

Original Article

Active video games as an exercise tool for children with cystic fibrosis



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Abstract

Background: Active video games are used in many hospitals as exercise tools for children with cystic fibrosis. However, the exercise intensity associated with playing these games has not been examined in this population.

Methods: Children with cystic fibrosis [n = 30, aged 12.3 (2.6) years, 17 boys, BMI 17.7 (2.8) kg/m²] were recruited from outpatient clinics in Dublin hospitals. Age and gender matched control children were recruited from local schools. Oxygen consumption, metabolic equivalents (METs) calculated from resting $\dot{V}O_2$, and heart rate were measured while playing Nintendo Wii™ (Nintendo Co. Ltd., Tokyo, Japan) Sports Boxing and Nintendo Wii Fit Free Jogging using a portable indirect calorimeter (Oxycon Mobile).

Results: Playing Wii Boxing resulted in light intensity activity (2.46 METs) while playing Wii Fit Free Jogging resulted in moderate intensity physical activity (4.44 METs). No significant difference was seen between groups in the energy cost of playing active video games.

Conclusion: Active video games are a useful source of light to moderate intensity physical activity in children with cystic fibrosis.

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Keywords: Video game; Physical activity; Metabolic equivalent

1. Introduction

Physical activity is defined as “any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above a basal level [1]”. Exercise is a subcategory of physical activity and is characterised by being “planned, structured, repetitive and purposive in the sense that the improvement or maintenance of one or more components of physical fitness is the objective”. Physical activity has been shown to have many beneficial effects among children including improved muscle strength [2], cardiorespiratory fitness [3], cardiovascular health [4], and bone health [5]. Physical activity has also been shown to reduce symptoms of depression [6] and enhance self esteem in children [7]. Current guidelines from the Centres for Disease Control and Prevention (CDC)

recommend that all children engage in at least 60 min of moderate to vigorous physical activity daily [8].

Cystic fibrosis (CF) is the most common lethal inherited disease in Caucasians [9]. CF is often characterised by recurrent respiratory infection, progressive airflow obstruction, hypoxemia, malnutrition and reduced muscle mass, factors which can adversely affect physical activity levels [10], and long-term prognosis [11]. Since peak aerobic capacity and peak oxygen consumption have been associated with improved prognosis in CF [12], physical activity and exercise are of central importance in the treatment of children with CF. Physical activity in children with CF has proven beneficial effects on pulmonary function and peak oxygen consumption, and can result in enhanced sputum clearance, reduction of breathlessness, increased exercise capacity, improved body image and improvements in quality of life [13]. Studies have shown that adherence to exercise programs among those with CF can be poor and that exercise which is “pleasant and enjoyable” can improve adherence to exercise programs [14,15].

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Therefore population specific studies into novel child friendly forms of exercise were warranted.

Active video games (AVGs) can be described as computer games which are designed to be controlled by a player's movement rather than by pressing buttons. Five reviews have been published on the energy cost of video game play among healthy children [16–20]. All reviews concluded that playing AVGs require more energy than playing sedentary games and that playing interactive consoles has the potential to lead to health benefits and the accrual of physical activity in children and youth. Furthermore, reviews stated that certain AVGs are capable of engaging children in moderate intensity physical activity. Therefore playing AVGs could present an effective, novel, and child friendly form of physical activity for children with CF. Many hospitals have a Wii console specifically for children with CF. However, the exercise intensity associated with playing these games has not been examined in this population. Kuys et al. [21] measured the heart rate, estimated energy cost, and rate of perceived exertion of adults with CF playing active video games on the Wii console. Gaming was found to result in moderate to vigorous intensity physical activity, and was comparable to exercise on both treadmill and cycle ergometers [21]. Participants in the study by Kuys et al. also rated the feasibility for including an AVG into exercise regimens as 8 out of 10, indicating that AVG play as a form of exercise appeals to adults with CF [21]. The energy cost of AVG play among children with CF is unknown. As the response to exercise in children may not mirror that in adults [22], there was a need to measure the exercise response of children with CF to AVG play. The aim of this study was to measure the energy cost and exercise intensity of AVG play among children with CF and healthy age and gender matched controls. Exercise intensity is an important consideration since only moderate and vigorous intensity exercise contributes to daily physical activity guidelines. Secondary aims were to compare results with recommended guidelines for moderate intensity activity, and to investigate the relationship between percentage predicted forced expiratory volume in one second (FEV₁% predicted) and the energy expended and exercise intensity reached playing active video games.

2. Patients and methods

Children with CF were recruited from paediatric outpatient cystic fibrosis clinics at two sites in Dublin. Age and gender matched children with no health concerns were recruited from schools in the Dublin locality. All participants completed a physical activity readiness questionnaire [23] and provided written informed assent and parental/guardian written informed consent before any testing took place. Diagnosis of CF was established according to standard published guidelines [24]. Children with CF were excluded if they were clinically unstable (defined as changes in symptoms or treatment in the four weeks preceding testing) or required oxygen to exercise at a moderate intensity. Exclusion criteria for both groups were the presence of any neuromuscular, musculoskeletal or rheumatologic condition that could affect exercise. Ethics approval was granted by the

Research Ethics Committee of St. James's Hospital/the Adelaide and Meath Hospital Dublin, Incorporating the National Children's Hospital and by the Ethics (Medical Research) Committee Office of Our Lady's Children's Hospital Crumlin, Dublin.

Body mass was measured to the nearest 0.1 kg, and height to the nearest complete 0.001 m using a Seca scales and stadiometer respectively (Seca Mod 220, Germany). Skinfold measurements were taken at the triceps, biceps, subscapular and suprailiac sites to the nearest 0.0001 m according to standardised guidelines [25]. Results were used to estimate body fat percentage using the Durnin Womersley equation [26].

The six-minute walk test (6MWT) was performed as described by the American Thoracic Society [27]. Oxygen consumption ($\dot{V}O_2$), kilocalories expended (kcal), and heart rate (HR) were measured at rest and while playing AVGs using an indirect calorimeter (Oxycon Mobile, Jaeger, Viasys Healthcare, Hoechberg, Germany) and a Polar HR monitor. The Oxycon Mobile is a lightweight portable system, which communicates telemetrically with the Polar HR monitor and laboratory computer to give details on $\dot{V}O_2$, energy expenditure and related cardio-respiratory parameters on a breath-by-breath basis. The Oxycon Mobile has been validated [28], and used in similar studies measuring the energy cost of AVG play [29].

AVGs used were Wii Sports Boxing and Wii Fit Free Jogging (hereafter referred to as Boxing and Jogging respectively). After 15 min of rest in the supine position, participants played each game for 15 min with at least a 5-minute seated rest between games to allow HR to return to resting values. Game order was randomised. Participants wore validated pedometers on each ankle during gaming conditions (Stepwatch, Orthocare Innovations) [30]. Pedometers were worn to determine if there was any difference in the number of steps taken between groups, which in turn could explain differences in the energy cost of gaming [29]. Perceived exertion was rated immediately after each game using the ten point ONMI rate of perceived exertion scale [31]. Among those with CF, oxygen saturation levels were checked at baseline and during all activities using a portable finger probe saturation monitor (Nonin Oxym II, USA).

Metabolic equivalents (METs) were calculated for each individual as gaming $\dot{V}O_2$ divided by resting $\dot{V}O_2$. Age predicted maximal HR was calculated as $208 - (0.7 * \text{age})$ [32]. Pedometer data from the last 10 min of game play was used in analysis, thus ensuring that participants had become accustomed to the movements required to play the game. To reduce any effect of leg dominance, the average data from pedometers on both legs was calculated for each participant for each game. Mean $\dot{V}O_2$ and HR were calculated from minute 9 to minute 14 to ensure that a steady state was reached. The sum of energy expended in kilocalories for the entire duration of each condition was calculated by the system software of the Oxycon Mobile using $\dot{V}O_2$ and $\dot{V}CO_2$ data, thus giving a realistic measure of the kilocalories expended during an AVG session. For those with CF, spirometry results were recorded within the month before testing took place by trained health care workers (one from each centre) using a calibrated plethysmograph. FEV₁ results were compared with normal age, sex, and height matched standard values (Pan and Cole, 2011, LMS software) and presented as FEV₁ z-scores. Percentage

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