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Research Article

A Virtual System As a Facilitator in the Perceived Exertion of Overweight Children

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Keywords

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Abstract

Objective: Observe the exercise intensity of overweight children, their perceived exertion and the motivational aspect, using an active video game compared to the ergometric treadmill test.

Methods: Cross-sectional study with children aged 6 to 10 years. The control group consisted of eutrophic (normal-weight) subjects and the experimental group of overweight children. The children were invited to take part in a racing video game and ergometric treadmill protocol. Maximal exercise intensity was assessed by maximum heart rate and perceived exertion by the modified Borg scale. A numerical scale was used to evaluate the motivational aspect.

Results: The sample consisted of 22 children (11 boys and 11 girls). Maximum heart rate was reached in all the modalities, except for the control group in the treadmill exercise. Perceived exertion was similar between the two groups and both reported to be motivated by the active video game ($p < 0.001$).

Conclusion: For overweight children, exercise intensity and motivation are higher in the video game and perceived exertion was similar between the treadmill and the video game.

ABBREVIATIONS

Hrmax: Maximum Heart Rate; HR: Heart Rate; EG: Experimental Group; CG: Control Group; BPM: Beats Per Minute; SD: Standard Deviation; BP: Blood Pressure; BMI: Body Mass Index

INTRODUCTION

In Brazil, the prevalence of overweight, obesity and a sedentary lifestyle is 33.5% in children between 5 and 9 years of age, representing an important public health problem [1-5].

The aforementioned children have little physical activity skills [2], and video games that require player interaction have become a popular means of motivating adherence to physical exercise [6].

In recent years, a series of studies on perceived exertion in children have focused on adapting to the assessment methods of exercise tests due to the formation of afferent signals originating in the skeletal muscles and their relation with the cardiorespiratory system, promoting physiological stress resulting from high-intensity exertion [7,8].

Age and cognitive development level are essential in assessing exertion intensity in children [7], since they may abandon the test due to lack of interest or fatigue before reaching pre-established maximum exertion [9].

In order to assess exercise intensity, scales have been developed with numerical or verbal expressions or illustrations that cater to the cognitive development level and age of test subjects [8,10]. However, studies [9,11] have used the modified Borg scale, since it is a reliable and easy-to-understand instrument to measure the subjective sensation of dyspnea after physical activity in children [14].

In addition to perceived exertion scales, maximum heart rate (HRmax) is also used to assess cardiovascular response during maximal exertion in exercise tests [14,16], since during exercise the cardiac system alters its behavior, causing peripheral vasodilation, which raises venous return, systolic volume and heart rate (HR) [16].

The hypothesis of the study is based on the premise that, due to its entertainment aspect, the virtual system facilitates perceived exertion intensity in overweight children. As such, the aim of the present study was to observe the exercise intensity of overweight children, their perceived exertion and the motivational aspect, using an active video game compared to the ergometric treadmill test.

METHODS

This is a cross-sectional observational study conducted with children between 6 and 10 years of age. The sample was divided into an experimental group (EG), composed of overweight individuals and a control group (CG), consisting of normal-weight subjects, according to the World Health Organization, 2007 [17]. The participants were recruited at a university outpatient facility in São Paulo, Brazil.

The study was approved by the institutional Research Ethics Committee, protocol number 9387, and the children's parents gave their written informed consent. They also completed a questionnaire on the child's clinical history. All the children were asked if they were willing to take part in the research and provided a cardiological certificate authorizing their participation in physical activities.

Sample size was calculated considering HRmax as outcome variable, expressed in beats per minute (bpm). The standard deviation (SD), was 12.7 bpm, with a difference of 15 bpm between means, and alpha and beta errors of 0.05 and 0.8, respectively, resulting in a sample of 10 children in each group.

Protocol

All the children were submitted to resting blood pressure (BP), assessment using a digital sphygmomanometer equipped with a child cuff and Techline® automatic device before physical exertion. Anthropometric assessment was conducted considering weight and height, using a digital balance (G-life, Magna®), 150 kg maximum capacity and 100 gm accuracy. Body weight was measured with the children barefoot, wearing pants and a t-shirt. Height was measured using a wall-mounted measuring tape, with children barefoot, feet parallel, ankles together, standing erect, arms extended along the side of their body and head positioned so that the lower part of the eye socket was on the same plane as the ear canal [18].

The study was conducted at two visits, 1 week apart. The first consisted of anthropometric, BP and resting HR assessment and video game evaluation. The child was invited to participate in a static racing game on a Nintendo Wii®, which enables the use of a wireless remote control to guide the figure that accompanies the player's movement on a race track. A maximum game duration of 20 minutes was established, but could also be terminated at the discretion of the researcher or if the child requested it due to exhaustion.

At the second visit, one week later, the children were reassessed for BP and resting HR to ensure exercise execution, followed by the ergometric treadmill test (Life Fitness 5500 HR®), according to the modified Balke protocol [19], consisting of nine 1-minute phases at a constant speed of 5.6 km/h, increasing elevation from 6 to 22% at 2% increments per minute and maximum duration of nine minutes [19].

HRmax was used to determine maximum exercise intensity, in which normal-weight children reach values above 180 bpm, and commonly around 200 bpm at peak exertion [20]. This measure was obtained using a Polar RS 800CX® heart rate monitor.

To assess perceived exertion during physical activity, the children completed the modified Borg scale at rest and after the tests, scored between 0 and 10 (0 the lowest and 10 the highest intensity) [13,21,22].

To assess the motivational aspect, a numerical scale was used to score motivation after the video game exercise and ergometric treadmill tests, ranging from 0 (completely unmotivated) to 10 (completely motivated).

Data analysis

Normal distribution was analyzed by the Shapiro-Wilk test. The numerical variables were expressed as mean and standard deviation. The non-paired student's t-test was applied to compare intergroup anthropometric data, in addition to the modified Borg scale values after the tests. The paired student's t-test was used to measure the Borg scale before and after the video game and treadmill tests, in addition to motivation in both modalities. Statistical significance was $p < 0.05$ in all the analyses.

RESULTS

The sample was composed of 22 children (11 boys and 11 girls). The groups were stratified according to their body mass index (BMI). Sample characteristics are described in Table 1.

HRmax was reached in all the modalities, except for the CG in the treadmill exercise. The highest HRmax was recorded in the CG in the video game. Intergroup comparison between exertion intensity and perceived effort showed no statistically significant difference between perceived exertion on the treadmill or in the video game (Table 2). Only two overweight children did not reach 20 minutes (15 and 16 minutes), in the video game.

With respect to perceived exertion and motivational aspect values pre- and post-participation, differences were observed

Table 1: Sample characterization expressed in mean and standard deviation.

Variable	EG (n = 12)	CG (n=10)	p-value*
Age (years)	7,83 ± 1,46	7,50 ± 1,43	0,59
Weight (kg)	37,95 ± 11,64	27,83 ± 9,81	0,04
Height (m)	1,34 ± 0,09	1,28 ± 0,13	0,24
BMI (Kg/m^2)	27,71 ± 4,26	15,28 ± 1,52	< 0,001

Student's t-test for independent samples. Legend: BMI = body mass index, EG = experimental group, CG = control group, SD = standard deviation, HRmax = maximum heart rate, kg = kilograms, m = meters, kg/m^2 = kilograms per square meter.

Table 2: Comparison between intensity (HRmax) and perceived exertion (Borg) after the treadmill and video game.

Variable	Treadmill		Video game	
	EG (n = 12)	CG (n=10)	EG (n = 12)	CG (n=10)
Post Borg	7,58 ± 3,37	7,60 ± 3,23	7,50 ± 3,14	8,40 ± 2,45
HRmax	181,16 ± 6,33 *	172,40 ± 13,14*	186,33 ± 30,00**	199,10 ± 15,30**

HRmax = maximum heart rate and Student's t-test for independent samples with p < 0.005.

(p < 0.001) between children's responses in the video game and treadmill tests (Table 3). In the video game, the children obtained a statistically higher mean when compared to the ergometric treadmill.

DISCUSSION

The results demonstrate that perceived exertion was similar between the treadmill and video game and that both groups reported being motivated in the active video game. On the other hand, exercise intensity for overweight children was higher in the videogame.

These characteristics may be related to the degree of difficulty that overweight children express while executing daily activities, exhibiting lower motor competence and expected performance for their age range and more effort spent, culminating in an increase in heart rate and resistance to interventions [23].

Corroborating our findings, Ferns, Wehrmache and Serratto, 2011 [24], found that during application of the Bruce protocol, overweight children reached HRmax faster when compared to normal-weight children, since they remained motivated for less time [24].

Overweight children aged between 12 and 16 years display lower psychomotor development and their perceived exertion is overstated [19]. This may explain the conscious sensation of fatigue, further limiting their physical capacity [25], which does not agree with our findings. In the present study, overweight children exhibited lower perceived exertion when compared to their normal-weight counterparts. We believe that this is because initial test intensity was higher for normal-weight than for overweight children, whose exercise intensity was constant throughout the entire game.

Post-participation Borg scale perceived exertion was similar for the video game and treadmill. The modified Borg scale is considered a suitable instrument for measuring the subjective sensation of chronic pneumopathic children older than 9 years of age, since the cognitive capacity for subjective perception is adequate when compared to younger children [13]. In a study on 7 to 14 year olds, the authors found that the younger children exhibited difficulty in quantifying fatigue via the Borg scale [26].

Marinov et al. 2008 [10], studied children between the ages of 7 and 11 years, reporting that this age group did not have the cognitive or verbal capacity to understand the exercise intensity descriptors of perception scales [10]. Our results show that 6 and 7-year-olds exhibited no difficulty in expressing their perceived exertion with the scale used, corroborating Marinov et al. 2008 [10], who assessed children between the ages of 7 and 17 years, confirming that if well trained and habituated to the test, they can reliably assess their perceived fatigue level on the 10-point Borg scale [12].

In relation to the treadmill test with maximum intensity protocols, assessing pediatric age groups is a challenge because children are too short for the equipment used [27]. This limitation, along with their shorter attention span and lower motivation, may result in poor performance and less physical exertion [27].

Belanger et al. [28], compared treadmill tests using a maximal and submaximal protocol, concluding that perceived intensity was higher during the latter, possibly due to its longer duration [28]. In the present study, all the children, regardless of BMI, completed the treadmill test.

The modified Balke protocol is a validated test indicated for overweight children [29], since it involves more homogeneous stages with an increase in workload and constant speed [30,31]. It is suitable and feasible for testing exercise tolerance in pediatric age groups [19]. Intergroup comparisons revealed differences, with normal-weight children exhibiting lower HRmax than EG children.

Children perceive the game as a challenge, and overcoming it boosts their self-confidence. These factors promote motivation and involvement with the activity. While children are being entertained they develop imagination, leading us to believe that they do not view the interactive video game as a test or assessment, but as a challenging leisure activity [32]. This was demonstrated by the high motivational score with the virtual system.

Table 3: Comparison of the Borg scale and motivation between the treadmill and video game.

Variable		Video game		Treadmill	
Motivation		9.40 ± 1.43*		9.04 ± 2.51 *	
Borg	**Pre-**	2.59 ± 3.55	< 0.001**	1.81 ± 3.34	< 0.001**
	Post-	7.90 ± 2.82		7.59 ± 3.23	

*p = 0.001 for the mean differences of the motivation scale between the video game and treadmill
**p-value for the difference between pre-and post-participation in the video game and treadmill tests.Paired samples student's t-test.

In regard to maximal exercises, overweight children should be encouraged so that the test does not seem too long or demotivating [5,9]. If motivation declines during the test, it will be difficult to keep the child engaged in the activity and obtain the expected response benefits [33].

Despite the small sample size, the sampling calculation certifies that the results can be extrapolated to overweight children. A study limitation is the fact that the tests were conducted sequentially, prioritizing the video game as the initial test, due to the space available at the facility and logistics in installing the equipment. However, we believe that the sequence influenced the children's adherence because the video game is more enjoyable and does not bore the participants.

Given that for overweight children exercise intensity and motivation are greater in the video game and perceived exertion similar between the treadmill and video game, we believe that the latter is an important tool in assessing intensity and perceived exertion in overweight children.

Overweight children identified changes in perceived exertion after the interactive video game and treadmill test, showing higher exertion and motivation intensity in the former.

CONCLUSION

This study showed that for overweight children, exercise intensity and motivation are higher in the video game and perceived exertion was similar between the treadmill and the video game. This confirms that video game can be used in the Perceived Exertion of Overweight Children.

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