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The Effect of Game-Based Balance Training on Body Composition and Psychomotor Performance of Obese Students

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Abstract

Objectives: The aim of this study was to investigate the effect of game-based balance training on body composition and psychomotor performance of obese students.

Methods: The study recruited a convenience sample of 23 volunteer students in the fifth and sixth grades. The students were randomly assigned to experimental and control groups. Anthropometric characteristics including weight, percent body fat, and muscle mass were measured at pretest and posttest via a body composition analyzer. The level of physical activity was measured by the international physical activity questionnaire-short form (IPAQ-SF). Psychomotor performance was measured using Vienna's universal system.

Results: The results indicated that all parameters of psychomotor performance improved following the game-based balance training ($P \leq 0.05$). Median cognitive reaction time (532 ms at pretest vs. 520 ms at posttest; $P = 0.027$) and median motor time (1.90 at pretest vs. 1.75 s at posttest; $P = 0.001$) improved significantly after the intervention. Movement accuracy including correct response (20.50 at pretest vs. 22.83 at posttest; $P = 0.001$) and correct rejection (30.37 at pretest vs. 32.2 at posttest; $P = 0.001$) also improved after the exercise protocol. However, no significant change was found in body composition variables ($P \geq 0.05$).

Conclusions: Game-based balance training is highly recommended for improving the psychomotor performance of obese students. However, such an exercise was unable to make positive changes in the body composition of obese students.

Keywords: Obesity, Body Composition, Psychomotor Performance

1. Background

Obesity is rising steadily worldwide to become a global epidemic. Based on the evidence, the percentage of obese children in the age range of 6 to 11 years has tremendously increased during the past three decades. Childhood obesity may be attributed in part to a sedentary lifestyle reflecting in too much television watching and playing sedentary computer games, leading to low energy expenditure and increased calorie intake (1). Children's interest in computer games is immensely popular in today's culture. As a challenging issue, it has always been considered a threat by parents and health professionals globally.

There are several studies demonstrating the negative role of sedentary electronic games in gaining more weight (2-4). One of the problems caused by such games pertains to the prevalence of physical inactivity. Hence, there has been increasing research interest in implementing active electronic games as effective interventions to promote physical activity (5). There is some research evidence supporting a relationship between obesity and cognitive impairment (6-8). On the other hand, research has shown that electronic games lacking physical activity and mobility can increase appetite, which plays a key role in the incidence of obesity (9).

Self-determination theory (SDT) is a hypothesis widely used to enhance the health behavior of children. It is concerned with children's desire and states that any intervention with the aim of health improvement in children should be based on children's interests. In this regard, a great deal of studies has demonstrated the benefits of intrinsic motivation in relation to behavior (10, 11). Accordingly, computer games can expose children to purse physical activity while they are intrinsically motivated. Therefore, computer technology has been used to strengthen health behavior over the past two decades (5).

2. Methods

This quasi-experimental study recruited a convenience sample of 23 volunteer obese students in the fifth and sixth

grades with low physical activity who referred to the sporting counseling center of the Sports and Youth Department of Qazvin province. The students were randomly divided into experimental and control groups. The sample size was calculated using Equation 1:

$$n = \frac{\left(\sigma_1^2 + \sigma_2^2\right)\left(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}\right)^2}{d^2} \quad (1)$$

The inclusion criteria were a BMI of above 30, the average score of over 17 in last year, the lack of musculoskeletal disorders, the lack of movement restriction, and a low level of physical activity measured by the International physical activity questionnaire-short form (IPAQ-SF).

This measure assesses the intensity of physical activity and sitting time that people do as part of their daily lives to estimate the total physical activity in min/week. The experimental group performed game-based balance training in a computer game format in three 10-min sessions per week for one month (12). A good balance device (an accurate, reliable instrument for training postural balance) was used to perform balance exercises via the computer game (13, 14). Anthropometric characteristics of the participants including weight, percent body fat (PBF), and muscle mass (MM) were measured at pretest and posttest via a body composition analyzer (Zeus 6 model, Korea). Data were collected using the Vienna universal test. Dependent and Independent *t*-tests were used to analyze the data using SPSS, version 22. The study was approved by the Ethics Committee of Imam Khomeini International University (ref no. 17628). Written informed consent was obtained from all subjects.

3. Results

The general characteristics of the participants are presented in Table 1. Due to the normal distribution of data in groups, the parametric tests were used for data analysis. As shown, no significant difference was found between the anthropometry features of the students at baseline ($P \geq 0.05$).

The results indicated that all the parameters of psychomotor performance improved following game-based balance training ($P \leq 0.05$) while no significant change was found in body composition variables ($P \geq 0.05$; Table 2).

As can be seen in Figure 1, the PBF did not significantly change in the experimental and control groups at posttest ($P \geq 0.05$). Moreover, based on Figure 2, no significant change was found in muscle mass in both groups ($P \geq 0.05$).

Table 1. The General Characteristics of the Participants[a]

Group	Exercise	Control	P Value
Age, y	0.8 ± 12.1	0.6 ± 12.3	0.21
BMI, kg/m²	1.6 ± 32.3	1.4 ± 32.9	0.49
PBF, %	35.1 ± 2.1	35.4 ± 2.1	0.31
MM, kg	17.1 ± 1.3	17.5 ± 1.6	0.19

Abbreviations: BMI, body mass index; MM, muscle mass; PBF, percent body fat.
[a]Values are expressed as mean ± SD.

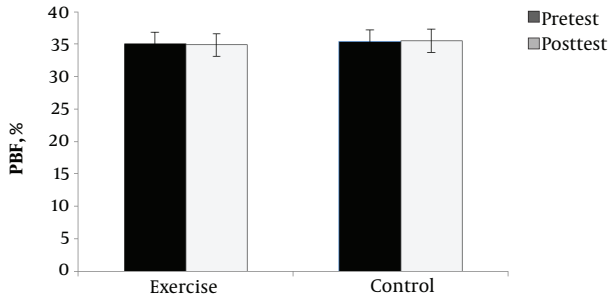

Figure 1. Comparing PBF in exercise and control groups

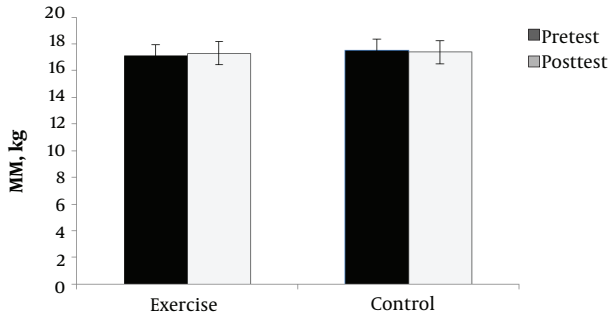

Figure 2. Comparing MM in exercise and control groups

4. Discussion

Computer games as effective media are increasingly popular for a variety of social issues. The implementation of such interventions for encouraging children to do a physical activity can be considered as a key strategy. Therefore, we aimed at determining the effect of game-based balance training on body composition and psychomotor performance of obese children aged 6 - 11 years.

The findings indicated that game-based balance training could improve psychomotor performance. Therefore, the results of the present study on the effectiveness of game-based balance training in improving the psychomotor performance are consistent with the results of a previ-

Table 2. The Effect of Exercise on Motor Perceptual Functions

Psychomotor Performance	Paired *t*-test						Independent *t*-test		
	Exercise Group			Control Group			df	t	P Value
	Pretest	Posttest	P Value	Pretest	Posttest	P Value			
MCRT (ms)	532.2 ± 0.39	520.0 ± 0.41	0.027*	524.3 ± 0.40	528 ± 0.40	0.10	19	-3.164	0.08
MMT (s)	1.90 ± 0.031	1.75 ± 0.48	0.001*	1.91 ± 0.020	1.91 ± 0.021	0.78	19	-12.041	0.001*
Movement accuracy									
Correct response	20.50 ± 1.21	22.83 ± 1.03	0.001*	20.31 ± 1.01	20.35 ± 0.81	0.69	19	8.475	0.001*
Correct rejection	30.37 ± 1.82	32.02 ± 1.72	0.001*	29.73 ± 1.78	29.80 ± 1.52	0.79	19	4.756	0.001*

Abbreviations: MCRT, median cognitive reaction time; MMT, median motor time.

ous study indicating that a cognitive-motor exercise provided a basis for improving the sensorimotor coordination (15). The mentioned study showed that any kind of exercise program involving decision-making challenges could lead to structural and cognitive changes in the brain, which ultimately resulted in improved psychomotor performance (16, 17). A great deal of studies suggests that playing computer games can improve the performance of perceptual and cognitive tasks (7, 18). According to Fahle, this improvement is highly dependent on context, thus, failing to generalize broadly (19). In line with the results, some surveys stated that any kind of exercise program that has decision-making challenges can be effective in structural and cognitive changes in the brain, which ultimately results in improved cognitive actions (16, 17).

Another finding of the present study was that body composition variables did not significantly change after implementing the computer game intervention. Inconsistent with our study, it was shown in a similar study that engaging in gross motor activity during gamification resulted in improved body composition in obese children due to more energy expenditure than sedentary video gameplay (20). One possible reason for the obtained results concerning the lack of changes in body composition (body fat percentage and muscle tissue) could be the short duration of training not only in each session (10 minutes) but also throughout the protocol period (one month). It should be noted that research evidences has shown that exercise type in terms of energy cost requirements can be capable of changing body composition (e.g., strength and aerobic exercises respectively for muscle mass and fat mass) (21-23). Therefore, it seems logical that balance training in sessions of 10 minutes with low intensity would not be capable of changing body composition in obese children. Generally, there were some limitations to the study. Undoubtedly, further research is needed to study the different implications of games, especially with regard to possible trade-offs between the potentially positive and negative effects of computer games in obese children. On the other hand, a randomized sampling method for recruiting a large sample size is highly recommended in future studies.

4.1. Conclusions

The results provided evidence that game-based balance training can enhance psychomotor performance, including movement accuracy, median cognitive time, and median motor time. However, the results failed to support the stronger claim that computer-based balance training improves the body composition of obese children.

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Footnotes

Authors' Contribution: Study concept and design, acquisition of data, analysis and interpretation of data, drafting of the manuscript and critical revision of the manuscript for important intellectual content: Morteza Taheri; statistical analysis, administrative, technical, and material support, and study supervision: Khadijeh Irandoust.

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