ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2013;94:401-7

ORIGINAL ARTICLE

Recumbent Cross-Training Is a Feasible and Safe Mode of Physical Activity for Significantly Motor-Impaired Adults With Cerebral Palsy

Mark D. Peterson, PhD,[a] Leah Lukasik,[a] Timothy Muth, MS,[a] Phil Esposito, PhD,[b] Heidi Haapala, MD,[a] Paul M. Gordon, PhD, MPH,[a] Heidi IglayReger, PhD,[a] Edward A. Hurvitz, MD[a]

From the [a]Department of Physical Medicine and Rehabilitation, University of Michigan, Ann Arbor, MI; and [b]Harris College of Nursing & Health Sciences, Texas Christian University, Fort Worth, TX.

Abstract

Objective: To examine the feasibility and potential benefits of using recumbent cross-training for nonambulatory adults with cerebral palsy (CP).

Design: Observational.

Setting: Clinical center for CP treatment and rehabilitation.

Participants: Significantly motor-impaired adults with CP (N = 11) with a mean age ± SD of 36.3±13.2 years and Gross Motor Function Classification System (GMFCS) levels III and IV.

Interventions: Participants completed a 40-minute session of aerobic exercise using the NuStep Recumbent Cross Trainer, in which resistance was progressively increased at 5-minute intervals.

Main Outcome Measures: Every 5 minutes during the exercise session, heart rate, blood pressure, oxygen consumption ($\dot{V}O_2$), energy expenditure, and respiratory exchange ratios (RERs) were recorded along with rating of perceived exertion. Immediately after, and 24 hours postexercise, participants received a standard survey to assess levels of pain and discomfort.

Results: All participants were able to complete the 40-minute exercise protocol. Five of the 11 participants achieved a heart rate of at least 60% maximum throughout the duration, 10 participants had a significant elevation in $\dot{V}O_2$ from baseline, and all participants had elevated RER values. Six participants reported pain during exercise, but only 2 reported pain after exercise was over.

Conclusions: The NuStep Recumbent Cross Trainer is a feasible exercise modality for significantly motor-impaired adults with CP, GMFCS III and IV. Moreover, this mode was sufficient to stimulate a significant cardiorespiratory response in all participants, and thus it and similar devices may serve as a viable option for aerobic exercise interventions in this population, to prevent obesity and related cardiometabolic consequences. Archives of Physical Medicine and Rehabilitation 2013;94:401-7

Cerebral palsy (CP) is a group of disorders that affect the development of movement and posture, resulting in significant activity limitations. Although CP is a chronic and permanent condition, most existing research is focused on the status and interventions for children with CP.[1] Moreover, and from a clinical context, there is no standard or systematic follow-up of individuals with CP after the age of 18 years, with little attention devoted to adults and the elderly.[2] Families of children with CP are often told that health, functional status, mobility, and musculoskeletal problems become relatively stable by early adulthood; however, as more people with motor disabilities live beyond middle and later adulthood, it has become increasingly evident that changes in health status and function may be of concern.[3] Importantly, individuals with CP are subject to the same secondary health risks as typically developing adults, such as obesity-related chronic disease, muscle atrophy and weakness, and reduced functional mobility.[4] Thus, in conjunction with the hallmark pain and chronic fatigue associated with CP,[5] these interrelated circumstances represent a unique challenge for the medical community regarding treatment of adults with CP and

No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit on the authors or on any organization with which the authors are associated.

0003-9993/13/$36 - see front matter © 2013 by the American Congress of Rehabilitation Medicine
http://dx.doi.org/10.1016/j.apmr.2012.09.027

appropriate interventions that preserve patient health, function, and quality of life.[3]

As adults with CP age, they experience an overall decline in physical functioning and become increasingly reliant on assistance to perform many activities of daily living.[6,7] To make matters worse, ample evidence exists to confirm that individuals with CP have lower fitness,[8,9] less muscle mass,[10] diminished bone density,[11,12] neuromuscular inefficiency,[13-15] and reduced functional reserve throughout the span of adulthood. Along with the hallmark of motor impairments, pronounced sedentary behavior and fitness deficits that occur in CP[16] have prompted concerns related to exaggerated cardiometabolic health risks.[4,17,18] These issues highlight the importance of habitual physical activity among individuals with CP, and indicate a greater need to maintain physical fitness than even the general population, to offset the inevitable declines that accompany the natural aging process.

Although several studies[19,20] have suggested a beneficial role for exercise participation among adults with CP, implementing physical activity programs for this population involves several physical and psychosocial challenges.[21] Most adults with CP do not exercise regularly enough to maintain strength, which is a primary contributing factor for losses of function. Barriers include chronic pain, fatigue, limited transportation, and access to equipment and facilities.[22,23] While exercise-induced exertion may indeed lead to a transient increase in pain for individuals with CP, regular/habitual participation in activity and movement may serve to decrease self-reported average levels of pain.[24] If patients with CP are able to access exercise facilities regularly, multimodality exercise programs are suggested to be beneficial for preserving muscle morphology and strength, as well as gross motor function.[25] Such improvements, particularly for wheelchair users, can be of great significance in everyday activities and may be a useful means to improve strength and manage pain.[26]

Regular exercise can also be an important factor in maintaining cardiovascular health and preventing disease. Indeed, mortality records have demonstrated a 2- to 3-fold greater death rate from coronary heart disease among adults with CP as compared with the general population.[27] Presently, there are no national surveillance programs that monitor patients with CP longitudinally; however, recent cross-sectional data demonstrate that overweight/obese adolescents with CP have a higher prevalence of dyslipidemia, hypertension, and fatigue than age- and weight-matched individuals without CP.[28] Thus, even small increases in physical activity may be more beneficial than previously thought. In fact, it has been recently demonstrated that individuals in the general population who engage in 150 minutes of moderate-intensity exercise per week have a 14% lower risk of developing coronary heart disease than those with no physical activity.[29] Even individuals who are physically active at lower than the recommended levels may have a significantly lower risk of developing coronary heart disease.

List of abbreviations:

BMI	**body mass index**
BP	**blood pressure**
CP	**cerebral palsy**
GMFCS	**Gross Motor Function Classification System**
HC	**hip circumference**
RER	**respiratory exchange ratio**
RPE	**rating of perceived exertion**
$\dot{V}O_2$	**[volume of] oxygen consumption**
WC	**waist circumference**

Although exercise is a vital part of health maintenance, there is limited research focusing on the impact of physical activity for simultaneous health and functional improvements in persons with CP. This is particularly an issue for patients with significantly compromised mobility (Gross Motor Function Classification System [GMFCS] III−V),[30] who face substantial barriers to exercise. Published exercise recommendations often encourage forms of exercise that are not appropriate for nonambulators or those who have great difficulty ambulating.[31] Virtually no research has been conducted to assess the feasibility or efficacy of exercise protocols for individuals at these GMFCS levels, especially with regard to tolerance of exercise at doses known to stimulate fitness improvements. Therefore, the primary purpose of this study was to examine the feasibility of an exercise program among significantly motor-impaired adults with CP (ie, GMFCS III and IV), to determine whether a threshold level of cardiorespiratory stimulus (ie, at least 60% of age-predicted maximum heart rate) could be achieved without adverse effects such as significant postexercise pain.

Methods

Study design

Patients with CP (GMFCS III and IV) were recruited from the University of Michigan Adult Cerebral Palsy Clinic, Department of Physical Medicine and Rehabilitation. All clinical assessments were conducted in a single session, and included tests of anthropometric characteristics, exercise-stimulated cardiorespiratory parameters, and exercise-induced, patient-reported fatigue and pain experiences. Data from 11 patients with GMFCS III and IV were eligible for inclusion in these analyses. Approval to conduct this study was received by the institutional review board for research with human subjects.

Patient population

The sample consisted of 8 men and 3 women recruited by physicians and researchers with flyers, and from other respondents who had already volunteered to participate. To be eligible, participants had to be previously sedentary and older than 18 years, have a diagnosis of CP (GMFCS III or IV) with significantly limited mobility, be able to communicate (even with a communication device), and be able to follow basic instructions. Individuals with a history of cardiac problems were excluded from the study. Participants were not excluded for asthma, arthritis, or other joint deformities. Written consent was obtained from each participant or legal guardian.

GMFCS levels

The GMFCS levels assess activity limitations for gross motor function with a 5-level ordinal grading scale.[32] Specifically, the GMFCS describes gross motor function of individuals with CP on the basis of self-initiated movement and with an emphasis on sitting, walking, and wheeled mobility. Distinctions between levels are also based on the need for assistive technology, including hand-held mobility devices (walkers, crutches, etc) or wheeled mobility. Individuals at "level I" can generally walk without significant restrictions, but may experience limitations in