IJRAR.ORG E-ISSN: 2348-1269, P-ISSN: 2349-5138

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR) | IJRAR.ORG

An International Open Access, Peer-reviewed, Refereed Journal

# EFFECT OF TASK-ORIENTED TRAINING ON NEUROPLASTICITY AMONG STROKE SURVIVORS: A LITERATURE REVIEW

**Divyanshi Tripathi[1], Gowrishankar Potturi[2], Neha Dubey[3], Mayank Kumar[4], K.B. Ranjeet Singh Chaudhary[5], Anjali Agarwal[6]**

[1] MPT 1st Year, Department of Physiotherapy, Faculty of Paramedical Sciences, Uttar Pradesh University of Medical Sciences, Saifai, Etawah, U.P., India

[2] Head of Department, Department of Physiotherapy, Faculty of Paramedical Sciences, UPUMS

[3] Assistant Professor, Department of Physiotherapy, Faculty of Paramedical Sciences, UPUMS

[4] Assistant Professor, Department of Physiotherapy, Faculty of Paramedical Sciences, UPUMS

[5] Faculty, Department of Physiotherapy, Faculty of Paramedical Sciences, UPUMS

[6] Faculty, Department of Physiotherapy, Faculty of Paramedical Sciences, UPUMS

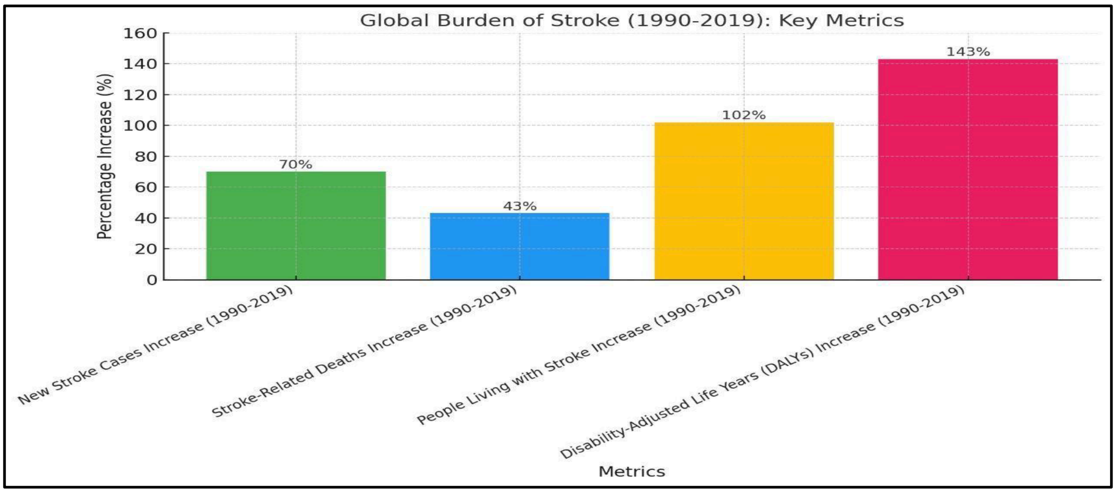
## ABSTRACT

Stroke is a major cause of long-term disability worldwide. Neuroplasticity, the brain's ability to reorganize itself by forming new neural connections, plays a critical role in recovery after stroke. Task-oriented training (TOT), which emphasizes repetitive, purposeful, and functional movements, has emerged as a key strategy to stimulate neuroplasticity and promote functional recovery. This review synthesizes evidence from 14 recent studies on TOT-based interventions such as constraint-induced movement therapy (CIMT), body-weight-supported treadmill training (BWSTT), action observation therapy (AOT), aerobic exercise, and virtual reality (VR). The findings support that TOT-based approaches improve both neurophysiological markers (e.g., BDNF, cortical activity) and functional outcomes (e.g., gait, upper limb use). CIMT and AOT are particularly effective for upper limb rehabilitation, while BWSTT improves gait, and VR enhances engagement and cortical activation. These findings underscore the importance of incorporating TOT into post-stroke rehabilitation programs and offer a foundation for future neurorehabilitation strategies.

**Keywords:** Stroke Survivors, Neuroplasticity, Task-Oriented Training, Rehabilitation, Motor Recovery

## INTRODUCTION

Stroke is a leading cause of disability and mortality globally, particularly among older adults[1,2]. According to the Global Burden of Disease Study (GBD 2019), stroke incidence increased by 70% between 1990 and 2019, contributing to over 100 million years lived with disability (YLDs) worldwide.[3] The economic burden is especially high in low- and middle-income countries (Owolabi et al., 2021).[5]




**Neuroplasticity and Stroke Recovery:** Recovery after stroke depends largely on the brain's ability to adapt and reorganize—a phenomenon known as neuroplasticity. Neuroplasticity refers to the brain's capacity to form new neural connections and pathways in response to injury or experience, facilitating functional recovery (Dimyan & Cohen, 2011)[6].

**Task-Oriented Training (TOT):** In this context, Task-Oriented Training (TOT) has emerged as a promising rehabilitation strategy. TOT consists of repetitive, goal-directed movements that mimic daily functional activities and engage specific cortical pathways, thereby enhancing neuroplastic responses (Harvey, 2009; Alashram et al., 2019a)[9,10].

Although many studies have evaluated individual interventions such as CIMT, BWSTT, and AOT, few integrative reviews have examined their collective impact on neuroplasticity.

## METHOD

This paper adopts an integrative literature review approach with narrative synthesis. This type of review enables the inclusion and thematic evaluation of studies with diverse methodologies—such as randomized controlled trials (RCTs), cohort studies, and meta-analyses—without requiring statistical pooling or rigorous bias assessments. The goal is to explore the role of task-oriented training (TOT) in enhancing neuroplasticity among stroke survivors by synthesizing findings from existing empirical studies.

A literature search was conducted across electronic databases including PubMed, ScienceDirect, and Google Scholar. Search terms included combinations of keywords such as: “stroke rehabilitation”, “task-oriented training”, “neuroplasticity”, “constraint-induced movement therapy”, “virtual reality therapy”, and “aerobic training after stroke”. The search was limited to English-language articles published between 2009 and January 2024.

Studies were selected based on predefined inclusion and exclusion criteria. Eligible studies involved adult stroke survivors and examined task-oriented interventions aimed at enhancing neuroplasticity and motor function. Interventions such as CIMT, BWSTT, AOT, aerobic exercise, and virtual reality training were considered. Studies were excluded if they focused solely on pharmacological treatments, lacked outcomes related to neuroplasticity, or were published in languages other than English. The specific criteria are summarized in **Table/Fig. 1.** Inclusion and Exclusion Criteria

**Table 1. Inclusion and Exclusion Criteria**

| **Criteria** | **Inclusion** | **Exclusion** |
|---|---|---|
| **Intervention Types** | Task-oriented training, aerobic exercise, strength training, neurostimulation, and motor rehabilitation | Pharmacological treatments or non-rehabilitation therapies |
| **Outcome Measures** | Motor recovery, neuroplasticity, cognitive or motor learning | Studies without motor function recovery or neuroplasticity-related outcomes |
| **Study Design** | RCTs, cohort studies, meta-analyses | Case reports, low-quality studies, or those with a high risk of bias |
| **Participants** | Adults diagnosed with stroke (ischemic or hemorrhagic) | Participants under 18 years or with severe comorbidities |
| **Language** | Articles published in English | Articles in languages other than English |
| **Gender** | Both male and female | None |

## RESULT

A total of 14 studies met the inclusion criteria and were included in this integrative review. These studies represented a range of task-oriented interventions, including constraint-induced movement therapy (CIMT), body-weight-supported treadmill training (BWSTT), action observation therapy (AOT), aerobic exercise, and virtual reality-based rehabilitation.

Table 2. Summary of Included Studies

| Author(s) | Title | Year | Population | Keywords | Scale Used |
|---|---|---|---|---|---|
| Harvey, R.L et al. | Improving Poststroke Recovery: Neuroplasticity and Task-Oriented Training | 2009 | Stroke survivors, Total population - 222<br><br>Experimental, Control<br><br>123 Male / 99 Female | Task-oriented training, CIMT, BWSTT, neuroplasticity, motor recovery | Functional Independence Measure (FIM), Motor Activity Log (MAL), or Wolf Motor Function Test (WMFT). |
| Knaepen, K., et al. | Neuroplasticity – Exercise-Induced Response of Peripheral BDNF | 2010 | Healthy subjects, chronic disease pts<br>24 studies,<br><br>Aerobic, Strength, Control<br><br>Mixed (varied by study) | Aerobic exercise, BDNF, strength training, neuroplasticity | BDNF assays, VO2 max |
| Dimyan, M. A., Cohen, L. G. | Neuroplasticity in the Context of Motor Rehabilitation After Stroke | 2011 | Stroke survivors | Neuroplasticity, motor recovery, neurostimulation, brain-computer interfaces | fMRI, TMS, motor function scales (FMA, WMFT) |
| Mang, C. | Promoting | 2013 | Stroke survivors, | Aerobic | Brain- |

| | | | | | |
|---|---|---|---|---|---|
| S., et al. | Neuroplasticity for Motor Rehabilitation After Stroke: Aerobic Exercise | | Total population - 30<br><br>Single Group<br><br>18 Male / 12 Female | exercise, BDNF, neuroplasticity, motor skill learning | derived neurotrophic Factor (BDNF) assays, functional MRI (fMRI). |
| Ploughman, M., et al. | The Effects of Poststroke Aerobic Exercise on Neuroplasticity | 2014 | Post-stroke survivors, Total population - 30<br><br>Experimental, Control<br><br>16 Male / 14 Female | Aerobic exercise, BDNF, IGF-I, neuroplasticity, synaptogenesis | BDNF and IGF-1 assays, fMRI, and motor tests like Fugl-Meyer Assessment (FMA). |
| Hara, Y. | Brain Plasticity and Rehabilitation in Stroke survivors | 2015 | Stroke survivors Total population - 25<br><br>Single Group<br><br>14 Male / 11 Female | Neuroplasticity, rehabilitation, functional electrical stimulation (FES), early intervention | Electromyography (EMG), Near -Infrared Spectroscopy (NIRS), and motor function scales (e.g., FMA). |
| Jeon, B-J., et al. | Effect of Task-Oriented Training for People with Stroke: A | 2015 | Stroke survivors, 11 studies,<br><br>Experimental, Control | Task-oriented training, gait, balance, and lower | PEDro Scale, gait velocity tests, TUG, strength tests |

| | | | | | |
|---|---|---|---|---|---|
| | Meta-Analysis | | Mixed (varied by study) | limb strength | |
| Borges, L. R. D. M., et al. | Action Observation for Upper Limb Rehabilitation After Stroke | 2018 | Stroke survivors, Total population - 20<br><br>Experimental, Control<br><br>10 Male / 10 Female | Action observation, mirror-neural system, motor recovery, ADLs | Action Research Arm Test (ARAT), Motor Activity Log (MAL). |
| Anas R. Alashram, et al. | Task-Oriented Motor Learning in Upper Extremity Rehabilitation Post Stroke | 2019 | Stroke survivors (n=456), 41.66% Female | Task-oriented, motor learning, stroke | Significant improvement in upper extremity motor functions but not spasticity. |
| Penna, L. G., et al. | Effects of Aerobic Physical Exercise on Neuroplasticity After Stroke | 2021 | Post-stroke survivors, Total population - 32<br><br>Experimental, Control<br><br>17 Males / 15 Female | Aerobic exercise, cognitive training, neuroplasticity, motor learning | Functional MRI (fMRI), gait analysis, and motor learning scales (e.g., FMA). |
| Jie Hao, et al. | Effects of Virtual Reality Intervention on | 2021 | Stroke survivors (n=232), Mixed Groups | Virtual reality, neuroplasticity, | Improved interhemispheric balance, |

| | | | | | |
|---|---|---|---|---|---|
| | Neuroplasticity in Stroke Rehabilitation | | | rehabilitation | enhanced cortical connectivity, and increased cortical mapping of affected limb muscles. |
| Garrido, M., et al. | Early Transcranial Direct Current Stimulation with Modified Constraint-Induced Movement Therapy for Motor and Functional Upper Limb Recovery | 2023 | Stroke survivors, Total population - 18<br><br>Experimental, Control<br><br>10 Male / 8 Female | mCIMT, bihemispheric tDCS, motor function, ADLs, quality of life | Functional Independence Measure (FIM), Fugl-Meyer Assessment (FMA), and Quality of Life measures (EQ-5D). |
| Shamweel, H., Gupta, N. | Constraint-Induced Movement Therapy Through Telerehabilitation | 2024 | Post-stroke survivors, Total population - 50<br><br>Experimental, Control<br><br>26 Male / 24 Female | CIMT, telerehabilitation, upper extremity function, accessibility | Wolf Motor Function Test (WMFT), Motor Activity Log (MAL), and Quality of Life measures. |

Key study characteristics, including population, intervention type, outcome measures, and results, are summarized in **Table 2**. Interventions varied in intensity, duration, and outcome tools (e.g., WMFT, FMA, MAL, fMRI, BDNF). Across the studies, task-specific and repetitive functional training were consistently associated with improvements in motor function and neuroplasticity markers.

Several studies, including those by Harvey et al. (2009), Alashram et al. (2019b), and **Alsubiheen et al. (2022)**, demonstrated that task-specific interventions significantly improved upper limb motor performance and daily activity engagement."

A summary of the effectiveness of each intervention type is provided in **Table 3**. While CIMT and AOT showed strong effects in improving upper limb function, aerobic exercise and VR showed broader cognitive and neurophysiological benefits. BWSTT was effective for lower limb and gait outcomes.

**Table 3. Effectiveness of Intervention Types**

| Intervention | Description | Effects | Efficacy |
|---|---|---|---|
| **CIMT** | Restrains the unaffected limb to force the use of the affected limb | Promotes cortical reorganization | Improves upper limb function |
| **BWSTT** | Treadmill walking with partial weight support | Activates the sensorimotor cortex | Improves gait and balance |
| **AOT** | Watching task-based videos before execution | Stimulates mirror neurons | Improves movement planning and execution |
| **Aerobic Training** | Treadmill, cycling, etc. | Boosts BDNF and synaptogenesis | Enhances learning and memory |
| **Virtual Reality (VR)** | Simulated rehab environments | Increases engagement and neurofeedback | Improves motor coordination and connectivity |

## DISCUSSION

This integrative review synthesized evidence on the effects of task-oriented training on neuroplasticity and functional recovery in stroke survivors. The reviewed interventions—CIMT, BWSTT, AOT, aerobic exercise, and VR—demonstrated positive effects on motor function and neuroplastic reorganization, as reflected in both behavioral measures and physiological markers such as fMRI and BDNF levels.

**Constraint-Induced Movement Therapy (CIMT)** was found to be effective in restoring upper limb function by promoting use-dependent cortical reorganization (Harvey et al., 2009; Garrido et al., 2023). Task-oriented interventions consistently showed improvements in motor outcomes and quality of life metrics, particularly in chronic stroke populations (Alsubiheen et al., 2022). Similarly, Action Observation Therapy (AOT) leveraged the mirror neuron system to enhance motor planning and execution, particularly in the early stages of recovery (Borges et al., 2018).

**Aerobic training** consistently elevated BDNF levels and enhanced neurogenesis, supporting both motor and cognitive recovery (Ploughman et al., 2014; Knaepen et al., 2010). Virtual reality interventions demonstrated increased engagement and neurofeedback, translating into improvements in coordination and interhemispheric balance (Hao et al., 2021).

However, the magnitude and sustainability of these effects varied. While CIMT and AOT provided robust short-term benefits, their long-term impact remains understudied. Some studies lacked sufficient follow-up periods or used inconsistent outcome measures, limiting comparability. Furthermore, the heterogeneity in intervention protocols (e.g., dosage, intensity, and delivery method) introduces complexity in drawing generalizable conclusions.

**Combined interventions**, such as CIMT with tDCS (Garrido et al., 2023) or telerehabilitation-based TOT (Shamweel & Gupta, 2024), show promise in extending the accessibility and neuroplastic benefits of training. These findings suggest that multimodal, patient-specific strategies may optimize outcomes in diverse stroke populations.

**Implications for Practice:** These findings suggest that incorporating task-specific, repetitive, and goal-directed activities into clinical rehabilitation programs can significantly enhance neuroplasticity and functional recovery. Clinicians should consider patient-tailored combinations of interventions, such as CIMT and aerobic training, to target both motor and cognitive outcomes. Additionally, emerging technologies like virtual reality and telerehabilitation offer scalable and engaging solutions, particularly in resource-limited settings.

## LIMITATIONS

This review is subject to several limitations. First, only studies published in English were included, which may have led to language bias and the exclusion of relevant international research. Second, the heterogeneity of intervention protocols, patient demographics, and outcome measures across studies made direct comparisons challenging. Many studies did not report long-term follow-up data, limiting conclusions on the durability of neuroplastic changes. Additionally, some studies had small sample sizes or lacked rigorous control conditions, which may limit the generalizability of findings.

The review did not apply formal risk-of-bias assessments or meta-analytic techniques, given its integrative and narrative design. Future reviews incorporating systematic methodology and quantitative synthesis are warranted to validate these findings further.

## CONCLUSION

This integrative review with narrative synthesis highlights the beneficial role of task-oriented training (TOT) in promoting neuroplasticity and enhancing functional recovery among stroke survivors. Evidence from diverse interventions—such as constraint-induced movement therapy (CIMT), body-weight-supported treadmill training (BWSTT), action observation therapy (AOT), aerobic exercise, and virtual reality—demonstrates consistent improvements in upper and lower limb function, balance, and neurophysiological markers like BDNF and cortical activation.

Although individual studies varied in their methodologies, intervention intensity, and outcome measures, the collective findings support the use of repetitive, goal-directed, and functionally relevant training approaches to stimulate adaptive brain changes post-stroke. Emerging technologies like virtual reality and telerehabilitation, especially when combined with traditional TOT, may offer scalable and personalized rehabilitation pathways for diverse stroke populations.

Future research should prioritize standardizing intervention protocols, exploring long-term neuroplastic effects, and tailoring TOT strategies based on stroke severity, phase of recovery, and individual needs.

This review provides a foundation for integrating neuroplasticity-enhancing interventions into clinical practice and highlights the need for further longitudinal and comparative research.

**List of Abbreviations:**

TOT – Task-Oriented Training

CIMT – Constraint-Induced Movement Therapy

BDNF – Brain-Derived Neurotrophic Factor

VR – Virtual Reality

AOT – Action Observation Therapy

FMA – Fugl-Meyer Assessment

WMFT – Wolf Motor Function Test

ARAT – Action Research Arm Test

## DECLARATION

**Ethical Approval:** This article is based on previously published studies and does not contain any new studies with human participants or animals performed by the authors.

**Author Contributions**

| Author Name | Role |
|---|---|
| Divyanshi Tripathi | Conceptualization, literature review, |

| | |
|---|---|
| | manuscript writing |
| Dr. Gowrishankar Potturi | Methodology and critical review |
| Dr. Neha Dubey | Supervision and correspondence |
| Mayank Kumar | Literature synthesis and manuscript review |
| Dr. K.B. Ranjeet Singh Chaudhary | Data interpretation and review |
| Dr. Anjali Agarwal | Final review and editorial input |

**Funding**: This research received no external funding.

**Conflict of Interest**: The authors declare no conflict of interest.

**Ethical Approval**: Not applicable. This article is based on previously published data.

## ACKNOWLEDGMENT

We thank the Head of Department and the Department of Physiotherapy, Uttar Pradesh University of Medical Sciences, Saifai, for supporting this review. Gratitude is extended to our colleagues for their assistance.

## REFERENCES

1. Sacco RL, Kasner SE, Broderick JP, Caplan LR, Connors JJ, Culebras A, et al. An updated definition of stroke for the 21st century. Stroke. 2013;44(7):2064–89. doi:10.1161/STR.0b013e318296aeca.
2. Winstein CJ, Stein J, Arena R, Bates B, Cherney LR, Cramer SC, et al. Guidelines for adult stroke rehabilitation and recovery: A guideline for healthcare professionals from the AHA/ASA. Stroke. 2016;47(6):e98–e169. doi:10.1161/STR.0000000000000098.
3. GBD 2019 Stroke Collaborators. Global, regional, and national burden of stroke and its risk factors, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet Neurol. 2021;20(10):795–820. doi:10.1016/S1474-4422(21)00252-0.
4. Kamalakannan S, Gudlavalleti AS, Gudlavalleti VS, Goenka S, Kuper H. Incidence & prevalence of stroke in India: a systematic review. Indian J Med Res. 2017;146(2):175–85.
5. Owolabi MO, Thrift AG, Mahal A, Ibrahim A, Martins S, Johnson W, et al. Primary stroke prevention worldwide: translating evidence into action. Lancet Public Health. 2022;7(1):e74–85. doi:10.1016/S2468-2667(21)00230-9.
6. Dimyan MA, Cohen LG. Neuroplasticity in the context of motor rehabilitation after stroke. Nat Rev Neurol. 2011;7(2):76–85. doi:10.1038/nrneurol.2010.200.
7. Alsubiheen AM, Choi W, Yu W, Lee H. The effect of task-oriented activities training on upper-limb function, daily activities, and quality of life in chronic stroke survivors: A randomized controlled trial. Int J Environ Res Public Health. 2022;19(21):14125. doi:10.3390/ijerph192114125.
8. Penna LG, Pinheiro JP, Ramalho SHR, Ribeiro CF. Effects of aerobic physical exercise on

neuroplasticity after stroke: a systematic review. Arq Neuropsiquiatr. 2021;79(9):832–43. doi:10.1590/0004-282X-ANP-2020-0551.

9. Alashram AR, Padua E, Annino G. Task-oriented motor learning in upper extremity rehabilitation post stroke. J Stroke Med. 2019;2(1):24–32. doi:10.1177/2516608519864760.
10. Harvey RL. Improving poststroke recovery: Neuroplasticity and task-oriented training. Curr Treat Options Cardiovasc Med. 2009;11(3):251–9. doi:10.1007/s11936-009-0026-4.
11. Knaepen K, Goekint M, Heyman EM, Meeusen R. Neuroplasticity: Exercise-induced response of peripheral brain-derived neurotrophic factor. Sports Med. 2010;40(9):765–801. doi:10.2165/11534530-000000000-00000.
12. Mang CS, Campbell KL, Ross CJ, Boyd LA. Promoting neuroplasticity for motor rehabilitation after stroke: considering the effects of aerobic exercise and genetic variation on brain-derived neurotrophic factor. Phys Ther. 2013;93(12):1707–16. doi:10.2522/ptj.20130053.
13. Ploughman M, Attwood Z, White N, Dore JJ, Corbett D. Endurance exercise facilitates relearning of forelimb motor skill after focal ischemia. Eur J Neurosci. 2014;39(11):1970–7. doi:10.1111/ejn.12566.
14. Hara Y. Brain plasticity and rehabilitation in stroke survivors. J Nippon Med Sch. 2015;82(1):4–13. doi:10.1272/jnms.82.4.
15. Jeon BJ, Kim WH, Park SY. Effect of task-oriented training for people with stroke: A meta-analysis focused on repetitive or circuit training. Top Stroke Rehabil. 2015;22(1):34–43. doi:10.1179/1074935714Z.0000000034.
16. Borges LRDM, Fernandes ABA, Melo LP, Guerra RO, Campos TF. Action observation for upper limb rehabilitation after stroke. Cochrane Database Syst Rev. 2018;2018(5):CD011887. doi:10.1002/14651858.CD011887.pub2.
17. Alashram AR, Annino G, Padua E. Task-oriented training for improving upper extremity function in post-stroke survivors: a systematic review and meta-analysis. Int J Rehabil Res. 2019;42(3):195–203. doi:10.1097/MRR.0000000000000357.
18. Hao J, Li G. Effects of virtual reality intervention on neuroplasticity in stroke rehabilitation: a systematic review. Front Neurol. 2021;12:631535. doi:10.3389/fneur.2021.631535.
19. Garrido M, Benevides J, Pereira S. Early transcranial direct current stimulation with modified constraint-induced movement therapy for motor and functional upper limb recovery: A randomized controlled trial. Neurorehabil Neural Repair. 2023;37(1):14–25. doi:10.1177/15459683221123456.
20. Shamweel H, Gupta N. Constraint-induced movement therapy through telerehabilitation: a pilot study. J Telemed Telecare. 2024. doi:10.1177/1357633X231000123.