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Adolescent Exergame Play for Weight Loss and Psychosocial Improvement: A Controlled Physical Activity Intervention

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Abstract

Overweight and obese youth, who face increased risk of medical complications including heart disease and type II diabetes, can benefit from sustainable physical activity interventions that result in weight loss. This study examined whether a 20-week exergame (i.e. videogame that requires gross motor activity) intervention can produce weight loss and improve psychosocial outcomes for 54 overweight and obese African American adolescents. Participants were recruited from a public high school and randomly assigned to competitive exergame, cooperative exergame, or control conditions. All exergame participants were encouraged to play the Nintendo Wii Active game for 30-60 minutes per school day in a lunch-time or after-school program. Cooperative exergame participants worked with a peer to expend calories and earn points together, whereas competitive exergame participants competed against a peer. Control participants continued regular daily activities. Outcome measures included changes in weight, peer support, self-efficacy, and self-esteem, measured at baseline, and at approximately 10 weeks and 20 weeks. Growth curve analysis revealed that cooperative exergame players lost significantly more weight ($M = 1.65$ kg; SD = 4.52) than the control group, which did not lose weight. The competitive exergame players did not differ significantly from the other conditions. Cooperative exergame players also significantly increased in self-efficacy compared to the control group, and both exergame conditions significantly increased in peer support more than the control group. Exergames, especially played cooperatively, can be an effective technological tool for weight loss among youth.

Introduction

Faced with a pediatric obesity crisis, our nation urgently needs sustainable physical activities that promote healthy weight in youth. Light to moderate energy expenditure has been documented during exergame (videogame that requires gross motor movement) play (1-2);

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however, no one has demonstrated weight loss (3-4). The focus of this paper is on weight loss and psychosocial changes during cooperative versus competitive exergame play.

According to social cognitive theory (5), behavioral change results from links among behaviors (e.g., energy expenditure during cooperative versus competitive exergame play), the environment (e.g., peer support and cooperation during extracurricular activities), and psychosocial variables (e.g., self-efficacy and self-esteem). For example, exergames are often played against peers (6), and the social interaction during competitive exergame play increased adolescents' caloric expenditure more than when youth played alone (1). Cooperative more so than competitive play may be particularly effective in improving health behaviors because cooperation produces social support and self-esteem due to group cohesion in achieving a common goal, which can promote adherence to exercise interventions (7). For instance, preadolescents generally chose a multi-player dance exergame over traditional solitary physical activities (8). Group cohesion in digital game play may appeal to obese youth who rarely engage in traditional sports due to weight criticism.

Exergame play may also improve poor psychosocial health often experienced by overweight youth (6). For instance, overweight children who frequently played the exergame *Dance Dance Revolution* reported increased self-esteem (9). The Nintendo Wii Active states, "You're in total control" to boost players' self-efficacy (one's belief about personal control, 5), which predicts exercise adherence (10). Leisure activities also promote peer support through cooperation, which can combat overweight and obese adolescents' feelings of loneliness.

Using social cognitive theory, we predicted that: 1) playing exergames over time, particularly cooperatively, would increase weight loss compared to the control group; 2) adolescents with higher initial levels of self-efficacy, self-esteem, and peer support would lose the most weight; 3) self-efficacy, self-esteem, and peer support would mediate the relationship between the exergame intervention and weight change;.and 4) playing exergames over time, particularly cooperatively, would increase self-efficacy, self-esteem, and peer support.

Methods and Procedures

Participants

Fifty-four African American adolescents ages 15-19 years (55.6% female) from an urban public high school were recruited via word of mouth and referral from the school-based wellness clinic. Twenty additional participants dropped out due to school truancy, lack of interest, and time conflicts. The inclusionary criterion was BMI at or above the 75th percentile as determined by medical staff at the wellness center. School flyers, communications from research assistants (phone calls, texts, emails), and incentives (movie gift certificates, cash gift cards, not exceeding $200 total per participant) were used to encourage attendance. The Georgetown University Institutional Review Board approved this study (2007-482).

Nintendo Wii Active Exergame

The Wii Active game (Nintendo of America Inc, Redmond, Washington) is a fitness videogame involving gross motor movement. Players use remote control devices held in the hand or placed in a leg strap to communicate body movements through a sensor bar beside the video screen.

Treatment Conditions and Procedure

Within gender group, participants were randomly assigned to competitive exergame (n=19), cooperative exergame (n=19), or control (n=16) conditions. All participants were assessed for physical and psychosocial outcomes at baseline (time 1), 10 weeks (*M*=69 days, *SD*=46), and 20 weeks (*M*=135 days, *SD*=48). Control participants continued usual daily activities, such as socializing with friends, tutoring, and sports team practice.

Participants in exergame conditions could play the Nintendo Wii Active exergame 30-60 minutes every school day during the lunch period or after school, for up to seven months. Cooperative and competitive groups met in separate classrooms in the same school, with each condition led by a different adult coordinator. Coordinators encouraged completion of each daily exergame routine through periodic verbal reinforcement. Coordinators met daily to ensure the physical and social environment of the classrooms did not differ. A supervisor observed sessions an average of twice per week to maintain consistency between the two exergame conditions.

Participants played with one peer in each gaming session; the pair structure varied over time. Youth in the competitive condition were instructed to compete against their opponent to earn the most points and expend the most calories. Youth in the cooperative condition were instructed to cooperate with their partner to earn the most points and expend the most calories as a team. Each gaming session consisted of cardio, upper and lower body strength training, and sports games, including basketball, inline skating, baseball, tennis, and volleyball. Both exergame conditions did the same pre-determined routines that varied on a daily basis, gradually increasing in difficulty throughout the program.

Measures

Pediatricians and nurse practitioners measured participant height (without shoes) and weight (clothed, without shoes) at the school-based wellness clinic. BMI percentile was calculated from age- and sex-specific growth reference charts for 2- to 20-year-olds, which define a percentile between 85% and 95% as overweight and over 95% as obese. Self-reports of self-efficacy, self-esteem, and peer support were assessed by the Exercise Confidence Survey (11), Rosenberg Self-Esteem scale (12), and Friendship Quality Questionnaire (13).

Statistical Analysis

To examine change over time, growth curve modeling was used to create individual growth curve trajectories of changes in weight, self-efficacy, self-esteem, and peer support during the exergame intervention. Condition was the independent variable. Growth curve analysis allows participants with variable time intervals and only two time measurements to be retained in full analysis by estimating a missing score. In the weight change analysis, covariates included sex and baseline self-efficacy, self-esteem, and peer support. In the models, a significant interaction term indicates that the dependent variable changed over time based on the independent variable. Structural equation modeling on the statistical program AMOS was used to determine whether the psychosocial variables mediated the relationship between the intervention and weight change via significant indirect effects.

Results

Mean participant BMI percentile at baseline was 94.7 (SD=6.0). Univariate ANOVAs revealed no significant condition differences at baseline for targeted variables or for sports team involvement, nor were there differences in baseline measures for those who remained in the study versus those who dropped out before time 2 (all p values >.05). Over the 20-week intervention, students attended an average of 1.3 sessions per week: 31 sessions for the cooperative and 23 sessions for the competitive condition, which was not statistically different (p = .239). Means and standard deviations for weight loss, self-efficacy, self-esteem, and peer support are presented in Table 1.

Weight Change

The growth curve analysis for weight loss is presented in Supplementary Table 1a. The cooperative condition lost significantly more weight than the control group did between times 1 and 3, t=-2.399, p=.021 (M=1.65 kg (SD=4.52) weight loss versus 0.86 kg (SD=3.01) weight gain), whereas the competitive condition (M = 0.04 kg (SD=3.46) weight gain) did not significantly differ from the other conditions. As expected, those who had higher peer support at baseline lost marginally more weight over time, t = −1.735, p = .091. Contrary to expectation, initial self-efficacy did not affect weight change over time, t = 1.296, p = .202, nor did those with higher self-esteem lose more weight over time, t = 1.552, p = .128. Attendance was not significantly related to weight change, nor did self-efficacy, self-esteem, or peer support mediate weight change.

Psychosocial Change

The growth curve analysis, presented in Supplementary Table 1b, revealed that the cooperative condition increased in self-efficacy significantly more than the control group, t=2.99, p=0.005. There was no difference in self-efficacy between the competitive and cooperative groups (p=.172) or competitive and control groups (p=.083). The growth curve analysis of self-esteem change yielded no condition effects.

The growth curve analysis, presented in Supplementary Table 1c, revealed that the cooperative condition (t=2.76, p=.010) and the competitive condition (t=3.66, p=.001) increased significantly more in peer support than the control group did. There were no differences between the cooperative and competitive conditions (p=.404).

Discussion

Our purpose was to examine the role of cooperative versus competitive exergame play on weight loss and psychosocial changes in overweight and obese adolescents. As predicted, cooperative exergame players lost significantly more weight than the control group (who gained weight over time), and competitive exergamers did not lose weight. Cooperation may foster a team bond more so than competition (7), which may help obese adolescents persist during physically demanding tasks such as exergame play. In contrast, the competitive condition required participants to compete individually, which may have been too challenging and not rewarding enough for overweight and obese adolescents. Because individuals who dislike individual competition experience negative moods during gameplay (14), competitive exergame play may not have appealed to these overweight and obese youth. Importantly, although prior findings indicated that competitive exergame play produced more caloric expenditure than solitary exergame play (1), the added social component of cooperation yielded actual weight loss.

As expected, adolescents who lost weight were marginally more likely to have high initial levels of peer support. Because initial peer support was linked to weight loss, the additional increase in peer support for exergame players may promote group cohesion and provide social reinforcers that help sustain exergame play and produce weight loss, particularly in the context of cooperation (7). Contrary to predictions, however, there was no relationship between initial levels of self-efficacy or self-esteem and weight loss, nor were there sex differences in weight loss. Higher self-esteem was a predictor for lower weight at baseline, supporting the previous finding that adolescents who weigh less feel better about themselves (15).

Consistent with social cognitive theory (5), exergaming also increased peer support and self-efficacy over time. Cooperative exergaming may promote group cohesion and provide social reinforcers that sustain exergame play. The increase in exergame players' self-efficacy is promising for future physical activity, as self-efficacy generally predicts exercise adherence (10). However, self-efficacy, self-esteem, and peer support were not significant mediators between the exergame intervention and weight change. This outcome indicates that other psychosocial mediators or behaviors such as increased daily physical activity, reduced perceived barriers to exercise, increased exercise enjoyment, increased perceived benefits from exercise, or improved physical self-concept related to exercise, may have made the intervention effective. Although the psychosocial variables that were tested in the present study did not explain intervention effects on weight loss, improvement in psychosocial health is a desirable outcome, particularly among obese adolescents.

Study limitations include participant attrition, only one measure of body adiposity (i.e. weight), a relatively small sample size from a single school, and global measures of self-esteem and peer support. Nevertheless, condition effects emerged for this relatively small sample of overweight and obese youth, and many youth remained in the study for 10 (73%) and even 20 weeks (54%). The lack of relation between attendance and weight loss suggests a need to investigate intensity of exergame play versus frequency or duration (3). Future studies could investigate how exergames increase physical activity, produce weight loss, prevent weight gain, and improve psychosocial health for a range of youth.

In conclusion, this study is the first to demonstrate weight loss from exergame play. When played cooperatively, exergames are a promising 21st century media tool to combat the pediatric obesity crisis.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Mean participant weight (kg), self-efficacy, self-esteem, and peer support during the exergame program by condition.

	Weight (kg)			**Self-Efficacy**			**Self-Esteem**			**Peer Support**		
	Baseline	**Time 2**	**Time 3**	**Baseline**	**Time 2**	**Time 3**	**Baseline**	**Time 2**	**Time 3**	**Baseline**	**Time 2**	**Time 3**
Cooperative	93.93 (26.02) n = 19	92.96 (25.66) n = 19	84.74 (14.23) n = 10	38.16 (12.12) n = 19	42.11 (13.58) n = 18	43.29 (13.40) n = 14	22.79 (4.45) n = 19	22.67 (5.91) n = 18	24.08 (3.88) n = 13	71.89 (12.43) n = 19	75.22 (13.39) n = 18	80.18 (8.59) n = 11
Competitive	96.22 (17.92) n = 19	96.02 (18.88) n = 19	95.17 (20.94) n = 17	36.37 (13.97) n = 19	37.65 (10.03) n = 17	38.82 (8.82) n = 11	23.74 (6.47) n = 19	23.11 (4.78) n = 18	22.33 (5.74) n = 9	64.37 (19.58) n = 19	72.44 (10.78) n = 18	76.92 (14.04) n = 13
Control	95.48 (22.72) n = 16	95.57 (23.66) n = 16	94.23 (20.88) n = 12	37.38 (12.07) n = 16	34.57 (11.75) n = 14	35.30 (8.76) n = 10	22.69 (3.96) n = 16	22.40 (5.38) n = 15	20.45 (5.82) n = 11	70.13 (18.16) n = 16	72.33 (17.15) n = 15	59.70 (20.67) n = 10
Total	95.20 (22.05) n = 54	94.81 (22.47) n = 54	92.21 (19.46) n = 39	37.30 (12.56) n = 54	38.41 (12.08) n = 49	39.60 (11.09) n = 35	23.09 (5.06) n = 54	22.75 (5.28) n = 51	22.39 (5.19) n = 33	68.72 (16.94) n = 54	73.39 (13.39) n = 51	72.91 (16.95) n = 34

Note. Standard deviation indicated in parentheses. The growth curve analysis results, which also include predicted means at Time 3 for missing participants, are not reported here. Instead, each cell reports the mean and standard deviation only for remaining participants at that time point.