Impact of Controlled Exercise Programs on Balance and Coordination: A Case Study of Stroke Survivors

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Introduction

"Supportive Living's (SLI) *Neuro-Fit Assisted Exercise Program* is an evidence-based exercise class designed for people living with functional limitations caused by a brain injury or other neurological condition. Each one-hour session features aerobic exercises to improve cardiovascular fitness, functional exercise to improve strength and mobility, as well as challenging balance and gait exercises. We provide one-on-one instruction to help participants work towards specific and individualized fitness goals." (Supportive Living Inc. n.d., para. 1)

Literature Review

"The effects of a stroke depend on several factors, including the location of the obstruction and how much brain tissue is affected. However, because one side of the brain controls the opposite side of the body, a stroke affecting one side will result in neurological complications on the side of the body it affects." (American Stroke Association, n.d., para. 3)

"We report that dynamic balance recovery was associated with a reduction in connectivity in the sensorimotor and cerebellar networks. Furthermore, dynamic balance recovery was negatively associated with baseline connectivity within the cerebellar-thalamic network and with baseline connectivity in the cerebellar-M1 network. Dynamic balance recovery was also positively associated with baseline connectivity within the cerebellar-putamen network and both the cerebellar-frontal and cerebellar-parietal networks. We also found that while morphological features were not correlated with dynamic balance impairment and recovery, they were associated with the time that passed since injury." (Joubran, 2022, p. 2)

"Many studies in human and animal models have shown that neural plasticity compensates for the loss of motor function after stroke. However, neural plasticity concerning compensatory movement, activated ipsilateral motor projections and competitive interaction after stroke contributes to maladaptive plasticity, which negatively affects motor recovery. Compensatory movement on the less-affected side helps to perform self-sustaining activity but also creates an inappropriate movement pattern and ultimately limits the normal motor pattern. The activated ipsilateral motor projections after stroke are unable to sufficiently support the disruption of the corticospinal motor projections and induce the abnormal movement linked to poor motor ability. The competitive interaction between both hemispheres induces abnormal interhemispheric inhibition that weakens motor function in stroke patients. Moreover, widespread disinhibition increases the risk of competitive interaction between the hand and the proximal arm, which results in an incomplete motor recovery. To minimize this maladaptive plasticity, rehabilitation programs should be selected according to the motor impairment of stroke patients. Noninvasive brain stimulation might also be useful for correcting maladaptive plasticity after stroke." (Takeuchi, 2021, p. 1)

Internship Project Objectives

Three participants of the Neuro-Fit program I am working with are survivors of strokes. Each person has goals to regain balance and coordination to be able to do activities they once enjoyed and to help with activities of daily living.

My objectives over the 12-week program include:

I. Track progress of balance

II. Track progress of coordination

III. Collect subjective data from each participant regarding their impressions of the effectiveness of the Neuro-Fit program

Methods and Tasks

Objective 1: Track progress of balance after 12 weeks

- Log exercises/activities
- Monitor & record improvements/changes: changes in rep/sets, change in intensity of exercise, change in length of time of exercise
- Record participants views of their progress of balance in the gym setting

Objective 2: Track progress of coordination after 12 weeks

- Log exercises/activities
- Monitor & record improvements/changes: improvements/changes: change/addition of exercise, change of length of time of exercise, change of intensity
- Record participants views of their progress of coordination in the gym setting

Objective 3: Participant interview

- Record participant views on how the exercises (balance/coordination specific) impact their daily lives (positive or negative)
- Record participant views on how they feel they progressed since starting the program, specifically towards goals they set when we met or prior to us meeting
- Record participants views on how their confidence has been impacted since the balance/coordination exercises

Results

Participant A June 6, 2022- August 1, 2022	**Hip Marches**	**Ball Tosses**	**Ball Kicks**	**Sit to Stands**	**Standing Timed**	**Leg Curl**	**Leg Extension**
Sets/Reps Weights/ resistance	3 Sets and 12 Reps	3 Sets and 12 Reps	3 Sets and 12 Reps	3 Sets and 10 Reps	N/A	3 Sets/12 Reps	3 Sets/12 Reps
Progress made	On June 27, increased the difficulty by adding heavier ankle weights	Noticed increase in less times ball dropped	On June 29, increased difficulty by adding heavier ankle weights.	Started on June 6 with 2 Sets of 10 Reps which increased to 3 Sets of 10 reps on July 6	From June 6-June 15, stood between 3-4 minutes each session, then from June 22-	Started on June 6 with green lighter resistance band then increase to a black resistance band on June 15	On June 13, increased difficulty by adding heavier ankle weights
Participant Interview	**In what ways do these exercises impact your daily life?** He reports being able to stand for longer periods of time and feels increase of strength in his left leg. **How do you feel you have progressed towards meeting your set goals?** He reports the increase length of time standing and increased lower body strength has helped him to be able to soon be at a point where he is able to ambulate using a walker. **How have these exercises impacted your confidence?** He reports feeling more confident while applying pressure on his left leg while standing, which was significantly impacted from his stroke. He feels more confident in his ability to support himself while standing.						

Participant B June 7, 2022 – August 2, 2022	**Bike**	**Hip Marches**	**Sit to Stands**	**Lateral Steps**	**Treadmill**	**Pallof Press**
Sets/Reps Weights/ Resistance/ Time	10 minutes	3 Sets and 12 Reps	3 Sets and 10 Reps	3 Sets and 10 reps	5 Minutes	Yellow band
Progress Made	June 7: started at 3 resistance July 5: increased to 4 resistance July 21: increased to 5 resistance	On July 5, increased difficulty from seated hip marches (in wheelchair) to standing hip marches	Increase in ease of standing and less breaks are needed In between reps and sets. On June 26, increased difficulty by not holding onto bar for assistance with standing	Increased distance between each step and increased endurance	June 7: started at 1.2 intensity June 21: 1.3 intensity July 12: 1.4 intensity July 26: 1..5 intensity	On 6/23, increase from 2 sets of 12 reps to 3 sets of 10 reps
Participant Interview	**In what ways do these exercises impact your daily life?** She feels better able to **How do you feel you have progressed towards meeting your set goals?** She reports feeling much stronger and much closer to her goal of transitioning out of a wheelchair. She also feels as though she may soon be strong enough to go into the pool and swim, which is her long-term goal. **How have these exercises impacted your confidence?** She reports feeling more confident with being able to ambulate which makes her feel safer/less risk of falls. She also reports feeling more confident in her ability to do some household tasks independently such as cleaning a table in her bedroom.					

Participant C June 7, 2022 – August 2, 2022	**Hip Marches/ Step Ups**	**Lateral Steps**	**Sit to Stands**	**Leg Extension**	**Leg Curl**	**Leg Press**	**Heel to Toe / Tandem Steps**
Sets/Reps Weights/ Resistance/ Time	3 Sets and 12 reps	3 Sets	3 Sets and 12 Reps	3 Sets and 12 Reps 15lbs	3 Sets and 12 Reps 40lbs	3 Sets and 12 Reps 25bs	3 Sets
Progress Made	On June 14, the difficulty was increased by progressing from Hip Marches to Step Ups onto platform	On July 21, the difficulty was increased by adding three platforms in between steps	Over course of 10 weeks, improvement includes less use of upper body to stand up	On June 21, difficulty was increased by progressing from using resistance bands to using weight of machine	On June 21, difficulty was increased by progressing from using resistance bands to using weight of machine	On June 21, this exercise was added	From June 7 – July 7, 3 Sets and 12 reps of Heel to Toe was increased to 3 sets of Tandem Walking across total distance of 50 feet
Participant Interview	**In what ways do these exercises impact your daily life?** He reports that when he first started the program, he was in a wheelchair and is now able to walk using a cane. He reports feeling better able to ambulate, general increased strength, and balance. **How do you feel you have progressed towards meeting your set goals?** He reports feeling better able to walk and feels more comfortable doing so independently. **How have these exercises impacted your confidence?** He reports feeling increased confidence in his ability to complete the exercises, walk with his cane. He also reports as a result of feeling confident in his current routine, he would like to try new exercise machines, including the bike and walking without his cane.						

Conclusions

Based on the results, it can be concluded that a controlled exercise program focusing on balance and coordination can benefit stroke survivors.

I. Progress of Balance

Participant A improved in the number of consecutive minutes he was able to stand without the need for support.

Participant B improved in her ability to walk on a treadmill at a faster speed and was able to transition to exercises while standing up.

Participant C was able to progress in his ability to walk straight and laterally without the need to hold onto the railing. He was also able to catch himself to prevent a fall if he felt unstable while walking.

II. Progress of Coordination

Participant A improved in the number of consecutive times he was able to catch and throw a small ball. He also improved in his ability to use his left leg (weaker side) to kick a yoga ball in a rapid consecutive motion.

Participant B improved her ability to be able to complete upper body exercises while standing. She also improved her ability to do exercises on her left side (weaker side) with consecutively with stable motion.

Participant C improved his ability to walk laterally and straight with stable and consecutive motion despite having a weaker side (right side).

III. Participant Interviews

An important part of most therapies and treatments is the impact it has on the patient's quality of life and outlook. From the interviews with the three participants who are all stroke survivors of similar age, they all report four similar opinions. Each has expressed to me:

I. The devastation the stroke had on their life and the frustration they feel day to day

II. The happiness they feel in the amount of progress they have made over the past few years with this program

III. Feeling confident enough in the progress that they already made so they feel they can set and accomplish new long-term goals

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