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Original Article

Impact of Exergaming on Intention to Physical Activity, Self-Efficacy and Physical Self-Concept in Adolescents with Obesity

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Abstract

Introduction: Exergames, characterized by their engaging and enjoyable nature, are posited to enhance physical activity (PA) objectives and associated health outcomes in youth suffering from obesity. Nevertheless, this phenomenon has been infrequently examined in prior research.
Objective: This study aimed to investigate the effects of exergaming on the intention to PA, self-efficacy, and physical self-concept among adolescents with obesity.
Methods: This study employed a semi-experimental design, utilizing a pre-test-post-test design alongside a control group. 50 students with obesity were selected as participants and were randomly and equally allocated into the exergaming and control groups. Participants in the exergaming group were invited to engage in the Exergaming Activity Program once a week for a duration of 12 weeks. The Intention to Physical Activity Scale, the General Self-Efficacy scale and short-form of Physical Self-description Questionnaire were used for measure research variables. Data was analyzed using ANCOVA.
Results: The results revealed significant differences among the groups for all assessed parameters, which include intention to PA ($F=15.638$, $P<0.001$), self-efficacy ($F=22.964$, $P<0.001$), and physical self-concept ($F=40.857$, $P<0.001$), where the exergaming groups had significantly higher scores than the control groups.
Conclusion: These findings emphasize on the demand for diverse and accessible PA options that engage obese young individuals in PA. Consequently, health and physical education instructors might consider incorporating exergames into their curriculum to promote enhanced PA among students.

Keywords: Exergaming, Exercise, Self-efficacy, Self-concept, Obesity

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1. Introduction

Adolescence is a critical period characterized by heightened sensitivity to social norms and peer acceptance (1). The experience of significant physical changes in body structure and shape, coupled with the transition from childhood to adulthood during puberty, can profoundly influence adolescents' perceptions of their bodies (2,3). The rising rates of obesity and overweight among adolescents are increasingly acknowledged as a critical public health concern. This trend is largely driven by various factors, including shifts in lifestyle, urban development, the intake of high-fat and high-carbohydrate diets, and a lack of physical activity (4). The World Health Organization reports that more than 2 billion people globally are considered overweight, with over 650 million classified as obese. Among young people, the number affected by obesity and overweight exceeds 340 million. Studies show that the rate of obesity has doubled in 73 countries between 1980 and 2020 (5). In adolescents aged 12 to 21, an increase in body dissatisfaction can lead to weight management issues that persist into late adolescence (4-6). The obesity rate in this age group, defined by a body mass index exceeding 35, consistently exceeds the normal threshold by 7.7 percent, correlating with various disorders and health conditions (7). The primary contributor to obesity in youth is a sedentary lifestyle, which is further exacerbated by urban living, excessive television viewing, and the consumption of unhealthy foods (5,7).

The management and prevention of non-communicable diseases are acknowledged as essential priorities in the Sustainable Development Goals set forth by the United Nations in 2015 (8). Overweight and obesity in youth are linked to significant health issues that can persist throughout an individual's life. As a major risk factor for non-communicable diseases, obesity has become a critical public health challenge, adversely affecting overall health and diminishing life expectancy (9,10). The incidence of obesity in young populations is increasing, presenting a growing public health concern, particularly in developing nations. Although obesity rates may be stable in some areas, low- and middle-income countries report a greater number of children classified as overweight or obese than their high-income counterparts (10,11). Most developing countries are transitioning from traditional lifestyles to Western lifestyles and from

traditional industries to mechanized industries. Accompanying this industrialization, dietary habits are also changing, with traditional plant-based and carbohydrate-rich diets being replaced by high-fat diets, contributing to the increase in overweight and obesity. Consequently, obesity and overweight represent some of the most prevalent health issues among youth, particularly as the onset of obesity occurs at increasingly younger ages (12).

With the advancement of science and technology, urban expansion, and the rise of urban living, there has been a notable increase in population density and a corresponding decrease in green spaces (13). These changes have led to a decline in physical activity (PA) and mobility among individuals. The consequences of these lifestyle alterations include a rise in obesity, diabetes, and cardiovascular diseases (14,15). A sedentary lifestyle, coupled with poor nutrition, has transformed obesity into a significant public health issue (16). Furthermore, the prevalence of sedentary behavior has markedly increased among adolescents in recent decades, largely due to the mechanization and modernization of societies, and this unhealthy lifestyle often persists into adulthood (17,18). The established guideline for adolescents recommends engaging in at least 60 minutes of moderate to vigorous PA daily while minimizing sedentary time. However, research indicates that adequate PA levels among adolescents are lacking (19,20).

The advantages of physical activity for health are well acknowledged, particularly when such activities are pursued consistently (21-23). For instance, exercise and movement play a crucial role in managing weight among children. Concerns regarding weight gain in youth are both valid and reasonable. Overweight children face increased risks of health issues such as hypertension, type 2 diabetes, growth hormone irregularities, respiratory problems, and bone-related conditions. Engaging in PA can enhance the quality of life for individuals of all ages. An active lifestyle positively influences overall well-being, contributing to improvements in balance, strength, coordination, flexibility, and endurance. In addition, appropriate patterns of PA established during childhood and adolescence tend to persist throughout an individual's life, laying a foundation for a healthy and active existence (24,25). Conversely, unhealthy habits such as a sedentary lifestyle, poor nutrition, and substance abuse, which may develop during youth, often continue into adulthood. In essence, exercise serves as a means to promote individual health and well-being, fostering physical, mental, and social wellness (16-18). Furthermore, it can alleviate various psychological issues faced by adolescents, including aggressive behaviors, shyness, social withdrawal, depression, and lack of self-confidence, thereby underscoring the importance of education and development in this area. Consequently, it is of significant importance to identify solutions, strategies, and interventions that can positively influence the engagement of overweight adolescents in PA.

The integration of computer technology and virtual reality represents one of the most significant innovations in educational systems (26,27). Virtual reality serves as a form of human-computer interaction, primarily aimed at inducing sensory errors in users, allowing them to perceive the virtual environment as if it were real. This facilitates effective and comfortable engagement in specific tasks (27,28). The advantages of this approach include the provision of targeted, repetitive assignments, as well as feedback and practice opportunities that are often absent in real-world settings (26). Virtual environments are three-dimensional and computer-generated, responding dynamically to user activities while minimizing distractions from the real world. This enhances focus, improves conceptual understanding, fosters social skills, cultivates a sense of belonging and competition, and deepens learning experiences (27,29,30). Furthermore, play is recognized as the most effective and crucial method for children's learning (31,32). Whether in real or virtual environments, children are continuously learning and, unlike adults, become fully immersed in virtual reality games, perceiving them as real. Consequently, they are more profoundly influenced by such environments, leading to heightened challenges in their motor, attentional, and cognitive responses.

Recently, products have emerged that integrate video games with physical exercises, such as the Nintendo Wii and Microsoft Xbox 360 Kinect, commonly referred to as exergames (33-37). Given the rapid increase in the popularity of these products among youth, attributed to their engaging and enjoyable nature, it is essential to conduct extensive studies aimed at determining the specific effects of these products on various functions related to adolescents (37,38). Adolescence represents a pivotal period for encouraging PA, and exergames could be an effective intervention to motivate teenagers to participate in such activities. Furthermore, considering the advancements in technology and the innovative nature of exergame environments, utilizing this technology could potentially foster improved health-related behaviors. One of the advantages of exergames is that individuals can independently engage with it, eliminating the necessity for attendance in specific locations or times for training sessions (36,38-40). Past research showed that exergames enhance PA and health among youth, acting as an alternative or at least a precursor for sedentary individuals with low physical fitness and movement capabilities, complementing traditional PA programs (37,39-41). Overall, it can be asserted that exergames are highly engaging and enjoyable, aligning with the needs and interests of adolescents, and can be leveraged to improve PA goals and its related health-outcomes in youth with obesity. Hence, the purpose of current study was to explore the impact of exergaming on intention to PA, self-efficacy and physical self-concept in adolescents with obesity.

2. Methods

2.1. Participants

This study employed a semi-experimental design with a practical application, utilizing a pre-test-post-test design alongside a control group. The focus was on male students aged 15 to 18 who are classified as obese. A screening process identified 50 students whose body mass index (BMI) was at or above the 95th percentile for participation in the study. These participants were chosen using a convenience sampling approach. The sample size was calculated with G*Power software, establishing a significance level of 0.05 and a power of 0.95. The selected students were divided into the exergaming and the control groups, with each group

consisting of 25 students. Prior to the research's commencement, both the participants and their parents were briefed on the study's aims and methods. Conversations were conducted regarding the challenges and implications of adolescent obesity, highlighting the critical role of parental involvement in its management, and written consent was secured from the parents. Following this, each student underwent a health assessment conducted by a qualified physician and received a health certificate, along with medical clearance for participation in PA. The criteria for inclusion in the study were as follows: 1) participants must be obese with a BMI at or above the 95th percentile, 2) they should not be using any nutritional supplements, 3) they must not be following a specific diet, 4) they should be free from any injuries or illnesses, and 5) they must not have any restrictions on engaging in PA. Individuals failing to meet any of these criteria were excluded from the study.

2.2 Measurements

2.2.1. Intention to Physical Activity

The assessment of the intention to PA was conducted through two questions utilizing a Likert scale from 1 (strongly disagree) to 7 (strongly agree). In this research, the questionnaire's validity was affirmed by eight experts, yielding a Content Validity Index (CVI) of 1.00 and a Content Validity Ratio (CVR) of 1.00. Additionally, the reliability of the questionnaire was found to be excellent, as evidenced by a Cronbach's alpha coefficient of 0.96.

2.2.2. Self-Efficacy

The self-efficacy was evaluated using the General Self-Efficacy scale, which comprises ten items designed to assess effective coping strategies and suggest a consistent internal attribution of success. Participants rated their responses on a four-point Likert scale, ranging from very untrue (1) to very true (4), with total scores spanning from 10 to 40; higher scores reflect greater self-efficacy. The validity of the questionnaire was established through the assessment of eight experts, yielding a CVI of 0.92 and a CVR of 0.94. Additionally, the reliability of the instrument was confirmed to be high, as evidenced by a Cronbach's alpha coefficient of 0.95.

2.2.3. Physical Self-Concept

The Short-form Physical Self-description Questionnaire (PSDQ-S), consisting of 36 items. Each item is presented as a straightforward declarative statement and is evaluated using a six-point Likert scale that ranges from "strongly agree" to "strongly disagree," yielding total scores between 36 and 216. In this research, the questionnaire's validity was affirmed by eight experts, resulting in a CVI of 0.88 and a CVR of 0.90. Additionally, the questionnaire demonstrated high reliability, as evidenced by a Cronbach's alpha coefficient of 0.92.

2.3. Procedure

The study began with essential collaboration with the Education Department, which was followed by securing the requisite permissions to advance. Afterward, a briefing session was held to familiarize the students and their parents with the research objectives, methodologies, and the implementation of the intervention. Written consent was subsequently obtained from the parents. Participants in the exergaming group were invited to engage in the Exergaming Activity Program once a week for a duration of 12 weeks, coinciding with their final class period on the designated day. This program was conducted on the school campus. The participants were organized into groups, each consisting of five to eight students. Over the course of 12 weeks, they engaged in rotational exergaming activities for 45 minutes during each of the 10 sessions (one session per week). Participants were instructed to rotate between game stations every 15 minutes, with the opportunity to choose their activities freely during 4 of the 10 sessions, while the remaining 6 sessions involved structured activities. Participants completed paper-based questionnaires on the first (i.e., pretest) and last days (i.e., posttest) of the Exergaming Activity Program. The participants in the control group did not undergo any supplementary interventions.

2.4. Data Analysis

In this study, the research variables were characterized by calculating the mean, standard deviation (SD), frequency, and percentage of frequency. The normality of the data distribution was assessed using the Kolmogorov-Smirnov test, with all results indicating $P>0.05$. Additionally, analysis of covariance (ANCOVA) was conducted to investigate the differences between the two groups from the pretest to the posttest. A significance threshold of 0.05 was established for all analyses, and data analysis was carried out using SPSS version 27.

3. Results

3.1. Demographic Data

Table 1 presents the mean and SD of the demographic characteristics of the study participants. The average ages of participants in the exergaming and control groups were 16.90 ± 0.18 years and 16.92 ± 0.18 years, respectively, with no statistically significant differences found ($P>0.05$). Initial evaluations indicated that BMI of participants in both groups was similar, again showing no significant differences ($P>0.05$). Regarding parental demographics, the analysis revealed that a significant majority of parents fell into the medium socioeconomic status category (42 individuals, 84%), with no significant differences between the two groups ($P>0.05$). Additionally, a substantial number of parents held undergraduate degrees (26 individuals, 52%), with no significant differences observed between the exergaming and control groups ($P>0.05$).

Table 1. Comparison of the Demographic Data Across Groups.

Variable	Exergaming	Control	Comparison
Age (years)	16.90 ± 0.18	16.92 ± 0.18	P=0.976
Height (m)	1.71 ± 0.03	1.70 ± 0.04	P=0.982
Weight (kg)	89.50 ± 3.86	88.72 ± 3.69	P=0.879
BMI	30.60 ± 1.48	30.70 ± 1.97	P=0.960

3.2. The Results of ANCOVA

Table 2 illustrates the mean and SD of research variables in the pretest to the posttest, along with the comparative outcomes across various groups. The analysis conducted at the conclusion of the intervention period revealed significant differences among the groups for all research variables (P<0.001). These results indicate that the exergaming-based intervention was effective in improving the intention to PA, self-efficacy, and physical self-concept among male adolescents with obesity.

Table 2. The Results of ANCOVA.

Variable		Exergaming	Control	F-Value	P-Value
Intention to Physical Activity	Pre-test	2.05 ± 0.12	2.10 ± 0.15	15.638	<0.001
	Post-test	4.32 ± 0.12	2.13 ± 0.16		
Self-Efficacy	Pre-test	15.69 ± 2.35	16.20 ± 2.84	22.964	<0.001
	Post-test	23.55 ± 3.05	16.37 ± 2.90		
Physical Self-Concept	Pre-test	96.58 ± 4.64	98.71 ± 5.33	40.857	<0.001
	Post-test	13..35 ± 6.89	101.02 ± 5.41		

4. Discussion

This study aimed to investigate the effects of exergaming on the intention to PA, self-efficacy, and physical self-concept among adolescents with obesity. The findings reveal that the exergaming intervention significantly improved the intention to PA, self-efficacy, and physical self-concept in male adolescents with obesity. These results are in line earlier studies (33,34,36,38,40) that highlighted various advantages of exergaming for youth, regardless of their obesity status.

To interpret these findings, it can be sated that young individuals hold a favorable view of exergaming as a viable PA alternative. Self-efficacy has been recognized as a crucial predictor of PA, and exergaming presents an innovative approach to enhance self-efficacy in this domain (40,42). For instance, it has been shown that involving in an exergaming resulted in improvements in exercise self-efficacy in children, particularly among those classified as overweight (35,40). Given that self-efficacy is a strong predictor of PA (44), and is positively associated with increased engagement during exergaming (35), it may serve as a valuable addition to physical education or activity programs. Specifically, physical education instructors can incorporate exergaming to enhance immediate engagement in PA or to foster overall self-efficacy in PA. Educators play a crucial role in creating exergaming environments that foster student success, as these positive experiences can significantly enhance self-efficacy. Therefore, it is vital to choose exergames that are not only aligned with the curriculum but also promote active engagement, achieve intended learning outcomes, are appropriate for school-aged children, and offer constructive feedback. The thoughtful selection of games, continuous assessment, and the provision of additional instruction and feedback are essential for the successful integration of exergaming, which can improve PA and self-efficacy beliefs. Furthermore, the engaging elements found in video games utilized for exergaming can further boost both self-efficacy and enjoyment (36,38,39). This enhancement occurs as users are granted control over their in-game experiences, face challenges, engage in creative self-expression, receive continuous feedback, and participate in competitive scenarios. The integration of exergaming into educational settings aligns with the contemporary movement among educators to incorporate game-like features—such as competition, established rules, and point systems—into the learning process, a practice known as "gamification" (36,37). Notably, many exergames enable players to select their preferred difficulty levels, allowing them to engage at a point where they can experience success while still facing challenges within their zone of proximal development. This approach is likely to foster intrinsic motivation, bolster self-efficacy, and enhance overall enjoyment. Consequently, it is imperative for physical educators to assist students in selecting suitable difficulty levels in exergames, ensuring that instructional differentiation is maintained for all learners.

Early adolescence represents a pivotal developmental phase for fostering PA, making exergames a potentially effective intervention for engaging this demographic. The inherent appeal and excitement of these games captivate adolescents, encouraging their active participation. Evidence suggests that engaging in these activities can enhance the strength of the ankle joint and lower limb musculature, thereby contributing to improved physical function (37,39,40). As adolescents advance through the game levels, the challenges increase, with the virtual environment and pathways evolving to offer more demanding options tailored to their abilities. Additionally, players receive performance feedback during gameplay, which is facilitated by Kinect technology that provides recorded visual feedback, aiding in the correction of movements. The immersive graphic environment of these games ensures a safe space for exercise, allowing individuals to engage in PA with confidence and without the fear of injury (33,34). The neural mechanisms activated during these virtual exercises closely resemble actual movements (36,40). The underlying cellular basis for this approach lies in the plasticity of the nervous system, particularly involving type 1 neurons in the

premotor cortex (37,41). This method effectively combines the benefits of training, movement visualization, observation, and imitation, suggesting that repeated practice with visual feedback can significantly enhance physical self-concept in youth with obesity.

This research faced multiple limitations. Notably, the study focused solely on male adolescents, which may hinder the generalizability of the results to female adolescents. To address this gap, future investigations should explore the effects of exergaming on the physical and psychological well-being of girls. Furthermore, the absence of a follow-up assessment conducted at a longer interval after the post-test restricts the evaluation of the long-term impacts of exergaming. Thus, it is recommended that subsequent studies include follow-up assessments with extended time frames to better understand these effects. One of the strengths of this research is its application of exergaming among obese adolescents, as the findings can be utilized to enhance PA and improve the mental health of this demographic.

4.1. Conclusion

This study aimed to investigate the effects of exergaming on the intention to PA, self-efficacy, and physical self-concept among adolescents with obesity. Based on the findings of this study it can be concluded that exergaming can improve the intention to PA, self-efficacy, and physical self-concept in male adolescents with obesity. In addition, these findings emphasize on the demand for diverse and accessible PA options that engage obese young individuals in PA. Findings from this study indicated that engaging in exergaming activities led to significant changes in intention to PA, self-efficacy or physical self-concept among obese male youth. Consequently, health and physical education instructors might consider incorporating exergames into their curriculum to promote enhanced PA among students.

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Footnotes

Authors' Contribution: This study was carried out solely by the corresponding author.

Conflicts of Interest

Non to declare.

Data Availability: The data that support the findings of this study are openly available upon request from the corresponding author.

Ethical Approval: The author confirms that all steps and requirements of this study comply with ethical guidelines. Participants were informed about the characteristics of the study and gave written informed consent.

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