Advanced Studies in Medical Sciences, Vol. 3, 2015, no. 1, 15 - 22
HIKARI Ltd, www.m-hikari.com
http://dx.doi.org/10.12988/asms.2015.583

Psycho-Physiological Benefits in a Rehabilitative Exercise Program: A Cerebral Palsy Case Study

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Abstract

Purpose: The purpose of this case study was to determine whether an individualized 12-week rehabilitative exercise program involving a wheel-chair bound cerebral palsy (CP) participant could improve self-efficacy regarding barriers to exercise, while also increasing their range of motion and flexibility.
Methods: Participant was a 51 year old female with Spastic Quadriplegia CP (also known as Spastic Tetraplegia). Activity sessions were designed around a whole-body experience, with five flexibility and five exercise stations utilized one time per week, for approximately 30 minutes per session. Several initial baseline/pre-test assessments were taken for range of motion in the knee and elbow (knee flexion/extension; elbow flexion/extension) using a hand-held goniometer. Self-efficacy related to exercise barriers was assessed at baseline and 12 weeks. Additionally, post-test physical assessments were taken after the 12-week program, and compared with baseline measures.
Results: Psychologically, the subject showed a dramatic overall increase from 56 to 102 points, almost doubling her total self-efficacy to overcome barriers score (possible range of score = 0 to 120). The subject specifically recorded positive increases in efficacy to overcome exercise barriers on all 12 questions. Results also

indicated physical improvements for increased ROM for right and left elbow flexion, left elbow extension, and extension in both knees.
Conclusions: The importance of this case study is discussed in relation to other CP survivors and the maintenance of their functional capacities.

Keywords: cerebral palsy (CP), exercise, range of motion (ROM), quality of life (QOL)

Introduction

Cerebral Palsy (CP) is a lifelong condition generally caused by damage of the developing brain [5]. The most common cause of CP is brain injury during pregnancy (i.e., through faulty blood supply or a genetic disorder). However, CP can also occur through injury to the brain during or after birth from a lack of oxygen, toxic poisoning, or infection to the nervous system [5]. CP is most evident in the first 12 to 18 months of life, with noticeable symptoms/deficits in the motor domain. These symptoms include motor delay, gait disorders, poor fine and gross motor coordination, swallowing disorders, and speech delay. Early signs of motor delay include postponement of key growth milestones such as rolling over, sitting, crawling, and walking. Indications of gait disorders common in CP comprise arms tucked in at the sides, knees crossed or touching, legs making a “scissor” movement, and walking on the toes. Examples of poor motor coordination consist of the inability to manipulate objects and perform skillful movements such as opening a door, or pouring water into a glass. The severity of symptoms will vary according to the extent of the brain damage suffered by each individual.

While there is no known cure for CP, and although the condition is permanent, CP is not unchanging. Many studies show that exercise can improve motor skills and overall quality of life (QOL) in children with CP. For example, Bryant and colleagues showed that a six-week exercise intervention was able to improve gross motor function in children with CP [3]. In another study, researchers investigated the effects of constraint-induced movement therapy (CIMT) on hand skills and muscle recruitment of children with spastic hemiplegic CP [8]. The authors suggested that children with CP may benefit from CIMT due to the increased stimuli it provides to the affected limb, and the fact that children’s nervous systems are still developing. Overall, the researchers found significant improvements in mean grip strength from baseline to all other phases. Additionally, the participants showed increases in self-care and play skills as well as satisfaction and participation in daily activities, and the parents of the participants also indicated seeing improvements in their children’s QOL.

More recently, C. Grecco and associates [4] investigated the effect of treadmill gait training on static and functional balance in children with CP. Results indicated both the experimental group and the control group achieved higher balance scores following gait training protocols. However, the experimental group had statistically better results in comparison to the control group ($p = .01$). Overall, both gait training on a treadmill and on the ground resulted in improved functional and static balance. Additionally, this study showed that treadmill training resulted in a greater functional balance improvement and less medial lateral oscillation with eyes open in children with CP.

A final study on children and adolescents with CP by Reid and associates investigated the neuromuscular outcomes of an eccentric strength-training program [7]. All of the children with CP underwent a 6-week home-based upper-limb eccentric training program that targeted the elbow flexors. Overall, this study showed that children/adolescents with CP who participate in eccentric strength-training can increase torque throughout their range of motion (ROM). The authors hypothesized that the eccentric exercises used in the study may decrease co-contraction, improving net torque development. While these results have significant implications for the prescription of strength-training programs for children and adolescents, unfortunately there is a lack of research concerning the effects of exercise in adults with CP. However, if exercise programs improve muscular strength, gait speed, and stride length in children with CP, then adults with CP who participate in an exercise program could see similar results.

While functional or physical improvements have been shown to occur in individuals with CP, little research has investigated the effects exercise may have on psychological factors such as QOL, psychological well-being, or self-efficacy. According to Bandura, self-efficacy is the belief that you can accomplish a task [1]. Put another way, self-efficacy levels are based on the amount of confidence you have to complete a skill or activity. For the purpose of this case study, we chose to look at self-efficacy in terms of one's ability or self-belief to overcome exercise barriers. For instance, barriers within a "normal" population that individuals have identified as limiting their participation in an exercise program include a lack of time, a lack of knowledge about exercising (i.e., correct intensity, duration, etc.), excessive cost, and facility location [9].

Traditional barriers affect not only a "normal" population, but also individuals with chronic diseases such as CP, Multiple Sclerosis, and cancer. For instance, Blaney and associates reported several additional barriers identified by cancer survivors as limiting their exercise participation [2]. Those additional barriers were disease or treatment-related fatigue and side-effects, de-conditioning, and facilities that lack accommodations for participants with special needs. Therefore, the purpose of this case study was to determine whether an individualized 12-week rehabilitative exercise program could increase self-efficacy to overcome exercise barriers in a wheel-chair bound CP participant, while also physiologically improving their ROM and flexibility.

Methods

Participant

The participant was a 51 year old female with Spastic Quadriplegia CP (also known as Spastic Tetraplegia). Spastic CP is a condition displaying stiff, jerky movements stemming from hypertonia of the muscles. Spastic Quadriplegia CP affects all four limbs more or less equally, but some areas of the body can be stiffer than others [5]. The participant was wheel-chair bound often sitting in a “hunched over” position with her neck limp and head leaning slightly forward and to the right. Initial assessment of the subject identified several areas of weakness, or issues limiting her ROM. Specifically, the volunteer had minimal flexion, extension, supination, and pronation in her left hand; limited flexion and extension at the left elbow; and little to no mobility at the left shoulder. She had limited mobility of the right shoulder, although it was significantly better than the left shoulder; and had limited extension and flexion in the right elbow, which was significantly better than the left elbow. Additionally, plantar flexion, dorsiflexion, pronation and supination of the ankles, and knee flexion and extension appeared to be minimal. However, it was discovered that the participant had moderate flexion and extension in her right hand (although supination and pronation was limited). The slight increase in mobility on the right side may be due to increased use of her right arm to control her motorized wheel-chair.

Measures & Procedures

A psychological survey was administered on the first and last day of the 12-week study. The Barriers Efficacy Scale (BES) was used to measure the subject’s perceived ability to exercise in the face of possible barriers (e.g., bad weather, on vacation, not interested in the activity, bored with the program, exercising alone; etc.) [6]. Total scores can range from 0 to 120, with higher numbers indicating more confidence (self-efficacy) to overcome barriers. Internal consistency reliability reported in past studies using the BES range between .82 and .96 [6]. The participant was unable to write her own answers. Therefore her answers to each question were given verbally to a non-biased 3rd party volunteer who was uninformed about the study’s parameters. From a physiological standpoint, ROM specifically related to flexion and extension of the knee and elbow where measured before and after the 12-week program using a hand-held goniometer. For this study, the second author met once per week for 30 minutes with the participant. All workouts were one-on-one with the trainer, isolated from the general population of the gym, with up-tempo music played during every session. Each workout started with assisted stretches of the shoulder (abduction and adduction in the frontal plane; flexion and extension in the sagittal plane), elbow (flexion and extension in the sagittal plane), hand (pronation, supination, flexion and extension in the sagittal plane), knee (extension and flexion in the sagittal plane while sitting in wheel chair), and ankles (supination, pronation, flexion and extension in the sagittal plane). A resistance band was used to assist in the knee and ankle stretches. Each session also included a resistance portion of the workout. The following is a general summary of the five main physical rehabilitation exercises completed by the volunteer:

- Shoulder: Manual band resistance to shoulder abduction in the frontal plane. No resistance occurred for the first six weeks while moving in the sagittal plane. Small amounts of band resistance was added the last six weeks.

- Rhomboids and scapular retraction: Participant held a band in front of her chest (to the best of her ability), and flexed her shoulders in the sagittal plane brining the band chest high (to the best of her ability). While holding the band in both hands, she retracted her scapula stretching the band in the transverse plane.
- Elbow: Flexion and extension of the elbow was completed with manual resistance for the first six weeks, with band resistance utilized during the last six weeks.
- Knee: Flexion and extension of the knee was completed with bands for all 12 weeks.
- Neck mobility: Participant was able to rotate her head left to right in the transverse plane. Also, she alternated touching her right ear to her right shoulder in the frontal plane, and her left ear to left shoulder in the frontal plane. She was also asked/able to alternate nodding her head forward and backwards in the sagittal plane.

Each of the main exercises were performed in two sets, with approximately 10 to 12 repetitions the first three weeks, gradually increasing to 16 and 18 repetitions respectively during weeks nine through twelve.

Results

Psychologically, the subject showed a dramatic increase by almost doubling her total self-efficacy to overcome barriers score from 56 to 102 points. The participant specifically recorded positive increases in efficacy to overcome exercise barriers on all 12 questions. Additionally, results indicated positive physical/functional improvements for increased ROM, as measured by a goniometer, for right and left elbow flexion, left elbow extension, and extension in both knees (see Table 1).

Table 1

Unassisted/Assisted ROM Results in Degrees

		Week 1	Week 12
Right Elbow Flexion:	Unassisted	34	36
	Assisted	36	40
Right Elbow Extension:	Unassisted	12	8
	Assisted	10	10
Left Elbow Flexion:	Unassisted	26	24
	Assisted	32	36

Table 1 (Continued):

Unassisted/Assisted ROM Results in Degrees

Left Elbow Extension:	Unassisted	16	8
	Assisted	16	6
Right Knee Extension:	Unassisted	48	52
	Assisted	54	62
Left Knee Extension:	Unassisted	46	48
	Assisted	50	52

Conclusions

The importance of this case study is discussed in relation to other CP survivors and the maintenance of their functional capacities. Several studies indicate that exercise can increase muscular strength, gait speed, and stride length in children with CP [3, 4, 7, 8], but little research has been conducted on adults with CP. Similarly, little is known about the psychological effects of exercise on adults with CP, such as their perception or self-belief to overcome exercise barriers. This case study's purpose was to determine whether an individualized 12-week rehabilitative exercise program could increase self-efficacy to overcome exercise barriers in a wheel-chair bound CP participant, while also improving the individual's ROM and flexibility.

Concerning the participant, results indicated that self-efficacy to overcome exercise barriers significantly improved for the individual over the twelve week time-frame. More specifically, her self-efficacy increased to overcome each possible barrier to exercise. As pointed out by Blaney and others, real and perceived barriers can keep individuals from utilizing physical activity in the form of physical therapy or exercise, which can then decrease one's QOL [2]. Hopefully future investigations will be able to replicate this increase in self-efficacy in studies involving more participants, and in other areas pertaining to QOL such as emotional, personal, and spiritual.

Results also indicated physical improvements in ROM; specifically her right and left elbow flexion, right and left elbow extension, and right and left knee extension. While these physiological changes may be interpreted as small or minor by some, we believe this case study infers that through a regimen of regular exercise for individuals with CP, health-care providers can increase the physical and mental health of their patients. Along those same thoughts, other considerations that may have helped with the participant's results were the very positive interpersonal interactions between the subject and the personal trainer. The importance of a caring and empathetic exercise leader/therapist should never be underestimated.

Additionally, “upbeat energetic” music and a positive atmosphere while exercising could have contributed to the success of this study and the QOL results.

Concerning future research, following a larger number of adults suffering from CP through a 12-week program could help to corroborate the physical and psychological benefits found in this research. Testing CP participants within an alternative environment might also be beneficial, such as investigating various exercise programs with differing levels of music and/or peer group interaction. Hopefully these types of future studies will allow us to create the most beneficial environment for individuals to workout in, while also eliminating any real or perceived exercise barriers that hinder CP patients from increasing their muscular strength, ROM, flexibility, and QOL.

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Received: August 27, 2015; Published: September 29, 2015