Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v31i8.7335

EFFECT OF WII SPORTS COMPARED WITH ROOD'S NEUTRAL WARMTH TECHNIQUE IN REDUCING SPASTICITY AND FATIGUE OF CHRONIC STROKE PATIENTS

Ishal Ayub[1], Dr. Sidra Majeed[2], Hifza Ahmed[3*], Rabeea Saeed[4], Aqsa Liaqat[5], Ulvina[6], Nimra Amin[7]

[1,3*,4,5,6,7]Physiotherapist, Department of Rehabilitation Sciences, The University of Faisalabad, Faisalabad, Pakistan.
[2]Assistant Professor, Department of Rehabilitation Sciences, The University of Faisalabad, Faisalabad, Pakistan.

***Corresponding author:** Hifza Ahmed;
*****Email: hifzaahmed77@gmail.com

ABSTRACT
Two typical problems a lot of victims of stroke experience are spasticity and weariness, both of which can impede their rehabilitation. Because Wii Sports can detect motion, researchers have used the five sports simulation activities in the game to help with balance. To lessen spasticity, another approach called Rood's neutral warmth technique includes covering the afflicted area for ten to twenty minutes. This study's objective was to look into as well as contrast efficaciousness for Rood's neutral warmth approach and Wii Sports in lowering fatigue as well as spasticity in individuals with chronic stroke. Purposive sampling was utilized to choose a total of twenty-six participants according to predetermined criteria, and a computer-based randomization tool was used to divide them up into two separate groups.; wii sports received treatment for a total of 28 days, five days a week. Neutral warmth received treatment 3-4 days of a week for 28 days. Data was analyzed 27 version of SPSS. Group A showed significant results in Fatigue, shoulder flexion ROM, Shoulder abduction ROM, Shoulder external rotation ROM, wrist flexion and wrist extension ($P<0.05$) while there was no significant difference between the two groups ($P>0.05$) in spasticity, elbow flexion and upper limb dexterity. The outcome demonstrated that Wii Sports outperformed the neutral warmth method in terms of effectiveness. Furthermore, Wii Sports was deemed the most pleasant and intriguing technique by the participants.

Keywords: chronic stroke, Wii sports, neutral warmth, spasticity, fatigue

INTRODUCTION
Stroke describes various conditions caused by blockages or bleeding in the blood vessels that supply the brain. Usually, blood flow is restricted where a vessel is blocked. Less often, a stroke can happen due to cardiac arrest, which stops blood flow to the whole brain. This leads to the death and dysfunction of brain cells, causing neurological issues that reflect the extent and location of the affected area (1).
Stroke is considered the most debilitating long-term illness. This unfortunate distinction arises because the aftermath of a stroke can impact nearly all functionality, that includes fine & gross motor

skills, moveability, the capacity to perform out important everyday tasks, feelings, speech, thinking, and judgement (2).

Both fatigue and spasticity are frequent post-stroke problems that seriously impede many survivors progress towards recovery. It's interesting to note that these two problems often appear in stroke patients at the same time, with spasticity and fatigue showing a connected connection and typically developing at the same time. Of the three symptoms, i.e., fatigue, pain, and spasticity, fatigue stands out as one that matters most and has a significant effect on the course of recovery. The treatment of these connected problems in stroke patients is further complicated by the apparent close relationship between pain and stiffness (3).

Conventional orthoses, physical therapy treatments, and careful attention to sitting and posture are the usual methods used to manage spasticity during acute rehabilitation attempts. Recent research, however, has looked at novel approaches to treating spasticity in people with illnesses including cerebral palsy and stroke, such as Wii sports-based therapy. These cutting-edge methods may help improve motor function & lessen spasticity, giving comprehensive rehabilitation program more choices (4, 5).

Wii Sports is a fun selection of five sports simulations designed to highlight the Wii Remote motion-sensing capabilities. Tennis, baseball, golf, bowling, and boxing are a few of the sports that are simulated, giving gamers a variety of sports experiences. Research comparing the Nintendo Wii to other gaming systems has shown its distinct benefits for cognitive rehabilitation. Virtual reality technology has also shown promise in aiding stroke sufferers in regaining their ability to walk and balance. These cutting-edge methods highlight how gaming and virtual reality may improve stroke therapy results and improve patients' quality of life (6). The inhibitory approach known as Rood's neutral warming technique is used to reduce spasticity. It has the effect of reducing spasticity by wrapping the afflicted region for ten to twenty minutes. In more severe situations, the patient's spasticity may be successfully reduced by bandaging the afflicted limb for at least three hours. By providing sensory input and encouraging muscular relaxation, this therapy seeks to lessen spasticity symptoms and enhance the functional results for the patient receiving rehabilitation (7, 8).

The study of Rood and Goff clarifies the response of the autonomic nervous system (ANS) to stimuli, especially with regard to control of muscle tone. They discovered that the first step in starting ANS responses that finally result in a decrease in muscle tone is the activation of C fibers or nonspecific free nerve terminals on the skin. This implies that what sets off the intended reaction is not only warmth but also the activation of these sensory receptors. These realizations opened the door to investigating the therapeutic possibilities of long-term cutaneous stimulation, like wrapping, for the treatment of spasticity. All throughout the upper extremities exist C-fiber sensory receptors, especially in proximal muscles and regions with hairy skin. Among its special traits include a sluggish adaptation during extended discharge and a comparatively high depolarization threshold. Given these characteristics, wrapping offers a good stimulation in terms of length and intensity for stimulating C fibers. Through knowledge of the fundamental processes of sensory stimulation, physicians may tailor therapy approaches to efficiently reduce spasticity and regulate muscle tone in stroke victims and other people with neurological diseases (9, 10, 11). A study conducted in 2020 compared traditional therapy with Wii for upper limb rehabilitation after, and results showed that Wii was as successful as traditional therapy in upper limb rehabilitation after stroke (12).

METHODS

This study used a Randomized clinical trial as a research design. The study was single-blinded. This study included participants with chronic stroke. Purposive sampling was the method used for sampling. The sample was taken from the Allied Hospital in Faisalabad. Thirty participants were accessed for eligibility, twenty-six met the criteria and were then randomized into two groups by an online randomization generator. The entire duration of this study was close to 4 months, during which time for data collection took 1 month with 5 sessions each week for Wii sports and 3-4 sessions a week for neutral warmth. Informed consent was taken from the participants and any that refused to

participate in the study were not included. Measurements were taken at baseline and at the end of 4 week.

INCLUSION CRITERIA

- Ischemic or hemorrhagic stroke
- Adult (30-50 years)
- Absence of any cognitive impairment, lack of vision, or ignorance that would have complicated following treatment plans.
- Able to voluntarily move the elbow, wrist, and shoulder to carry out game directions.
- Not frequent Nintendo Wii users
- They hadn't had a botulinum toxin injection in the three months prior to the study (12,13).

EXCLUSION CRITERIA

- Cerebellar stroke
- Any episode of epilepsy during the previous year
- Pacemaker
- visual defects left untreated
- Cognitive issues (mini-mental score less than 20)
- No voluntary movement of upper limb
- Fixed contracture or bony deformity of upper limb
- Using any medication that may impair balance (12,13).

DATA COLLECTION MEASURES

For the purpose of the measurements, the process was;

- **AROM** (the found Active ranges) of upper extremity that was affected. (the needed Pre as well as the post values).
- **Test, Box and block** (pre with the post-values) (14).

It was utilized for the evaluation purpose of the gross dexterity (manual) on that one side.

DATA COLLECTION TOOLS

- For the purpose of **AROM**, following tool helped in assessment;
- Goniometer (hand held)
- For finding out about the test of **Box and block,** the tools named below on the lines were mentioned;
- A wooden box used to measure about almost of twenty-five-point four cm x fifty-three-point seven cm and lastly of eight-point five cm
- Needed stopwatch
- A supposed division inside the wooden box to divide it into two separate parts
- 2.5-centimeter cubes of wooden

Other needed scales for the purpose of the gathering data from the finalized patients were these;

- **Modified Ashworth (MAS) scale**

Used particularly for assessing the spasticity in the patients for both the pre as well as the post value.

- **Fatigue severity (FSS) scale**

To figure out the severity of the found fatigue in the selected research patients same with the pre and the found post values.

DATA COLLECTION PROCEDURE

Patients were added in the current work after passing the set criteria. Participants were put in the current work of study by the use of purposive sampling procedure only after having their consents verbal with the written one as well. These participants were finally allocated into the two different interventional groups by formulating a list with a randomization software generator in an online process in which group A were for the Wii and neutral warmth was for group B. Modified Ashworth (MAS) scale, box and block, goniometer and lastly the scale for the fatigue severity were utilized to figure out individually the spasticity, natural arm dexterity, AROM with finally fatigue.

Group A

Following Group, A, reserved for the Wii sessions. Patients were found in particular specific group in which they received unique game interventional sessions or techniques for almost of 4 weeks with the total of 5 days in a whole week where different games were played by them on the Wii sports console that were mainly the tennis, boxing and golf. These specific games for the patients were played by them for about 15 minutes by sitting any kind of stool (12).

Figure 1. Wii sports technique

Group B

Group B, for neutral warmth. In this, patients received treatment sessions for almost 4 weeks with about 3-4 days in a complete week in that which the supposed affected side or that particular limb was completely wrapped in the white bandages to generate the internal heat or warmth for almost the total of 3 hours duration (7).

Figure 2. The technique of applying neutral warmth process using bandages

OUTCOMES

- **Modified Ashworth Scale (MAS)**
- **Fatigue severity scale (FSS)**
- **Upper limb dexterity by box and block test (BBT)**
- **AROM for upper limb (Shoulder Flex, Abd, Ext Rot, Elbow Flex, Wrist Flex, Ext)**

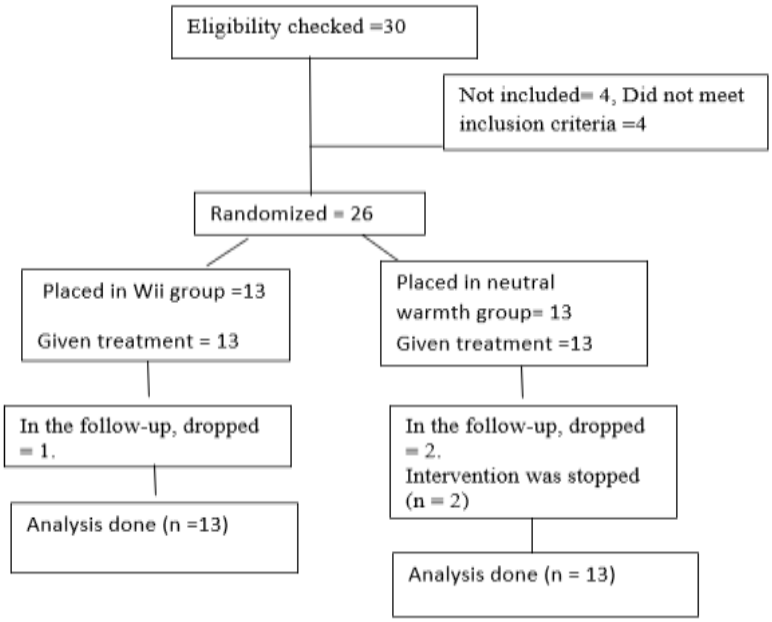

Figure 3. Study flow chart

STATISTICAL ANALYSIS

SPSS version 27 was used for statistical analysis. The analysis was mainly done to compare the effects of the interventions on the outcomes. Normality for data was tested before the other tests, data was normally distributed for all variables except for spasticity and elbow flexion. The Shapiro-Wilk test showed that the p-value for these variables was >0.05. Frequency tables, pie charts, and bar charts were utilized to display fundamental demographic data and descriptive statistics. Parametric tests like paired sample t-test for comparing pre and post-treatment changes and independent sample t-test for comparing changes between the two groups were used for these variables. Variables that did not have normally distributed data showed p value of <0.05 on the Shapiro wilk test and non-parametric like Wilcoxin to compare pre and post-treatment changes and Man-Whitney to compare changes between the two groups were used for them.

ETHICS

Ethics approvals were obtained from The University of Faisalabad under the Ref. No. Tuf/IRB/360/24

RESULTS

Twenty-six patients were included in this study according to the descriptive statistics age ranging from 30 to 50 years. The mean and SD of gender was 1.50±0.510 for both groups with an equal number of males and females present in the study. More participants had their left side affected by stroke than the right side, 14 to 12 with a mean±SD of 1.54±0.508. The analysis of baseline measures showed no significant difference with p-value >0.05 so both groups were comparable at baseline. For MAS there was significant improvement in group 1 indicated by mean±SD of 2.08±0.862 prior and 0.92±0.900 post-treatment with a p-value of 0.001, group 2 also showed significant results of 2.23±0.832 prior and 1.40±0.843 post-treatment with p-value 0.003. The comparison between groups for MAS resulted in a p-value of 0.202 after the treatment which was more than 0.05 and suggested

there wasn't discernible contrast among spasticity scores for the two groups as determined by MAS. For the variable of fatigue, both groups showed significant changes with 45.50±3.090 prior and 24.00±4.390 post-treatment with a p-value of 0.000 for group 1 and 45.90±4,701 prior and 30.60±6.979 post-treatment with a p-value of 0.000 for group 2. The P-value was 0.014 for comparison between groups which was less than 0.05 and proved that there was a significant difference between the two groups.

Upper limb dexterity scores for both groups showed significant changes, group 1 had a mean±SD of 18.83±2.082 prior and 30.33±6.719 post-treatment with a p-value of 0.000 and group 2 had a mean±SD of 15.70±5.272 prior and 25.30±5.208 post-treatment with p-value of 0.000. The between-group comparison showed there wasn't discernible contrast among upper limb dexterity scores for the two groups as determined by the p-value of 0.068 which is greater than 0.05. For the outcome of AROM, all the ranges measured (Shoulder Flex, Abd, Ext Rot, Elbow Flex, Wrist Flex, Ext) showed significant improvements in the between-group comparison with p-values of 0.019,0.005,0.003,0.027 and 0.014 respectively except elbow flexion which had a p-value of 0.092 which is greater than 0.05 that indicated that there was no discernible contrast among elbow flexion score for the two groups. The pre and post-changes within the group for Shoulder Flex had mean±SD of 92.00±15.339 prior and 126.58±14.902 post-treatment with p-value of 0.000 for group 1 and 91.30±24.074 prior and 102.70±28.222 post-treatment with p-value of 0.001 for group 2. Similarly for the shoulder Abd mean±SD was 87.25±18.400 prior and 119.92±19.979 post-treatment with a p-value of 0.000 for group 1 and 87.20±18.203 prior and 93.00±20.221 post-treatment with a p-value of 0.005 for group 2.

Shoulder Ext Rot, Elbow Flex, Wrist Flex, and Ext also showed significant changes in their within the group test. For group 1 of the shoulder, Ext Rot mean±SD was 63.42±9.020 prior and 70.33±7.315 post-treatment with a p-value of 0.000, and group 2 had a mean±SD of 46.60±13.006 prior and 55.70±12.893 post-treatment with a p-value of 0.000. Elbow Flexion mean±SD for group 1 was 102.46±9.86 prior and 120.00±8.623 post-treatment with a p-value of 0.002 and for group 2 it was 95.77±31.412 prior and 100.90±27.687 post-treatment with a p-value of 0.005. The variable of Wrist Flex had a mean±SD of 50.67±13.027 prior and 62.75±8.854 post-treatment with a p-value of 0.000 for group 1 and mean±SD of 49.50±9.812 prior and 53.40±9.559 post-treatment with a p-value of 0.000 for group 2. Lastly for wrist Ext within group comparison group 1 had a mean±SD of 45.58±13.097 prior and 57.25±8.604 post-treatment with a p-value of 0.000 and group 2 had a mean±SD of 38.70±8.920 prior and 44.00±14.126 post-treatment with a p-value of 0.019. The results for all these tests showed that Wii sports showed better results than neutral warmth in both within and between group comparisons except for in the variables spasticity, elbow flexion, and upper limb dexterity where both the groups showed similar results.

Table 1. Gender distribution in the study

Gender	Frequency	Percentage
Male	13	50.0
Female	13	50.0
Total	26	100.0

The above table shows that there was an equal number of males and females in the study

Table 2. Distribution of the side affected by stroke in the study

Side affected by stroke	Frequency	percentage
Right	12	46.2
Left	14	53.8
Total	26	100.0

The above table shows that there was higher number of participants with left side affected by stroke than right side affected.

Table 3. Within group results of Three outcomes

Outcomes	Group	Before or after treatment	Mean±SD	P-value
MAS	Group 1	Before	2.08±0.862	0.001
		After	0.92±0.900	
	Group 2	Before	2.23±0.832	0.003
		After	1.40±0.843	
FSS	Group 1	Before	45.50±3.090	0.000
		After	24.00±4.390	
	Group 2	Before	45.90±4.701	0.000
		After	30.60±6.979	
Upper limb dexterity	Group 1	Before	18.83±2.082	0.000
		After	30.33±6.719	
	Group 2	Before	15.70±5.272	0.000
		After	25.30±5.208	

The above table displays the pre- and post-treatment values of three of the outcomes for both groups. Both groups for these outcomes showed significant results post treatment as showcased by the mean±SD and p-values.

Table 4. Within group results of AROM of upper limb

Shoulder Flex	Group 1	Before	92.00±15.339	0.000
		After	126.58±14.902	
	Group 2	Before	91.30±24.074	0.001
		After	102.70±28.222	
Shoulder Abd	Group 1	Before	87.25±18.400	0.000
		After	119.92±19.979	
	Group 2	Before	87.20±18.203	0.000
		After	93.00±20.221	
Shoulder Ext Rot	Group 1	Before	63.42±9.020	0.000
		After	70.33±7.315	
	Group 2	Before	46.60±13.006	0.000
		After	55.70±12.893	
Elbow Flex	Group 1	Before	102.46±9.86	0.002
		After	120.00±8.623	
	Group 2	Before	95.77±31.412	0.005
		After	100.90±27.687	
Wrist Flex	Group 1	Before	50.67±13.027	0.000
		After	62.75±8.854	
	Group 2	Before	49.50±9.812	0.000
		After	53.40±9.559	
Wrist Ext	Group 1	Before	45.58±13.097	0.000
		After	57.25±8.04	
	Group 2	Before	38.70±8.920	0.019
		After	44.00±14.126	

The above table displays the pre-and post-treatment values of the outcome AROM for both groups. Both groups for these outcomes showed significant results post-treatment as showcased by the mean±SD and p-values.

Table 5. Between-group results of all the outcomes

	Group	Mean±SD	P-value
Post MAS		1.14±0.889	0.202
Post FSS	Group 1	24.00±4.390	0.014
	Group 2	30.60±6.979	
Post Upper limb dexterity	Group 1	30.33±6.719	0.068
	Group 2	25.30±5.208	
Post Shoulder Flex	Group 1	126.58±14.902	0.19
	Group 2	102.70±28.222	
Post Shoulder Abd	Group 1	119.92±19.979	0.005
	Group 2	93.00±20.221	
Post Shoulder Ext Rot	Group 1	70.33±7.315	0.003
	Group 2	55.70±12.893	
Post Elbow Flex		100.90±27.687	0.092
Post Wrist Flex	Group 1	62.75±8.854	0.027
	Group 2	53.40±9.559	
Post Wrist Ext	Group 1	57.25±8.604	0.014
	Group 2	44.00±14.126	

The above table displays the within group result of all the outcomes. All the outcomes had significant difference between the groups except MAS, Upper limb dexterity and Elbow flexion as seen by the mean±SD and p-values showcased above.

DISCUSSION

Donna J. Twist's 1985 study aimed to assess the impact of a wrapping approach on the range of motion in patients with spastic upper extremities. Over a period of two to four weeks, four adult patients with post-stroke durations of less than a year underwent alternate-day upper limb wrapping sessions lasting three hours each. Initial passive range of motion measurements were taken for various movements, such as shoulder flexion, abduction, and external rotation, as well as elbow and wrist flexion and extension, which were typically limited in these patients. The study outcomes revealed a notable enhancement in passive range of motion following the intervention (7).The findings from the present study further corroborate the conclusions drawn from the earlier research. The implementation of the neutral warmth technique, entailing the application of bandaging to the affected limb for a duration of three hours, demonstrated notable efficacy in alleviating both spasticity and fatigue among chronic stroke patients.

Rood's neutral warmth technique has been validated as an effective method for reducing spasticity in localized areas of the body. Rood utilized down comforters to apply neutral warmth, thereby mitigating spasticity. Research by Kenshalo and Thomas elucidated the role of C nonmyelinated fibers, which exhibit a specific responsiveness to heat stimulation, in reducing neuronal activity upon exposure to skin warming. Rood and Goff further explained that autonomic nervous system responses contributing to muscle tone reduction are triggered by the stimulation of C fibers or nonspecific free nerve endings on the skin, rather than the warmth itself. These findings prompted an investigation into the therapeutic impact of sustained cutaneous stimulation on spasticity. C-fiber sensory receptors encode various sensory modalities, including pain, temperature, and tactile sensation, and are predominantly distributed throughout the upper extremities, particularly in areas with hairy skin and proximal muscles. Their slow adaptation and heightened threshold for depolarization suggest that wrapping may serve as an effective stimulus for C-fiber excitation over an extended period (9, 10, 11).This research builds upon previous evidence by demonstrating the efficacy of neutral warmth

intervention in reducing spasticity and fatigue among patients. In this study, the affected limb was bandaged for a duration of three hours, yielding significant results in improving patient outcomes
Ayhan Askin's 2018 investigation delved into the efficacy of virtual reality gaming training utilizing sensors in the rehabilitation of stroke patients. The study aimed to assess the impact of Kinect-based virtual reality training on the functional outcomes and upper-limb motor rehabilitation of chronic stroke patients. Participants in Group A exhibited significant enhancements in their training outcomes, underscoring the potential benefits of sustained utilization of Kinect-based VR training in augmenting upper extremity motor proficiency and active range of motion in chronic stroke patients (13).In the context of the present study, while a comparison between Wii sports and traditional exercises was absent, the comparison between Wii sports and neutral warmth revealed the superiority of Wii sports over the latter in effectively addressing spasticity and fatigue in chronic stroke patients.
Given the frequent integration of commercial gaming systems into stroke rehabilitation protocols, Maxime Térémetz conducted a study to explore their therapeutic effects. The objective was to assess the impact of dose-matched traditional therapy versus interactive video games on upper-limb rehabilitation, focusing on the recovery of elbow extension in individuals with chronic stroke who exhibit compensatory trunk movements. Both intervention groups demonstrated modest yet comparable improvements in clinical outcomes. While training enhanced the rate of arm acceleration during Wii therapy sessions, it did not similarly impact trunk movement. While monitored upper-limb gaming therapy facilitated the restoration of elbow extension akin to traditional therapy, it did not effectively promote the acquisition of adaptive trunk motion in chronic stroke patients. The study was conducted in 2020 (12). In the current study, there was no direct comparison between traditional therapy and Wii sports. However, unlike the above study where no significant contrast was observed in the results of the two treatments, the current study demonstrated that Wii sports yielded better outcomes compared to neutral warmth.

CONCLUSION

The study concludes that, although both interventions demonstrated significant improvements in spasticity and fatigue scores pre- and post-treatment, Wii sports therapy yielded superior results compared to the neutral warmth technique. Furthermore, Wii sports therapy was more engaging and thus preferred by the participants, enhancing compliance and overall rehabilitation outcomes.

Conflict of Interest: The authors declare no conflict of interest

Funding: None

Compliance with Ethical Standards: Ethics approvals were obtained from The University of Faisalabad under the Ref. No. Tuf/IRB/360/24

REFERENCES

1. Lo EH, Dalkara T, Moskowitz MA. Mechanisms, Challenges And Opportunities In Stroke. Nature Reviews Neuroscience. 2003; May 4(5):399-414.
2. Verbrugge LM, Lepkowski JM, Imanaka Y. Comorbidity And Its Impact On Disability. The Milbank Quarterly. 1989 Jan 1:450-84.
3. Bhimani R, Horowitz C, Mathiason MA, Anderson LC. Are Symptoms Of Spasticity, Pain, And Fatigue Related In People With Stroke? Rehabil Nurs. 2022; Jan 1; 47(1):31-40.
4. Bhakta BB. Management Of Spasticity In Stroke. Br Med Bull. 2000; Jan 1; 56(2):476-85.
5. Chiu H-C, Ada L, Lee H-M. Upper Limb Training Using Wii Sports Resort™ For Children With Hemiplegic Cerebral Palsy: A Randomized, Single-Blind Trial. Clinical Rehabilitation. 2014; May 21; 28(10):1015-24.
6. Unibaso-Markaida I, Iraurgi I. Effect Of The Wii Sports Resort On Mobility And Health-Related Quality Of Life In Moderate Stroke. Behavioural Neurology. 2021; June 29; 2021:6635298.

7. Twist DJ. Effects Of A Wrapping Technique On Passive Range Of Motion In A Spastic Upper Extremity. Physical Therapy. 1985; Mar 1; 65(3):299-304.
8. Cash JE, Downie PA. Cash's Textbook Of Neurology For Physiotherapists. 3rd Ed. / Edited By Patricia A. Downie Ed: Faber & Faber; 1982 Jan 4; P: 55.
9. Rood M. The Use Of Sensory Receptors To Activate, Facilitate, And Inhibitmotor Response, Autonomic And Somatic Developmental Sequence. In: Approaches To Treatment Of Patients With Neuromuscular Dysfunction. Third International Congress, World Federation Of Occupational Therapists; Dubuque: IA, Wm C Brown Group; 1962. Oct 26; P. Pp:26-37.
10. Goff B. Appropriate Afferent Stimulation. Physiotherapy. 1969; Jan 3; 55(1):9-17.
11. Schmidt RF, Dudel J, Jaenig W, Zimmermann M. Fundamentals Of Neurophysiology: Springer Science & Business Media; 2012 Dec 6; P: 202.
12. Térémetz M, Garcia Alvarez A, Hanneton S, Roby-Brami A, Roche N, Bensmail D, Et Al. Improving Upper-Limb And Trunk Kinematics By Interactive Gaming In Individuals With Chronic Stroke: A Single-Blinded RCT. Annals Of Physical And Rehabilitation Medicine. 2022; Feb 26; 65(3):101622.
13. Aşkın A, Atar E, Koçyiğit H, Tosun A. Effects Of Kinect-Based Virtual Reality Game Training On Upper Extremity Motor Recovery In Chronic Stroke. Somatosensory & Motor Research. 2018; Mar 13; 35(1):25-32.
14. Mathiowetz V, Volland G, Kashman N, Weber K. Adult Norms For The Box And Block Test Of Manual Dexterity. The American Journal Of Occupational Therapy. 1985; June 1; 39(6):386-91.