



The effect of a combined strength and proprioceptive training on muscle strength and postural balance in boys with intellectual disability: An exploratory study



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ABSTRACT

The aim of our study was to investigate the effect of a combined strength and proprioception training (CSPT) program on muscle strength and postural balance in children with intellectual disability (ID). The maximum voluntary contraction (MVC) and postural parameters (CoP_{Vm}, CoP_{LX}, CoP_{LY}) of 20 children with ID were recorded before and after 8 weeks of a CSPT program. The participants were divided into two groups: an experimental group who attended a CSPT program and a control group who continued with daily activities. In the trained group, the MVC increased significantly ($p < 0.001$) after the training period and the postural parameters decreased significantly in Double-Leg Stance (DLS) and One-Leg Stance (OLS) during the firm surface condition as well as in the DLS during the foam surface condition; in both eyes open (EO) and eyes closed (EC) conditions. A CSPT program improves postural balance in children with ID could be due to the enhancement in muscle strength and proprioceptive input integration.

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1. Introduction

Postural performances are relevant to check in individuals with intellectual disability (ID) since posture serves as a reference frame for the production of accurate movements that are vital for the activities of daily living like walking, stepping up the stairs, or standing in a bus. Previous studies showed that individuals with ID present several balance (Cabeza-Ruiz et al., 2011; Srikanth, Cassidy, Joiner, & Teeluckdharry, 2011; Zur, Ronen, Melzer, & Carmeli, 2013) and gait (Cleaver, Hunter, & Ouellette-Kuntz, 2009; Galli et al., 2008; Smith, Kubo, Black, Holt, & Ulrich, 2007) disorders. These balance and gait problems are one of the well-established risk factors for falling as previously reviewed (Enkelaar, Smulders, van Schrojenstein Lantman-de Valk, Geurts, & Weerdesteyn, 2012). The impairment of postural balance in individuals with ID was explained by deficits in visual (Little, Woodhouse, Lauritzen, & Saunders, 2007; John, Bromham, Woodhouse, & Candy, 2004; Woodhouse et al., 1996), somesthetic (Carvalho & Almeida, 2009; Golubovic, Maksimovic, Golubovic, & Glumbic, 2012; Hale, Miller, Barach, Skinner, & Gray, 2009), and vestibular inputs (Rogers, Hepburn, & Wehner, 2003; Zur et al., 2013). Moreover, some individuals

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with ID suffer from several anomalies in their central nervous systems (Yu et al., 2008) that may affect the sensory inputs integration. Furthermore, it has been reported that these individuals developed lower muscle strength level than individuals with typical development (Borji, Zghal, Zarrouk, Sahli, & Rebai, 2014; Zafeiridis et al., 2010).

It is important to note that the motor deficit of individuals with ID could be influenced and deteriorated by behavioral factors, such as sedentary life (Carmeli et al., 2008). Therefore, inactivity may increase the prevalence of falls in these individuals (Hall & Thomas, 2008; Temple, Frey, & Stanish, 2006). Involvement in exercise is a key strategy in the prevention of health problems arising from inactivity (Rimmer & Braddock, 2002) and a sedentary lifestyle often adopted by individuals with ID (Graham & Reid, 2000). A beneficial effect of exercise on postural balance in individuals with ID in different ages was revealed. In this context, it has been demonstrated that dynamic equilibrium of adults with ID was improved after a rhythmic gymnastics (Fotiadou et al., 2009) and Greek dancing (Tsimaras, Giamouridou, Kokaridas, Sidiropoulou, & Patsiaouras, 2012) training programs. Strength training was found to be one of the most efficient interventions to improve postural balance in individuals with typical development (Pua et al., 2011; Rätsepsoo et al., 2013; Sung et al., 2013). Similarly, Carmeli, Zinger-Vaknin, Morad, and Merrick (2005) reported a postural balance improvement in adults with ID after six month of strength training program. Likewise, it has been shown that adults with Down's syndrome (DS) improved their postural balance after 12 weeks of a combined training program of muscle strength and dynamic balance exercises (Tsimaras & Fotiadou, 2004).

Balance and gait capacities acquisition of individuals with ID in the various developmental stages during childhood is delayed and it may not reach the same level of maturation as individuals without ID (Agiovlasis, McCubbin, Yun, Mpitsos, & Pavol, 2009; Dellavia, Pallavera, Orlando, & Sforza, 2009). In this context, the postural balance impairment has been identified as the main intrinsic risk factor of falling (Tinetti et al., 1994). Moreover, it has been demonstrated that even young people with ID presented an increased risk of fall (Sherrard, Tonge, & Ozanne-Smith, 2001; Weeks, Chua, & Elliott, 2002). Injury rates were similar for children, adolescents and adults with ID and mostly (60% approximately) caused by falls (Sherrard et al., 2001). Nevertheless, while individuals with ID are at higher risk of fall across all ages, early intervention has so far been overlooked in the falls in these individuals. In fact, such research remains rare. Giagazoglou et al. (2012) Giagazoglou, Arabatzi, Dipla, Liga, and Kellis (2012) reported an improvement of static equilibrium in adolescents (15 years) with ID after a hippotherapy intervention program. In addition, Gupta, Rao, and SD (2011) proved a beneficial effect of strength and balance training in children with DS. Moreover, a previous study showed that 12 weeks of trampoline intervention program can improve motor and balance ability of school aged children with ID (Giagazoglou et al., 2013). Recently, Alfieri et al. (2012) compared the efficacy of multisensory rehabilitation versus strength training to improve postural balance in aging people. The multisensory rehabilitation consisted on physical exercises performed on varied surface including mattresses and different densities of foam rubber. These authors reported that both interventions were efficient to improve postural balance in aging people but without any difference between its efficacies. Conversely, Gillespie et al. (2012) reported that, in elderly people, a multimodal program might have more beneficial effects on postural balance, than any restrictive training program. To our best knowledge, no intervention based on a combined strength and proprioception training (CSPT) program has been conducted in children with ID. We think that an intervention program acting simultaneously on sensory input integration and muscle output responses could have beneficial effects in optimizing the postural balance enhancement.

Therefore, the aim of our study was to investigate the effect of CSPT program on muscle strength and postural balance in children with ID. We hypothesized that such intervention could have beneficial effects on muscle strength and postural balance of these children which could be useful for their parents or guardians by decreasing their parental dependency, and for clinicians interested in designing new rehabilitation therapies for these individuals.

2. Methods

2.1. Participants

Our recruitment strategy consisted of three-stage screening process to delineate the sample. In the first stage, we screened 40 children with ID from the database of the educational center "Tunisian Union of Aid to Mental Insufficiency" (TUAMI). In the second stage, 28 of these screened individuals who met the selected inclusion and exclusion criteria were selected. These inclusion criteria were: mild ID with an intelligence quotient (IQ) between 50 and 70 (reported in their medical files and determined by the TUAMI psychologist using the WAIC-IV test (Wechsler, 2003); an age between 9 and 13 years and no DS or multiple disabilities. Four of the 28 screened children were excluded from the study because they failed to do all of the pre training measurements or they were absent in the familiarization or in the testing sessions preceding the training program. Of the 24 left children who underwent these measurements, 2 girls did not want to participate in the training program neither in the post training measurements. The 22 left children were 2 girls and 20 boys. As the educational center director stated that these girls have a weak attendance rate in the educational center, they were excluded from the study. As result, 20 boys participated in the study. They were divided into two groups (a control group and a training group) matched in terms of age, duration of institutionalization, and IQ level (Table 1). The control group was not involved in any rehabilitation interventions during the study period and continued their habitual daily activities and practiced only recreational activities irregularly. The training group participated in a CSPT program for 8 weeks with 3 training sessions per week. For every participant, a percentage of 100% attendance to the training program was allocated if he participated to the 24 training sessions. Every unattended session was sanctioned by -4.16%. At the end of the program a mean percentage of 97.9% attendance was calculated for the training group. The experimental protocol was explained to all participants, their

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