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Sit-to-stand movement in children: A longitudinal study based on kinematics data



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ABSTRACT

Although the ability to stand from a seated posture is relevant for clinical practice, there are few studies investigating the process of acquisition and refinement of the motor components involved in sit-to-stand movement (STS) in children. Therefore, this longitudinal study aims to describe kinematic characteristics of the STS movement in children from 12 to 18 months, and also to investigate the relationship between changes in STS movement and childrens' daily-life mobility. Ten healthy children were evaluated at 12,13,14,15 and 18 months of age. A motion analysis system was used to measure total duration of STS movement and angular movements of each joint, and frequencies of successful and unsupported STS were obtained. The Pediatric Evaluation of Disability Inventory was used to assess childrens' daily-life mobility. Results showed that children tend to increase the frequency of successful trials over the months by reducing the total duration and decreasing peak ankle dorsiflexion and trunk flexion during STS. Children also started to stand up from chair with decreased trunk flexion angle among ages. At the end of the STS, we observed decreases in trunk flexion and knee flexion over age. Furthermore, kinematic characteristics that reflect improvements in STS movement are related to better performance of functional skills and decreased level of assistance provided by the caregiver in daily-life mobility of younger children. However, the strength of these associations decreases from 14 months of age onwards.

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1. Introduction

The International Classification of Functioning, Disability and Health (ICF) model published by the World Health Organization proposed the assessment of various components in the interactions among functioning and disability, namely the activities executed in daily living, the conditions of body structure and body function as well as social participation (Goldstein, Cohn & Coaster, 2004). According to Damiano (2009), identifying and analyzing the activities that are most demanded in everyday life is crucial for guiding and planning rehabilitative interventions in individuals with neuromotor disabilities.

One of the most commonly executed movements in the child daily routine is the sit-to-stand movement (STS). According to Ploutz-Snyder, Manini, and Wolf (2002), STS is a high-demanding task, requiring integrity of neural, sensory, motor systems and balance capacities. In fact, STS is a clinically-relevant skill, widely used to evaluate motor control and equilibrium in children with functional limitations, and included in several standardized measurement tools such as GMFM (Gross Motor Function Measure), TUG (Timed Up and Go) and Berg tests (Berg Balance Scale) (Kembhavi, Darrah, Magill-Evans & Loomis, 2002; Russell et al., 2000; Williams, Carrol, Reddihough, Phillips, & Galea, 2005). Moreover, STS movement is often included as one of the multi-joint exercises in strength training protocols of rehabilitation programs for children with cerebral palsy (Katz-Leurer, Rotem, Keren, & Meyer, 2009; Liao, Ying-Chi, & Wen-Yu, 2007; Verschuren et al., 2011).

While the ability to stand up from a chair is commonly used in clinical practice, there are few studies investigating the process by which children acquire and refine the movements involved in STS movement, and the strategies used to overcome biomechanical constraints. We believe that studies on development of motor skills demanded in daily life are very important, since it is essential to describe typical parameters of performance (Thelen, 1995; Thelen & Smith, 1998).

In previous studies (Da Costa, Savelsbergh, & Rocha, 2010), we reviewed studies assessing STS movement in children. It was evidently a gap in the literature regarding the development of this skill from its acquisition to refinement. Only one study by McMillan and Scholz (2000) investigated the development of STS movement in five healthy children over an 18-week post-onset period from rising to standing unsupported. The authors concluded that acquisition of this skill occurs at approximately 12 months of age. However, the emphasis was on relative temporal coordination in STS movement rather than analyzing other kinematic variables that are important for a complete understanding of this skill acquisition and refinement process.

Therefore, the current study aims to describe kinematic characteristics of the STS movement from 12 to 18 months of age, i.e., since the acquisition period until six months after. This age-range is based on the period proposed by Cahill, Carr, and Adams (1999) as the first phase of STS acquisition. In addition, we will conduct a longitudinal study during the first months of acquiring this skill to investigate rapid changes and improvements. This study also aims to investigate the relationship between changes in STS movement and daily-life mobility in children. For this purpose, children were assessed by using the Pediatric Evaluation of Disability Inventory (PEDI) (Haley, Coster, Ludlow, & Haltiwanger, 1992).

Based on the knowledge that development is a process characterized by qualitative and quantitative improvements in performance, we expect that kinematic characteristics of the STS movement will change across months. At the same time, the children will also improve performance in daily-life mobility over months. Another issue that will be addressed concerns whether changes in kinematic variables during STS are related to changes in the child's daily routine over the same period. Previous studies showed that limitations in the ability to perform STS movement adequately are closely related to increased dependence in activities of daily living and low quality of life in adults (Janssen, Bussman, & Stam, 2002). Therefore, we believe that STS movement may be correlated with functionality at this age.

2. Methods

The parents/guardians of 60 children were initially invited to participate. Due to refusal, absence of caregivers or incompatibility with inclusion criteria, a convenience sample of ten children, five boys

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