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GENDER DIFFERENCES IN UPPER LIMB MOTOR RECOVERY POST-STROKE: EFFECTS OF TASK-ORIENTED TRAINING AND REPETITION COUNTS

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ABSTRACT

Background: Stroke often results in significant impairments in upper limb motor function and daily activities, requiring various rehabilitation approaches. Constraint-Induced Movement Therapy and Task-Oriented Training are recognized interventions, but their efficacy may vary based on gender differences and repetition frequency.

Aim: To investigate gender differences in upper limb motor rehabilitation post-stroke, focusing on the effects of task-oriented training and repetition counts.

Methods: Stroke patients without severe motor or cognitive impairments were included in the study. Demographic and clinical data were collected, and upper limb motor function was assessed using the Motor Activity Log (MAL) and the Wolf Motor Function Test (WMFT). Participants performed a task involving the transfer of small wooden blocks between compartments for one hour, with the number of repetitions recorded every 15 minutes. Chi-square tests were used to examine relationships between variables and predict task repetition ability. The significance level was set at ≤ 0.05.

Results: Among 75 participants (40 males, 35 females, aged 19-98), males completed slightly more task repetitions (53.3% vs. 46.7%). Participants averaged 437.50 task repetitions (range: 15-590). Statistical analysis showed no significant association between gender and the number of task repetitions ($P > 0.05$).

Conclusion: The study found a strong correlation between WMFT and MAL in assessing upper limb impairment across both genders. Understanding gender-specific responses to task-oriented exercises and optimal repetition counts is essential for developing tailored rehabilitation strategies.

Keywords: *Stroke rehabilitation; Motor function; Task-oriented exercises; Gender differences, Repetition counts.*

INTRODUCTION

Stroke is a major global health issue, leading to significant mortality and long-term disability, especially in low- to middle-income countries, where 87% of disabilities and 70% of deaths occur (Akinyemi *et al.*, 2021). One of the most common post-stroke deficits is upper limb motor impairment, which can significantly affect an individual's disability and overall health. The variability in upper limb recovery is well recognized, highlighting that each patient has unique rehabilitation needs (Coupar *et al.*, 2012).

To address declines in upper limb motor function and self-care after a stroke, various treatments have been developed (Liu et *al.*, 2023). Constraint-Induced Movement Therapy (CIMT) and Task-Oriented Training (TOT) are key interventions (Reddy *et al.*, 2022). CIMT, which emphasizes task practice, is effective but requires simplified protocols for wider use. TOT has also been shown to speed up recovery across all stages of stroke in the upper limb (Liu *et al.*, 2023).

Reports on gender differences in functional outcomes after stroke are limited (Sabo *et al.*, 2022). However, these differences may influence stroke recovery, and understanding gender-specific rehabilitation outcomes remains challenging. Research indicates that women experience greater post-stroke disability and

depression, as well as a higher risk of severe strokes and poorer overall outcomes (Niewada *et al.*, 2005). In a study by Paolucci *et al.* (2006), males were more likely to achieve independence in tasks after rehabilitation, suggesting slightly less favorable outcomes for females.

The reasons for these differences are not fully understood but may be related to variations in muscle strength, which tends to be greater in men and decreases with age. Additionally, gender-based differences in muscle metabolism and composition can impact rehabilitation outcomes, particularly in terms of task repetition rates during therapy (Devries *et al.*, 2016). Research in neurorehabilitation has shown a direct correlation between the number of repetitions and motor function recovery.

Interestingly, Birkenmeier (2010) and colleagues reported that, practicing tasks approximately 300 times daily for two weeks led to significant motor function improvement, with these 300 repetitions achievable in just one hour each day. This suggests that the critical factor for motor recovery is the number of repetitions, not the duration of practice in upper limb stroke rehabilitation (Abdullahi, 2018b).

Some studies have shown inconclusive evidence regarding gender differences in stroke outcomes (Reeves *et al.*, 2008), often due to small sample sizes or a focus on patients in rehabilitation units (Sabo *et al.*, 2022). Determining the optimal number of repetitions needed for effective motor function recovery remains a key goal in upper limb stroke rehabilitation (Abdullahi, 2018a). This study aimed to explore gender differences in post-stroke upper limb motor rehabilitation, specifically examining the impact of task-oriented training and repetition counts.

MATERIALS AND METHODS

Study design and participant selection

This study employed a cross-sectional survey design to assess stroke patients attending physiotherapy outpatient clinics. The study population comprised stroke patients attending physiotherapy outpatient clinics in Kano metropolis at Murtala Muhammed Specialist Hospital (MMSH), Muhammad Abdullahi Wase Specialist Hospital (MAWSH), and Sir Sunusi Specialist Hospital. Participants were included if they: (1) Had mild cognitive impairment with a Mini-Mental Status Examination score greater than or equal to 17,(2)Could follow verbal and visual instructions, (3) Had mild upper limb motor function impairment with the ability to grasp and release a towel or abduct a finger by 10 degrees, (4) Had a Fugl-Meyer Assessment-Lower extremity score of 21 or below out of 34,(5)Were between 18 and 90 years old. However, participants were excluded if they had sensory loss of two or more points on the sensory item of NIHSS or severe cognitive impairment with a Mini-Mental Status Score of less than 17.

Sampling Technique

Systematic sampling was used for recruiting stroke patients. This method involved creating a comprehensive list of all eligible stroke patients and selecting every 10th person from the list. With a desired sample size of 100 from a population of 1000, the interval size was determined to be 10 to ensure systematic selection. Starting from a randomly chosen point, such as the 2nd participant, every 10th person thereafter was selected. Consequently, the 2nd, 12th, 22nd, 32nd, and so on participants were chosen until a total of 155 participants were reached. This process ensured that participants

were randomly but systematically selected, resulting in a representative sample.

Study Procedure

Ethical clearance for this study was obtained from the ethical review committees of the Kano State Hospital Management Board (NHREC/17/03/2018). Participants were thoroughly informed about the study's purpose and procedures, and informed consent was obtained. Screening was conducted to ensure all participants met the inclusion criteria.

The data collection process included gathering both demographic and clinical information. Demographic variables collected were gender, age, occupation, education level, and socioeconomic status. Clinical variables included stroke type, lesion site, stroke stage, and number of repetitions. In this study, a range of assessment tools for participants screening was employed to gather comprehensive data on the participants' physical and cognitive conditions. The Modified Ashworth Scale measured wrist joint spasticity, providing an objective assessment of muscle tone. The Visual Analog Scale assessed shoulder pain, with participants indicating their pain level on a 0-10 continuum. Sensory loss and motor function severity were evaluated using the National Institutes of Health Stroke Scale (NIHSS). Joint range of motion was measured with a goniometer, and cognitive impairments were assessed using the Mini-Mental Status Examination Scale, with scores of 17 or higher indicating mild impairment. A stopwatch was used to time task repetitions over 15-minute intervals.

For upper limb assessments, the Motor Activity Log (MAL) and the Wolf Motor Function Test (WMFT) were used. The MAL, a subjective tool consisting of 30 items scored from 0 to 5, assessed the quantity and quality of movement in the affected upper limb. The MAL has been validated and shown to be reliable for capturing perceived motor function changes (Uswatte *et al.*, 2006). The WMFT, an objective tool with 17 items also scored from 0 to 5, evaluated upper limb motor function, providing a standardized measure of ability with good construct and criterion-related validity and inter-rater reliability (Morris *et al.*, 2001; Nisland, 2010).

Participants' non-affected upper limbs were restrained to ensure the use of the affected limb during task practice. However, it is important to note that, the constraint does not have to be physical. Behavioral constraint wherein the patients consciously limit the use of the unaffected limb is also used (Brogårdh *et al*, 2009). Seated in a chair with a table in front, participants were given a wooden box with two compartments containing small wooden blocks. They were instructed to transfer the small blocks from one compartment to the other at their own pace over the course of one hour. A stopwatch tracked the total time, including rest periods. The number of

repetitions within each 15-minute interval was recorded using a recording sheet.

Data Analysis

Descriptive statistics summarised participants' socio-demographic and clinical characteristics. Chi-square tests were used to assess relationships between dependent and independent variables and to predict the ability to perform high repetitions of tasks practice. The significance level was set at ≤ 0.05

RESULTS

Socio-Demographic Variables of participants

Table 1 presents data on 75 stroke patients aged 19 to 98 who participated in the study. The largest age group was 49-78 years, comprising 50.7% of participants. There were 40 males (53.3%), and 51 participants were married (68.0%). The highest level of education attained was tertiary education, achieved by 30 participants (40.0%). Most participants were self-employed (77.3%). Ischemic stroke was the most common type (73.3%), with 50.7% of participants experiencing left-sided involvement. Additionally, 77.3% had diabetes. The duration of stroke varied from 3 to 132 months, and the number of task repetitions ranged from 15 to 590, with a mean of 437.50 (±1.573).

Association Between Socio-Demographic Variables with Number of Repetitions

Table 2 shows that there is no statistically significant association between the number of repetitions and socio-demographic variables, including age (χ^2=37.972, p=0.335), gender (χ^2=13.470, p=0.190), employment status (χ^2=8.207, p=0.145), marital status (χ^2=16.603, p=0.343), and education status (χ^2=19.523, p=0.191).

Summary of Association Between Clinical Variables with Number of Repetitions

From Table 3 the results indicate that the Motor Activity Log (χ^2=40.716, p=0.025) and the Wolf Motor Function Test (χ^2=44.171, p=0.001) are significantly associated with the number of repetitions. However, there are no significant associations with the type of stroke (χ^2=2.795, p=0.732), side affected (χ^2=1.355, p=0.929), diabetes status (χ^2=5.682, p=0.338), or duration of stroke (χ^2=11.083, p=0.747).

Table 1: Socio-demographic Characteristics of Participant

Variables	Frequency	Percentage
Age (years)		
19-48	33	44.0
49-78	38	50.7
79-109	4	5.3
Gender		
Female	35	46.7
Male	40	53.3
Education Status		
Primary	35	46.6
Secondary	10	13.3
Tertiary	30	40.0
Marital Status		
Divorced	6	8.0
Married	51	68.0
Single	15	20.0
Widow	3	4.0
Employment Status		
Civil Servant	17	22.7
Self Employed	58	77.3
Clinical Variables		
Repetitions		
15-214	25	33.3
215-414	31	41.3
415-614	19	25.3
Duration of Stroke(month)		
0-24	49	65.3
25-49	22	29.3
50-74	3	4.0
125-149	1	1.3
Type of Stroke		
Ischemic	55	73.3
Hemorrhagic	20	26.7
Side Affected		
Left	38	50.7

Right	37	49.3
Diabetes Status		
No	58	77.3
Yes	17	22.7

Table 2: Showing Association of Socio-demographic Variable with Number of Repetition

Socio-Demographic Variables	χ^2	df	p-value
Age	37.972	35	0.335
Gender	13.470	5	0.190
Employment Status	8.207	5	0.145
Marital Status	16.603	15	0.343
Education Status	19.523	15	0.191

Key; df=degree of freedom, χ^2= chi square

Table 3: Showing Association of Clinical Variables with Number of Repetition

Clinical Variables	χ^2	df	p-value
Type Of Stroke	2.795	5	0.732
Side Affected	1.355	5	0.929
Diabetes Status	5.682	5	0.338
Motor Activity Log	40.716	25	0.025
Wolf Function Test	44.171	20	0.001
Duration Of Stroke	11.083	15	0.747

Key; df=degree of freedom, χ^2= chi square, p-value

DISCUSSION

The objective of this research was to investigate the association between gender differences and the number of repetitions during task-oriented training (TOT) among stroke patients. Stroke-induced brain injuries often hinder patients' ability to regain functional independence, particularly in upper limb motor function, which remains incomplete for one-third of stroke survivors (Langhorne *et al.*, 2011; Kwakkel *et al.*, 2019). TOT is known to improve motor function by inducing neuroplasticity (Lang *et al.*, 2016). However, various clinical and personal factors can limit patients' ability to achieve the necessary repetitions for recovery (Winstein *et al.*, 2016).

Previous studies have reported varying numbers of repetitions required for significant motor improvement. For example, Birkenmeier *et al.* (2010) found that 600 repetitions over two weeks were beneficial, while Abdullahi *et al.* (2018)

observed improvements with 300 repetitions. This study found that age did not significantly affect task performance during TOT, contrary to findings by Bagg *et al.* (2002) and Kugler *et al.* (2003), which indicated age as a significant predictor. The discrepancy may be due to differences in study methodologies and participant characteristics.

Women generally perform daily tasks less effectively than men post-stroke, due to factors such as older age, lower pre-stroke physical function, and diminished internal locus of control (Niewada *et al.,* 2005). However, this study did not find a significant association between gender and the number of repetitions, contrasting with Sabo *et al.,* (2022), who reported that gender influences repetition rates during constraint-induced movement therapy (CIMT). This discrepancy could be due to the balanced gender distribution in the current study. To enhance the effectiveness of upper limb task practice in female patients, incorporating motivational interviewing and addressing mental health issues, such as depression and anxiety, could be beneficial (Epuela *et al.,* 2019).

Education level, often linked to better recovery outcomes (Putman *et al.,* 2007), did not show a significant association with the number of repetitions in this study. Similarly, employment and marital status were not significant predictors. These findings emphasize the complexity of socio-demographic factors in stroke recovery and the importance of individualised rehabilitation approaches (Teasell *et al.,* 2020).

Regarding clinical variables, neither the type of stroke (ischemic or hemorrhagic) nor the affected side significantly influenced the number of repetitions. This aligns with previous research suggesting that although hemorrhagic stroke patients may experience greater initial impairments, their recovery trajectories can be more pronounced (Hemphill *et al.,* 2015). The lack of a significant association between diabetis status and repetitions further supports the need for tailored interventions.

The significant relationship between the Motor Activity Log and the number of repetitions highlights the importance of consistent task practice for motor recovery, in line with Abdullahi *et al.* (2018). Additionally, the significant association between the Wolf Motor Function Test and repetitions reaffirms the efficacy of high-repetition task practice in improving upper limb function (Nilsen *et al.,* 2015).

In terms of practical implications, the study underscores the need for rehabilitation programmes that are tailored to the specific needs of individual patients, considering both gender differences and the complex interplay of socio-demographic and clinical factors. Exploring non-significant findings in depth and conducting further research with larger sample sizes and power analyses can help clarify the influences of these variables on rehabilitation outcomes.

Clinicians should consider incorporating both the WMFT and MAL into their assessment protocols to comprehensively evaluate upper limb function and recovery progress. The results suggest that achieving a sufficient number of task repetitions is critical for improving motor function, but the exact number required may vary based on individual patient characteristics.

CONCLUSION

The study demonstrated a strong correlation between the Wolf Motor Function Test (WMFT) and the Motor Activity Log (MAL) in evaluating upper limb impairment in both male and female

stroke patients. The number of task repetitions varied widely, ranging from 15 to 590, with a mean of 437.50 (±1.573). This variability underscores the importance of understanding gender-specific responses to task-oriented exercises and determining optimal repetition counts for effective rehabilitation.

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Author Contributions: B.S conceived the idea. A.U.A. and B.S. designed the study with inputs from M.Y.U., M.A.A. monitored and actively involved in the data collection. M.A.A. analyzed and interpreted the data. L.U, B.S., A.U.A., M.Y.U. reviewed the data analysis and interpretation. L.U. drafted the manuscript. A.U.A., M.A.A, M.Y.U. critically reviewed the drafted manuscript. All authors approved the manuscript for submission.

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