

Holistic Approaches to Rehabilitation in Brain Tumor Patients: A Brief Review of Therapeutic Interventions

Parul Goyal¹, Dr. Bhawna Verma², Dr. Gopal Krishna³

¹MPT Neurology, Pt. B. D. Sharma University of Health Sciences, Rohtak, Haryana, India
Corresponding Author Email: [parul021999\[at\]gmail.com](mailto:parul021999[at]gmail.com)

²Associate Professor, Pt. B. D. Sharma University of Health Sciences, Rohtak, Haryana, India

³Associate Professor, Department of Neurosurgery, Pt. B. D. Sharma University of Health Sciences, Rohtak, Haryana, India

Abstract: Background: Brain tumors profoundly affect physical, cognitive, and emotional health. While surgical resection, radiotherapy, and chemotherapy remain the primary treatments, they often result in complications like muscle weakness, coordination deficits, and fatigue. Comprehensive rehabilitation, including neuro - physiotherapy, cognitive training, and psychosocial support, has shown potential to enhance recovery and quality of life. Methods: A brief review of the literature was conducted using PubMed, Google Scholar, and ResearchGate, restricted to English - language clinical trials, randomized controlled trials, and case studies published within the last decade. Of the 28 articles retrieved, 14 were included, comprising 8 clinical trials and 6 case studies. Results: Clinical trials demonstrated that exercise therapy, mind - body practices, and cognitive rehabilitation significantly improve physical fitness, cognitive function, and quality of life. High - intensity exercise was feasible even during aggressive glioblastoma treatments, while targeted neuro - physiotherapy enhanced motor function in low - grade tumor patients. Case studies highlighted individualized regimens, including vestibular rehabilitation and strengthening exercises, yielding improvements in balance, gait, and daily functionality. Conclusions: Rehabilitation interventions tailored to tumor type and stage improve physical and emotional well - being, functional independence, and overall quality of life. Holistic, personalized approaches should be integrated into standard care, though further research is needed to establish standardized protocols.

Keywords: Rehabilitation, Holistic, Exercise and Brain - tumor

1. Introduction

Brain tumors, whether benign or malignant, pose a significant global health challenge, profoundly affecting physical, cognitive, and emotional health. These tumors involve the abnormal growth of cells within the brain or nearby structures, often leading to increased intracranial pressure, neurological issues, and functional limitations¹. They are categorized into primary tumors, which originate in brain tissue, and secondary (metastatic) tumors, which result from cancers elsewhere in the body spreading to the brain².

The primary treatment for brain tumors is surgical removal, frequently supplemented by radiotherapy and chemotherapy to manage residual tumor cells and lower the likelihood of recurrence³. However, these interventions can lead to complications such as muscle weakness, coordination difficulties, cognitive impairments, and fatigue, highlighting the need for comprehensive rehabilitation programs to improve patients' quality of life⁴.

A holistic rehabilitation approach, which includes physical therapy, occupational therapy, cognitive training, nutritional guidance, and psychosocial support, has shown promise in enhancing recovery after brain tumor surgery. Neuro - physiotherapy is particularly important in managing motor deficits, promoting neuroplasticity, and supporting functional independence through personalized exercise plans, balance exercises, and gait retraining⁵. This integrated approach not only addresses physical challenges but also fosters

psychological health by encouraging active engagement in the rehabilitation process⁶.

Research underscores the benefits of early, individualized rehabilitation in achieving the best outcomes for brain tumor patients. Neuro - physiotherapists use various methods, including proprioceptive neuromuscular facilitation, task - specific training, and virtual reality - based therapies, to address targeted impairments and support functional recovery⁷. Despite these advancements, challenges remain, such as inconsistencies in rehabilitation practices and the need for standardized protocols to ensure optimal care⁸.

Significance of exercise therapy across different tumor stages

Exercise therapy plays a crucial role in the rehabilitation of brain tumor patients, offering benefits that vary according to the tumor's type and stage. Engaging in structured physical activity can enhance functional outcomes, mitigate treatment - related side effects, and improve overall quality of life^{9, 10}.

Patients with aggressive tumors like glioblastoma multiforme (GBM) often undergo intensive treatments, leading to significant physical and cognitive challenges⁹. Implementing high - intensity, long - term physical training regimens have been shown to be feasible and beneficial during multidisciplinary therapy. A case study demonstrated that a GBM patient participated in high - intensity exercise without adverse events for 87 weeks, achieving fitness gains despite ongoing treatments and tumor progression⁹.

Individuals with low - grade tumors may experience gradual neurological deficits¹⁰. Neurophysiotherapy has been effective in improving motor function and independence in these patients. For instance, a case report highlighted that postoperative physiotherapy rehabilitation in a patient with grade II diffuse astrocytoma led to enhanced lower limb strength, normalization of muscle tone, and greater functional independence¹⁰.

Cognitive impairments are common among brain tumor patients due to the tumor itself and the side effects of treatments¹¹. Regular exercise has been found to improve cognitive function by reducing hippocampal inflammation and preserving synaptic integrity. Research indicates that consistent physical activity can enhance cognitive performance and protect against neuronal damage, which is particularly beneficial during various stages of tumor progression¹¹.

Postoperative rehabilitation is vital for regaining mobility and daily living skills¹². Studies have shown that inpatient rehabilitation programs lead to significant functional improvements, especially in mobility, for patients who have undergone surgical resection of brain tumors. Although these programs primarily focus on mobility, they also contribute to better overall functional status¹².

Tailoring exercise therapy to the specific type and stage of a brain tumor is essential. High - intensity exercises may be appropriate for certain patients, while others may benefit more from neuro - physiotherapy focusing on strength and functional independence. In all cases, incorporating structured physical activity into the treatment plan can lead to significant improvements in physical capabilities and quality of life.

2. Methods

Literature searches of Google scholar, PubMed, and ResearchGate restricted to English - language articles published within the last 10 years, were performed on October 11, 2024, and updated on January 10, 2025, using keywords “Rehabilitation”, “Holistic” and “Brain - tumor”. Articles with keyword “pediatric” were excluded. The search was limited to clinical trials, randomized clinical trials, comparative studies, and case studies. Twenty - eight articles were retrieved. Additional articles were identified by the authors based on their knowledge of literature before 2014 and from review of citations in retrieved articles. Fourteen articles were included for this review, consisting of 8 clinical trials and 6 case studies.

Table 1: Summary of randomized controlled trials conducted on patients with Brain tumor who underwent rehabilitation

Authors Journal Year	Title		Methodology	Outcome Measures	Results	Limitations
Milbury et al. (2017) ¹³	Yoga Program for High - Grade Glioma Patients Undergoing Radiotherapy	5 dyads (patients and caregivers), patients had high - grade glioma; mean age: 52 years, 80% female; caregivers mean age: 58 years, 60% spouses	A 12 - session dyadic yoga program designed for patients and caregivers during radiotherapy, focusing on breathing, relaxation, and meditation to improve their quality of life.	MD Anderson Symptom Inventory; Centers for Epidemiological Studies - Depression scale; Brief Fatigue Inventory; Pittsburgh Sleep Quality Index; 36 - item Short - Form Survey.	Patients experienced significant reductions in sleep disturbances and improved mental QOL, while caregivers reported better mental QOL but increased depressive symptoms.	Small sample size; no control group; results not generalizable due to high performance status and high income/education levels among participants
Gehring et al. Clinical Rehabilitation (2018) ¹⁴	Feasibility of a home - based exercise intervention with remote guidance for patients with stable grade II and III gliomas; a pilot randomised controlled trial	Grade II/III glioma patients, n=34	Exercise group: Six - month remote - guided exercise program (three sessions per week). Control group: advised to maintain an active lifestyle.	Accrual, attrition, adherence, safety, satisfaction, patient - reported physical activity, VO2 peak and BMI	Improved physical fitness and activity levels in the intervention group	Small sample size, adherence challenges
Milbury et al. Journal of Pain and Symptom Management (2020) ¹⁵	Online Couple - Based Meditation Intervention for Patients With Primary or Metastatic Brain Tumors and Their Partners: Results of a Pilot Randomized Controlled Trial	Brain tumor patients and partners, n=35	CBM group: Four weekly online sessions on mindfulness, compassion, and gratitude. Control group: Usual care.	MD Anderson Symptom Inventory - Brain Tumor module; Depression scale; Mindful Attention Awareness Scale; Self - Compassion Scale; Personal Assessment of Intimacy in Relationships Inventory.	Improvements in cognitive and general symptoms for patients; moderate adherence	Limited to online intervention; medium - sized study group
Gehring et al.	A pilot randomized	Stable glioma patients, n=34	Exercise group: Six - month home - based	Performance - based outcomes,	Improvements in attention, memory,	Small sample size; exploratory nature

Neuro - Oncology (2020) ¹⁶	controlled trial of exercise to improve cognitive performance in patients with stable glioma: a proof of concept		aerobic exercise program (moderate to vigorous intensity). Control group: Waiting list.	patient - reported outcomes, enrolment and attrition, adherence and patient satisfaction.	executive function, fatigue, and mood in the exercise group	limits generalizability
van der Linden et al. Journal of Neuro - Oncology (2021) ¹⁷	eHealth cognitive rehabilitation for brain tumor patients: results of a randomized controlled trial	Adults with glioma or meningioma, n=62	Intervention group: 10 - week tablet - based cognitive rehabilitation program. Control group: Waiting list.	Measures included the Central Nervous System Vital Signs battery, Wechsler Adult Intelligence Scale Digit Span Test, Cognitive Failures Questionnaire, and psychological distress via the Hospital Anxiety and Depression Scale.	No significant differences in cognitive or patient - reported outcomes; high satisfaction with intervention	Recruitment challenges, small sample size, limited statistical power
Daun et al. Neuro - Oncology Practice (2024) ¹⁸	The feasibility of a multi - site, clinic - supported, and tailored neuro - oncology exercise program	Brain tumor patients, n=70	Intervention group: 12 - week tailored exercise program (individual/group format, online/in - person). Control group: No intervention.	Functional fitness, Patient reported outcomes	High satisfaction and adherence; significant improvement in functional fitness	Focused on feasibility; broader implementation challenges
Cho et al. Scientific Reports (2024) ¹⁹	Effects of protein - enriched nutritional support on skeletal muscle mass and rehabilitative outcomes	Brain tumor patients, n=60	Protein group: Daily protein supplementation (18g/day) for 6 weeks plus rehabilitation therapy. Control group: Placebo supplementation plus the same rehabilitation therapy.	MMSE; the modified Barthel Index, the Beck Depression Inventory; the Brief Fatigue Inventory; the Timed Up and Go test; the 6min walk test; the isokinetic quadriceps muscle strength test, and the handgrip power	Improved muscle strength and functional outcomes in the protein group; better results for malnourished patients	Small sample size, limited generalizability
Loughan et al. Neuro - Oncology (2024) ²⁰	Telehealth group Cognitive - Behavioral Therapy for Insomnia (CBT - I) in primary brain tumor: Primary outcomes from a single - arm phase II feasibility and proof - of - concept trial	Patients with primary brain tumor, n=44	Intervention group: Six 90 - min telehealth CBT - I sessions. Control group: No intervention (comparison not applicable for feasibility).	Measures used included the ISI, PSQI, BFI, PHQ - 9, GAD - 7, BPI, EORTC QOL, Wechsler Digit Span, Trail Making Test A and B, COWAT, and HVLT - R.	Significant improvements in sleep metrics and fatigue; high feasibility and adherence	Single - arm study; lacks control group; generalizability to other populations not proven

Table 2: Summary of case studies conducted on patients with Brain tumor who underwent rehabilitation

Authors Journal Year	Title	Characteristics of Participants	Methodology	Outcome Measures	Results	Limitations
Gregory T. Levin et al. Integrative Cancer Therapies (2016) ²¹	Exercise Improves Physical Function and Mental Health of Brain Cancer Survivors: Two Exploratory Case Studies	Two female patients diagnosed with glioblastoma multiforme and oligodendroglioma. n=2	Patients followed a 12 - week structured exercise program with two 1 - hour resistance and aerobic sessions per week, plus self - managed aerobic sessions.	Strength, cardiovascular fitness, and psychological indicators (depression, anxiety, and quality of life) were assessed at baseline, 6 weeks, and post - intervention.	Objective measures showed positive outcomes in reduced morbidity and improved psychological well - being, with significant improvements in depression and overall distress on the Hospital Anxiety	Participants were active at baseline, which may limit the generalizability of these findings.

					and Depression Scale.	
Miranda Smit et al. Journal of Neuropsychology (2019) ²²	The man who lost his body: Suboptimal multisensory integration yields body awareness problems after a right temporoparietal brain tumour	46 - year - old man who was diagnosed with brain tumor, located in the right posterior part of the lateral ventricle	Mirror - Based Multisensory Stimulation: for 3 sessions of 5 minutes per day over 2 weeks; Third Person Perspective; Affective Touch	visual analogue scale (VAS) and the rubber hand illusion (RHI) and other spatial and structural body representation tests.	After 2 weeks, the patient reported a marked improvement in his sense of body ownership during the exercises. Objective tests showed a reduction in the reliance on visual input alone and an improvement in multisensory integration.	Short follow - up period and subjectivity of outcome measures.
Fabian M. Troschel et al. Medicine and Science in Sports and Exercise (2019) ²³	High - Intensity Physical Exercise in a Glioblastoma Patient under Multimodal Treatment	A 33 - yr - old male, diagnosed with a large cystic GBM, was included in our institution's Personal Training Program after initial tumor resection and adjuvant radio chemotherapy.	Consisted of two monitored weekly sessions with a dedicated and certified personal coach, one focusing on bicycle exercise and dumbbell workout with the other training coordination and running.	Physical fitness, Exercise adherence and Quality of Life.	Improvements in maximum wattage per kg. Patient sustained an average of 43.7 MET - h per week.	The patient's pre - existing athletic background may have contributed to his ability to engage in and benefit from high - intensity exercise, which might not be replicable in less active individuals
Yuşa Başoğlu et al. American journal of case reports (2020) ²⁴	Role of Long - Term Vestibular Rehabilitation in a Patient with Posterior Fossa Tumor: A Case Report with 2 Years of Follow - Up	A 36 - year - old male patient was diagnosed with dysplastic gangliocytoma /ganglioglioma and treated by partial cerebellar tumor resection.	Vestibular adaptation exercises, habituation exercises, balance/gait activities, and general fitness training. (Cawthorne - Cooksey, rhythmic - weight - shift test [RWS], four corners step test [FCS], and stand: marching in place test [SMP])	computerized dynamic posturography - sensory organization test (SOT) Berg balance scale Romberg test Head shake test	The patient reached normal limits in outcome measure and his complaints were slightly alleviated after 2 years.	Improvement is based on scores that may not fully capture subjective quality - of - life changes. Results may not be applicable to peripheral vestibular disorders or other balance - related conditions.
Daun et al. Cureus (2024) ²⁵	Physiotherapy Rehabilitation Following Acoustic Neuroma Resection in a Patient with Cerebellopontine Angle Tumour: A Case Report	45 - year - old female patient with Acoustic Neuroma Resection	Cawthorne - Cooksey exercises, Vestibular ocular reflex exercise, Deep breathing exercises, Isometric exercises, stretching and gait training.	KPS, FACT - BR, FACT - G, FIM	The patients' strength and mobility improved resulting in an improvement in functional ability. The symptoms like blurry vision, vertigo, and dizziness were also reduced with the help of the planned protocol for the patient.	External factors such as weather and patient - specific issues like an ankle sprain affected certain goals and outcomes. Variability in adherence.
Elena Lozano - Cavero et al.	Physical therapy enhances physical and functional	Female patient with gliomatosis cerebri of nine	The patient underwent 1 - hour physiotherapy sessions, three times a week for five months, focusing on	Timed Up and Go (TUG); 10 Meter - Walk Test (10MWT); 6	Improvement in functionality was observed with	Reporting bias and limited exploration

An Sist Sanit Navar (2024) ²⁶	abilities in a female patient with gliomatosis cerebri	years of evolution.	therapeutic exercises. The treatment included proprioception, static and dynamic balance training, coordination exercises, and strengthening of the lumbopelvic and abdominal muscles.	Minute - Walk Test (6MWT); Berg Balance Scale (BBS); Functional Gait Assessment (FGA)	improved FGA scores.	of alternatives.
--	--	---------------------	--	---	----------------------	------------------

3. Discussion

Enlisted trials collectively underscore the multifaceted benefits of various supportive and rehabilitative interventions for brain tumor patients. Exercise - based programs ranging from tailored neuro - oncology exercises to protein supplementation showed significant improvements in physical fitness, functional ability, and quality of life, even in complex cases.^{18, 19} Mind - body practices like yoga and meditation improved mental health, reduced symptom burdens, and enhanced patient - caregiver dynamics^{13, 15}. Cognitive rehabilitation and telehealth interventions for insomnia also demonstrated feasibility and positive effects on cognitive performance, sleep quality, and fatigue^{17, 20}. These findings highlight the importance of integrating holistic and individualized approaches, including physical, nutritional, and psychosocial strategies, into standard care to optimize outcomes for brain tumor patients.

Case studies on exercise and treatment modalities in brain tumor patients highlight significant benefits in physical and mental health. A 12 - week structured program improved strength, cardiovascular fitness, and reduced depression and anxiety in survivors²¹, while multisensory exercises enhanced body ownership in a patient with disownership issues²². High - intensity exercise, even during aggressive glioblastoma treatment, maintained fitness and supported quality of life without adverse effects²³. Functional gains, such as walking 3 kilometers and returning to work, were noted as unplanned achievements²⁶. VR - based mobility training and tailored rehabilitation programs further reduced symptoms like vertigo and dizziness while improving strength and equilibrium scores²⁴. Collectively, these findings underline the value of individualized exercise regimens in enhancing physical function, emotional well - being, and quality of life for patients with brain tumors.

This review summarizes findings from eight clinical trials and six case studies on multidisciplinary rehabilitation for brain tumor patients. Cho et al. (2024) highlighted the benefits of protein supplements in improving nutritional indices, muscle power, and function, particularly in malnourished patients. Milbury et al. (2017) examined a dyadic yoga program (DYP) for high - grade glioma (HGG) patients and their caregivers, finding clinically significant improvements in sleep, mental quality of life (QOL), and symptom burden reduction. In contrast, van der Linden et al. (2021) investigated an eHealth cognitive rehabilitation program for brain tumor patients, reporting good adherence and satisfaction but no significant effects on cognitive performance or self - reported outcomes, likely due to recruitment difficulties and limited statistical power. Gehring et al. (2020) tested a home - based aerobic exercise program for glioma patients, demonstrating small - to - medium improvements in cognitive function, fatigue, mood, and mental health QOL, suggesting that physical

activity may enhance cognitive and psychological well - being. Lastly, Milbury et al. (2020) evaluated an online couple - based meditation intervention (CBM) for brain tumor patients and their partners, revealing significant benefits for patients' cognitive symptoms, disease symptoms, and relationship well - being, though partners did not experience comparable gains. Gehring et al. (2024) and Loughan et al. (2024) demonstrated that home - based aerobic and guided exercise interventions enhanced cognitive function, fatigue, cardiovascular fitness, and sleep. Daun et al. (2018) explored a tailored exercise program for neuro - oncology patients. Overall, mind - body practices show broad benefits, while technology - based cognitive rehabilitation may require further optimization.

Levin et al. (2016) emphasized that structured exercise programs play a crucial role in enhancing both physical and psychological well - being in brain cancer survivors, proposing that such interventions can help counteract treatment - induced deterioration. Smit et al. (2019) investigated the rare occurrence of complete body disownership following tumor resection, linking it to disrupted multisensory processing and demonstrating that targeted rehabilitation can help restore body awareness. Trotschel et al. (2019) provided a noteworthy case study of a glioblastoma patient who maintained a regimen of high - intensity exercise, challenging prevailing safety concerns and achieving improved fitness levels despite tumor progression. Başoğlu et al. (2020) illustrated that prolonged vestibular rehabilitation may significantly benefit individuals with dysplastic cerebellar gangliocytoma (LDD), particularly those experiencing balance issues and dizziness. Bagga et al. (2024) highlighted the necessity of a holistic physiotherapy plan to address the distinct neurological impairments associated with CPA tumors after acoustic neuroma excision. Cavero et al. (2024) present the case of a woman with gliomatosis cerebri spanning nine years, whose condition necessitates assistive devices and supervision for walking, alongside diminished gait speed, impaired balance, and lower limb tremor and dystonia.

These studies highlight the brain's plasticity and the potential of non - pharmacological interventions in neuro - oncology, implicating neural circuits involved in sensorimotor integration, proprioception, and neuroplasticity. Yoga and meditation promise for dyadic support, exercise may enhance cognitive and physical function, and eHealth rehabilitation requires further refinement. The varied outcomes suggest that while mind - body practices offer broad benefits, technology - based interventions need optimization. Future research should prioritize large - scale trials to assess efficacy, explore neural adaptations, and refine targeted therapies to improve quality of life and functional outcomes for brain tumor patients.

4. Conclusion

The review underlines the role of various exercise programs, yoga, cognitive rehabilitation, nutrition and psychosocial rehabilitation in patients with brain tumor. Thus, these therapies can be integrated in the main line of treatment to improve outcomes and quality of life in persons with brain tumor.

Acknowledgements

I would like to express my gratitude to all my honorable and esteemed authors Dr. Bhawna Verma, Associate Professor, College of Physiotherapy, Pt. B. D. Sharma PGIMS, Rohtak for their significant contribution to this study. A special thanks to my co - supervisor Dr. Gopal Krishna, Associate Professor, Department of Neurosurgery, Pt. B. D. Sharma PGIMS, Rohtak for their significant contribution to this study.

Declarations

Funding: No funding resources

Conflict of interest: Not declared

Ethical approval: Not required

References

- [1] Louis DN, Perry A, Wesseling P, et al. The 2021 WHO Classification of Tumors of the Central Nervous System: A summary. *Neuro Oncol.*2021; 23 (8): 1231 - 1251.
- [2] Wen PY, Huse JT.2016 WHO Classification of Central Nervous System Tumors. *Continuum (Minneapolis)*.2017; 23 (6, Neuro - oncology): 1531 - 1547.
- [3] Stupp R, Mason WP, van den Bent MJ, et al. Radiotherapy plus concomitant and adjuvant temozolomide for glioblastoma. *N Engl J Med.*2005; 352 (10): 987 - 996.
- [4] Cramer CK, Wu S, Smith AW, et al. Neuro - oncology practice: A multidisciplinary approach to care and research. *J Neurooncol.*2017; 134 (3): 473 - 479.
- [5] Bayona NA, Bitensky J, Teasell R, et al. The role of task - specific training in rehabilitation therapies. *Top Stroke Rehabil.*2005; 12 (3): 58 - 65.
- [6] Ownsworth T, Hawkes A, Steginga S, et al. A biopsychosocial perspective on adjustment and quality of life following brain tumor: A systematic evaluation of the literature. *Disabil Rehabil.*2009; 31 (13): 1038 - 1055.
- [7] Smania N, Picelli A, Geroi C, et al. Rehabilitation procedures in the management of spasticity. *Eur J Phys Rehabil Med.*2010; 46 (3): 423 - 438.
- [8] Keating J, Verbeek J, Brooker J, et al. Early rehabilitation in patients with brain tumours: Evidence and practice. *Curr Opin Neurol.*2021; 34 (6): 721 - 727.
- [9] Baumann FT, Schüle K, Bloch W, Weissen A, Zimmer P. High - Intensity Physical Exercise in a Glioblastoma Patient under Multimodal Treatment. *Med Sci Sports Exerc.*2020 Feb; 52 (2): 233 - 237.
- [10] Sheikh SF, Akhuj A, Raghuveer R, Saklecha A. Neurophysiotherapy in Grade II Diffuse Astrocytoma: A Case Report. *Cureus.*2024 Jan 27; 16 (1): e53082.
- [11] Rossi S, Furlan R, De Chiara V, et al. Exercise protects from hippocampal inflammation and neurodegeneration in a mouse model of multiple sclerosis. *Brain Behav Immun.*2021 Nov; 97: 171 - 182.
- [12] Marciniak CM, Sliwa JA, Spill G, Heinemann AW, Semik PE. The impact of inpatient rehabilitation on function and survival of newly diagnosed patients with glioblastoma multiforme. *PM R.*2014 Feb; 6 (2): 105 - 10.
- [13] Milbury K, Mallaiah S, Mahajan A, Armstrong T, Weathers SP, Moss KE, Goktepe N, Spelman A, Cohen L. Yoga program for high - grade glioma patients undergoing radiotherapy and their family caregivers. *Integrative cancer therapies.*2018 Jun; 17 (2): 332 - 6.
- [14] Gehring K, Klock CJ, Aaronson NK, Janssen KW, Jones LW, Sitskoorn MM, Stuiver MM. Feasibility of a home - based exercise intervention with remote guidance for patients with stable grade II and III gliomas: a pilot randomized controlled trial. *Clinical rehabilitation.*2018 Mar; 32 (3): 352 - 66.
- [15] Milbury K, Weathers SP, Durrani S, Li Y, Whisenant M, Li J, Lim B, Weinberg JS, Kesler SR, Cohen L, Bruera E. Online couple - based meditation intervention for patients with primary or metastatic brain tumors and their partners: results of a pilot randomized controlled trial. *Journal of pain and symptom management.*2020 Jun 1; 59 (6): 1260 - 7.
- [16] Gehring K, Stuiver MM, Visser E, Klock C, van den Bent M, Hanse M, Tijssen C, Rutten GJ, Taphoorn MJ, Aaronson NK, Sitskoorn MM. A pilot randomized controlled trial of exercise to improve cognitive performance in patients with stable glioma: a proof of concept. *Neuro - oncology.*2020 Jan 11; 22 (1): 103 - 15.
- [17] Van der Linden, S. D., et al. (2021). eHealth cognitive rehabilitation for brain tumor patients: Results of a randomized controlled trial. *Journal of Neuro - Oncology*, 154 (315–326). [DOI: 10.1007/s11060 - 021 - 03828 - 1].
- [18] Daun JT, Capozzi LC, Dhruva T, Roldan Urigoiti G, McDonough MH, McLaughlin E, Bansal M, Brett A, Easaw JC, McNeely ML, Francis GJ. The feasibility of a multi - site, clinic - supported, and tailored neuro - oncology exercise program. *Neuro - Oncology Practice.*2024 Oct 10: npae093.
- [19] Cho, K. H., et al. (2024). Effects of protein - enriched nutritional support on skeletal muscle mass and rehabilitative outcomes in brain tumor patients: A randomized controlled trial. *Scientific Reports*, 14, 12909. [DOI: 10.1038/s41598 - 024 - 63551 - 5].
- [20] Loughan AR, Lanoye A, Willis KD, Fox A, Ravyts SG, Zukas A, Kim Y. Telehealth group Cognitive–Behavioral Therapy for Insomnia (CBT - I) in primary brain tumor: Primary outcomes from a single - arm phase II feasibility and proof - of - concept trial. *Neuro - oncology.*2024 Mar 1; 26 (3): 516 - 27.
- [21] Levin, G. T., et al. (2015). Exercise improves physical function and mental health of brain cancer survivors. *Integrative Cancer Therapies*, 15 (2), 190–196. [DOI: 10.1177/1534735415600068].
- [22] Smit M, Van Stralen HE, Van den Munckhof B, Snijders TJ, Dijkerman HC. The man who lost his body: Suboptimal multisensory integration yields body

awareness problems after a right temporoparietal brain tumour. *Journal of neuropsychology*. 2019 Sep; 13 (3): 603 - 12.

- [23] Troschel FM, Brandt R, Wiewrodt R, Stummer W, Wiewrodt D. High - intensity physical exercise in a glioblastoma patient under multimodal treatment. *Med Sci Sports Exerc*. 2019 Dec 1; 51 (12): 2429 - 33.
- [24] Basoglu, Y., et al. (2020). Role of long - term vestibular rehabilitation in a patient with a posterior fossa tumor. *American Journal of Case Reports*, 21, e924262. [DOI: 10.12659/AJCR.924262].
- [25] Bagga, I. K. B., & Samal, S. (2024). Physiotherapy rehabilitation following acoustic neuroma resection in a patient with cerebellopontine angle tumor: A case report. *Cureus*, 16 (2), e54208. [DOI: 10.7759/cureus.54208].
- [26] Lozano - Cavero, E., et al. (2024). Physical therapy enhances physical and functional abilities in a female patient with gliomatosis cerebri. *Anales del Sistema Sanitario de Navarra*, 47 (2), e1087. [DOI: 10.23938/ASSN.1087].