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REVIEW ARTICLE (META-ANALYSIS)

Systematic Review of the Clinimetric Properties of Laboratory- and Field-Based Aerobic and Anaerobic Fitness Measures in Children With Cerebral Palsy

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Abstract

Objective: To systematically evaluate the level of evidence of the clinimetric properties of measures of aerobic and anaerobic capacity used for children with cerebral palsy (CP).

Data Sources: A systematic search of databases PubMed, Embase, SPORTDiscus, and PsycINFO through April 2011 was performed.

Study Selection: Two independent raters identified and examined studies that reported laboratory- or field-based measures of maximal aerobic or anaerobic capacity in children with CP aged 5 to 14 years.

Data Extraction: The COnsensus-based Standards for the selection of health status Measurement INstruments (COSMIN) checklist was used by 2 independent raters to evaluate the methodologic quality of the included clinimetric studies and to identify measures used in these studies.

Data Synthesis: Twenty-four studies that used a maximal aerobic or anaerobic capacity measure were identified. Five studies reported clinimetric properties for 5 measures (2 aerobic and 3 anaerobic measures). Methodologic quality was excellent in 3 studies, showing good validity and reliability of field-based aerobic (Shuttle Run Test) and anaerobic (Muscle Power Sprint Test) measures. The studies on laboratory-based measures were rated fair, mainly because of inadequate statistics. The level of evidence was strong for good validity and reliability of the field-based tests. The level of evidence was unknown for validity and low to moderate for good reliability of laboratory-based tests.

Conclusions: There is a paucity of research on the clinimetric properties of measurement instruments to assess aerobic and anaerobic capacity for children with CP. Further clinimetric studies of laboratory-based measures in children with CP at all Gross Motor Function Classification System (GMFCS) levels, and clinimetric studies of field-based measures in children who are classified as GMFCS levels III to V are required.

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Cerebral palsy (CP) is the most common cause of physical disability in children and is associated with activity limitations in daily life.[1] CP is defined as a group of permanent disorders with an abnormal development of movement and posture causing activity limitations, which are attributed to nonprogressive lesions or anomalies of the brain arising in early development.[2] In

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addition to activity limitations, children with CP have decreased levels of physical fitness.[3-5]

The health-related components of physical fitness are defined by the American College of Sports Medicine as cardiovascular fitness, body composition, muscular strength, muscular endurance, and flexibility.[6] Cardiovascular fitness (ie, aerobic capacity) is defined as the ability to deliver oxygen to the muscles and to use it to generate energy during exercise reflecting the maximal capacity of the cardiorespiratory system.[7] During activity lasting longer than 30 to 45 seconds, the cardiorespiratory system provides the oxygen delivery to the exercising muscle. Short bursts of exercise, which is a major part of children's physical activity patterns, are supported by the anaerobic system. Anaerobic capacity is the maximal amount of adenosine triphosphate resynthesized via anaerobic metabolism during short bursts (30−45s) of high-intensity exercise and is manifested by short-term muscle endurance and peak muscle power.[8,9]

Limitations in aerobic and anaerobic fitness can influence a child's ability to be physically active and to participate in activities of daily living. Reduced fitness levels may also lead to higher risks for developing secondary conditions.[3] Despite the nonprogressive character of CP, children with this condition have a tendency to lose functional mobility with growth and age.[10,11] Adequate physical fitness contributes to maintaining high physical activity levels and can prevent further deconditioning and loss of mobility.[3]

To prevent the cycle of decreased physical activity and fitness, rehabilitation professions are interested in increasing aerobic and anaerobic fitness levels in children with CP. Previous results suggest that aerobic and anaerobic fitness interventions may prevent/reduce the decline in functional mobility observed with growth and development.[12,13] In order to increase aerobic and anaerobic fitness levels in children with CP, it is important for rehabilitation professionals to develop effective fitness interventions and to evaluate these interventions using measures that have been specifically developed, tested, and validated for children with CP. Results from a recent Delphi survey[14] identified the available exercise tests that are appropriate for children with CP. However, the level of evidence of the clinimetric properties of these measures has not been evaluated yet. In this article, clinimetric properties refers to the reliability, validity, and clinical utility of the reviewed measures.

In a systematic review of fitness interventions for children with CP, 3 studies were included that evaluated changes in aerobic fitness after the intervention.[13] All 3 studies detected change in aerobic fitness; however, the measures were not standard across or even within studies. Some studies used submaximal tests to estimate maximal capacity, making it difficult to interpret findings and to compare trends across studies.[13]

Children with CP have a musculoskeletal system with different biomechanic and energetic properties compared with children who are typically developing.[2] It is important that measurement instruments, protocols, or both are developed and evaluated for this specific population. These measures require adequate clinimetric properties to guide and evaluate interventions, monitor progress, and to establish reference values for this population. To achieve these goals, there is a need for standardization of testing protocols and procedures. Interpretation and confidence in test results and intervention outcomes will be stronger once proper measurement tools and procedures are available.

The aim of this study was to systematically evaluate the level of evidence of the clinimetric properties of measures of aerobic and anaerobic capacity used for children with CP. Information from this review will guide selection of measurement instruments and protocols for future clinical trials evaluating aerobic and anaerobic capacity in children with CP.

List of abbreviations:

COSMIN	**COnsensus-based Standards for the selection of health status Measurement INstruments**
CP	**cerebral palsy**
GMFCS	**Gross Motor Function Classification System**
HR	**heart rate**
ICC	**intraclass correlation coefficient**
LoA	**limits of agreement**
MeSH	**medical subject heading**
MIC	**minimal important change**
MPST	**Muscle Power Sprint Test**
RER	**respiratory exchange ratio**
SDC	**smallest detectable change**
SEM	**standard error of measurement**
SRT	**Shuttle Run Test**
Vo_2peak	**peak oxygen consumption**

Methods

Search strategy

A systematic search was performed of the following computerized databases: PubMed, Embase, SPORTDiscus, and PsycINFO through April 2011 without any time restrictions. The search was performed using the medical subject heading (MeSH) terms and text words (or synonyms) for ("physical fitness" OR "aerobic capacity" OR "anaerobic capacity" OR "exercise test") AND "cerebral palsy" AND ("children" OR "adolescents"). The search was expanded using citation tracking and including key words and MeSH terms that were revealed in the primary search.

Study selection

The a priori inclusion criteria for this systematic review were studies (1) that evaluated laboratory- or field-based aerobic or anaerobic fitness measures; (2) with the study population having a diagnosis of CP; (3) with the children aged <14 years; (4) written as full reports; and (5) published in English, French, German, or Dutch. The age criterion was selected because puberty can influence aerobic and anaerobic capacity. In addition, younger children have more difficulty adhering to vigorous test protocols than adolescents or young adults. Therefore, in this systematic review, we chose to include studies that described measures used in children younger than 14 years.

Aerobic and anaerobic fitness measures were included if they aimed to determine maximal capacity.[7-9] For *aerobic capacity,* protocols were incremental until maximal capacity was achieved and peak oxygen consumption (Vo_2peak), maximal power output, or another indicator of maximal exercise was measured. For *anaerobic capacity,* short-term muscle endurance and/or peak muscle power during short-duration (<45s), high-intensity exercise was measured.[8]

Laboratory-based fitness measures are defined as measurements that are performed in a standardized environment using standardized test protocols and equipment. *Field-based* fitness measures are measurements that are performed using standardized