

A Pilot Study on the Effects of Competitive Exergames on Life Satisfaction among Overweight and Obese Male Adolescents in Fujian, China

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Abstract

This pilot study examined the effects of competitive exergames on life satisfaction among overweight and obese male adolescents in Fujian, China. Twenty-four participants aged 12 to 15 years were randomly divided into three groups: a peer involvement competitive exergames group (PICE), a single-player competitive exergames group (SPCE), and a control group physical education class (PEC). The intervention lasted for two weeks, three times a week. Life satisfaction was assessed using the Multidimensional Student Life Satisfaction Scale (MSLSS). The results showed that the PICE group was significantly better than the control group in friend satisfaction ($p = 0.017$, $d = 1.443$) and self-satisfaction ($p = 0.027$, $d = 1.009$). Other dimensions also showed positive trends, especially in the PICE group, although these trends did not reach statistical significance. These findings suggest that peer involvement in competitive exergame interventions can have a positive impact on adolescents' social and psychological well-being. This study provides preliminary evidence that competitive exergame can be a feasible and effective method to improve life satisfaction in overweight and obese adolescents. Intervention duration and exercise intensity may need to be adjusted in the future to verify and expand these effects and feasibility.

Keywords: competitive exergames, life satisfaction, overweight and obese, male adolescents

1. Introduction

According to the latest data released by the National Health Commission, the overweight rate of adolescents aged 6 to 18 in China has reached 20.4%, and the obesity rate has reached 12.7% (Hong et al., 2023). In addition, the overweight rate in some provinces is even higher. For example, the obesity rate of boys in some cities in Fujian Province exceeds 14%, while the obesity rate of girls is less than 10% (Zhang et al., 2023). This shows that male adolescents face more severe challenges with obesity. Obesity not only threatens their physical health but also increases their mental health problems (Färster et al., 2023; Itriyeve, 2022; Rosengren, 2021).

Life satisfaction is closely related to mental health, and in adolescents, it is also closely associated with psychological adaptation, self-esteem, and social functioning (Orben et al., 2022; Cavioni et al., 2021). Studies have shown that obese adolescents are more likely to suffer from peer rejection and discrimination in school environments, and this experience will directly or indirectly reduce their life satisfaction (Hendy et al., 2025; Pearl & Hopkins, 2022; Lopez-Agudo & Marcenaro-Gutierrez, 2021). In addition, social support and sports participation can effectively improve life satisfaction (Baria & Gomez, 2022; Huang et al., 2022).

Competitive exergames (CE) create opportunities for social interaction through multiplayer competition, enabling overweight and obese adolescents to gain peer support and a sense of social belonging in gaming scenarios (Chan et al., 2024; Nekar et al., 2023). Exergames are an innovative intervention method that combines physical exercise with video games (Ketelhut et al., 2022). Studies have shown that CE can significantly

improve adolescents' physical activity and mental health; however, research on life satisfaction remains limited (Calcaterra et al., 2023; Yu et al., 2023). In this study, physical activity refers to any bodily movement requiring energy expenditure (e.g., walking, exergaming, physical education classes). Sports activity typically involves structured, competitive, and skill-based physical exertion (e.g., organized team sports) (Hastürk & Akyıldız Munusturlar, 2022). Our intervention (competitive exergames) bridges these categories by incorporating game-based competition (e.g., peer/individual challenges) but differs from traditional sports in its digital, non-athletic framework. We will explicitly define this distinction in the revised manuscript.

Therefore, this study aimed to explore the intervention effect of CE on life satisfaction among overweight and obese male adolescents in Fujian, China, and to compare the differences between peer participation and individual participation models.

2. Method

2.1 Participants

This study involved 24 overweight and obese male middle school students from Fujian Province, China. They were randomly divided into three groups: two experimental groups and one control group, each comprising eight people. They were peer involvement Competitive Exergames play (PICE), single-player Competitive Exergames (SPCE), and the control group physical education class (PEC).

The inclusion criteria were as follows:

- a) Male middle school boarding students aged 12-15;
- b) BMI \geq 85th percentile;
- c) Never experienced Exergames before;
- d) No disease or mental illness that affects physical activity.

Exclusion criteria included:

- a) Not living in school;
- b) Taking diet pills, other medications, or dieting;
- c) Participant is injured, ill, or has a motor disability;
- d) Subjects participated in other forms of additional physical exercise.

The participants' weight status was determined using the Chinese BMI classification standards for children and adolescents (Working Group on Obesity in China, 2004), where:

- Overweight: BMI \geq 85th percentile for age/sex.
- Obese: BMI \geq 95th percentile for age/sex.

This study has obtained ethical approval from the Medical Research Ethics Review Committee of the Third People's Hospital of Fujian Province (reference number: 2024-185). All participants were instructed to participate only in the CE intervention throughout the study period and to refrain from engaging in any additional physical activities. In addition, all participants voluntarily signed an informed consent form to participate in physical activities, and assistants will monitor students' daily diets and record their energy intake. Repeated measurements were performed after the two-week intervention period to evaluate the effectiveness and feasibility of the intervention.

2.2 Characteristics of Participants

Basic anthropometric measurements, including height and weight, were performed on all subjects in this study. The specific measurement data are shown in Table 1. Height was measured using a SECA 213 portable stadiometer (SECA GmbH & Co. KG, Hamburg, Germany), and weight was measured using a TANITA BC-420MA bioelectrical impedance analyser (TANITA Corporation, Tokyo, Japan).

Table 1. Descriptive statistics for PEC, SPCE, and PICE groups

Variables	PEC	SPCE	PICE
Age (Months)	155.30 (3.11)	157.31 (3.61)	151.30 (4.23)
Height (cm)	173.75 (2.02)	166.12 (2.54)	164.50 (4.23)
Weight (kg)	84.97 (3.67)	80.38 (4.23)	78.59 (6.81)

2.3 Intervention Programmes

The intervention implementation program of this study was based on a previous research design and followed the FITT (frequency, intensity, time, and type) principle (Xu et al., 2024). The latest version of the Nintendo Switch model that supports multiplayer sports was selected. Finally, the modification suggestions of six experts were referenced and integrated to ensure the effectiveness and operability of the training program. The main goal of the intervention was to improve the life satisfaction of overweight and obese male adolescents through two weeks of CE training.

- i. Warm up (10 minutes): Move all joints and activate organs. This includes bowling in the first week and golf in the second week.
- ii. Sports (20 minutes): Choose a sport that involves two-person competition, including tennis in the first week and boxing in the second week.
- iii. Aerobic exercise (15 minutes): Select aerobic exercise sports for two-person competition, including fencing in the first week and dancing in the second week.
- iv. Frequency and duration: The CE intervention lasted for two weeks, three times a week, 45 minutes each time.
- v. Intensity: Moderate intensity exercise (60-75% of maximum heart rate). The difficulty of the exercise game was set to moderate intensity to ensure sufficient physical stimulation to achieve the predicted effect.

2.4 Test Instrument

The Multidimensional Student Life Satisfaction Scale (MSLSS) is a multidimensional life satisfaction assessment tool developed by American scholars for use with children and adolescents (Huebner & Gilman, 2002). It is used to assess students' subjective well-being in multiple areas of life. The scale has been translated into Chinese and verified by Tian Li and Liu Wei, demonstrating good reliability and validity (Cronbach's $\alpha = 0.90$) (Tian et al., 2015). The scale comprises 40 questions, covering five dimensions: family satisfaction, friend satisfaction, school satisfaction, self-satisfaction, and satisfaction with the living environment. The subjects answered using a 6-point Likert scale (1 = strongly disagree, 6 = strongly agree). Among them, questions 3, 4, 9, 13, 23, 24, 27, 32, 34, and 39 are reverse-scoring questions, which are flipped when scoring.

2.5 Data Analysis

The data processing software used in this study for all statistical analyses was SPSS version 27.0. Descriptive statistics were performed for the pre-test and post-test data of the three groups. To test the normality of the data, the Shapiro-Wilk test was used. If the normality assumption was met, parametric tests were used. Otherwise, nonparametric tests were used. For comparing pre-test and post-test scores within the group, for normally distributed data, we used the paired sample t-test. If the data did not meet the normality assumption, the Wilcoxon signed rank test was used. For the comparison of the post-test scores of the three groups (PICE, SPCE, and PEC), one-way analysis of variance (ANOVA) was used. If significant differences were found, Tukey's honest significant difference (HSD) test was used for post hoc comparisons. The effect size was calculated to determine the size of the intervention effect. Cohen's d was used for pairwise comparisons, and eta square (η^2) was used for the results of the analysis of variance. The significance level of all statistical tests was set at $p < 0.05$.

3. Results

3.1 Validity and Reliability

The Multidimensional Students' Life Satisfaction Scale (MSLSS) used in this study has been previously validated by Tian and Liu. Before the formal intervention of competitive exergames, this study invited six experts in adolescent psychology and sports to evaluate the content validity of the experimental design and measurement scale. The experts assessed the rationality of the intervention procedure, the adaptability of the target population, and the relevance of the selected life satisfaction scale. The content validity index (I-CVI), calculated based on the expert ratings, exceeded 0.90, indicating a high consistency in the clarity and relevance of the items. Based on this result, this study believes that the measurement and intervention design is appropriate and effective for data collection of the target population.

To ensure internal consistency, this study used Cronbach's alpha coefficient for reliability analysis. The total Cronbach's alpha coefficients for the pre-test and post-test of MSLSS were 0.91 and 0.93, respectively, indicating good internal reliability. These results are consistent with the pre-test results of the scale, confirming its reliability in measuring adolescent life satisfaction across domains. Therefore, the tool has good validity and

reliability in this study.

3.2 Preliminary Tests of Statistical Assumptions

Before conducting inferential statistical analysis, preliminary tests were conducted in the study to evaluate the basic assumptions of normality and homogeneity of variance. The Shapiro-Wilk test was used to test the normality of the pre-test and post-test scores within each group. As shown in the results of Table 2, each variable in each group followed a normal distribution ($p > 0.05$).

Table 2. Normality Test Using Shapiro-Wilk (p-value) at Pre-test.

Group	Variables					
	Family	Friends	School	Self	Living	MSLSS
PEC	0.254	0.388	0.351	0.772	0.816	0.355
SPCE	0.986	0.913	0.441	0.888	0.728	0.950
PICE	0.848	0.411	0.837	0.774	0.958	0.214

Levene's test for homogeneity of variance was subsequently performed to verify the assumption of homogeneity of variance of the post-test scores of the three groups. The test results are presented in Table 3, which indicates that there is no significant deviation in the results ($p > 0.05$), suggesting that the variances between the groups are sufficiently equal. When normality is met, one-way analysis of variance can be performed to compare the groups. Based on the results of these hypothesis tests, parametric methods were used in the primary statistical analysis to ensure robustness and accuracy.

Table 3. Homogeneity Test of Pre-test Results

Variables	Levene Statistic	df1	df2	P-value
Family	0.514	2	21	0.605
Friends	0.194	2	21	0.168
School	0.196	2	21	0.824
Self	0.365	2	21	0.698
Living	1.180	2	21	0.327
MSLSS	1.192	2	21	0.310

3.3 Descriptive Statistics

Descriptive statistics were calculated for all participants to summarise the overall and subscale scores of the life satisfaction scale before and after the intervention across the three groups: Physical Education Class (PEC), Single-Player Competitive Exergame (SPCE), and Peer Involvement Competitive Exergame (PICE).

In the pre-test of the experiment, descriptive statistics of the five life satisfaction subscales and the total score of MSLSS were calculated for the PEC group ($n = 8$), SPCE group ($n = 8$), and PICE group ($n = 8$). The means and standard deviations of the groups are listed in Table 4.

Table 4. Mean Comparison among Groups in Pre-test (Mean, SD)

Variables	PEC	SPCE	PICE	F-value	P-value
	n=8	n=8	n=8		
Family	33.00 (2.78)	34.75 (3.50)	37.25 (4.20)	2.914	0.076
Friends	39.38 (3.54)	37.75 (3.20)	34.25 (6.50)	2.533	0.103
School	35.50 (3.38)	38.16 (4.52)	37.50 (4.28)	0.900	0.422
Self	32.88 (4.97)	35.88 (3.65)	39.38 (5.56)	3.369	0.142
Living	36.88 (3.52)	32.25 (5.23)	34.88 (6.20)	1.652	0.216
MSLSS	177.50 (5.86)	178.25 (5.52)	183.38 (9.10)	1.662	0.214

A one-way analysis of variance (ANOVA) was conducted to determine whether there were statistically significant differences among the three groups before the intervention. The results showed that there were no significant differences in all subscales or the total score of MSLSS in the pretest phase (all $p > 0.05$). This suggests that the three groups were statistically comparable in terms of their initial levels of life satisfaction.

Although the baseline scores of family satisfaction ($M = 37.25$, $SD = 4.20$) and self-satisfaction ($M = 39.38$, $SD = 5.56$) were slightly higher in the PICE group, the differences were not significant. The PEC group and the SPCE group showed similar patterns on each subscale, further supporting the equivalence of the two groups in the pretest.

As shown in Table 5, the posttest means of most variables improved, especially in the PICE and SPCE groups. One-way ANOVA results showed that there were statistically significant differences between the groups in the friend satisfaction subscale ($F = 2.165$, $p = 0.014$). Although the overall MSLSS score ($F = 2.716$, $p = 0.089$) and other subscales of the intervention group improved, the differences were not statistically significant ($p > 0.05$).

Table 5. Mean Comparison among Groups in Post-test (Mean, SD).

Variables	PEC	SPCE	PICE	F-value	P-value
	n=8	n=8	n=8		
Family	33.00 (3.16)	36.00 (3.89)	37.87 (4.48)	3.206	0.601
Friends	39.75 (3.15)	38.38 (3.20)	34.88 (7.06)	2.165	0.014
School	35.37 (3.62)	39.25 (4.68)	38.25 (4.16)	1.853	0.081
Self	32.75 (5.12)	36.63 (3.74)	39.88 (5.74)	4.173	0.301
Living	37.13 (3.48)	33.12 (4.70)	35.63 (6.14)	1.362	0.278
MSLSS	178.13 (5.67)	183.84 (7.95)	186.63 (9.52)	2.716	0.089

Notably, the PICE group consistently showed higher posttest scores in multiple domains (e.g., self-satisfaction: $M = 39.88$, $SD = 5.74$), indicating a positive trend of improvement in life satisfaction in the PICE group compared with the PEC group. These results suggest that participating in competitive sports games, especially those involving peer interaction, may increase the social dimension of perceived life satisfaction to a greater extent. However, not all observed differences reached statistical significance.

To further explore group differences following the intervention, pairwise comparisons were conducted using post hoc tests. The results are summarised in Table 6.

Table 6. Pairwise Comparison among Groups at Post-test.

Variables	Between Groups	Mean Difference	p-value	95%CI		Effect Size (d)
				Lower	Upper	
Family	PEC vs SPCE	-3.000	0.412	-8.053	2.053	0.772
	PEC vs PICE	-4.875	0.061	-9.928	0.178	0.755
	SPCE vs PICE	-1.875	1.000	-6.928	3.178	0.483
Friends	PEC vs SPCE	-1.375	1.000	-4.910	7.660	0.285
	PEC vs PICE	-4.875	0.017	-1.410	11.160	1.443
	SPCE vs PICE	-3.500	0.487	-2.785	9.784	0.724
School	PEC vs SPCE	-2.875	0.550	-8.312	2.652	0.688
	PEC vs PICE	-3.875	0.233	-9.311	1.562	0.927
	SPCE vs PICE	-1.000	1.000	-2.561	8.312	0.239
Self	PEC vs SPCE	-3.875	0.395	-10.299	2.549	0.785
	PEC vs PICE	-7.125	0.027	-13.549	-0.701	1.009
	SPCE vs PICE	-3.250	0.607	-3.173	9.674	0.658

Living	PEC vs SPCE	-1.500	1.000	-4.870	7.870	0.306
	PEC vs PICE	-4.000	0.352	-2.370	10.370	0.817
	SPCE vs PICE	-2.500	0.957	-3.870	8.870	0.511
MSLSS	PEC vs SPCE	-5.625	0.433	-15.276	4.026	0.758
	PEC vs PICE	-8.500	0.097	-18.151	1.151	1.146
	SPCE vs PICE	-2.875	0.097	-6.776	6.526	0.387

From the results of the post hoc comparisons, it is evident that the "friend satisfaction" score of participants in the PICE group was significantly higher than that of the PEC group (mean difference = 4.875, $p = 0.017$). The effect size was large ($d = 1.443$), indicating that peer competitive sports games had a significant positive impact on the social satisfaction of adolescents with their peers. Secondly, the "self-satisfaction" score of the PICE group was also significantly higher than that of the PEC group (mean difference = 7.125, $p = 0.027$), and the effect size was also large ($d = 1.009$). This shows that participating in sports games with peers can not only improve interpersonal satisfaction but also promote adolescents' self-cognition and mental health. Although other comparison results did not reach statistical significance, some results showed medium to large effect sizes, such as family satisfaction ($d = 0.755$), school satisfaction ($d = 0.927$), and overall MSLSS score ($d = 1.146$) when comparing the PICE group and the PEC group.

4. Discussion

This pilot study aimed to investigate the effects of competitive exergames on life satisfaction among overweight and obese male adolescents in Fujian Province, China. Specifically, the study compared the effects of PICE and SPCE with PEC on five domains of life satisfaction. The results provide preliminary support for competitive exergames as a promising intervention to improve subjective well-being in this population.

Data analysis revealed that although no significant differences were observed between groups at baseline, participants in the PICE group achieved significantly higher posttest scores on friend satisfaction and self-satisfaction compared to those in the PEC group. The large effect sizes observed (Cohen's $d = 1.443$ for friend satisfaction and $d = 1.009$ for self-satisfaction) suggest that these improvements are not only statistically significant but also of practical significance. These findings are consistent with previous research indicating that peer support and social connection are key factors in enhancing adolescent psychological well-being (Butler et al., 2022). The multiplayer nature of PICE provides opportunities for cooperation, competition, and encouragement, which can help strengthen peer connections and a sense of belonging.

In terms of self-satisfaction, the PICE intervention may have improved participants' self-perceptions by enabling them to engage in enjoyable physical activity experiences successfully. The sense of accomplishment, competence, and physical engagement during exergames may improve their self-image and confidence, especially in a group that is often discriminated against or marginalised in physical activity environments based on weight status.

Other subscales (family satisfaction, school satisfaction, and residential environment satisfaction) did not differ significantly between groups, but the effect sizes for these dimensions were small. Interestingly, the SPCE group also showed slight improvements on multiple dimensions, but they did not reach statistical significance. This may suggest that while individual exergame participation can yield certain psychological benefits, the social context of the game, particularly peer interaction, is crucial in amplifying positive outcomes. This finding supports social cognitive theory, which posits that learning and behavioural outcomes can be enhanced through social modelling, reinforcement, and mutual participation (Rodrigues et al., 2023).

Although the findings are encouraging, some limitations should be acknowledged. First, the small sample size ($n = 24$) limits the generalizability of the results and reduces the power to detect more subtle effects (Lakens, 2022). Second, the intervention lasted only two weeks; longer interventions may be needed to observe stronger, more sustained effects across all life domains. Third, the study focused only on male participants, which may limit its applicability to female adolescents or mixed-sex settings.

Future research should aim to adjust the intervention duration and exercise intensity to verify and expand these effects and feasibility, include female participants, and explore the long-term effects of different exergame mode interventions. Additionally, incorporating qualitative data could provide a deeper understanding of the subjective experiences and motivational dynamics underlying the observed changes.

5. Conclusion

This pilot study investigated the effects of competitive exergames on life satisfaction among overweight and obese male adolescents. The results showed that the peer involvement exergame group had the most significant improvement in life satisfaction, especially in the domains of friend satisfaction and self-satisfaction, with significant differences and large effect sizes. This result highlights the significance of peer interaction and social support in fostering weight-related emotional and psychological well-being in adolescents.

Although other dimensions, such as family satisfaction, school satisfaction, and living environment satisfaction, did not show statistically significant differences, the observed trends and effect sizes suggest that a more extended intervention period or a larger sample size may lead to more comprehensive improvements. The single-player exergame group also showed some positive trends, although less pronounced, suggesting that exergames alone may have limited benefits without the inclusion of social factors. This study further demonstrates that exergames are a feasible and engaging intervention tool to promote adolescent well-being. Given the limitations of sample size, gender representation, and intervention duration, future studies should use larger and more diverse samples to capture participants' life experiences and motivational factors.

In conclusion, peer-involvement competitive exergames provide a promising approach to improve life satisfaction in overweight and obese adolescents. As an alternative or supplement to traditional physical education, they offer an innovative, fun, and socially meaningful way to improve the mental and emotional health of this at-risk population.

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