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Evaluation of upper limb movements in children with Down's syndrome: A systematic review

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ABSTRACT

The aim of the present study was to perform a review of the literature on current quantitative clinical methods for the evaluation of upper limb movements in children and adolescents with Down syndrome, with a focus on describing the variables, protocols, motor function and motor control.

Methods: A survey of PubMed, Scielo, BVS Bireme and PEDro databases using the following key words: upper limb and EMG and Down syndrome; upper limb and kinematics and Down syndrome; upper limb and motion analysis and Down syndrome; movement and upper limb and Down syndrome; upper limb and Down syndrome; reach and Down syndrome.

Results: In all, 344 articles and five were selected to compose the present systematic review. No standardization was found among the studies analyzed with regard to data collection, data processing or procedures for the evaluation of the variables.

Conclusion: A kinematic evaluation is effective for the discussion of the results, but methodological differences among the studies and inconsistent results exert a negative influence on clinical interpretations and the possibility of reproducibility. The standardization of an upper limb movement evaluation protocol using kinematic analysis is important, as it would provide the basis for comparable, reproducible results and facilitate the planning of treatment interventions.

1. Introduction

Down's syndrome (DS) is a genetic disease with a high incidence throughout the world (De Kegel et al., 2010) and is the most common chromosome disorder among live births. In the United States, it is estimated that 5400 of the four million children born per year have DS (proportion: one out of every 700 births) (Aiello-Vaisberg, 1999; Almeida, Corcos, & Hansan, 2000; Bell, Pearn, & Firman, 1989; Curie, Nazir, & Brun, 2014; Dessen and Pereira-Silva, 2000; Ferreira, Salles, & Marques, 2009). This condition is caused by an additional copy of chromosome 21 and affected children generally exhibit congenital anomalies, including heart or gastrointestinal defects, varying degrees of intellectual disability, hypotonia and ligament laxity (Dessen and Pereira-Silva, 2000; Ferreira et al., 2009; Ferreira and Salles, 2009; Gage and Novacheck, 2001; Gianni MAC, 2005; Lewada, Matsoff, Revenis, Harahsheh, & Futterman, 2016; Lin and Wuang, 2012).

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According to Ferreira et al. (2009), changes in movement patterns occur throughout life in individuals with typical motor development (no neuromotor abnormalities), which may be related to the age of each individual (Ferreira et al., 2009) and interactions between perceptual and motor processes during the production, correction and comprehension of movement. The population with DS exhibits deficits with regard to the learning process and development, which compromises the acquisition of motor skills and functional independence (Bell et al., 1989; Curie et al., 2014; Dessen and Pereira-Silva, 2000). This compromised neuropsychomotor development causes delays in all phases of development, requiring a longer time for children with DS to acquire motor skills, such as controlling the head and trunk, rolling over, sitting, crawling, walking and running (Ferreira and Salles, 2009; Gage and Novacheck, 2001).

The current discussions found in the literature on selective motor development and dexterity are of considerable importance (Goldinf, Emmentt, Caven- lhes, & Steer, 2014). Fine motor coordination, which is also denominated adaptive motor behavior, is responsible for hand movements and dexterity (Sonne and Jennifer, 2004; Mancini, Silva, Gonçalves, & Martins, 2003). Fine motricity consists of a set of movements of particular segments of the body and the capacity to control these movements with minimal effort to achieve precise responses to a given task (Bomono and Rosseti, 2010; Butler and Rose, 2012). Deficiencies in dexterity can exert a negative impact on the ability to perform activities of daily living in an independent fashion (Andel, Cole, & Pepping, 2016). Recovering or enhancing dexterity signifies the recuperation of at least part of one's autonomy, giving an individual with motor deficits more independence as well as enhancing his/her self-esteem and potentiating performance throughout the treatment process (Andel et al., 2016).

Many therapeutic approaches and different techniques have been studied for the rehabilitation of individuals with upper limb impairment and the evaluation, planning and monitoring of therapies aimed at improving functional capacity of the upper limbs has become a vast field of research. Current methods for upper limb evaluations are based on function, motor control, sensory deficiency, dexterity, muscle tone and range of motion (Guimarães and Blascovi-Assis, 2012; Sonne and Jennifer, 2004). The diversity of upper limb functions and the numerous possibilities of hand movements have led to a large number of standardized scales and objective assessment tools for measuring upper limb movements (Guimarães and Blascovi-Assis, 2012; Lopes, Grecco, & Moura, 2017; Moura, Grecco et al., 2016a). However, quantitative measures are needed to describe upper limb movement patterns. Such measures could provide an objective description of upper limb performance based on technical measurements and calculations, such as joint angles, movement duration and velocity.

Three-dimensional (3D) movement analysis is a powerful tool for the quantitative evaluation of movement in all degrees of freedom (Grecco, Duarte, & Zanon, 2014). Researchers have recommended the use of kinematics as an objective, quantitative analysis of upper limb movements in children (Duarte, Grecco, Galli, Fregni, & Oliveira, 2014; Jaspers et al., 2011; Lazzari, Politti, & Santos, 2015). Motion analysis is considered the gold standard for the evaluation of the lower limbs during gait in individuals with neurological disorders (Moura, Almeida et al., 2016b). Motion analysis of the upper limbs is technically more challenging due to the non-cyclic use of the upper limb and the complexity of shoulder movements (Santos et al., 2015). Besides joint kinematics, spatiotemporal variables, such as the duration, velocity, smoothness and trajectory of a given movement, provide important quantitative information on the quality of upper limb movements (Schneiberg et al., 2010). However, no studies were found that clearly address the best method for objective upper limb analysis in the population with DS.

The aim of the present study was to perform a review of the literature on current quantitative clinical methods for the evaluation of upper limb movements in children and adolescents with Down syndrome with a focus on describing the variables, protocols, motor function and motor control used in the performance of upper limb movements.

2. Materials and methods

2.1. Eligibility criteria

Studies that met the following inclusion criteria were selected for the present review: clinical trials and cross-sectional studies published in English in the previous five years. Studies that met one of the following criteria were excluded from the review: publication date more than five years ago; study design that did not meet the needs of the present systematic review; non-analysis of upper limb movement in patients with DS as the primary outcome; and studies not involving humans.

2.2. Search strategy

A systematic review of the literature was performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The PubMed (National Library of Medicine), Scielo, BVS Bireme and PEDro databases were searched from February to August 2016 for original articles, clinical trials and cross-sectional studies using the following key words: Down syndrome; upper limb and kinematics and Down syndrome; upper limb and motion analysis and Down syndrome; movement and upper limb and Down syndrome; upper limb and Down syndrome; reach and Down syndrome) (Macedo et al., 2010; Moher, Liberati, Tetzlaff, & Altman, 2009).

2.3. Review process

The title and abstract of the articles retrieved during the initial search were analyzed independently by the researchers (RDL, NACE and RCFM) using a systematic strategy based on defined inclusion criteria. Any divergences of opinion among the reviewers

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