]argued that short intervention periods are insufficient to fully assess the impact of MI or to observe clinically significant improvements in physical performance, especially given the cumulative effects of aging. Long-term interventions were found to yield superior outcomes compared to short-term or immediate interventions. MI training works by reinforcing motor patterns through repeated imagery, a process analogous to memory formation, which also requires frequent and sustained repetition to produce lasting effects[32], Additionally, as aging reduces brain volume and neuronal density, cognitive decline and memory deficits may arise, further underscoring the need for prolonged interventions to achieve meaningful outcomes[33]. Future research should design interventions with extended durations and higher frequencies, tailored to the needs of elderly participants. Long-term follow-up studies are also essential to evaluate the persistence of MI's effects over time.

3.4 Design of MI Intervention Methods

The design of MI interventions involves selecting appropriate intervention methods and guiding participants' imagery processes. Among the 11 experiments included in this study, various combinations of intervention strategies were utilized. For instance, in Oh's study[23]combining MI training with task-oriented training significantly improved static and dynamic balance, walking ability, and fall prevention efficacy among the elderly. Temporiti[20]found that the AO+MI group and the AO+MI-sleep group showed significant improvements in maximum walking speed and balance ability compared to the control group. However, Boraxbekk et al[34]reported that combining functional movements with MI did not yield better outcomes than MI alone. Similarly, Goudarzian[24]found that combining whole-body vibration (WBV) with motor training (MT) did not produce significant additional effects compared to either intervention alone. These findings indicate that more research is needed to determine whether combining MI with other interventions offers tangible benefits for the elderly.

When designing intervention methods, the process of guided imagery is often more critical than the choice of the intervention itself. Batson[22]introduced two imagery scripts at different stages of their study but failed to evaluate participants' preferences for these scripts. This may have contributed to variations in results, potentially due to one script being clearer than the other, thereby affecting participants' imagery processes. Despite participants' efforts to engage in imagery, they often struggled to distinguish between visually observed and kinesthetically felt movements, leaving researchers unable to provide targeted assistance. Chiacchiero[26] reported that participants only showed improvements on stable surfaces, as the guided imagery recordings did not include instructions for unstable surfaces. Nicholson[19]suggested that standing while performing MI could be more effective, as adopting a posture similar to the imagined task may enhance results.

Future studies could improve efficiency by increasing the frequency and duration of imagery sessions, familiarizing participants with the imagined environment in advance, or incorporating physical movements into the imagery process. Moreover, because the quality of MI varies among individuals, helping participants maintain focus is crucial to maximizing intervention efficacy.

3.5 Selection of Measurement Methods

This study investigates the impact of motor imagery on improving balance in the elderly. The included studies measured post-intervention outcomes using widely recognized tools, such as the Timed Up and Go Test (TUG), the Berg Balance Scale (BBS), and the Falls Efficacy Scale (FES). While these methods yielded significant results in earlier studies, Kim[18]found no notable differences in balance scores despite using the same scales. Kim argued that future research should adopt a multifaceted evaluation approach to assess balance in the elderly comprehensively. Existing studies lack direct measurement systems or instruments for assessing balance, which could provide more accurate and reliable data. Tools such as the Biodex Balance System[35]、Force Platforms[36]、Wobble Boards[37]、and Dynamic Posturography[38]could enhance the precision of experimental data, offering stronger support for research conclusions and interventions.

3.6 Limitations of the Study

①Methodological Quality: Among the 11 studies included, six were rated as high-quality using the PEDro scale, but the remaining five failed to achieve a score of 7. The primary factors contributing to lower scores included the lack of blinding of researchers or participants, unclear descriptions of allocation concealment, and insufficient reporting of dropout or attrition rates and their reasons. ②Systematic Review Framework: This systematic review was designed using the International Classification of Functioning, Disability, and Health (ICF) methodology framework, focusing solely on qualitative analysis of the included literature without performing quantitative meta-analysis. ③Language Bias: Only English-language studies were included in the final selection, which may have introduced potential bias and affected the generalizability of the conclusions.

4 Conclusion

Motor imagery (MI) training has demonstrated significant benefits in improving lower limb function and overall motor abilities in older adults. It effectively extends balance standing time, enhances postural control, improves gait function, prevents falls, and strengthens lower limb muscle power. Moreover, MI helps mitigate the decline in executive function and memory, thereby improving daily living skills and overall quality of life. As such, MI training represents a promising adjunctive therapeutic approach for promoting and maintaining motor function in the elderly. Despite its advantages, current research has not yet established definitive conclusions regarding the combined effects of MI with other intervention strategies. Future studies should adopt comprehensive research designs, incorporate outcome measures that accurately reflect the multifaceted health status of older adults, and develop MI training protocols tailored to variations in age, gender, and physical condition. Additionally, efforts should focus on expanding rehabilitation training systems and constructing an integrated framework for elderly rehabilitation to maximize the potential benefits of MI training.

Disclosure

Author's contribution

This article is designed and written by Mufan Zhang and Jiong Luo. Tingran Zhang and Jiahan Zhang are responsible for literature collection and organization. Meanwhile, Luo Jiong is the manager of the project and has approved the author and corresponding author of this study.

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The authors deny any conflict of interest.

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