



## Review article

# The clinimetric properties of aerobic and anaerobic fitness measures in adults with cerebral palsy: A systematic review of the literature



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## ARTICLE INFO

## Article history:

Received 6 January 2015

Received in revised form 31 July 2015

Accepted 4 August 2015

Available online 27 August 2015

## Keywords:

Exercise test

Reliability and validity

## ABSTRACT

**Objective:** To analyze the clinimetric properties of maximal aerobic and anaerobic fitness measurement protocols in adults with cerebral palsy (CP).

**Data Sources:** A systematic search through March 2015 of databases PubMed, Embase, SPORTDiscus and PsycINFO was performed with medical subject heading terms for 'cerebral palsy' combined with search terms adults or adolescents and multiple text words for fitness and exercise tests that yielded 864 articles.

**Study Selection:** Abstracts were screened by two reviewers to identify use of maximal fitness measurements in adolescents (14–18 yrs) or adults (>18 yrs) with CP of all abilities. Ninety-four articles were reviewed. No studies of adolescent (14–18 yrs) qualified. Eight articles reported clinimetric properties for adults with CP who walk or propel a wheelchair independently. Five articles reported on aerobic capacity, one reported on anaerobic capacity and two reported on both.

**Data Extraction:** Methodological quality of the studies was rated using portions of the COSMIN (Consensus-based Standards for the selection of health status Measurement Instruments) checklist. Quality of the measurement protocols was evaluated based on statistical strength of the clinimetrics. Synthesis of the overall evidence was based on the Cochrane review group guidelines which combine methodological quality and statistical strength.

**Abbreviations:** CP, cerebral palsy; ACSM, American college of sports medicine; ATP, adenosine triphosphate; MeSH, medical subject heading; COSMIN, consensus-based standards for the selection of health status measurement instruments; RER, respiratory exchange ratio; ICCs, intraclass correlation coefficients; SEM, standard error of measurement; LoA, limits of agreement; MDC, minimal detectable change; MIC, minimal important change; 6MWT, six minute walk test; GMFCS-ER, gross motor function classification system-expanded and revised; CP-ISRA, cerebral palsy international sports and recreation association; SDD, smallest detectable difference; HR, heart rate.

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<http://dx.doi.org/10.1016/j.ridd.2015.08.002>

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**Data Synthesis:** Eight articles reported on 4 aerobic and 1 anaerobic protocols. Overall synthesis revealed that for ambulatory adults with CP there is (i) moderate evidence for good reliability and good construct validity of maximal aerobic and anaerobic cycle tests, (ii) moderate evidence for good criterion validity of sub-maximal aerobic cycle tests, and (iii) strong evidence for poor criterion validity of the six-minute walk test as a maximal aerobic test. And for adults who propel a wheelchair there is limited evidence of good reliability for maximal aerobic wheelchair ergometer tests.

**Conclusions:** Limited quality research exists on the clinimetric properties of aerobic and anaerobic capacity measures for adults with CP who have independent mobility. Quality aerobic and anaerobic measures for adults with more severe mobility impairments are absent.

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## 1. Introduction

Cerebral palsy (CP) is the most common cause of motor disability in childhood; prevalence among school-aged children in the U.S. is estimated at 3.3 per 1000 (Arneson et al., 2009). Motor coordination and muscle tone are impaired, resulting in secondary musculoskeletal deformities with life-long impacts. The effects of motor disturbances on health-related function for adults with CP has gained attention as survival into late adulthood has become more prevalent (Haak, Lenski, Hidecker, Li, & Paneth, 2009; Hombergen et al., 2012). A number of studies report deterioration in mobility, daily function, and participation as well as increases in the incidence of pain, fatigue, and secondary health conditions for adults with CP compared to childhood status (Andersson & Mattsson, 2001; Bottos, Feliciangeli, Sciuto, Gericke, & Vianello, 2001; Sandström, Alinder, & Oberg, 2004; Usuba, Oddson, Gauthier, & Young, 2014; van der Slot et al., 2012; Walsh, Morrison, & McGuire, 2011). Some authors cite poor fitness as a potential factor associated with decline in quality of life as persons with CP age (Fowler et al., 2007; Hemming, Hutton, & Pharoah, 2006; Nieuwenhuijsen et al., 2011; Opheim, Jahnsen, Olsson, & Stanghelle, 2011; Peterson et al., 2013; Rimmer, 2001; Strauss, Ojdana, Shavelle, & Rosenbloom, 2004; Vogtle, Malone, & Azuero, 2014). Fitness is a broad term, and understanding the specific impairments associated with negative outcomes requires separate evaluation of the health-related components of fitness defined by the American College of Sports Medicine (ACSM): cardiovascular fitness (aerobic capacity), muscular strength, muscular endurance (anaerobic capacity), flexibility, and body composition (American College of Sports Medicine, 2010).

As clinicians and researchers evaluate the fitness status of adults with CP and study its impact on health, daily function, and physical activity, quality measurement protocols of aerobic and anaerobic capacity specific to adults are needed. Reduced fitness has been implicated in the increased prevalence of co-morbidities such as cardiovascular disease and osteoporosis in adults with CP (Kim et al., 2014; Peterson, Haapala, & Hurvitz, 2012; Ryan, Crowley, Hensey, McGahey, & Gormley, 2014; Sheridan, 2009; van der Slot et al., 2013). For adolescents and adults with CP, the risks of reduced aerobic fitness or an accelerated decline in aerobic fitness with age are quite high because of reduced mobility and sedentary activity

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