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Virtual reality as means to improve physical fitness of individuals at a severe level of intellectual and developmental disability

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ABSTRACT

Individuals with intellectual and developmental disabilities (IDD) are in need of effective and motivating physical fitness training programs. The aim was to test the effectiveness of a virtual reality (VR)-based exercise program in improving the physical fitness of adults with severe IDD when implemented by on-site caregivers. A research group ($N = 20$; mean age $\pm$ standard deviation = 47.9 ± 8.6 years; severe IDD level) was matched for age, IDD level and functional abilities with a comparison group ($N = 24$, mean age = 46.2 ± 9.3 years; severe IDD level). An 8-week fitness program consisting of 2–3 30-min sessions per week included game-like exercises provided by the IREX/GX video capture VR system. Changes in physical fitness were monitored by changes in heart rate at rest. A significant ($P < 0.005$) reduction in heart rate was demonstrated for the research group. No change in heart rate was monitored in the comparison group. Despite statistically significant improvements in heart rate, the results are not strong enough functionally to claim that this program improved physical fitness of individuals with severe intellectual disability.

1. Introduction

Despite positive effects of regular physical activity that include improvement in cardiovascular and respiratory muscle function, a reduction in coronary artery disease risk factors (Franklin, Whaley, & Howley, 2000), decreased anxiety and depression, enhanced feelings of well-being, and improved performance during work, recreational and sports activities (Franklin et al., 2000) most individuals with intellectual and developmental disability (IDD) tend to avoid participation in such activities. Rather, they show a considerable lack of physical fitness as well as very low levels of cardiovascular endurance when compared to peers without IDD (King & Mace, 1990; Lotan, Isakov, Kessel, & Merrick, 2004; Pitetti & Boneh, 1995). The low level of fitness found in persons with IDD is attributed to their passive lifestyle (Lotan et al., 2004; Pitetti & Boneh, 1995), low motivation (Halle, Gabler-Halle, & Chung, 1999) as well as other psychological and physiological factors (Fernhall & Tymeson, 1988). Of all the factors examined, an inactive life style appears to be most detrimental to physical fitness in this population (Bickum, 1995).

Due to specific challenges presented by individuals with IDD, especially low motivation (Lotan, 2007) and reduced access to health care than the general population (Surgeon General, 2002), conventional training programs that provide only fitness

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routines or remedial-type instruction are not sufficiently motivating (Gignac, 2003). Thus, when seeking to activate individuals with IDD, a broader perspective should be applied, taking into account the person's social, emotional and cognitive development as well as the trainee's areas of interest (Temple, 2007). The implementation of fitness programs that incorporate motivational factors is highly recommended (Lotan, 2007; Rogers-Wallgren, French, & Ben-Ezra, 1992).

Virtual environments afford a variety of assets for rehabilitation and special education including the opportunity for experiential, active learning which encourages and motivates the participant (Mantovani & Castelnuovo, 2003; Rizzo & Kim, 2005; Schultheis & Rizzo, 2001; Weiss, Kizony, Feintuch, & Katz, 2006). It also provides the ability to objectively measure behavior in challenging but safe and ecologically valid environments, while maintaining control over stimulus delivery and measurement to individualize treatment needs with gradually increased levels of task complexity (Rizzo & Kim, 2005).

Over the past decade, virtual reality has begun to be used for the enhancement of functional abilities of individuals with IDD (e.g., Barkley, Anderson, & Kruesi, 2007; Weiss, Bialik, & Kizony, 2003). We previously reported the utility of VR for this population with a group of 33 individuals with IDD and CP who participated in a 12-week intervention program using an adapted video capture VR system (Yalon-Chamovitz and Weiss, 2008). The most prominent finding was that the VR experiences were motivating enough to encourage the participants to engage in intense levels of physical activity than commonly demonstrated by this population. This result led directly to a second study (Lotan, Yalon-Chamovitz, & Weiss, 2009). The research population in the second study included 30 adults with a moderate level of IDD, and they were trained twice a week in a 5–6-week long program, implemented by occupational therapy students. The pre- and post-assessments used to evaluate the physical fitness of this group of participants were the Energy Expenditure Index (EEI) (Rose, Gamble, Burgos, Medeiros, & Haskell, 1990; Rose, Gamble, Lee & Haskell, 1991), the Improved Cooper test, also known as the 12-min walk test (12-MWT) (Cooper, 1968), and later revised by McGavin, Gupta, and McHardy (1976) and the Total Heart Beat Index (THBI) (Hood, Granat, Maxwell, & Hasler, 2002). The results showed significant improvements in physical fitness in all tests for the research group as opposed to no change in the control group.

In this study, our aim was to investigate the effectiveness of video capture VR to enhance the physical fitness of individuals with a severe level of IDD. An additional goal was to determine whether the program could be implemented by the direct-care staff who worked with this population and who did not have any specialized training in advanced technologies such as virtual reality.

2. Methods

2.1. Participants

In a pre-study pilot experiment, 10 participants (5 males, 5 females) were randomly selected from the general study group to determine the most appropriate outcome measures. Their mean age ± SD is shown in Table 1.

Forty-four men and women participated in the full study. They ranged in age between 21 and 60 years and were classified by the residential facility as functioning at a severe level of IDD. They had adequate vision and cognition to see and respond to programs on a computer monitor and sufficient motor ability to be able to carry out some daily tasks (e.g., they were independent eaters, could self-propel a wheelchair). The participants were randomly divided into research ($N = 20$; age range = 37–58 years, mean age = 48.9 ± 5.8 years; IDD level—severe) and comparison groups ($N = 24$, age range = 25–58 years, mean age = 49.0 ± 6.4 years; IDD level—severe) (see Table 1).

There were no significant differences ($P > 0.05$) between the research and control groups when comparing most baseline measures. Functional measures of both groups were also compared and found similar. As can be seen within the table, there were significant differences in the male\female ratio in both groups. All participating residents were divided to two groups of 10 participants.

Table 1
Demographic parameters of participants.

Pilot study ($N = 10$)		
Mean age: years (SD)		47.3 (7.2)
Age range (years)		35–54
Number of males and females		5, 5
Demographic data	**Research ($N = 20$)**	**Comparison ($N = 24$)**
Mean age: years (SD)	47.9 (8.6)	46.2 (9.3)
Age range (years)	37–58	25–58
Number of males and females	5, 15	15, 9
Ambulation (%)		
Walking	83.3	83.3
Wheelchair users	16.3	16.3