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RESEARCH ARTICLE

COGNITIVE RETRAINING IN NEURODEGENERATIVE DISORDERS: A SCOPING REVIEW

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Key words:-
There is a steady rise of elderly population in developing country. Simultaneously the risk for neurodegenerative diseases is also high in India.
The focus is to maintain not only physical health but also cognitive health. Therefore, importance of cognitive retraining has been emphasised.

Abstract

Background:There is a decline in cognitive functions in neurodegenera tive disorders. Cognitive deficits are often treated with cognitive rehabilitation which can improve their functionality in day-to-day life. This scoping review aimed to explore the current studies available on cognitive retraining in various neurodegenerative disorders.
Method: The review followed the six stages outlined by Arksey and O'Mally guidelines. The articles were searched through database like PubMed, EMBASE, Web of Science, Science Direct, EBSCO, ProQuest and APA PsycNet. The following information was extracted from the included studies, such as, author, year, objective, country, study design, material and methods, major findings.
Results:About 287 articles were extracted based on their titles and abstracts. Their screening resulted in 104 eligible articles. The review of these articles have found that most Randomized Control Trials have focused on various cognitive domains such as attention, memory, and/o r executive functions; age range; different psychiatric and neurological disorders. There has been significant improvement in functionality, behavioral and psychopathological domains of the individuals. The limitations of our results were no follow-up studies to explore the after effect of intervention, articles did not specifically reflect the local, cultural appropriate contexts. The future systematic research addresses increased generalizability of intervention, replication on larger samples, with control group, longitudinal studies, optimal duration of rehabilitati on and long-term effects of cognitive retraining on patients.
Conclusion:Lastly, it implies that intensive cognitive retraining tends to strengthen the brain plasticity and increases synaptic pruning in the brain. The culturally-appropriate retraining has shown improvement in an individual.

Introduction:-

As per World Health Organization[1], there will be 80% elderly living in developing countries by 2050.Simultaneousl y the risk for neurodegenerative diseases is also increasing in India, such as, epilepsy (11.3%), Senile Dementia of Alzheimer's Type and other types of dementia (4.6%), brain & CNS cancer (2.2%).[2] In 2019, India was the 4th

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largest contributor to the global burden of dementia and by 2050 it is expected to become 2nd largest country with dementia cases.[3]Moreover, India rank 3rd highest contributor to cancer cases. It is estimated that cancer cases would rise to 57.5% in 2040 from 2020.[4]

The rate of Disability-adjusted life years is increasing from 8.3% in 1990 to 9.9% in 2019 in India.[2]Moreover, per day cost of inpatient stay for non-communicable illness is 170 USD. The cost tends to increase in case of elderly patients.[5,6]The cost of cancer patients per day is 23 USD. The annual cost of patients with dementia ranges from Rs.45600 to Rs.202450 in cities and Rs.20300 to Rs.66025 in villages.[7]
Both these diseases cause blood-brain barrier dysfunction, inflammation, mediation of neuroplasticity, tauopathy and many more.[8] Moreover, there is a loss of synaptic connection or axonal connectivity due to protein aggregation in the cerebral cortex, dispositions of β-amyloid dispositions and phosphorylated Tau protein result in neuroinflammation.[9]Memory, processing speed, attention and executive functions are the most impaired cognitive functions in cancer patients.[10]Short-term memory loss and impaired visuospatial functions are early signs of cognitive decline in Alzheimer's disease.[11] The cognitive decline affectsthe psychosocial functioning of an individual and their caretaker.

To cater to cognitive deficits, cognitive plasticity has been emphasizedto strengthen fluid and process-based abilities such as reasoning, episodic memory, working memory and executive functions.[12]Cognitive retraining uses restorative approach and is often delivered in neurodegenerative diseases at a home setting, acute ward, OPDs, or a community setup.[13]

Narrative or systematic review articles on neurodegenerative diseases have not been studied. To develop a greater understanding of this topic, we conducted a systematic scoping review using an adapted version of Arksey and O'Malley[14] scoping study framework as a guide. A scoping review helps to study the breadth of the knowledge and gaps in the existing literature. The research question of the present study is to examine the characteristics of cognitive retraining that was delivered to patients. The outcome measures that were studied by researchers and limitations or existing gaps.

Materials and Methods :-

We adhere to the PRISMA for Scoping Review (PRISMA-ScR) reporting guidelines.Moreover we used the Arksey and O'Malley[14]scoping study framework to guide our review methods, along with Levac[15]and Daudt[16]modified framework. This framework consists of six stages: (1) a specific research question, (2) a review of existing literature, (3) screening for the eligible articles as per criteria, (4) data extraction, (5) synthesizing and reporting of the results and (6) optional consultation with various stakeholders.[14]We structure the scoping review report in line with the Joanna Briggs Institute format.[17]

Eligibility criteria

In keeping with the Arksey and O'Malley[14] recommendation to maintain a broad review scope, we aimed to comprehensively examine the research studies that examine the impact of cognitive retraining in neurodegeneration diseases. Therefore, randomized controlled trials were included in the study. There was also no restriction on the publication date for article inclusion. All searches were limited to the English language. To clarify the scope of our review, the key population, concept and context eligibility criteria were defined as follows.

Population

Articles were included in our review if the participants were diagnosed with neurological/neurodevelopmental/neuropsychiatric conditions either based on screening tests or by standardized criteria like the Diagnostic Statistical Manual[18]or the International Classification of Diseases.[19]The qualifying participants receiving intervention in home-based, inpatient, ward, daycare and many more settings were included. Neuropsychiatric conditions encompass medical conditions of both psychiatry and neurology. It impacts cognition, emotions and mood.

Concept and Context

For our scoping review, we used the restorative approaches to cognitive retraining. It focuses on the brain plasticity principle. Cognitive retraining has been measured within experimental or interventional contexts. The retraining will vary based on duration, intensity, procedures, temporal length and outcomes. The primary outcome will include cognitive (memory, speed, attention) and non-cognitive (mood, quality of life, depression, activities of daily living)

factors. Articles were included in our review if they focused on cognitive retraining in the context of neurodegenerative diseases. For our review, we used the definition of neurodegenerative diseases (NDDs), "a series of chronic diseases that lead to progressive loss of neuronal structure or function".[20] Neurodevelopmental disorders are "behavioral and cognitive disorders arising during the developmental period that involve significant difficulties in the acquisition and execution of specific intellectual, motor, language or social functions".[19]

Search strategy

As suggested by Peters[17] we began by searching online search engines; PsychINFO and Web of Science, using various keywords covering the population, concept and context of the research question. These terms were chosen through discussion with research experts in this field. The titles, abstracts and subject terms of the articles identified in this search were analyzed to determine keywords to be included as search terms in the full literature search. Based on the research articles retrieved from the initial searches, we decided to conduct the full search using the population and context search terms to increase the breadth of coverage.

A full search was conducted across all relevant online databases (MedLine, Embase, Cochrane, Scopus) on December 2022 to February 2023 using the keywords. Any searches were included iteratively as search terms to improve the scope of the review coverage.

The lead reviewer (AC) searched the reference lists of all the articles included in the review for additional unidentified, relevant sources. Due to resource limitations, we were not able to contact the authors of the articles included in the review for further sources of information. The selection of relevant studies is shown in the PRISMA flow chart (Figure 1).

Sources of evidence selection

All search results identified through the above search strategy were exported into Endnote and duplicate entries were removed by the lead reviewer. The remaining articles were reviewed and selected for inclusion, using our specified eligibility criteria. In line with Peters[17], scoping review methodology recommendations, two independent reviewers analyzed the article selections. Firstly, the tiles and abstracts of all articles were screened, with those not meeting the inclusion criteria were excluded from the review. The full text of each article was analyzed and those meeting inclusion criteria were included for further examination. Articles meeting the eligibility criteria were finally included in the review. Discrepancies in any articles were examined by two independent reviewers. The detailed number of articles included and excluded at each stage of the screening process was displayed in the flowchart.

Data extraction

The necessary data were extracted from the included articles as recommended by Arksey and O'Malley[14] the data extraction form was designed to capture general information about the articles (e.g., first author, publication year, article type) as well as information directly relating to the research question (e.g., type of cognitive retraining, focused cognitive domains, measures used, outcome assessed). The data extraction form was piloted on a small number of articles and updated to improve functionality, before conducting the full search.

It is suggested that at least two reviewers complete the data extraction process.[17] However, full data extraction by two reviewers was not feasible for this scoping review due to limited resources. Instead, the lead reviewer extracted data from all the included articles, with the second reviewer independently extracting data from approximately half (48%) of the articles. Data extracted by each reviewer were compared to ensure replicability. On average the extracted general data was 89.73% concordant between the reviewers and the research data was 75% concordant. The lead reviewer then coded the extracted data against various neurodegenerative diseases.

Analysis and presentation of results

Quantitative descriptive analysis of the extracted data was done.[16] For quantitative analysis, frequency counts and averages were generated from the extracted article data to provide a detailed summary of the characteristics of the articles included in our review.[15]To quantitatively report on the concept of our research question (Cognitive domains outcome), frequency counts and percentages were generated to capture the number of articles addressing each outcome domain.

As scoping reviews aim to describe, not synthesize, available information[15], we deemed the above combination of methodologies to be the most appropriate to provide an overview of the range of research literature available. Unlike systematic reviews, scoping reviews do not aim to provide an assessment of the quality of the articles included.[16]

Therefore, we did not conduct any quantitative analyses of articles, or methodological quality for this scoping review.

Presentation of the results

The quantitative data was presented in a tabular format for clarity, sub-divided by the generated themes (provided in supplementary sheet).

Results:-

Characteristics of Sources of Evidence

Review of eligible Randomized Control Trials (RCTs) focusing on various domains such as cognition, attention, memory, and/or executive functions in different neurological disorders document certain evidence driven beneficial effect of cognitive training in attenuating psychiatric alterations.

General article characteristics

In total, 123 articles met the criteria for inclusion in this scoping review. They were journal articles. All the articles included in our review were published between 1990-2020. Only three articles were published in the period 1990-1999, with eight published in 2000-2009 and 112 published in 2010-2023. The geographical spread of the articles was not even. In developed countries like the USA (n=28) and the U.K. (n=28) most researches were done on cognitive retraining. The articles further originated from different countries like Iran (n=9), Korea (n=6), India (n=13), New Zealand (n=2), Italy (n=8), Brazil (n=6), Africa (n=2), Israel (n=2), Australia (n=2), Japan (n=1), Turkey (n=1), China (n=3) and Thailand (n=1). (Figure 1)

Population characteristics

The articles focused on the age range between 0-17 years (n=25), 18-60 years (n=67) and 65 and above (n=16). Overall participants were educated and both gender (male & female) was provided CRT. The participants had diagnoses as, Attention deficit hyperactivity disorder (n=5), Alzheimer's disease (n=10), Attention problem (n=1), Autism (n=4), Brain tumor (n=2),Cancer (n=17), Cerebral Palsy (n=1), Dementia (n=2), Depression (n=2), Epilepsy (n=3), Human immunodeficiency virus (n=5), Huntington disease (n=3), Intellectual disability (n=2), learning disability (n=7), leukemia (n=1), multiple sclerosis (n=21), Parkinson disease (n=5), Stroke (n=9), Schizophrenia (n=1), Traumatic brain injury (n=9). The majority of cognitive retraining has been done in patients with multiple sclerosis, cancer and Alzheimer's disease. Mostly group based cognitive retraining was delivered in cancer patients. Majority articles have included caregivers as co-therapist to maintain a compliance to regular cognitive retraining (Supplementary Table 1).

Context characteristics

The majority of articles report the diagnosis of multiple sclerosis, cancerand Alzheimer's disease. The cognitive retraining has focused on the following cognitive domains such as, attention, processing speed, executive function, memory. The duration of cognitive training per session was about 60 minutes in the majority of the studies. But four study has delivered 15-20 minutes session as well. It has also been found that duration has reached up to 120minutes. The retraining sessions ranges from 4 to 288 sessions. But majority of studies provided 8 to 24 sessions to the patients. Several studies have provided cognitive retraining along with several other therapies such as occupational therapy, physical exercises, neurofeedback, mindfulness based cognitive therapy. Several studies provided computerized cognitive retraining also. These are Cog med, BrainHQ, CogSMART,CogEx, COMET and many more.

Concept characteristics

Across the 123 articles included in our review, efficacy of cognitive retraining among patients were measured on the following outcomes, cognitive symptoms (memory, attention, executive functions), functional domain (activities of daily living, school performance, scholastic abilities), behavioral symptoms (hyperactivity, inhibition), psychopathology (depression, sleep disturbance, anxiety, stress) and well-being (quality of life, self-efficacy, management strategies).

The different diseases were provided different kind of cognitive retraining programs and focus of cognitive domains also varies. Every disease has different area of focus and hence intervention also vary from one disease to another. It suggests a potential disparity between the focus of systematic research in this area.

It should be noted that each individual article may address more than one domain and some additional domains were added by the reviewer to capture article results that addressed the domain but did not fall into any specific category.

Discussion:-

Through this scoping review, we have identified a wide range of cognitive domains, psychopathology and functional outcomes that are experienced by patients suffering from neurodegenerative, neurodevelopmental and/or neuropsychiatric conditions. This supports the argument that to reduce cognitive decline one needs to cater to the cognitive faculty of an individual.[21]However, despite the quantity and variety of articles included in this review, it is likely that the systematic literature addressing all neurodegenerative diseases in context to cognitive retraining is limited to preconceived areas of importance and therefore not representative of the true clinical picture.

It is further documented that intensive retraining tends to strengthen the brain plasticity and increase synaptic pruning in the brain. This in turn tend to control rapid cognitive decline among the patients. Moreover, adequate cognitive reserve in the brain enhances quality of life, psychosocial functioning and reduce caregiver burden as well. This is in line with the integration model of cognitive rehabilitation where "brain is the organ processing distance between subject and object in terms of time, space and interpersonal relationships".[22]

It is important that future systematic research addresses increased generalizability of intervention, replication on larger samples, with control group, longitudinal studies, optimal duration of rehabilitation and long-term effects of cognitive retraining on patients. It is worth noticing that majority of randomized controlled trials were included in our review were from developed countries of the world. But due to varying healthcare contexts and cultural expectations, future research needs to understand the culture-specific cognitive retraining for patients.
It is also important to mention that experimental studies included in our review also had several limitations. These are the Hawthorne effect, lack of use of parent-rating scales in case of children and adolescents, small sample size. Performance time was considered more important than functional improvement, presence of placebo effect of knowing about cognitive retraining. Due to experimental study, there were high dropout rates, mediation of confounding variables like different diagnostic groups, treatment received, time from treatment received, severity of illness and many more.

Contextual factors such as demographics of caregivers were not reported by the articles in our review. Sanjuan[23]reported that when caregivers are provided cognitive training then it improved the cognitive, functional and health-related quality of life in older adults. The caregivers also reported higher work satisfaction and compliance towards treatment also remained high. Therefore, exploring the sociodemographic details of the caregiver is also necessary. But the articles in our review have provided very limited or no information about them and it could result in underestimation or misrepresentation of caregiver's needs.
Finally, it may be beneficial for future research in this area to focus on longitudinal effect of cognitive retraining and cultural adaptation of cognitive retraining. It could help to develop practical, affordable, culturally-relevant intervention to best support families and patients and provide long-term care to patients with chronic illnesses.
Limitations of this scoping review

The articles included international nature of cognitive retraining programs. Our results did not specifically reflect the local, cultural appropriate contexts. The studies reported improvement on the basis of post-intervention assessment. But no follow-up studies were present to report the after effect of intervention.
Due to practical limitations for this scoping study, we were unable to formally conduct the optional sixth stage of the Arksey and O'Malley[14]framework: consultation with relevant stakeholders. Therefore, our interpretations may be limited by our own perceptions and preconceptions. We tried to minimize the effect of this limitation by consulting with research colleagues who have expertise working with people in cognitive retraining to shape an appropriate review focus and scope. However, future research in this area would benefit from consultation with caregivers, as well as clinical staff working in this area.

Although the Arksey and O'Malley[14]framework dismiss quality assessment as a necessary part of a scoping review, it has been argued that this limits the ability to comment on the clinical implications of scoping review results.[16] As the purpose of our review was to address the research studies in a specific area, and not necessarily to provide clinical recommendations, we did not feel that a quality assessment of included articles was essential. However, it

Figure

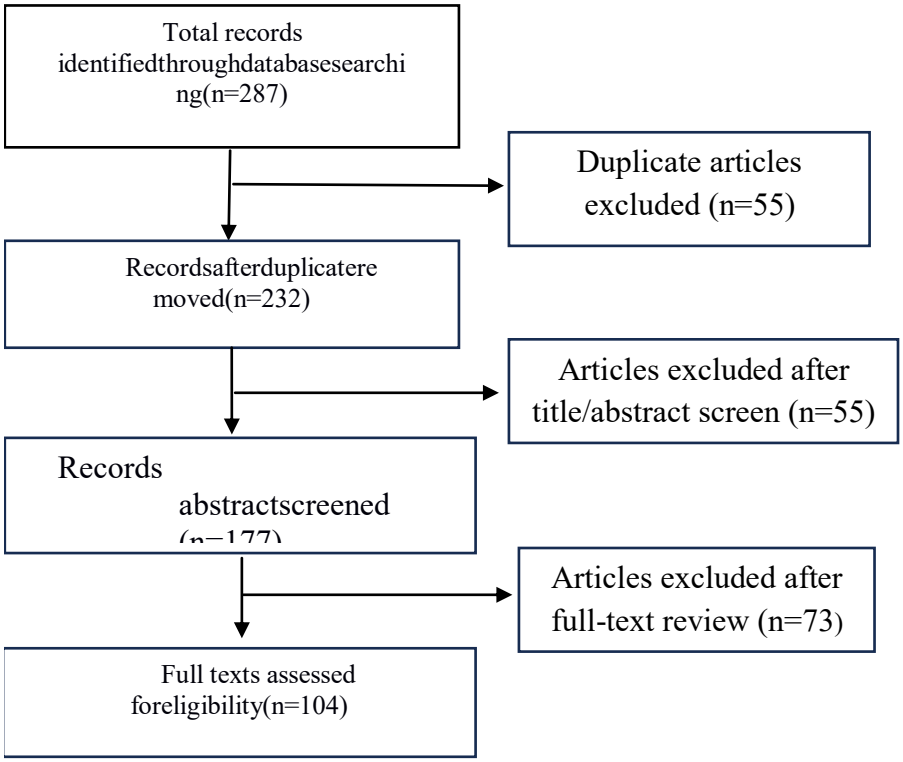

Figure 1. PRISMA Flow Chart of the scoping review

Supplementary Table 1. Tabular format of the data included in this scoping review

S. No	First Author/Year/Country	Diagnosis	Intervention	Measures	Findings
1.	Yazdanbakhsh[24] (2018)	ADHD	12 Sessions Computerised mode 2 sessions/week Each for 60 min	1.Neuropsychological assessment 2.Conners ADHD Scale 3.Sleep quality index	Improvement in behavioural symptoms (response inhibition), sleep quality, executive function
2.	Kim[25] (2020)	ADHD	16 sessions 2 sessions/ week Computerised mode	1.ARS 2.RIEF 3.HPC 4.CCTT	Improvement in executive function, self-directed learning, impulsiveness
3	Kianbhakt[26] (2015)	ADHD	Notreported	1.IVAPLUSTEST	Improvementin attentionand response inhibition
4.	Malhotra[27] (2011)	ADHD	Twice a week 18 weeks 36 sessions	1.Learning assessment 2.Neuropsychological battery	Improvement in attention, academic performance, behavioural domains
5.	Weiner[28]	Alzheimer's	6 week	1.Neuropsycholo	Limited effect of memory training

	(2010)	Disease		gical assessments 2.MSE	Both experimental and control group showed same performance in cognitive tests
6.	Bajpai[29] (2018)	Alzheimer's Disease	8 weeks 30-45 min Session/ per day	1.Neuropsychological battery	Effective in memory & verbal domain Borderline in attention domain
7.	Biins[30] (2020)	Alzheimer's Disease	7 weeks 60 min Weekly sessions Computerized	1.OCA 2.Expression 3.QOL 4.Cognition 5.Balance 6.Functional mobility	No significant changes due to long assessments Training was not feasible
8.	Zanetti[31] (1997)	Alzheimer's Disease	15 sessions 5 sessions/per week 60 min	1.MMSE 2.ADL	Improvement in ADL, procedural memory
9.	Avila[32] (2004)	Alzheimer's Disease	14 weeks 60 min/ weekly Group sessions offline	1.MSE 2.Anxiety 3.Depression 4.QOL 5.Memory	Improvement in functional tests Modest improvement in cognitive tests and psychiatric symptoms
10.	Bottino[33] (2005)	Alzheimer's Disease	90 min Group session Once a week	1.Cognitive functions 2.ADL 3.Social interaction 4.Depression	Effective in attention, memory, language No improvement in anxiety, depressive symptoms
11.	Arkin[34] (2000)	Alzheimer's Disease	10 sessions Audio tape	1.Neuropsychological tests	Improvement in MMSE domains
12.	Kim[35] (2015)	Alzheimer's Disease	8 sessions 60 min/ week	1.QOL 2.MMSE	Improvement in satisfaction, QOL, orientation and memory No improvement in modified Barthel index scores, occupational performance
13.	Kesslak[36] (1997)	Alzheimer's Disease	15 min Weekly	1.Memory 2.Digit Copying 3.Depression 4.Attention 5.Dementia	Effective in free recall, selective attention, depressive symptoms and memory
14.	Moore[37] (2018)	Attention Problems	40 sessions 4 times a week 90 min 15 weeks Computerised	1.Neuropsychological battery	Improvement in working memory, long term memory, processing speed. No improvement in visual processing
15.	Spaniol[38] (2020)	Autism	-	1.Scholastic ability 2.SPM 3.Behavioural questionnaires	Improvement in scholastic ability No improvement in intelligence and behavioral abilities
16	Eack[39]	Autism	18 months	1.Client	Improvement in neurocognition, cognitive

.	(2013)		60 hours/sessions Computerised	satisfaction questionnaire 2.Emotional intelligence tests 3.Cognitive style	style, social cognition and social adjustment
17.	Varanda[40] (2017)	Autism	21 SESSIONS Weekly	1.PM 2.DI-R 3.CST	Improvement in set shifting, No improvement in communication, intelligence
18.	Yang[41] (2014)	Brain Tumor	4 weeks 5 times a week 30 min	1.Neuropsychological battery	Improvement in visual and auditory performance tests, verbal tests, digit span, visual span test, learning test, trail making test, MMSE
19.	Corti[42] (2018)	Brain Damage	40 sessions 20 min/ day 8 weeks	1.Intrinsic motivation 2.Feasibility outcome 3.Treatment outcome	Improvement in performance and intellect
20.	Maeir[43] (2021)	Cancer	8 week 25min/ session Computerized 12 weeks Attention, speed of processing, visual working memory, attentional control	1.Neuropsychological tests 2.Perceived cognitive function 3.GHQ 4.QOL 5.Perceived stress scale	Improvement in performance, satisfaction, neurocognitive tests, social wellbeing, sustained attention, emotional and functional wellbeing, mood. No improvement in visual working memory, physical wellbeing.
21.	Bray[44] (2017)	Cancer	Computerised 15 weeks 40 min/weekly	1.Neuropschological functions	Improvement in perceived cognitive functions, anxiety, depression, fatigue, stress, QOL
22.	Santos[45] (2020)	Cancer	Computerised 3 month 9 sessions 60 min	1.Subjective cognition 2.Objective cognition 3.QOL 4.Anxiety & depression	Improvement in working memory, depressive symptoms, perceived cognitive functions, QOL No improvement in anxiety, fatigue
23.	Cherrier[46] (2013)	Cancer Survivor	7 weeks 60min weekly	1.QOL 2.Perceived cognition 3.PHQ 4.Anxiety 5.Chronic illness therapy fatigue 6.Nueorcogngitive battery	Improvement in perceived cognitive impairments, cognitive abilities, QOL
24.	Vardy[47] (2022)	Cancer Survivor	6 week 120min Weekly computerised	1.Cognition 2.Depression & anxiety 3.Fatigue	Improvement in verbal, visual and executive functions.

				4.QOL 5.Neuropsychological assessment	
25.	George[48] (2015)	Cancer	10 weeks/ offline mode/ weekly/ group setting / 120 min session	1.Feasibility 2.Acceptability 3.Cognitive function 4.QOL	Improvement in feasibility, acceptability, memory, attention No improvement in QOL
26.	Benzing[49] (2020)	Cancer	8 weeks Three times a week 45 min computerized	1.Neuropsychological battery	Improvement in visual working memory No improvement in other cognitive functions and motor functions
27.	Klaver[50] (2020)	Cancer	12 week	1.Goal attainment scale 2.Cognitive complaints 3.Work ability 4.Work functioning 5.Absenteeism & presentism 6.Need for recovery 7.QOL	Effective in goal attainment, cognition, work ability, functioning, absenteeism, presentism & QOL.
28.	Mayo[51] (2021)	Cancer	8 week Home based, online 1 hour/ day/ 5 days per week=40 sessions	1.Neuropsychological assessment	Effective in processing speed, psychomotor efficiency. No improvement in learning, memory, executive functioning, self-reported cognitive functions
29.	Von Ah[52] (2022)	Cancer	10 weeks 40 hours	1.Satisfaction 2.Cognitive ability	Improvement in working memory. No changes were seen in memory, executive functioning, self-reported cognitive functioning
30.	Gooch[53] (2021)	Cancer	16 weeks 30 min daily	1.neuropsychological battery	Improvement in processing speed, visual attention, working memory
31.	Farahimanesh[54] (2021)	Cancer	six sessions weekly 60 min	1.ptsd 2.depression 3.memory test	Improvement in memory bias, depressive symptoms
32.	Bellens[55] (2020)	Cancer	3 times a week 60 min	1.cognitive assessment 2.depression and anxiety 3. sleep quality	Improvement in attention, visual memory, response Inhibition, processing speed
33.	Hardy[56] (2010)	Cancer	50 min/weekly 12 week	1.WAIS 2.CBCL	Effective in working memory index
34.	Kleijn[57] (2018)	Cancer	1 hour 4 weekly sessions	1.ego integrity and despair 2.psychological distress 3.QOL 4.anxiety and depression	Improvement in ego integrity and despair No improvement in distress, QOL, anxiety and depression

35.	Lakshmi[58] (2019)	Cancer	16 weeks Twice a week 90 min	1.Nimhans battery	Improvement in attention, working memory, visual and auditory learning, visual memory
36.	Wotherspoon[59] (2019)	Cerebral Palsy	Online 30min/ session 20 weeks Thrice/ week	1.QOL 2.SDQ 3.Communication skills 4.Behavioural difficulties 5.Conners rating scale 6.BRIEF	Effective in QOL,SDQ, BRIEF, Conners rating scale, behavioural difficulties, communication n skills
37.	Moore[60] (2010)	Dementia	5 week weekly	1.depression 2.adl 3.dementia 4.memory	Improvement in recall, forgetting, memory, daily living
38.	Sakamoto[61] (2018)	Depression	36 sessions 3 sessions/ week 20 min/ session	1.Depression 2.Stroke 3.Emotional disturbance 4.MMSE 5.Trail making	Improvement in depression, stroke, emotional disturbance, cognitive functions, trail making
39.	Priyamvada[62] (2023)	Depression	15 session 3 months	1.Depression 2.WAIS 3.Memory	Improvement in concentration, attention, verbal learning and memory, psychomotor speed, executive function, depressive symptoms
40.	Gupta[63] (2002)	Epilepsy	6 week 1 hour/ weekly	1.Neuropsychological battery	Improvement In attention, memory, executive function
41.	Glyn[64] (2016)	Epilepsy	4 week 20 min per day 4 times a week	1.Neuropsychological battery	Effective in cognitive functions
42.	Ezeamama[65] (2020)	HIV	40min/ session Computerized 2sessions/ week 5 weeks	1.Depression 2.Psychosocial adversity 3.Cognitive performance 4.QOL 5.Frailty	Effective in learning, recall, QOL, frailty, depression, psychosocial adversity
43.	Frain & Chen[66] (2018)	HIV	8 Week	1.MoCA 2.Sleep quality index 3.Depression scale	Effective in MoCA, executive functions, memory, attention
44.	Walsem[67] (2018)	Huntington Disease	3 week 4 hours manualized	1.Neuropsychological assessment	Improvement in cognition, flexibility, attention, psychomotor speed No improvement in vocabulary, recognition, backward
45.	Eaton[68] (2019)	HIV	9 Sessions 3-hour weekly	1.acceptability 2.stress 3.anxiety 4.coping 5.mindfulness	Effective in acceptability, stress, anxiety, coping, mindfulness

46.	Livelli[69] (2015)	HIV	36 sessions 4 months	1.neuropsychological battery	Effective in learning, memory, executive functioning, verbal fluency, attention, working memory No improvement in processing speed
47.	Sadeghl[70] (2017)	Huntington Disease	25 sessions 5 days per week 50 min	1.neuropsychological battery	Effective in digit span, spatial span, auditory working memory, symbol span
48.	Mayo[71] (2022)	HIV	9 WEEKS 120 min	1.cognitive functions	Improvement in cognitive functions
49.	Yhnell[72] (2018)	Huntington Disease	12 week 3 times a week 30 min	1.neuropsychological battery	Improvement in cognitive functions
50.	Favre[73] (2018)	Intellectual Disable	16 therapy sessions weekly	1.self esteem 2.qol 3.cognitive functions	Effective in self-esteem, QOL, cognitive functions
51.	Alba[74] (2022)	Intellectual Disability	48 sessions Two weekly sessions	1.BRIEF 2.Cognitive Examination	Improvement in executive functions, verbal memory
52.	Jurigova[75] (2021)	Inattention	7 sessions 30 min 5 times a week	1.ADHD Vanderbilt	Improvement in inattention No improvement in hyperactivity
53.	Avtzon[76]	Learning Disability	12 week Computer based 5 days/ week 30min/ session	1.Neuropsychological battery	Effective in executive functions, working memory, speed of processing, short term memory, attention
54.	Naimian[77] (2022)	Learning Disability	14 sessions 1 hour	1.neurofeedback 2.learning disability	Improvement in working memory and attention
55.	Nisha[78] (2013)	Learning Disability	computer 20 sessions 3-5 weeks 60-90 min	1.BKT 2.SLD Testing	Improvement in attention, reading, comprehension, spellings and arithmetic
56.	Daftary[79] (2015)	Learning Disability	60min weekly	1.handwriting test	Improvement in handwriting skills
57.	Kaboli[80] (2022)	Learning Disorders	30 min Thrice a week 18 sessions	1.academic self-regulation 2.academic performance	Effective in self- regulation and academic performance
58.	Egset[81] (2021)	Leukemia	5 sessions 3 months	1.neuropsychological battery 2.Fatigue severity index 3.QOL	Improvement in fatigue, QOL, Cognitive functions
59.	Morales[82] (2021)	Multiple Sclerosis	45 min/ session 10 sessions/ biweekly	1.Neuropsychological assessment	Improvement in verbal memory, visuospatial memory, processing speed, attention and working memory, verbal fluency
60.	Sharbafshaaer[83] (2022)	Multiple Sclerosis	10 weeks 2hour/ week Manualized	1.Neuropsychological assessment	Effective in memory, executive functions

61.	Sharifi[84] (2019)	Multiple Sclerosis	12 sessions 50min Twice/ week Computerized	1.WCST	Improvement in executive functions
62.	Plohmann[85] (1998)	Multiple Sclerosis	12 session 40min/ session Three weeks	1.Attention test battery 2.Depression	Improvement in attention, depressive symptoms
63.	Stuifbergen[86] (2011)	Multiple Sclerosis	8 weeks 90min/sessions	1.Neuropsychological assessment	Effective in attention, executive function, memory, problem solving
64.	Lincoln[87] (2019)	Multiple Sclerosis	10 sessions weekly	1.Multiple sclerosis impact scale 2.GHQ 3.Neuropsychological tests	Effective in multiple sclerosis, health and cognitive functions
65.	Reilly[88] (2018)	Multiple Sclerosis	8 sessions	1.Goal attainment scale 2.Neuropsychological assessment	Improvement in verbal memory, visual memory, attention, processing speed
66.	Vilou[89] (2020)	Multiple Sclerosis	6 week Twice a week	1.Neuropsychological tests	Effective in verbal learning, visuospatial memory, visual attention, reading speed, response inhibition
67.	Prouskas[90] (2021)	Multiple Sclerosis	9 week 90min	1.Energy level 2.Motivation level 3.Patient burden	Effective in energy, motivation level and patient burden
68.	Impellizzeri[91] (2020)	Multiple Sclerosis	8 weeks 6 times/ week 60min	1. Neuropsychological battery 2.QOL 3.Beck depression inventory 4.Emotional awareness questionnaire 5.McClelland motivational factor	Effective in cognitive functions, QOL,depressivesymptoms, emotional awareness, motivation
59.	Rahmani[92] (2020)	Multiple Sclerosis	21 sessions 5 months 60 min/ weekly	1.Neuropsychological battery	Improvement in working memory, executive functions, attention No improvement in processing speed
70.	Shevil[93] (2009)	Multiple Sclerosis	6 week 120 min	1.knowledge 2.self-efficacy 3.neuropsychological assessment	Improvement in knowledge, self-efficacy, cognitive functions
71.	Birnboim[94] (2004)	Multiple Sclerosis	6 month Weekly One hour Mixed mode	1.Attention test 2.Executive function test 3.Depression 4.Fatigue	Improvement inn attention, executive function, depression, fatigue
72.	Hanseen[95] (2015)	Multiple Sclerosis	4 week 120min	1.neuropsychological battery	Effective in executive functions, QOL

				2.brief 3.quality of life	
73.	Barbarulo[96] (2018)	Multiple Sclerosis	2 sessions weekly 60 min 24 weeks	1.motor function 2.trait anxiety 3.neuropsychological assessment	Effective in motor functions, anxiety and cognitive functions
74.	Moghaddam[97] (2021)	Multiple Sclerosis	30 min weekly	1.cognitive functions 2.GAD	Effective in cognitive functions and anxiety
75.	Shahpouri[98] (2019)	Multiple Sclerosis	10 sessions 120 min	1.memory	Effective in memory
76.	Martin[99] (2017)	Multiple Sclerosis	12 sessions weekly 75 min computerized	1.neuropsychological battery	Effective in verbal memory, visuospatial delay recall, working memory, executive function, phonetic speed
77.	Nauta[100] (2023)	Multiple Sclerosis	9 weekly 120 min	1.cognitive assessment	Effective in speed, executive function, memory
78.	Simone[101] (2018)	Multiple Sclerosis	3 months 60 min Twice a week	1.neuropsychological battery	Effective in memory, recall
79.	Lincoln[102] (2015)	Multiple Sclerosis	10 sessions 1.5 hours 10 weeks weekly	1. neuropsychological battery	Effective in cognitive functions
80.	Robert[103] (2020)	NCD	Computerized 12 weeks 4 sessions per week	1.neuropsychological battery	Effective in learning, memory, attention
81.	Weijer[104] (2019)	Parkinson Disease	Online CT 12 weekly 3 weekly sessions/30 min	1.Neuropsychological tests	Effective in cognitive functions
82.	Sousa[105] (2021)	Parkinson's Disease	8 SESSION Twice a week 120 min	1.Neuropsychological battery 2.QOL	Effective in attention, verbal fluency, visuospatial function, QOL
83.	Santini[106] (2022)	Parkinson	14 SESSION twice weekly 6 months	1.MMSE 2.Neurological battery	Effective in attention, memory, fluency, language, visuospatial
84.	Das[107] (2022)	Parkinson	8sessions 4weeks 60 min	1.neuropsychologicalbattery	Effective incognitivefunctions
85.	Petrelli[108] (2014)	Parkinson	12sessions 90 min 6weeks	1.neuropsychologicalbattery	Effective inworkingmemory,short-termmemory
86.	Jiang[109] (2022)	Stroke	15min/session Twiceaday 6 timesaweek	1.OL 2.oCA 3.arthel index 4.Trailmakingtest 5.Functional independencemeasure	Improvementin QOL,attention,orientation,memory,workingmemory,functionalindependence
87.	Sharma[110] (2017)	SlowLearners	90days	1.Scholastictesting	Improvement inreading

88.	Jung[111] (2020)	StrokeSurvivors	12 week Twice a week 30minperday	1.MSE 2.Digitspan 3.WAIS 4.Geriatricdepressionscale 5.Systemusabilityscale	Improvementin MMSEscores,depressivesymptoms,workingmemory
89.	Baltaduoniene[112] (2019)	Stroke	45 min 5timesaweek	1.Moca	Improvementin attention,workingmemory,orientation,language
90.	Cho[113] (2015)	Stroke	Computerized 8 week 5times/week 30 min	1.neuropsychologicalbattery	Effective inmemory andattention
91.	Thaivon[114] (2020)	Stroke	6week 45 min	1.neuropsychologicalbattery	Improvementin attention,memory,workingmemory
92.	Lee[115] (2020)	Stroke	30 min 6 timesaweek	1.Cognitiveassessment 2.depression	Improvementin perception,organization,memory
93.	Kim[116] (2020)	Stroke	Twiceaweek 16weeks 30 min	1.moca 2.sleep quality 3.depression	Effective inexecutivefunction,attention,depression,sleep
94.	Youze[117] (2021)	Stroke	5sessions 60 in	1.MoCA 2.ADL	Effective inorientation,attention,workingmemory,learning,memory,dailyliving
95.	Pages[118] (2018)	Stroke	60 min 5sessionsperweek6weeks	1.neuropsychologicalbattery	Effective inattention,memory,executivefunctions
96.	Boman[119] (2004)	TraumaticBrainInjury	60 min 3times/week	1.Attentionprocesstrainingtest 2.Digitspan test 3.Memorytest 4.Braininjurytest	Effective inattention,memory,digitspan
97.	Vas[120] (2021)	TraumaticBrainInjury	30activities	Notmentioned	Effective incognitivefunctions
98.	Gella[121] (2013)	TraumaticBrainInjury	8sessions 60 min 5months	1.Cognitivefunctions	Effective inattention,memory
99.	Afsar[122] (2021)	TraumaticBrainInjury	20sessions 2 monthsThrice/week	1.NIMHANS battery2.Post-concussionscale3.Perceived stress scale4.QOL 5.VAS	Effective inprocessingspeed,workingmemory,memory,QOL,PSS
100.	Zhou[123] (2021)	TraumaticBrainInjury	5days/week 15min	1.Glasgowcomascale 2.MMSE	Effective inorientation,attention,memory
101.	Kannan[124] (2019)	TraumaticBrainInjury	2 month onehoursession 5daysaweek	1.pgi battery	Improvement in memory test

102.	Nangia[125] (2012)	TraumaticBrainInjury	48sessions 2months 6timesaweek 90 min	1.nimhans battery 2.RPQ 3.neurobehavioral ratingscale	Improvementin mentalspeed,categorical fluency,workingmemoy. Slightimprovementin sustainedattention,planning,verballearning,visuospatial 114constructiveability Noimprovementin motorspeed, verbalcomprehension
103.	Corti[126] (2020)	TraumaticBrainInjury	8 week	1.Cognitivefunctions 2.behavioralassessment	Effective inmemory,attention,workingmemory
104.	Mahncke[127] (2021)	TraumaticBrainInjury	13weeks 5 days/ week60min /session Computerbased	1.Neuropsychological battery 2.ADL 3.PTSD 4.Frontal symptom behavioral	Improvementin cognitivefunctions,daily living,depressivesymptoms

would be beneficial for future study to assess the quality of research studies in this area.

As with any literature review, scoping reviews are limited by the availability of relevant sources of information.[17] Although we did include empirical studies in our review, it is possible that by focusing our research question on understanding the academic literature we could have missed important sources of alternative information (e.g., narrative accounts, case reports, qualitative studies). Similarly, due to our stringent inclusion criteria, we excluded some studies focusing on caregiver's cognitive training, healthy aging and cognitive training. Although this provided the homogeneity of articles needed to address our research question, this may not accurately reflect the entire clinical picture.

*ADHD-Attention Deficit Hyperactivity Disorder; ADL-Activities of Daily Living; BRIEF-Behavior Rating Inventory of Executive Function; BSID-Bayley Scale of Infant Development; BKT-Binet-Kamat Intelligence Test; BDI-Beck's Depression Inventory; CARS-Connors Autism Rating Scale; CCTT-Children's Color Trails Test; CBCL-Child Behavior Checklist; ERP-Event Related Potential; EEG-Electroencephalogram; GHQ- General Health Questionnaire; GAD- Generalized Anxiety Disorder; HPC-Homework Problem Checklist; HIV- Human Immunodeficiency Virus; IVA PLUS- Integrated Visual and Auditory Plus Test; IADL-Instrumental Activities of Daily Living; MMSE- Mini Mental Status Examination, MoCA- Montreal Cognitive Assessment; PHQ- Patient Health Questionnaire; PTSD- Post Traumatic Stress Disorder; QOL-Quality of Life; RPQ-Rivermead Post-Concussion Symptoms Questionnaire; SLD-Specific Learning Disability; SPM-Standard Progressive Matrices; SDQ-Strength Difficulty Questionnaire; VAS- Visual Analogue Scale; WISC- Weschler's Intelligence Scale for Children; WCST- Wisconsin Card Sorting Test; WAIS- Wechsler's Adult Intelligence Scale

Conclusion:-

Thecurrent literature shows that cognitive retraining for a neurodegenerative/neurodevelopmental and/or neuropsychiatric condition can have a positive impact on cognitive functions, behavioral, psychopathology and overall functioning of an individual. However, to date, most research in this area has consisted of experimental studies that examine the efficacy of cognitive retraining in various diseases. This limited focus and methodology overlooks the significant complexity of cognitive retraining. Understanding these complexities sometimes provide culturally-appropriate cognitive retraining programs that seem feasible, affordable and accessible to patient and their family.

Ethical Approval: This is scoping review and does not require any ethical approval.

Patient Consent:Not applicable.

Declaration regarding the use of generative AI: No AI tool was used to collect, analyze, produce or write this research paper.

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