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The effects of an exercise training program on hand and wrist strength, and function, and activities of daily living, in adults with severe Cerebral Palsy

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ABSTRACT

The purpose of the current study was to establish measurement reliability in adults with Cerebral Palsy (CP), and to examine the feasibility and outcomes of an upper extremity strength training program (three times per week for 90 min each time). A control group design mixed with a prospective time series design for the intervention group was completed, including a pre-test, a post-test after a 12-week intervention period, and a follow-up in the intervention group after an additional 10-week period. Seventeen adults with CP with severe motor impairment took part in the study (10 in the intervention and seven in the control group). The test battery was comprised of wrist and hand dynamometry; dominant hand upper-extremity function measures (Jebsen Hand Function Test = JHFT, Minnesota Manual Dexterity Test = MMDT, and the Nine Hole Peg Test = NHPT); and activity of daily living with the Barthel Index.

The results indicated that in both the control and the intervention groups, the strength tests exhibited good-to-excellent reliability during pre-test and post-test. The group comparison revealed that while in the pre-test no between-group differences existed, in the post-test the strength training group demonstrated significantly higher values in five out of eight strength measures, as well as in the MMDT. Discontinuing the program for eight weeks reversed the effects almost to baseline. In conclusion, the outcomes demonstrated the reliability of the assessments utilized in this study, as well as the feasibility of the strength training program, in adults with severe motor impairment due to CP.

1. Introduction

Cerebral Palsy (CP) describes a group of permanent disorders of the development of movement and posture causing activity limitations, which are attributed to non-progressive disturbances that occur in the brain development of the fetus or

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infant. The motor impairment of CP is often accompanied by epilepsy; sensory abnormalities; and cognitive, perceptual, communication, and behavior disorders (see Krugger, 2006; Odding, Roebroeck, & Stam, 2006; Rosenbaum, Paneth, Leviton, Goldstein, & Bax, 2007). In an epidemiological survey of CP across Europe, an occurrence of 2.12–2.45 per 1000 live births was reported (Surveillance of Cerebral Palsy in Europe, 2002). The frequency of CP increases to 40–100 per 1000 preterm births (Odding et al., 2006). Every year there are approximately 10,000 newborns diagnosed with CP in the European Union (Surveillance of Cerebral Palsy in Europe, 2002). The prevalence of CP has not decreased, and some authors argue that in the past forty years it has even increased (Odding et al., 2006). It is estimated that 65–90% of children with CP survive to adulthood (Zaffuto-Sforza, 2005). The mean lifetime cost of treatment and lost income for a person with CP has been estimated in the United States as US$ 921,000 (CDC, 2004).

The limitation of activity in CP typically leads to muscle weakness and atrophy (Bottos, Feliciangeli, & Sciuto, 2004), which increases in adulthood (Allen, Dodd, Taylor, McBurney, & Larkin, 2004). Most adults with CP, regardless of the degree of disability, have common limitations in performing activities of daily living (ADL; see Verschuren et al., 2011). The degree of functional performance in CP is typically classified across five categories by means of the Gross Motor Function Classification System (GMFCS; see Bax et al., 2005; Palisano, Rosenbaum, Bartlett, & Livingston, 2007), based on independence in locomotion and ranging from *walks without limitations* (Level I), through *walks with limitations* (Level II), *walks using a hand-held mobility device* (Level III), *self-mobility with limitations – may use powered mobility* (Level IV), up to *transported in a manual wheelchair* (Level V).

In a systematic review that extracted and summarized 10 clinical trials using strength training as their major intervention (Dodd, Taylor, & Damiano, 2002), it was reported that the majority exhibited a significant impact on strength with effect sizes ranging between 0.5 and 5.0. However, non-significant poor effects were seen in motor function, mostly walking. In a more recent systematic review performed with randomized clinical trials only (Scianni, Butler, Ada, & Teixeira-Salmela, 2009), the beneficial effect on strength was seen to diminish. However, most of this research has focused on children and adolescents with fair to moderate levels of functional limitation (i.e., GMFCS levels I–III; see Verschuren, Ketelaar, Takken, Helders, & Gorter, 2008). Moreover, there is very little evidence regarding the outcomes of strength training in adults with CP, particularly in those with severe functional limitations (GMFCS levels IV and V).

Experts in rehabilitation and health promotion of persons with CP have addressed the significant role of being physically active and of physical training in functional ability and quality of life. For example Thorpe (2009) acknowledged that as more and more persons with CP lead meaningful lives into advanced age, it is imperative that the scientific community provide definitive information to help guide decisions related to the type and extent of fitness-related activities that might benefit these individuals. In addition, Zaffuto-Sforza (2005) reported that although there is an increasing awareness of the rights of people with disabilities, there is more work to be done particularly as relates to the cost and availability of adaptive equipment and exercise. Nevertheless, very few reports regarding the physical activity and functional ability of adults with CP have been published. In a study of 51 adults with CP, Gaskin and Morris (2008) reported very low physical activity participation rates, and a medium correlation between physical activity and functional ability ($r = .45$). In a more recent study (Maltais, Dumas, Boucher, & Richards, 2010), it was found that in individuals who were able to walk, inactivity was associated with an increase in the severity of additional health problems or complications. However, in non-walkers inactivity was most clearly associated with perceived range-of-motion limitations.

In an intervention study of Andersson, Grooten, Hellsten, Kaping, and Mattsson (2003), ten adults with spastic diplegia who participated in strength training twice a week over 10 weeks, were compared to seven individuals with a similar disability who did not participate in training and served as controls. The authors reported significant improvements in the experimental groups in most outcome measures: (a) isometric strength of the hip extensors ($p < .01$) and hip abductors ($p < .01$), (b) isokinetic concentric work at 30° of the knee extensors ($p < .05$), (c) Gross Motor Function Measure (GMFM) dimensions D and E ($p < .005$), (d) walking velocity ($p < .005$), and (e) timed Up and Go ($p < .01$), while no change in these measures was observed in the controls. In addition, the authors noted that no adverse spasticity effects were encountered in the participants.

Very limited information has been reported so far about the impact of a training program on the strength and motor function of the hand and wrist in rehabilitation clients with CP, all of them children or youth. O'Connell and Barnhart (1995) studied the effect of an eight-week upper body concentric resistance training program on wheelchair propulsion in three children with CP and three with Spina Bifida, aged 4–16 years. These authors reported significant increases in strength (six-repetition maximal load in upper extremity muscle groups that are relevant for wheelchair propulsion) as well as distance covered in 12 min, suggesting that a specific muscle strengthening program could assist in wheelchair propulsion. A recent study performed on nine children with CP with a mean age of 9.1 years (SD = 1.8 years) reported improvement in the velocity of a reaching task at a comfortable speed as a result of a 10-week three times per week home based strength training program (Kim et al., 2012). Furthermore, the same reaching task as well as hand function in the Jebsen Taylor Hand Function Test (JHFT) improved significantly as a result of a Comprehensive Hand Repetitive Intensive Strength Training (CHRIST) program lasting 10 weeks, with three sessions of 60 min per week, in 10 children with CP with a mean age of 8.6 years (SD = 1.9 years; Lee et al., 2013). This program included body weight supported treadmill training for the upper limbs (body in quadruped position).

So far no strength training outcomes on wrist and hand function have been reported in adults with CP. Therefore, the aim of the current study was to establish measurement efficacy in adults with CP who are unable to walk, and to examine the feasibility and efficacy of a strength training program designed to improve their strength and upper-extremity functionality.