HOME-BASED INTERACTIVE THERAPY FOR IMPROVING UPPER LIMB FUNCTION IN STROKE PATIENTS: SYSTEMATIC REVIEW AND META-ANALYSIS

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ABSTRACT:

Background: Stroke is one of the most common causes of motor impairment, and most of stroke patients remain their life with residual upper limb function which needs long-term of rehabilitation at hospitals or rehab centres. Spread of COVID-19 around the world prevent hospital admission for long period, so many patients continue their treatment at home.

Objective: to detect the role of home-based interactive therapy in improving upper limb function post stroke.

Data sources: Electronic databases of PubMed, Cochrane library and Google scholar were searched up to May 2021, in addition to manual search of reference lists of relevant studies and reviews.

Methods: Randomized controlled trials were included if they involved any form of home-based interactive therapy. Two authors independently screened articles, extracted data, and assessed the methodological quality using the PEDro scale, with any conflict resolved by the third author. Modified Sackett's Scale was used to determine the level of evidence for each outcome. Because of the clinical heterogeneity between the included studies; only 2 studies were appropriate for meta-analysis.

Results: Out of 583 records screened, 3 studies with 286 participants met the inclusion criteria. The duration of treatment ranged from 30 to 60 min, 5-6 times a week and for 5–8 weeks. The quality of studies was good for the 3 studies, with a mean PEDro score of 6.3 out of 10. All included studies showed positive effects in the measured outcomes. The results showed level 1a evidence for the effectiveness of home-based interactive therapy in improving upper extremity function post stroke. Meta-analysis of 2 included trials used the action research arm score test showed no significant difference (P=0.28) in the overall effect of (SMD= -0.14; 95% CI) between intervention and control groups.

Conclusion: Findings of this review found a strong evidence that home-based interactive therapy for stroke patients can improve their upper limb function but its effect is not superior to conventional therapy. This evidence is based on a limited number of RCTs and more high-quality RCTs are needed to support this evidence.

I. INTRODUCTION:

Stroke is one of the most common neurovascular incidents. It is one of the main causes of acquired disability in adults(1). Stroke criteria are high incidence, poor prognosis, significant disability rate, high recurrence rate, and several effects(2). Some of the most frequent disabling symptoms of stroke are
motor, sensory, cognitive impairments, speaking problems, and emotional disorders. Hemiplegia or hemiparesis affects about 30% of survivors, who have persistent motor impairment(3). For this reason most rehabilitation efforts focused mainly on motor function restoring(4). Strong data suggests that treatments should promote high-intensity, repeated, task-oriented physical therapy throughout the post-stroke period and Traditional physical treatment has been proved to provide these benefits(5). Specific treatments for stroke are most successful when started as soon as possible following the beginning of symptoms(6). Most patients have some hospital/clinic rehabilitation; then they may have home-based rehabilitation due to the high cost long-term rehabilitation training needed and the psychological problems such as depression and anxiety(7). The spread of COVID-19 around the world and the social distancing measures impact hospital admission and long staying period in hospitals(8). As a result, it is critical to develop an effective, low-cost, and acceptable home-based rehabilitation and evaluation system(9).

Interactive therapy is expression that used to describe treatment that is done by interfacing between patient and computer in which patient deal with virtual items and motion is tracking by sensors ,this aid in brain recovery(10) Interactive video gaming is a kind of therapy for stroke patients. It has some advantages over conventional therapy approaches since it encourages people to practice everyday activities that are cannot be performed in hospitals(11) Most findings showed that using home-based interactive therapy in rehabilitation is easier to be motivated in a safe place, such as at home(12)

II. METHODS:

This review was registered on the PROSPERO register with a registration number (CRD42021228184). The databases PubMed, Cochrane library and Google scholar have been searched without limitation regards language from 2010 up to May 2021. The following keywords were used: "interactive therapy" " human-computer interaction" "video game", "virtual reality games", "Wii based games ", "stroke patients" and" upper limb function".

The titles and abstracts of the trials found through the search were compared to the eligibility criteria (Table 1) by two independent reviewers. All publications that were determined to be possibly eligible were downloaded in full text, and the reference lists of the eligible research were also screened manually.

A copy of the complete search strategy is included in figure 1(PRISMA flow diagram)(13). The PEDro scale was used to assess the methodological quality of the included studies (14).Two authors independently used the PEDro scale to assess the studies, and the third author resolving any disagreements.

The methodological quality was rated using the following classification: PEDro score of less than 4=poor quality; 4-5=fair quality; 6-8=good quality; and 9-10=excellent quality (15). The modified Sacket's scale was used to evaluate the level of evidence for interpreting of data for each outcome (16).

Data were extracted from the articles by one of the reviewers (S.M.E). As well as a second reviewer double-checked it. It includes the participants’ characteristics, the outcomes measures and the interventions description. Mean and SD were extracted and represented from in the included studies (17).

III. RESULTS:

The search strategy found 583 studies. After deleting duplicates and screening titles and abstracts, 128 complete articles were found. The search last updated in May 2021; three papers were included in the review after they were evaluated against the eligibility criteria. Figure( 1)for search strategy and the list of excluded studies.(13)

The collected studies were summarized in Table 2. Table 3 summarizes the PEDro scale results.

From table 2 we can conclude that there is homogeneity in patient's characteristics as age average and duration of diagnosis, intervention as all patients treated by the different form of interactive therapy at home but there is heterogeneity in outcomes measurements. Two studies(18)(19) measured arm function by (action research arm test), this allows to do meta-analysis for results, but the last study used different measures as (wolf motor function test)(20) therefore including in meta-analysis not appropriate.
The studies’ quality was good (18)(19)(20) and PEDro scores mean 6.3 out of 10 (range 4:7) (Table 3). According to the main methodological in terms of randomization and allocation, there was a lack of clarity as to whether software, random numbers, or other approaches were used to create randomization, so there is a higher probability of bias. All of the articles were randomized, reported on the differences between groups and variability estimations. Only one study (20) reported allocation concealment. All studies reported blinded assessors. Intention-to-treat analyses, as well as blind participants and therapists, were not used in any of the research.

Participants were 286 adult patients with an average age (18:90) confirmed the diagnosis with stroke since at least 6 months including both sexes. Different types of home-based interactive therapy were used in treatment as VR games (20) video games (18) and Wii sports games (19) Treatment duration ranged from 30 min to 1h/day four around 5:8 weeks for 5:6 time /week(18)(19)(20). Control groups treated by conventional exercises.

The main outcome for all studies was UL function but the measurement was different, two studies used the action research arm test (17)(19), and the last one used wolf motor function test (20).

By the end, there is strong quality evidence (level 1a) according to the modified Sacketts scale (16) that home-based interactive therapy improving hand function in stroke patients, but there is no significant difference from conventional exercises.

Meta-analysis combined data at the study level. Action research arm test score is assessed at the end of the intervention period as a measure for arm function improvement of chronic post-stroke patients. To allow comparison of data from different scales, pooled statistics was calculated using standardized mean differences (SMDs), which were computed using Review Manager program (RevMan software, version 5). Means, mean change, and standard deviations (SDs) for intervention group and control group were used to compute SMDs. The forest plots were computed by means, SD, and sample size effect for control group versus intervention group for each study enters in meta-analysis. When appropriate, estimated effect size was calculated if the outcome variable was reported in ≥2 studies and action research arm test score outcome was continuous variables.

Action research arm test score outcome was pooled across studies and analysed using a fixed-effects model for data collated from all eligible included studies. Outcome measures used one scale of measurements with 95% CIs was used to investigate differences. Study variability and heterogeneity was tested by fixed effects model and I² statistic The statistical analysis was conducted by using Review Manager Program for windows (RevMan software, version 5.4.1).

Two studies assessed arm function improvement at chronic post-stroke by the Action research arm test (ARAT) in the intervention and control groups (Forest plot 1). There was no heterogeneity in ARAT scores between the two studies (n=2 studies, n= 233 participants, P=0.32; I²=0%). There was no significant difference (P=0.28; P>0.05) in overall effect of action research arm score test (SMD= -0.14; 95% CI, -0.40 to 0.11) between intervention and control groups.

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Intervention group</th>
<th>Control group</th>
<th>Std. Mean Difference IV, Fixed, 95% CI</th>
<th>Std. Mean Difference IV, Fixed, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Total SD</td>
<td>Mean Total SD</td>
<td>Weight</td>
<td></td>
</tr>
<tr>
<td>Adie et al. (2018)</td>
<td>47.5 14.2 101</td>
<td>49 13.6 106</td>
<td>99.1%</td>
<td>-0.10 [0.37, 0.17]</td>
</tr>
<tr>
<td>Rand et al. (2018)</td>
<td>30 19.3 13</td>
<td>46.1 16.7 11</td>
<td>9.9%</td>
<td>-0.54 [1.30, 0.26]</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>114</td>
<td>119 100.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterogeneity Ch²</td>
<td>P=0.30; df=1 (P=0.32); P= 0%</td>
<td>Test for overall effect; Z = 1.09 (P = 0.26)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IV. DISCUSSION

The purpose of this systematic review is to provide the evidence for the role of home-based interactive therapy in improving hand function of stroke patients. As patients may tend to home treatment to avoid social interactions nowadays
According to previous systematic review, high-intensity, repeated, and task-specific training aids motor recovery following a stroke. Patients don’t perform the exercises that therapists instruct for different reasons including: tiredness, lack of self-efficacy, and expectation of negative outcomes(21)

Interactive video-gaming encourages patients to practice everyday activities at home. Furthermore, there are a variety of interactive software options which may be useful (11)Computer-assisted therapy with little therapist involvement is known as home-based interactive rehabilitation therapy(21)

Developing a positive attitude toward games can aid in the recovery process by increasing the patient’s interest, enjoyment, and immersion in the game; which are all factors that lead to motivation throughout rehabilitation. Patients react to the game in such a manner that their brains interpret information in a similar way that computers do. The game encourages the patient to activate both long-term and working memory.

The patient can acquire additional training in moving their hand by repeating the task in the game, which can then be transformed into involuntary or automatic memory in the brain to aid movement recovery(22)

Rand D, et al 2017 said that despite both groups improve in upper limb function and when the treatment duration increased the improvement become better and they detect that in follow-up assessment, there is no more positive effect when we use video games than traditional exercises.

The study by Standen PJ, et al2017 conducted that the experimental group was greatly improved in upper extremity function than base-line assessment but the difference between groups was not evident and this may be due to large number of drop out without any clear reasons.

Adie K et al had shown that the arm function improved in both groups from baseline assessment but no difference between groups in arm function measured by action research arm test score at 6weeks. And after 6months follow up they found further improvement in each group but between groups, results were not affected.

Strength of the study:

This study depended on high quality RCT that published from 2010 to 2021. All studies used different types of home–based interactive therapy alone with comparison with conventional physical therapy.

Limitation:

The limitation of the review is that few numbers of studies, the results were for upper limb function only. And we can't do meta-analysis for all results

Conflict of interest:

Author(s) declared no possible conflicts of interest.

Funding:

The author(s) received no financial support for their search.
# Table 1: Inclusion criteria:

<table>
<thead>
<tr>
<th>Design</th>
<th>Randomized controlled trial (RCT), published in any language from 2010 up to May 2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>Adults (i.e. &gt;18 years old) with stroke</td>
</tr>
<tr>
<td>Intervention</td>
<td>Any form of home-based interactive therapy (e.g. video games, virtual reality games, Wii based game)</td>
</tr>
<tr>
<td>Comparison</td>
<td>Conventional/Traditional or in clinic exercises</td>
</tr>
<tr>
<td>Outcome (measures)</td>
<td>Upper limb functions measured by:</td>
</tr>
<tr>
<td></td>
<td>Action research arm test</td>
</tr>
<tr>
<td></td>
<td>Wolf motor function test</td>
</tr>
</tbody>
</table>

# Table 2: Summary of included studies

<table>
<thead>
<tr>
<th>First author (year)</th>
<th>Subjects number (MF) (Age range)</th>
<th>Selection criteria</th>
<th>Intervention</th>
<th>Protocol</th>
<th>Outcome (measure)</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rand, Debbie (2017)</td>
<td>24 (15/9) (NR)</td>
<td>Patients who had: Stroke since 36 months. Mild to moderate weakness in UL. NO cognitive deficit. Walking ability for at least 10 in. NO other neurological condition.</td>
<td>G1: Video Games G2: Traditional exercises for hand</td>
<td>Training 1h/day 6 times/week for 5 weeks</td>
<td>Function of upper limb (action research arm test)</td>
<td>The post training assessment was better for both group but there was no significant difference between groups.</td>
</tr>
<tr>
<td>Staines (2017)</td>
<td>27 (16/11) (18y or more)</td>
<td>Patients who had: Residual arm impairment. No pain in shoulder. NO other neurological conditions</td>
<td>G1: Virtual Reality Games G2:usual care exercises</td>
<td>Training for 8 weeks</td>
<td>Function arm movement (wolf motor function test)</td>
<td>There was significantly greater change from baseline assessment in intervention group.</td>
</tr>
<tr>
<td>Adie, Kati (2016)</td>
<td>235 (183/51) (24-90)</td>
<td>Patients who had: Stroke since 6months. Arm weakness due to stroke. Ability to use Wii games</td>
<td>G1:Wii sport games G2:arm exercises</td>
<td>Training for 6weeks</td>
<td>Upper limb function (action research arm test)</td>
<td>No significant difference between groups in arm function.</td>
</tr>
</tbody>
</table>
Table 3. PEDro scores of included studies.

<table>
<thead>
<tr>
<th>study</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>6th</th>
<th>7th</th>
<th>8th</th>
<th>9th</th>
<th>10th</th>
<th>11th</th>
<th>Total Score (0-10)</th>
<th>quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standen et al (2017)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td></td>
<td>7</td>
<td>Good</td>
</tr>
<tr>
<td>Adie et al (2016)</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td></td>
<td>6</td>
<td>Good</td>
</tr>
</tbody>
</table>

* This criterion is not counted for the total PEDro score.

Criteria of PEDro Scale: 1=eligibility specified; 2=random allocation; 3=concealed allocation; 4=prognostic similarity at baseline; 5=subject blinding; 6=therapist blinding; 7=assessor blinding; 8=85% follow-up of at least 1 key outcome; 9=treatment and control subjects received treatment as allocated; 10=between group statistical comparison for at least 1 key outcome; and 11=point estimates and measures of variability provided for at least 1 key outcome. **Scoring:** N= no (absent/unclear) = 0, Y=yes (present) =1.

**REFERENCE:**

10. Johnson PM. UC Irvine UC Irvine Electronic Theses and Dissertations. 2015;123.