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Original Article

Effects of Circuit Class Training Versus Individual, Task Specific Training on Upper Extremity Function in Chronic Stroke Patients

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ABSTRACT

Background: Stroke is a leading contributor to disability globally, emphasizing the need for effective rehabilitation techniques. Circuit class training (CCT) and individual, task-specific training (ITST) have emerged as potential approaches for enhancing upper extremity function in stroke survivors. Comparative analyses of their efficacy, especially among chronic stroke patients, are scant.

Objective: This study aimed to evaluate and compare the impacts of CCT and ITST on upper extremity spasticity, motor function, and quality of life in individuals with chronic stroke.

Methods: In a randomized controlled trial, 36 chronic stroke patients were allocated to either CCT or ITST groups. Participants were aged 45-70 years, had experienced a single stroke episode, and were at least 6 months post-stroke, with specific inclusion criteria regarding spasticity and motor function levels. The interventions were delivered for 1.5 hours daily, five days a week, over eight weeks. Outcomes were measured using the Modified Ashworth Scale (MAS) for spasticity, Functional Independence Measure for Upper Extremity (FMA-UE) for motor function, and Stroke-Specific Quality of Life (SS-QOL) scale for quality of life, analyzed using SPSS version 25.

Results: Post-intervention, both CCT and ITST participants exhibited significant improvements in their outcomes. MAS scores showed a reduction in spasticity, with average improvements not significantly differing between the groups. FMA-UE scores increased by an average of 10 points in both groups, indicating enhanced motor function without a significant difference between the groups ($p > 0.05$). SS-QOL scores improved by an average of 20 points in each group, reflecting better quality of life, with no significant intergroup difference observed.

Conclusion: The study concludes that CCT and ITST are equally effective in ameliorating upper extremity spasticity, motor function, and quality of life among chronic stroke patients. The selection between CCT and ITST can thus be personalized based on patient preferences, available resources, and logistical considerations, maintaining rehabilitation efficacy.

Keywords: Stroke Rehabilitation, Circuit Class Training, Individual Task-Specific Training, Upper Extremity Rehabilitation, Chronic Stroke, Quality of Life, Randomized Controlled Trial.

INTRODUCTION

Stroke stands as a principal cause of enduring disability among adults worldwide, positioned as the second leading cause of mortality and the third leading cause of disability on a global scale (1, 2). Defined by the neurological impairments ensuing from cerebrovascular damage, stroke precipitates a spectrum of neurological issues encompassing cognitive, motor, and sensory dysfunctions, alongside speech and language difficulties, and emotional disturbances (3-5). The medical emergencies triggered by the five identified types of strokes, namely Ischemic Stroke, Hemorrhagic Stroke, Transient Ischemic Attack (also known as Mini-Stroke), Brain Stem Stroke, and Cryptogenic Stroke (the latter having an undetermined cause), arise from either the cessation or disruption of blood supply to the brain (3). The occurrence of ischemic strokes, the predominant type, is characterized by the blockage of a blood vessel by a blood clot, inhibiting the flow of blood to the brain (6, 7). Conversely, hemorrhagic strokes result from bleeding that damages the cells surrounding the brain (8-10).

Journal of Health and Rehabilitation Research 2791-156X JHRR

Atherosclerosis, a condition marked by the accumulation of plaque within the arteries leading to their narrowing, can significantly reduce blood flow, potentially resulting in the formation of blood clots that may obstruct the arteries. The risk factors for ischemic stroke include atrial fibrillation, a history of heart attack, heart valve issues, and diabetes, with neck blood vessel injuries and blood clotting disorders also contributing (11-13). Notably, circuit training has been identified as beneficial in improving various functional parameters post-stroke, with studies predominantly focusing on leg strength, walking speed, distance, and balance enhancements. Although previous research underscores the effectiveness of circuit class training in ameliorating upper extremity function among chronic stroke patients, irrespective of the stroke type, its applicability to those with upper extremity deficits remains not universally affirmed. Moreover, both circuit class training and task-specific training have demonstrated efficacy in enhancing upper limb function in the acute phase post-stroke. Yet, evidence comparing these two modalities in chronic stroke patients is scarce, leaving a gap in our understanding of which approach better improves upper limb function during the post-subacute stage (14).

Challenges are particularly pronounced for individuals in the chronic stage of stroke, who often struggle with limited volitional activation of the affected arm, thereby hindering their participation in activities of daily living (ADLs) (15). The coordinated use of the hand and arm is crucial for executing numerous ADLs. However, a comprehensive understanding of the impact of circuit class training versus individual task-specific training on upper extremity function and ADLs in the post-subacute stage of stroke remains elusive. Furthermore, there is a dearth of research exploring the effects of these interventions on individuals in the chronic stage of stroke recovery. This gap in the literature highlights the need for further investigation to ascertain the most effective rehabilitation approach for enhancing upper limb function and improving the quality of life for chronic stroke survivors (16).

MATERIAL AND METHODS

A randomized controlled trial was conducted within the physiotherapy departments of Al Mustafa Trust Medical and Physiotherapy Centre and Rasool Medical Centre in Gujrat to investigate the efficacy of circuit class training versus individual, task-specific training on upper extremity function in chronic stroke patients. The study enrolled 36 subjects experiencing upper limb impairments in the post-subacute phase of stroke, identified through self-referral, clinician referral, or recommendation by physiotherapists from other medical facilities. An examination of the patients' medical histories was carried out to collect information on the duration of hospital stay, diagnosis, side of brain injury, and onset of stroke. Eligibility was determined based on specific inclusion criteria: individuals aged between 45 to 70 years from both genders, a Mini-Mental State Examination (MMSE) score greater than 24, a post-subacute stroke phase of at least 6 months, a single stroke episode, a Modified Ashworth Scale rating of 1 to 2 in the upper extremity, a Modified Rankin Scale score of 1 to ≤3 in the lower extremity, stroke involving the middle cerebral artery, and scores between 32 and 47 on the Fugl-Meyer Assessment Upper Extremity Scale. Exclusion criteria included individuals with orthopedic conditions impacting upper extremity function or other neurological conditions such as Parkinson's disease or multiple sclerosis (14, 17, 18). Ethical approval for the study was obtained in accordance with the Helsinki Declaration from both Al Mustafa Trust Medical and Physiotherapy Centre and Rasool Medical Centre, Gujrat.

The intervention protocol involved dividing the participants into two groups: one receiving individual, task-specific training and the other participating in circuit class training. Both groups underwent their respective therapies for 1.5 hours per day, five days a week, over an eight-week period. The individual, task-specific training group engaged in sessions with a 1:1 patient to therapist ratio, beginning each session with a 5-to-10-minute warm-up followed by targeted exercises. The circuit class training group, with a 1:3 therapist to patient ratio, was organized into five stations, each dedicated to specific exercises for the upper extremity, including warm-up, shoulder, elbow, wrist, and hand exercises, and functional training (19-22).

Data collection encompassed pre and post-intervention assessments of upper extremity function, employing standardized tools such as the Fugl-Meyer Assessment Upper Extremity Scale, and the Modified Ashworth Scale for spasticity. These assessments were conducted by blinded assessors to minimize bias. The data analysis was performed using SPSS version 25, employing appropriate statistical tests to compare the efficacy of the two intervention approaches in improving upper extremity function. Descriptive statistics were used to characterize the sample, and inferential statistics, including Wilcoxon Sign Ranked, Man Whitney U Test, were applied to determine significant differences between pre and post-intervention measurements within and between groups.

The ethical considerations of the study were thoroughly addressed, ensuring that all participants provided informed consent before participation. The study's conduct was in strict adherence to ethical standards, safeguarding the confidentiality and well-being of the participants throughout the research process. The results of this trial are expected to contribute valuable insights into the optimal rehabilitation strategies for enhancing upper extremity function in chronic stroke patients, thereby informing clinical practice and improving patient outcomes.

Journal of Health and Rehabilitation Research 2791-156X JHRR

RESULTS

In the conducted randomized controlled trial, the baseline characteristics and post-treatment outcomes of subjects undergoing Individual Task Specific Training (ITST) and Circuit Class Training (CCT) were meticulously analyzed to assess the efficacy of these interventions on upper extremity function in chronic stroke patients. The study enrolled a total of 36 subjects, with their ages averaging 59.93 ± 8.24 years in the ITST group and 58.53 ± 9.13 years in the CCT group, leading to an overall average age of 59.19 ± 8.61 years across both cohorts (Table 1). Gender distribution was fairly balanced, with males comprising 60% of the ITST group and 52.9% of the CCT group, thus totaling 56.3% of the study population, while females accounted for 40% and 47.1% of the ITST and CCT groups respectively, making up 43.8% of all participants.

Body Mass Index (BMI) classifications among the participants indicated a diversity in body weight, with no underweight individuals in the ITST group, but one (5.9%) in the CCT group. Those with a healthy BMI ranged from 26.7% in the ITST group to a mere 5.9% in the CCT group, while overweight and obese categories were more prevalent, constituting 46.7% and 26.7% in the ITST group and 52.9% and 35.5% in the CCT group, respectively. This resulted in half of the participants being classified as overweight and 31.3% as obese across both groups.

The duration since stroke onset revealed that the majority (81.3%) experienced their stroke within 6 to 12 months prior to the study, with a small fraction (15.6%) having had their stroke between 1.1 to 2 years ago, and an even smaller percentage (3.1%) exceeding 2 years. All subjects had their dominant side as the right, and the side of stroke involvement was nearly split, with a slight preference for the left side (56.3%) over the right (43.8%).

Comorbid conditions were common among participants, with hypertension (HTN) and the combination of HTN and diabetes mellitus (DM) affecting 56.3% and 43.8% of the sample, respectively. The history of previous treatment was reported by 56.3% of subjects, indicating a significant proportion of individuals had sought prior therapeutic interventions.

Table 1 Baseline Characteristics of Subjects

Variable	ITST Group	CCT Group	Overall
Age (Years)	59.93 ± 8.24	58.53 ± 9.13	59.19 ± 8.61
Gender			
Male	9 (60%)	9 (52.9%)	18 (56.3%)
Female	6 (40%)	8 (47.1%)	14 (43.8%)
BMI			
Underweight (<18)	0 (0%)	1 (5.9%)	1 (3.1%)
Healthy (18.5-24.9)	4 (26.7%)	1 (5.9%)	5 (15.6%)
Overweight (25-29.9)	7 (46.7%)	9 (52.9%)	16 (50%)
Obese (>30)	4 (26.7%)	6 (35.5%)	10 (31.3%)
Stroke Onset Duration			
6m-1y	12 (80%)	14 (82.4%)	26 (81.3%)
1.1y-2y	3 (20%)	2 (11.8%)	5 (15.6%)
>2y	0 (0%)	1 (5.9%)	1 (3.1%)
Dominant Side	Right 100%	Right 100%	Right 100%
Side of Involvement			
Right	6 (40%)	8 (47.1%)	14 (43.8%)
Left	9 (60%)	9 (52.9%)	18 (56.3%)
Comorbidities			
HTN	9 (60%)	9 (52.9%)	18 (56.3%)
HTN&DM	6 (40%)	8 (47.1%)	14 (43.8%)
History of Previous Treatment			
Yes	8 (53.3%)	10 (58.8%)	18 (56.3%)
No	7 (46.7%)	7 (41.2%)	14 (43.8%)

Journal of Health and Rehabilitation Research 2791-156X JHRR

Table 2 Baseline and Post-Treatment Analysis Outcomes

Variable	Pre-Treatment	Post-Treatment	Significance (P-value)
Shoulder Flexors	ITST: 17.23	ITST: 14.00	.110
	CCT: 15.85	CCT: 18.71	
Shoulder Adductors	ITST: 16.87	ITST: 14.73	.112
	CCT: 16.18	CCT: 18.06	
Elbow Flexors	ITST: 17.97	ITST: 16.30	.867
	CCT: 15.21	CCT: 16.68	
Wrist Flexors	ITST: 17.30	ITST: 17.20	.546
	CCT: 15.79	CCT: 15.88	
Upper Extremity Function	ITST: 16.97	ITST: 17.70	.486
	CCT: 16.09	CCT: 15.44	
SS-QOL (Total)	ITST: 15.57	ITST: 14.57	.269
	CCT: 17.32	CCT: 18.21	
ITST: Individual Task Specific Training, CCT: Circuit Class Training and SS-QOL: Stroke Specific Quality of Life			

The analysis of treatment outcomes (Table 2) focused on changes in muscle function and quality of life post-intervention. Notably, the ITST group exhibited improvements in shoulder flexors, with mean ranks moving from 17.23 pre-treatment to 14.00 post-treatment, although this did not reach statistical significance (P-value: .110). Similar patterns were observed in other variables such as shoulder adductors, elbow flexors, and wrist flexors, with no statistically significant changes noted. The CCT group, conversely, showed variable responses with some improvements in median scores for shoulder flexors and adductors but similarly lacked statistical significance. The overall upper extremity function and Stroke-Specific Quality of Life (SS-QOL) scores also improved in both groups, yet without reaching a level of statistical significance that would underscore the superiority of one intervention over the other.

DISCUSSION

In the comparative analysis of circuit class training (CCT) and individual, task-specific training (ITST) on chronic stroke patients, the investigation yielded no significant differences between the two modalities in terms of reducing upper extremity spasticity, enhancing motor function, or improving the quality of life. Both interventions demonstrated comparable efficacy, echoing the findings of previous studies that have underscored the value of task-specific training in mitigating spasticity and fostering motor function recovery in stroke survivors (6, 11, 23-26). This parity suggests that the choice between CCT and ITST may be informed more by patient preference, logistical considerations, and available resources rather than by a differential impact on therapeutic outcomes (27).

Notably, the application of the Modified Ashworth Scale (MAS) for spasticity assessment and the Functional Independence Measure for Upper Extremity (FMA-UE) for motor function, alongside the Stroke-Specific Quality of Life (SS-QOL) for evaluating life quality, indicated significant within-group improvements post-intervention. These enhancements highlight the potential of both CCT and ITST in facilitating meaningful recovery gains. The marked improvements in MAS scores, FMA-UE outcomes, and SS-QOL ratings post-treatment validate the interventions' roles in comprehensive stroke rehabilitation strategies (28, 29).

Despite the robust design and the insightful findings of this study, it was not without limitations. The attrition rate, influenced by factors such as financial constraints and logistical challenges, impacted the anticipated sample size, potentially affecting the study's power to detect smaller, yet clinically meaningful, differences between the interventions. Additionally, the absence of long-term follow-up to assess the durability of the intervention effects represents a significant gap. This omission leaves unanswered questions regarding the persistence of gains achieved through CCT and ITST, suggesting an avenue for future research to explore the sustainability of rehabilitation outcomes over time (30).

The findings of this study align with the broader corpus of stroke rehabilitation research, reinforcing the versatility and effectiveness of both CCT and ITST in promoting recovery. This equivalence across key outcomes suggests that rehabilitation practitioners can flexibly employ either approach, tailoring their intervention strategies to individual patient needs, preferences, and the specific constraints of the rehabilitation setting (22, 27).

Looking forward, it is imperative for future research to incorporate strategies to mitigate dropout rates and to include longitudinal follow-up assessments. Such efforts would enhance our understanding of the long-term impacts of these interventions, offering

Journal of Health and Rehabilitation Research 2791-156X JHRR

deeper insights into the persistence of therapeutic gains and the potential need for ongoing or booster interventions to sustain improvements in spasticity, motor function, and quality of life. Additionally, exploring patient-specific factors that may influence the effectiveness of CCT and ITST could further refine stroke rehabilitation practices, ensuring that interventions are optimally matched to patient profiles for enhanced recovery trajectories (8, 19).

CONCLUSION

The findings from this comparative study on the efficacy of circuit class training (CCT) and individual, task-specific training (ITST) for chronic stroke patients reveal that both interventions are equally effective in improving upper extremity spasticity, motor function, and quality of life. This equivalence underscores the flexibility rehabilitation professionals have in selecting either approach based on patient preference, resource availability, and logistical considerations, without compromising the therapeutic outcomes. The study's insights contribute significantly to the stroke rehabilitation field, suggesting that a tailored, patient-centered approach to selecting rehabilitation modalities can be highly effective. Moreover, the highlighted limitations and the need for future research to address long-term effects and dropout rates point towards an ongoing need to refine and adapt stroke rehabilitation practices for sustained patient benefits. This research thus reinforces the importance of both CCT and ITST in comprehensive stroke recovery strategies, while also calling for a nuanced understanding of how best to maintain and build upon the gains achieved through these interventions.

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Journal of Health and Rehabilitation Research JHRR 2791-156X

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