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Effectiveness of computer-based telerehabilitation software (RehaCom) compared to other treatments for patients with cognitive impairments: A systematic review

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Abstract

Background: The rehabilitation process for cognitive disorders is long and complex, which can lead to reduced rehabilitation outcomes and reduced quality improvement. Thus, there is a need to use new methods to boost conventional rehabilitation (e.g., drug therapy, herbal therapy, paper, and pencil tasks). Innovations such as RehaCom can be helpful to remove the obstacles to treatment, but evidence for their effectiveness is limited.

Objectives: To compare the effectiveness of RehaCom with other cognitive therapies (computer-based, non- computer) in patients with cognitive impairment (CI).

Methods: Eight bibliographic databases (PubMed, Cochran Library, Scopus, Science Direct, Web of Science, Embase, ProQuest, and google scholar) were used in this research. The initial search resulted in the extraction of 2466 articles; after the review of the title, abstract, and full text, 19 articles were selected. Quality assessment was performed using the CONSORT checklist. Then, data extraction was done using the form set by the researcher in Word 2016 software.

Results: Overall, RehaCom achieved more positive clinical effects compared to other cognitive therapies (e.g., improvement in memory, attention, and motor function) on multiple sclerosis ($n = 7$), schizophrenia ($n = 6$), stroke ($n = 3$), Parkinson ($n = 1$), mild CI ($n = 1$), and acquired brain damage ($n = 1$). In six studies, a follow-up period of some weeks to 6 months has been used. Additionally, six studies used conventional therapy plus RehaCom for intervention. Except one study, all studies used RehaCom individual training.

Conclusions: This review provides evidence for the potential effectiveness of RehaCom for the improvement of clinical outcomes in patients with CI. However, more robust Randomised Controlled Trials (RCTs) are needed to confirm the observed positive effects.

Keywords

RehaCom, telerehabilitation, cognitive impairment, effectiveness, clinical outcome

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Introduction

Cognition refers to the process of acquiring and understanding information received from the environment and judging accordingly.[1] Cognitive impairment (CI) is a major health challenge worldwide[2] and is defined as a clinical syndrome characterized by a decline in at least two cognitive domains.[3,4] Depending on the affected cognitive domain, people having CI face more problems related to memory and learning, and they have problems with the ability of focusing on a task. These problems ranges from mild deficits that are not clinically detectable to dementia.[5] Genetic, age, sex, education, hypertension, obesity, depression, metabolic derangements, physical inactivity, smoking, cardiovascular disease, and social isolation are some risk factors for CI. Also, high-income countries have shown a decrease and low- and middle-income countries have indicated an increase in the prevalence of CI over time.[4,6,7] Few studies have reported the prevalence of CI, as well as the incidence of new cases.[8] It is predicted that by 2050, we will see a significant increase in CI, with more than 131.5 affected million people.[9] CI significantly leads to hospitalization, mortality, lower quality of life (QoL), and less ability to perform daily activities.[2,3] In addition, CI has significant social and economic consequences in terms of increased care costs, loss of independence, and an increased need for permanent caregivers and healthcare assistants.[8,10]

Various forms of therapeutic interventions, including pharmacological treatments (e.g., butylphthalide soft capsule, donepezil, and memantine) and cognitive training (computer-based and non-computer/conventional rehabilitation), have been used to reduce cognitive deficits. Although pharmacological treatments have improved tolerability and QoL, they have little efficacy in alleviating CIs. Findings related to the limited efficacy of pharmacological treatments on cognition prioritize the need to use potentially more effective behavioral treatments called cognitive training. Cognitive training includes cognitive remediation (i.e., curative/routine treatment and compensatory strategies) and cognitive rehabilitation (i.e., relative restoration of premorbid levels), specifically targets memory, attention, reasoning, and similar tasks, and has the ultimate aim of enhancing daily functioning.

Over the past years, various non-computer cognitive training programs such as herbal therapy, passive muscle massage and joint movement, active training of the affected limb, turning exercises from the healthy side to the affected side, sitting and standing balance training, activities of daily living (ADLs) training, problem-solving, paper and pencil tasks, and so on have been developed to support the people with CI. These programs differ from other rehabilitation programs in terms of methodology, theory, support, duration and intensity of sessions, personal or group programs, and combined or not-combined programs. Also, the results of clinical trials have shown several methodological limitations. These include inappropriate randomization methods and single-site studies, showing the lack of appropriate control groups and objective neuropsychological status assessment at baseline, the inconsistency of outcome measures, the of the interventions. From all different methodologies, computer-based cognitive training is modular, interactive, dynamic, and flexible.[11–17]

RehaCom is a computerized telerehabilitation software that improves cognitive deficits. This software features three main treatment strategies, namely, psychoeducation and awareness of cognitive functions, enhancement of motivational functions, and training of compensatory and adaptation skills. It also includes five different programs of training attention, improving attention, memory, visuospatial processing, and executive functions. Each program has one to four different tasks. RehaCom contains 29 modules in English and also modules in 21 other languages. For each module, the therapist can select a certain number of variables (first level, frequency and duration of the session, choice of stimuli, time limits for the tasks, etc.) that allow an individualized therapy for patients. The software has auto-adaptive ability, which means that the level of difficulty of the task is automatically changed depending on the patient function. It also allows therapist to monitor the performance of the patients online and provide feedback. Once the training is completed, the therapist can review the results on charts, graphs, and comparisons. The most common formats of the results are the level of progression (score), number of errors, and reaction time.[13,15,18–24]

Although the effectiveness of RehaCom has been approved in studies having a pre- and post-design with or without follow-up in Randomised Controlled Trials (RCTs) of patients with CI (brain injury, schizophrenia, Parkinson, Alzheimer, multiple sclerosis [MS], mild CI [MCI], and stroke), the findings are still inadequate and inconsistent. On the one hand, their efficacy has been demonstrated in a comparison of various test conditions such as (a) "active - training" vs. "control - not training", (b) "baseline - first testing" vs. "endpoint - second testing", and (c) "active - training" vs. "passive - training." On the other hand, some studies have pointed to the advantages of a multi-domain computer-based cognitive training rather than a specific domain approach. In addition, although most of the studies have had poor methodological quality, current rehabilitation programs are very heterogeneous, and large RCTs remain scarce. Furthermore, comparisons of various forms of training have demonstrated that computer-assisted techniques are more effective at improving certain domains of cognitive function (e.g., memory, attention, and executive function). Research on the follow-up effect has shown inconsistent data, as some studies suggested the continuity of positive effects for at least 6 months after completing computer-based training or paper-and-pencil task, while other studies have demonstrated different results.[15,25] Computers save time and cost of treatment. Therefore, computer cognitive training is useful for people with CI since it can slow down their

cognitive decline or, even, in some cases, optimize their cognitive functioning.[12]

For example, a *systematic review and meta-analysis* study including1837 stroke patients reported that compared with conventional therapy alone, the addition of computer-assisted cognitive rehabilitation (e.g., RehaCom and ZM3.2 System) significantly improved the global cognition and ADLs of patients ($p < .05$).[26] Another systematic review also reported the beneficial effect of computer-based cognitive training (e.g., CogniPlus and Nintendo Wii) on Parkinson's disease. The findings were indicative of improvement in most cognitive domains, specially memory, attention, executive function, and processing speed.[27] Furthermore, another systematic literature review and meta-analysis showed the effects of cognitive interventions on cognition, depression, and anxiety in dementia. Patients benefited significantly from the computer-based cognitive interventions (e.g., Big Brain Academy) than from the non-computer interventions in cognition ($p = .0$).[27] Georgopoulou et al.[28] found that both cognitive training programs were beneficial for Alzheimer's disease. Moreover, paper-and-pencil tasks improved delayed memory, verbal fluency, attention, processing speed, executive function, general cognitive ability, and ADLs. In contrast, RehaCom improved memory (delayed and working), naming, and processing speed.[29]

In recent years, computer-based cognitive rehabilitation has been recognized as a good substitute or supplement for conventional rehabilitation. Some RCTs and reviews have been carried out, but no systematic review has been published on patients with CI using RehaCom has been published. Therefore, the current research conducted a systematic review of studies related to RehaCom to provide evidence-based data for its promotion and use. RehaCom has low implementation and management costs and high accessibility and adoption, so this paper would contribute to the wider global community.

The present review had been conducted in 2023 to investigate the effectiveness of RehaCom on patients with CI. Especially, this review addressed the questions of whether RehaCom could achieve better clinical outcomes compared to other cognitive therapies (computer or non-computer) in terms of improvement in cognitive domains (e.g., memory, attention, processing speed, and reasoning), whether RehaCom could ensure greater safety for patients than other cognitive therapies, and whether RehaCom was better than other cognitive therapies in terms of cost-effectiveness. The findings were expected to help clinicians individualize therapeutic strategies by choosing the most appropriate approach for each patient.

Methods

Databases and searching strategies

The research protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO) and is accessible using the unique identification number CRD42024581299. Then, a general and rapid search of the Cochrane Library was performed to ensure that no similar studies existed so far. This systematic review was conducted based on the Preferred Reporting Item for Systematic Reviews and Meta-analyses (2020 PRISMA) guidelines. An integrated approach was then employed, which included a comprehensive review of literature (peer review and grey literature), using electronic databases as PubMed, Cochran Library, Scopus, Science Direct, Web of Science, Embase, ProQuest, and Google Scholar from inception until 3 September 2023. Bibliographies of identified articles and manual search of the included studies for additional references were conducted by two authors (SE and SAFA). In this regard, backward and forward reference list checking of the included studies was applied. The same principle was used to search each database, which included all terms and phrases describing RehaCom and CIs, which was combined using the Boolean "OR." These terms were then grouped with the Boolean operator "AND," and the final search of the articles was performed from the displayed results. The search filter "title, abstract, and keyword" was selected for this study. MeSH search terms in PubMed were used for all databases, and a searching keyword was used if the MeSH term was not available.

The search strategy has been shown in Table 1. Also, the PICO for the research question "Was the use of RehaCom equally effective compared to other cognitive therapies for patients with CI?" was as follows: population (P) patients with CI, intervention (I) RehaCom, comparison (C) cognitive therapies (O) effectiveness.

Inclusion criteria

Inclusion criteria are as follows: (a) English language original RCTs, (b) receiving RehaCom or other therapies in addition to RehaCom (such as drug, acupuncture, and usual care) by the experimental group, (c) receiving other cognitive therapies by the control group (computer and non-computer), (d) peer review, and (e) obtaining a score higher than 11 by the Consolidated Standards of Reporting Trials (CONSORT) checklist.

Exclusion criteria

Exclusion criteria are as follows: (a) Duplicating publications, (b) excluding patients with significantly different baseline conditions in the study (regardless of the severity of the disease), (c) not reporting the outcome indicators, (d) not including animal experimental research and experimental reports, (e) extracting the abstract that was available but had no full text, (f) excluding articles having the type of publication other than journal articles (e.g., books, reviews, letters, editorials, conferences, brief reports, posters, case reports/series, and dissertations), (g) protocols, (h) pilots, (i) feasibility, and(j) observational studies.

Table 1. The search strategy.

Strategy	#1 AND #2 AND #3
#1	RehaCom.
#2	Cognitive impairments OR cognitive disorders OR cognitive dysfunctions OR cognitive deficits OR cognitive decline OR cognition disorders OR cognit* OR memory impairments OR neurological disturbance OR neurocognitive disorders OR neurodegenerative disorders OR functional neurological disorders OR mental deterioration OR thought disorder OR attention OR memory OR executive function OR concentration OR perception OR learning OR orientation OR language OR thinking OR processing speed OR response control OR visuospatial skills.
#3	Effect OR Clinical Impact OR Influence OR Efficacy OR Outcomes OR RCT.

Screening and studies selection of the studies

The step-by-step screening was performed based on the 2020 PRISMA.[30] The studies identified from the databases were entered into an X9 EndNote library, and duplicates were removed. Simultaneously, two authors (FS and SE) independently screened the studies according to the eligibility criteria in three steps: (a) title, (b)abstract, and (c) full text. If necessary, disagreements were shared between the two authors and resolved through a third author (KB). Also, the articles with many citations were carefully checked to avoid bias in their selection (it was aimed to select articles that met the acceptable criteria for a RCT study and followed the CONSORT guidelines).

The search resulted in 2466 articles. However, 67 items were removed as duplicates. Screening the titles of 2399 articles resulted in removing 2320 studies (irrelevant objectives). The abstracts of the remaining 79 articles were assessed, and 59 articles were removed (did not meet the research criteria). Eventually, the full texts of 20 articles were studied, and 19 were selected (the 20th article scored <11 and was excluded). Then, the backward and forward reference list checking was conducted on the full texts of the remaining relevant articles ($n = 19$). No additional articles were found.

Quality assessment

After screening, three authors (FS, SE, and KB) independently evaluated the quality of the selected RCTs using the CONSORT 25-item checklist. This checklist is divided into six sections: title and abstract (one item), introduction (one item), methods (10 items), results (seven items), discussion (three items), and other information (three items). We confirmed the adherence to the 25 items and scored each item as 0 (no adherence) or 1 (full adherence). Finally, the sum of the scores was calculated based on the items, and the average score of each section and the percentage of obtained scores were considered. Studies that scored more than 50% (score >17) were evaluated as good, between 30% and 50% (score 11–17) as average, and <30% were considered as poor (score <11).[31] At this stage, all studies were RCT. The CONSORT score ranged from 10 to 21. The quality of 12 studies was evaluated as average and the quality of seven studies as good (one study with score of 10 was excluded). The steps of the selection of studies were based on PRISMA and have been shown in Figure 1.

Data extraction and synthesis

After quality assessment, four authors (FS, SE, KB, and FF) independently extracted data from the full text of the relevant studies. Data extraction was done using the form set by the researcher in Word 2016 software (the items of the form have been adjusted and combined by reading the relevant review articles).

Results

The majority of the included studies were conducted in 2020 and 2019, five[19,21,32–34] and four[12,15,24,25] studies respectively. Two studies were conducted each in 2016[21,35] and 2017,[20,32] and one study had been conducted in 2010,[14] 2011,[36] 2013,[11] 2014,[37] 2020,[34] 2021,[18] and 2023.[23] Five studies have been conducted in Iran,[18,22,24,33,37] and three studies were conducted in Poland[11,19,25] and Greece.[13,15,32] One study had been conducted in Spain,[12] Ireland,[35] Cuba,[20] Egypt,[34] China,[21] and Italy,[23] and two studies had been conducted in France.[14,32] The studies evaluated a total of 1172 participants, ranging from 15 to 204. Two studies have been conducted by Mak et al. in Poland,[11,25] and two studies had been conducted by Messinis et al. in Greece.[13,32]

The characteristics of RehaCom interventions characteristics

Detailed information about the content of RehaCom and other interventions in included studies have been presented

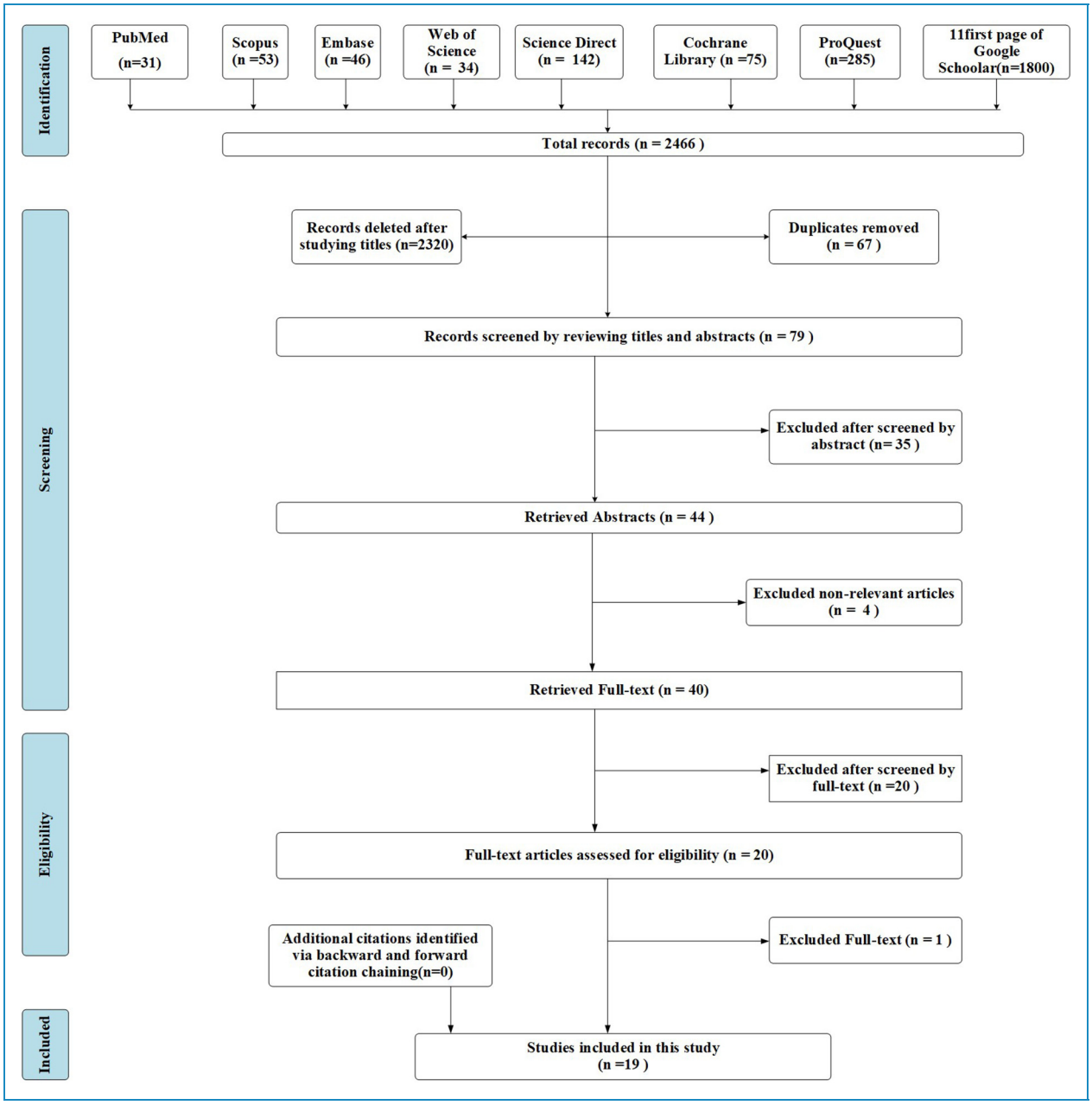

Figure 1. PRISMA flow diagram.

in Table S2 in Appendix 1 in the online supplemental materials. The interventions used in the studies varied and generally consisted of cognitive rehabilitation and educational components. RehaCom has been used for different types of MS,[19,22,23,32,33,35] schizophrenia,[11,12,14,25,36,37] stroke,[18,21,24] Parkinson,[34] MCI,[15] and acquired brain damage (ABD)[20] diseases. Most of the interventions were done in the clinic and at home, 10[15,18,20,22–24,33,34,36,37] and four[13,19,32,35] studies, respectively. Two studies had been conducted in the hospital.[14,21] All studies, except three,[21,23,34] had two groups. Three studies were multi-centric RCT,[13,14,32] and only one study had $2 * 2$ factorial design RCT.[21] The duration and intensity of the RehaCom interventions varied and ranged from 5 to 36 weeks. Most of the interventions were done twice a week. Also, in six studies,[12,14,19,21,25,34] RehaCom has been used in combination with other treatments (pharmacological, standard, and acupuncture). Only one study had used RehaCom group training and most studies used RehaCom individual training.[34] Two studies[12,32] have used usual treatment combined with computer activities for the control group. One study had compared watching a series of natural history DVDs with RehaCom.[35]

The effectiveness of RehaCom interventions

All studies assessed the participants immediately after the intervention, but other utilized follow-up periods and outcome measures varied between trials. Long-term follow-up of up to 6 months was reported in only two trials.[12,13] There were more than two assessment time points in studies.[12,13,22,33,35,37] The details of outcome measures and assessment time points have been tabulated in Table S3 in Appendix 2 in the online supplemental materials using RehaCom and other interventions for each trial.

Clinical effectiveness

Multiple sclerosis. A study in Ireland showed that in comparison with watching natural history DVDs, RehaCom increased activation in the bilateral prefrontal cortex and right temporoparietal regions at follow-up ($p < .05$).[35] Another study reported greater efficacy for RehaCom in verbal and visuospatial episodic memory, processing speed/attention, and executive functioning compared with standard care. Moreover, the improvement obtained on attention was retained over 6 months.[13] Comparison of standard rehabilitation with standard rehabilitation plus RehaCom on 30 patients showed significant improvement of the non-dominant hand ($p = .037$) and dominant hand ($p = .007$) for experiment group.[19] Messinis et al.[32] found that unlike the standard treatment plus computer activities, RehaCom improved cognitive, psychosocial, physical, and general fatigue levels as well as depression and QoL ($p = .000$) from pre- to post-test. A study in Iran showed that RehaCom improved all cognitive functions at the post-test (Week 5). This effect also remained at the follow-up (Week 10) for some cognitive functions (working memory, response control, and processing speed).[22] Darestani et al.[33] found that RehaCom improved verbal learning, memory, and verbal fluency of 53 MS patients at post-test (Week 5) and follow-up (Week 10). Also, a study showed that MS patients benefited from a combined approach (cognitive and motor) more than cognitive rehabilitation and motor rehabilitation separately using RehaCom.[23]

Schizophrenia. A study[25] in Poland compared pharmacological therapy combined with RehaCom to pharmacological therapy alone. The results showed that the first treatment was more effective than the second treatment in cognitive domains such as flexibility, cognitive inhibition, and high executive processing ($p < .001$). The findings of a prospective RCT study[12] proved that RehaCom was not effective on improving cognition nor functioning compared to computer activities. Findings from another study[14] showed a larger effect size for RehaCom plus standard treatment compared to standard treatment ($p < .0001$). In a study,[36] comparing RehaCom with standard treatment indicated more effectiveness of RehaCom on verbal memory, spatial working memory, attention, and reasoning. Another study[37] showed that 18 weeks of RehaCom therapy had a significant effect in reaction time, Wechsler Adult Intelligence Scale (WAIS/Wsd), and Prospective and Retrospective Memory Questionnaire (PRMQ) ($p < .5$). Also, compared to control group, RehaCom led to moderate improvement in Wisconsin Card Sorting Test (WCST) and Trail Making Test (TMT) for schizophrenia patients.[11]

Stroke. A study by Amiri et al.[18] proved that comparing RehaCom with traditional physiotherapy indicated a significant greater improvement on working memory and processing speed during 5 weeks. Another study in China showed that acupuncture combined with RehaCom enhanced therapeutic effects on the functional outcomes of the stroke patients over 3 months (Mini Mental State Examination [MMSE] scale, Montreal Cognitive Assessment [MoCA], and Functional Independence Measure [FIM]) ($p < .05$).[21] Furthermore, the authors reported significant improvement in attention, response control, and ADLs with ten 45-min sessions of RehaCom therapy.[24]

Parkinson. A study in Egypt showed that compared with physical therapy alone, the addition of 36 sessions to RehaCom group training was more effective in the improvement of functional outcomes and QoL for patients. After 3 months, improvements in the score of neuropsychological battery, Unified Parkinsonism Diseases Rating Scale (UPDRS), Perceived Deficits Questionnaire (PDQ-39), and WHO Disability Assessment Schedule II (WHO-DAS-II) confirmed this claim.[34]

Mild CI. Nousia et al. found that 15 weeks of RehaCom therapy had statistically significant effect compared to standard care in most cognitive domains (delayed memory, word recognition, naming, semantic fluency, attention, processing speed, and executive function.). Before and after assessments showed that there was no significant difference between the groups on the Recall, Word recognition, and the Digit Span Forward (DSF).[15]

Acquired brain damage. Fernandez et al. found that both RehaCom and conventional treatments had a significant effect on neuropsychological performance of patients from pre- to post-assessments but RehaCom reached a better performance in focused attention (Trail A), two subtests (digit span memory test and logical memory test), and Wechsler Memory Scale (WMS) ($p < .001$).[20]

Process evaluation (satisfaction/acceptance of the RehaCom). No studies reported any data on patients' and therapists' satisfaction attributable to RehaCom (aesthetic aspect of the intervention and prescribed tasks).

Safety. None of the included studies reported any serious adverse effects attributable to RehaCom.

Cost-effectiveness. No studies reported any data on cost-effectiveness, investment costs, or resource utilization.

Caregiver-related issues. Caregiver burden or social integration (in the form of return to work, study, etc.) was not evaluated in any of the studies.

Discussion

Research on the effects of RehaCom for improving cognitive outcomes has demonstrated the positive effects of cognition in computer environments for patients with CI. The RehaCom penetration factor is also increasing rapidly. In the present review, most studies have indicated certain levels of evidence for the efficacy of RehaCom in terms of improvements in attention, memory, processing speed, executive functions, and so on for MS[19,22,23,32,33,35] and in the cognitive domains of training, flexibility, problem-solving, etc. for schizophrenia patients.[11,12,14,25,36,37] Some papers have even reported positive results for the stroke in ADLs, response control, and others.[18,21,24] Moreover, valuable studies have mentioned the improvement of clinical outcomes (recall, naming, etc.) for MCI,[15] ABD,[20] and Parkinson's disease.[34]

Our results were in agreement with those of previous studies, showing the positive effects of other software's on cognitive disorders[38–43]. For example, Yang et al.[43] revealed that significant improvement in working memory was obtained using CogniPlus on older adults with MCI ($P = 0.01$); i.e., CogniPlus was more effective than other computer activities (reading online e-books and playing online games). Klojčnik et al.[40] concluded that compared to standard rehabilitation, CogniPlus led to a positive effect on attention and executive functions of stroke patients. Sharifi et al.[41] revealed that significant improvements in executive functions were obtained using Captain's Log on patients with MS ($P < 0.001$). According to the results of Barbarulo et al., there was evidence for significant positive effects of cognitive treatment (ERICA and paper–pencil tasks) complemented by conventional motor rehabilitation on spatial memory, attention, cognitive flexibility, as well as depression, balance, and gait in MS patients. Therefore, interventions combining motor and cognitive training were more effective than conventional motor rehabilitation alone.[38] Cavallaro et al. found that significant improvements in executive function, attention, and daily functioning were obtained using Cogpack plus standard rehabilitation on schizophrenia; i.e., Cogpack plus standard rehabilitation was more effective than computer activities plus standard rehabilitation.[39] Even though this review continues to support the effectiveness of computer-based cognitive training, this approach is not always expected to result in significant improvements in the treatment process. Accordingly, Kosta-Tsolaki et al. showed that both paper–pencil tasks and Complete Brain Workout software are beneficial for people with MCI, but paper–pencil tasks were better than the Complete Brain Workout software (Oak Systems) in visual selective attention. Overall, paper–pencil tasks affected a greater range of cognitive abilities.[42] Therefore, RehaCom has had the potential to be used as a beneficial tool in cognitive therapy fields for patients with CI. However, according to the current review, it seems that much more evidence is needed to examine other complications by performing more original RCTs. Furthermore, it is recommended that future studies could focus on the cost-effectiveness and safety of RehaCom in addition to clinical aspects.

The findings of the current review also showed that five studies in Iran used RehaCom for their rehabilitation objectives.[18,22,24,33,37] Among these five studies, one study was conducted in 2021 on stroke,[18] one study in 2014 on schizophrenia,[37] two studies in 2020 on MS,[22,33] and one study in 2019 on stroke.[24] It should be noted that e-health initiatives such as RehaCom have been widely viewed as an opportunity for improvement in cognitive rehabilitation fields to mitigate the enormous demand and supply of healthcare in both developed and developing countries. In recent years, RehaCom has gained more popularity in developing countries where many governments and policymakers are recognizing the possible benefits of RehaCom and have integrated it into their plans to meet their health system needs. As a substitute or supplement to conventional rehabilitation, RehaCom has tremendous potential to benefit people in low- and middle-income countries, which can also improve the treatment process. Additionally, RehaCom is used to decrease the cost of healthcare and plays a key role in improving treatment adherence, appointment compliance, and gathering data.[18,22,24,33,37,44,45] Our study showed that Iran has also begun to use this technology frequently in recent years. This result indicated that RehaCom has gradually shifted from being a commercial technology to becoming a more beneficial technology that many people can use worldwide.[46–48] Therefore, RehaCom is relatively inexpensive and available in most places due to its popularity. Since the availability, reliability, acceptability, and cost of rehabilitation products can become a barrier for rehabilitation centers and patients, this issue should be considered by researchers before conducting the original RCTs, especially in developing countries that face more financial, cultural, legal, insurance, and security challenges. Also, it is recommended to carry out needs assessment, readiness, and feasibility studies in this direction.

In this review, only six of 19 studies had follow-ups in a period ranging from some weeks to 6 months. These studies showed the positive impact of RehaCom therapy during the post-test or follow-up without any adverse effects, confirming the stability of the effectiveness of this technology during the rehabilitation period. Additionally, all six studies have shown significant improvements in cognitive outcomes at post-tests or follow-ups.[13,25,38,39,41] Erfannia et al.[49] also emphasized on the importance of follow-up in increasing the effectiveness of technology-based

interventions. It should be noted that two of these six studies have focused on long-term follow-up[12,13] and only one study had two follow-up periods.[37] It should be considered that the purpose of follow-up is to assess the stability of the outcomes over time.[50] Therefore, researchers should consider a follow-up period for evaluating the long-term effectiveness of RehaCom therapy. In other words, although studies with a follow-up period have shown a positive effect for RehaCom intervention in terms of improving the patients' outcomes, the majority of the studies did not use a follow-up period to evaluate the stability of the effects of the RehaCom. Therefore, it seems that a follow-up period and preferably a long-term follow-up should be considered in future studies to better evaluate the effectiveness of the RehaCom in the long time.

Our findings showed that only six studies[12,14,19,21,25,34] used conventional therapies in addition to RehaCom for the intervention. These papers showed the positive impact of combination/hybrid therapies during the intervention without any adverse effects. Our results were in agreement with study,[51] showing the positive effects of hybrid comprehensive telerehabilitation plus usual care on overall QoL, physical domain (PD) of QoL, and three specific areas of QoL: physical functioning, role functioning related to physical state (RF), and body pain for heart failure patients. Since the combination therapies provide a potential solution to respond to the heterogeneity of therapies by taking advantage of distinct mechanisms of multiple therapeutic/modality actions, they also optimize the therapeutic effects and facilitate long-term management.[52,53] Therefore, using of this type of therapy is recommended in future clinical trial studies.

Except for a study,[34] all studies had used RehaCom individual training. Because of the difference in patients' response to treatment, individual therapy choices would increase the effectiveness of therapy to the extent that patients would be allocated to the treatments that are more suitable for them.[54] Therefore, when patients are heterogeneous or do not have the same conditions, individual therapy is preferable to group therapy.

Our review showed that despite the advantages of RehaCom for patients with CI, there were some challenges such as low ecological validity of the diagnostic methods, lack of follow-up or short follow-up period, no blinding for patient or assessor, small sample size, heterogeneity in cognitive domains, absence of a control group, heterogeneity in type, frequency, and duration of intervention, the non-multi-centric design, diversity of patients, inappropriate random assignment methods, and short time of cognitive training. In this respect, Ebrahimi et al.[48] identified a number of challenging issues, such as communication (internet); legality; security; privacy; insurance; technology literacy; cultural, linguistic, psychological issues; and data reliability. Also, Amatya et al.[55] have mentioned challenges for patients such as varying levels of disability and the need for an individualized treatment, the ignorance of the perspectives of users in rehabilitation projects, and inaccurate outcome measures. Therefore, it is necessary to achieve a balance between care and technology with regard to device type, cost, disease, culture and income of patients, government policies, reimbursement, and the investment strategies of healthcare organizations.

For example, it is recommended to use simple, low-cost, accessible, and compatible technologies in developing countries where people have middle and low incomes. Paying attention to this issue will encourage patients to use technology to receive healthcare services. Therefore, a balance is created between the use of technology and care, and patients can receive necessary care that does not require an in-person visit through easy and accessible technologies. The use of technology prevents overcrowding in care centers and saves time, money, and healthcare resources, and patients' privacy is guaranteed. Also, technological literacy is an important factor in choosing the type of technology, especially for developing countries and disadvantaged communities. It is recommended to use easy and user-friendly technology in deprived areas where people are less technologically literate. Culture plays an important role in the acceptance and use of technology. The view of people of each country is different toward the acceptance of technology. For example, in developing countries, people prefer face-to-face therapy to virtual therapy. Therefore, it is better to use technology when a physical examination is not necessary (e.g., sending tests and radiology pictures). This causes patients to trust technology more to continue the treatment.

One of the main limitations of this study was the lack of access to the abstract and full text of many articles. Although the mentioned databases were searched, we could not access all the databases. Additionally, we searched in English, so we might have missed relevant articles in other languages. Therefore, we may not have included some articles.

Conclusions

This review confirmed the effectiveness of computerized cognitive therapy (RehaCom) to improve clinical outcomes in patients with CI. Given the increasing prevalence of cognitive disorders, imbalance between patient demand and supply of rehabilitation services, inadequate clinical resources, rising costs of care, poor economic status, the high volume of patients, and the therapist's workload, the use of innovations such as RehaCom seems more important than the past. Therefore, more RCTs are needed to make a definitive statement about the effectiveness of RehaCom compared to other cognitive therapies and to discuss the limitations, unknown biases, and potential complications of this technology. One of the current study's goals was to investigate the safety and cost-effectiveness of RehaCom. Our findings showed that there was no study in this field. Therefore, it is recommended that future

studies could focus on the safety and cost-effectiveness of this software in addition to clinical outcomes.

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