

Effects of Active Video Games on Parent-Child Relationships among Overweight and Obese Adolescents in China: A Pilot Study

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Abstract

The purpose of this study is to explore the effect of AVG intervention on the parent-child relationships of overweight and obese male adolescents under a family-based parental involvement model. A cluster randomised controlled trial (C-RCT) was conducted with 12- to 14-year-old participants, divided into three groups: (1) Parental Involvement in Active Video Games (PIAVG), (2) Single Player Active Video Games (SPAVG), and (3) Control (watching TV-WTV). The intervention lasted for two weeks, during which changes in parent-child relationship levels were assessed at baseline and post-intervention. Although no significant changes were observed within the three groups, the trend analysis indicated an upward trajectory in both experimental groups. Notably, the PIAVG group demonstrated significantly more improvement in the measured outcomes than the WTV group in the inter-group comparison. The findings suggest that parental involvement in active video games enhances the effectiveness of such interventions, leading to better parent-child relationships among overweight and obese adolescents. This underscores the potential for family-based interventions to combat adolescent obesity in this population.

Keywords: Active Video Games, Overweight Adolescents, Physical Activity, Parental Involvement, Cluster Randomised Controlled Trial.

Introduction

In 2019, the COVID-19 outbreak, an acute stressor, negatively impacted people's mental health. Some researchers detected anxiety and depression symptoms of different degrees when testing the people (Zheng et al., 2020) and found that the more individuals in the hardest-hit areas of the epidemic, the higher the level of anxiety (Su et al., 2020). The outbreak of COVID-19 has also had varying degrees of impact on their psychological health (Chen et al., 2020). The continuous spread of COVID-19 has changed the individual lifestyle, and home isolation has become the main coping style (F, 2021). Furthermore, home isolation can alter people's lifestyles and habits, resulting in a restricted range of activities,

unpredictable work schedules, and a solitary mode of communication. This can lead to adverse psychosocial outcomes such as life cycle disorders, relationship disorders, and inactive behaviour (Pedrosa et al., 2020).

A previous study indicated that, compared to unhealthy and damaging parent-child relationships, individuals with intimate and positive parent-child relationships have significantly exhibited higher levels of psychological health (Hazel et al., 2014). However, with the advancement of technology, the use of screen media such as televisions, computers, and screen-based devices is becoming increasingly widespread. The frequency and duration of contact between adolescents and electronic devices have significantly increased, resulting in varying degrees of impact on their academic performance and exacerbating parent-child conflicts (Song et al., 2022).

With significant changes in sociodemographics (Li, 2016), a heavy emphasis on children's academic achievement (Ding et al., 2022), and the low prevalence of PA among Chinese schoolchildren (Liu et al., 2023; Fan & Cao, 2017), these findings suggest that under the present cultural context in China, there has been a drop in parent-child relationships, resulting in reduced closeness and heightened conflict. A review of family-based interventions for reducing sedentary time in youth found that parental involvement appeared more critical than in the intervention setting (Marsh et al., 2014). Recent meta-analyses have demonstrated that high levels of family involvement are associated with more significant reductions in obesity than low or no family involvement (Liu et al., 2022). It becomes increasingly essential that family and parent factors that either promote or impede children's PA be identified so that targeted, family-based PA promotional strategies can be developed for the most vulnerable children, significantly overweight and obese adolescents.

Active video games (AVGs), a new generation of video games, require players to physically interact with video games during gameplay through various arm, leg, or whole-body movements such as dancing, jogging, and kicking (Zeng & Gao, 2016). Given that children spend a large proportion of their time engaging in screen-based sedentary behaviour (Cai et al., 2017), AVGs bring physical benefits to children and adolescents in attenuating weight gain, psychological well-being, and physiological fitness. For example, a few studies have reported that biking AVGs can make the player's heart rate level reach more than 60% of the maximum heart rate, similar to traditional high-intensity training (Moholdt et al., 2017). More importantly, different AVGs are related to other heart rate levels and calorie energy expenditure. For example, boxing, running, and dancing AVGs are more intense than golf AVGs. Sports experts also affirm that AVGs can replace traditional game items in physical activity and help improve the actual sports level by pointing to the muscle group training coordination and balance related to specific items (Gioftsidou et al., 2013).

Ultimately, this research aims to provide insights that can inform evidence-based interventions for addressing overweight and obesity in male adolescents in China. By clarifying the effects of parental involvement in AVG play, the research intends to contribute to developing strategies that empower parents to support the parent-child relationship of overweight and obese adolescents in China, promoting healthier lifestyles.

Materials and Methods

Study Design

The research design was based on a Cluster Randomized Controlled Trial (CRCT). This true experimental design consists of two intervention groups: parental involvement AVG play (PIAVG) and single-player AVG (SPAVG), and one control group: watching television (WTV). Clusters were composed of the three middle schools randomly selected from six middle schools in Jiaozuo City, China, with students ages 12 to 14 years.

Participants

For this trial, overweight and obese male adolescents were enrolled in the three designated middle schools in Jiaozuo, China. There are three steps to screening participants to evaluate the eligibility of potential participants. First, overweight, and obese male adolescents were recruited via word of mouth and referral from the school-based wellness clinic and physical education teachers since the clinic has physical examination data for each student. At the same time, physical education teachers can determine overweight and obese students through observation.

Secondly, the research asked the participants and their parents through decided inclusion and exclusion criteria. The details are shown in Table 1

Table 1

Inclusion and Exclusion Criteria

Inclusion Criteria

- (a) The family needs to install a TV and 2-3 meters of open space in front of the TV;
- (b) The family has never purchased a game console similar to AVG before;
- (c) Ensure that at least one parent has enough time to accompany his or her child to complete the experimental task;
- (d) The students' BMI percentile should be more than 85;
- (e) There are no other sports besides daily physical activities;
- (f) The age of the experimental subjects should be 12-14 years old.

Exclusion Criteria

- (a) Having self-reported physical and/or mental disabilities;
 - (b) Contradictions to PA participation as determined by PAR-Q responses;
 - (c) Relevant weight loss drugs taken within half a year;
 - (d) Single-parent family;
 - (e) Having motion sickness reaction when exercising under AVG based condition.
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Once the student meets all the criteria above, the participant is confirmed in this study. Subsequently, complete the informed consenters. Subsequently, participants received a link to rent AVGs online, according to the required brand and model. Finally, the researcher will refund everyone's rental fees to the participants. The minimal intended study sample size of 24 participants starting with the training program was based on similar feasibility studies (Nawaz et al., 2016; Wüest et al., 2014).

AVG Intervention

The intervention protocol was developed using past research. Additionally, six experts reviewed and validated the intervention protocol. The type of intervention programme includes PIAVG, SPAVG, and WTV. The final part is intervention validity. This section presents the chosen measurements. It mainly contains one instrument called the Nintendo Wii. This intervention lasted for two weeks, thrice weekly, 30 minutes per session. Based on the article (Hwang et al., 2019), according to the characteristics of the Nintendo Wii, to increase the subject's compliance with the game and maximise the training effect, each gaming session consisted of upper body, cardio, and sports games (Staiano et al., 2013). Routines were pre-determined and varied daily, gradually increasing in difficulty throughout the program. AVG participants were tracked for individual progress in the two experimental groups by earning points, continuously reported by the Wii console as the participants played. After each game session, the participants can take photos, record the current game's data through the TV screen, and send it to their WeChat group. The control group was informed to engage in 30-minute TV-watching behaviour thrice weekly.

Measurements

i. Height and weight. Height and weight were measured using a wall-mounted stadiometer and calibrated scale. Two measurements were taken for each variable to the nearest 0.1 unit, with a third measurement taken if there was a greater than 0.5-unit difference. The website calculated the BMI percentile (*Baylor College of Medicine, 2020*).

ii. Age. The age calculation is based on each subject's ID card date.

iii. Parent-child relationships (PCR). Parent-child relationship from adolescents' perspective, this scale includes 29 items. It is divided into four dimensions: closeness (10 items), conflict (8 items), trust (7 items), and satisfaction (4 items) to measure the quality of the parent-child relationship. This questionnaire adopts a 5-point Likert scale, with 1-5 representing increasing support (1=strongly disagree; 2 = disagree; 3 = not necessarily; 4=agree; 5=strongly agree). The scores of each dimension and scale are added based on the scores of each item. A higher score represents better parent-child relational qualities. This scale is adapted from J. Li et al., (2008) and found to be reliable. The Cronbach's α value is 0.837 (Zheng, 2015).

Statistical Analysis

The study collected data primarily through statistical analysis and descriptive analysis. All quantitative data were collected during the experiment and analysed using SPSS software (version 23; IBM Company, Chicago, IL, USA). Statistical significance was determined using two-tailed p-values at the 0.05 alpha level. Data cleaning and hypothesis testing were performed before analysis. Researchers use descriptive techniques for quality checking, including identifying missing data, outliers, and coding errors. All variables were analysed using descriptive statistics. Means and standard deviations (SD) or medians and interquartile range (IQR) were used to describe continuous variables (according to their distribution), and frequency and percentage were used to describe categorical variables. Defining each variable individually, including its characteristics, demographic data, and research variables is helpful. Prior to data analysis, group homogeneity was assessed using a one-way ANOVA for continuous variables. Standard empirical statistical test rules for normality ensure that the P-value in the Shapiro-Wilk test is more significant than 0.05 (Jurečková & Pícek, 2007). In the

pre-test, the data were checked for homogeneity of variances using Levene's test. A generalised estimating equation (GEE) model evaluated intervention programmes' effectiveness on dependent variables. GEE extends the logistic regression model to allow for clustering (Peters et al., 2003). This study illustrates the longitudinal data analysis on physical activities among male overweight and obese adolescents using GEE under various intervention correlation assumptions.

Results

Primary outcomes

Before testing the research hypotheses, a one-way ANOVA was used to determine the homogeneity of the research variables for all groups. This included demographic variables such as age, height, weight, BMI percentile, and parent-child relationships. According to the results, there were no significant differences among groups at the pre-test for all research variables ($p > 0.05$). See Table 2 for details.

Table 2

Mean Comparison among Groups for Demographic Variables and Parent-child Relationships in Pre-test (Mean, SD)

Variables	PIAVG	SPAVG	WTV	F-value	P-value
	n=8	n=8	n=8		
Age	12.56 (0.548)	12.73 (0.588)	12.45 (0.702)	0.135	0.824
Height	159.48 (3.548)	158.41 (3.218)	159.46 (2.837)	0.015	0.896
Weight	57.991 (2.372)	57.427 (1.872)	57.112 (2.421)	0.757	0.329
BMI percentile	88.861 (2.252)	89.400 (1.660)	89.526 (1.637)	0.345	0.583
PCR	64.679 (1.671)	64.385 (1.468)	64.321 (1.501)	0.523	0.431

Evaluating the Effectiveness of the AVG Intervention on PCR among Groups

The effects of PIAVG, SPAVG, and WTV on PCR were observed through the PCR scale. A GEE technique was applied to test whether there is a statistically significant difference among groups across time. Descriptive data (mean and standard error) for PCR levels are shown in Table 3.

Table 3

Descriptive Statistics (Mean and SE) of PCR among Groups Across the Time

Variables	Time	PIAVG	SPAVG	WTV
PCR	Pre-test	64.679 (0.563)	64.385 (0.601)	64.321 (0.565)
	Post-test	65.910 (0.408)	64.658 (0.568)	64.445 (0.646)

PCR= Parent-child relationships.

The main effect of group and time on the level of PCR ($\chi^2=5.861$, $p=0.188$, $\chi^2=3.231$, $p=0.341$) was not statistically significant. However, the interaction between groups and time

(group*time) on PCR was statistically substantial ($\chi^2=10.182$, $p=0.021$), showing that groups had a significantly different pattern over time. The details are shown in Table 4.

Table 4

Results of GEE on LTS and PCR Score

Variables	Source	Wald Chi-Square	df	p-value
PCR	Group	5.861	2	0.188
	Time	3.231	2	0.341
	Time*Group	10.182*	4	0.021

Note. * Mean difference is significant at the 0.05 level.

The post hoc test (Bonferroni) was applied to determine the differences in PCR among three groups of overweight and obese male adolescents across time (Table 5). There was no statistically significant change among groups between the pre and post-time for PCR. The p-values are all greater than 0.05.

Table 5

Pairwise Comparison of PCR Mean Score across Time for Three Groups

Variables	Group	Time	Mean Difference	SE	p-value	95%CI	
						Lower	Upper
PCR	PIAVG	Pre-Post	-4.674	0.676	0.041*	-8.252	-4.796
	SPAVG	Pre-Post	-0.102	0.531	0.238	-4.266	-1.355
	WTV	Pre-Post	0.126	0.205	0.397	1.010	0.542

Note. * Mean difference is significant at the 0.05 level.

The Post Hoc (Bonferroni) test was applied to compare the mean value. The results are summarised in Table 6. No significant differences were seen for PCR among groups at the pre-test ($P>0.05$). While at the post-test, one significant difference was seen between PIAVG and WTV ($P=0.021$).

Table 6

Pairwise Comparison among Groups at Pre-test and Post-test for PCR

Variables	Time	Between Groups	Mean Difference	p-value	95%CI	
					Lower	Upper
PCR	Pre-test	PIAVG vs SPAVG	1.494	0.687	-2.151	4.565
		PIAVG vs WTV	2.368	0.165	-1.534	5.467
		SPAVG vs WTV	0.884	0.172	-3.167	2.323
	Post-test	PIAVG vs SPAVG	3.772	0.265	-2.488	1.336
		PIAVG vs WTV	1.476*	0.021	5.208	7.542
		SPAVG vs WTV	5.612	0.636	0.748	3.865

Note. * Mean difference is significant at the 0.05 level.

Discussion

The observed significant effects in only PIAVG underscore the potential of AVG as a catalyst for enhancing parent-child relationships. AVG sessions' shared physical activity, decision-making, and interactive nature likely contribute to improved communication, mutual understanding, and positive interactions within the parent-child dyad.

According to previous research, one study aligns with these results, highlighting that playing games with children at home can actively promote PCR (Helen, 2016). In addition to forging a solid PCR, spending time with children makes a child feel special. It helps parents understand their child's ideas and feelings; the interaction is essential in promoting PCR (Lobo, 2018). A long-term study from China found that having enough parental involvement, such as monitoring, behavioural participation, and a sense of warmth, can help improve PCR and stop internet gaming disorders (Dou et al., 2022).

Similarly, in adolescent competitions, the attendance rate of parents is also an essential factor affecting parent-child relationships, which confirms that indirect parental involvement also plays a vital role in improving PCR (Stefansen et al., 2018). A qualitative study reported that digital game co-playing could impact the PCR and technology co-use in the context of gaming, such as an essential relational tool that parents can use to promote conversations with their children (Musick et al., 2021). Moreover, the results of one study indicated that the change in PCR is due to parental involvement in behaviour (e.g., encouragement, praise, and recognition from parents), regardless of their gender (Teufl & Ahnert, 2022).

While the present study provides valuable insights, avenues for further exploration exist. Future research could delve into the long-term sustainability of these positive effects beyond the eight-week intervention. Additionally, investigating individual differences, such as age and gender, could offer a more nuanced understanding of how various demographic factors may influence the effectiveness of AVG interventions on PCR.

Limitations

The small sample size may have restricted identifying substantial training effects when comparing measurements taken before and after the intervention. Nevertheless, pilot studies are specifically conducted to produce initial data that enables establishing systems and protocols for future investigations. Applying the "rule of 12," we can be assured of our values (Moore et al., 2011). Moreover, the training period should be extended in future studies to increase the potential for training improvements.

Conclusion

The results of this study indicate that while there were no statistically significant changes within each of the three groups individually, the overall trends observed in the data suggest a positive impact of the intervention, particularly in the PIAVG group. Notably, the PIAVG group exhibited a more pronounced upward trend than the WTV group. Furthermore, inter-group comparisons revealed that the experimental effect in the PIAVG group was significantly better than that of the WTV group. These findings suggest that parental involvement in active video games may enhance the effectiveness of such interventions, highlighting the potential

for family-based approaches to improve parent-child relationship outcomes in overweight and obese adolescents.

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Conflict of interests

The authors declare that there are no conflicts of interest.

Author contributions

All authors have contributed equally in terms of ideas and preparation of the manuscript.

Data availability Statement

The datasets used and analysed during the current study are available from the corresponding author upon reasonable request.

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