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Mediators of Physical Activity Between Standard Exercise and Exercise Video Games

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Abstract

Objective: Exercise video games (EVGs) may offer an attractive, sustainable alternative or supplement to traditional modes of exercise. Understanding psychosocial factors that influence the appeal of EVGs is important for improving the efficacy of video games as a method of promoting the uptake and long-term maintenance of physical activity.

Method: This study examined changes in psychosocial constructs from Self-Determination theory and Self-Efficacy theory as mediators of intervention efficacy among 189 healthy, sedentary adults randomized to 12-week programs of either EVGs or Standard exercise (e.g., treadmill walking, stationary cycling) followed by 6-months follow up. The EVG condition engaged in significantly more weekly minutes of moderate to vigorous physical activity (MVPA) at end of treatment compared to Standard exercise. Univariate and multivariate mediational models were

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used to examine theoretically derived psychosocial constructs as potential mediators of differential intervention effects.

Results: Univariate mediational models suggest a significant indirect effect of treatment on MVPA outcomes through enjoyment, self-efficacy, stress management, depressive symptoms and positive engagement ($p<0.05$). Multiple mediational analyses confirm all the univariate results ($p<0.05$) with the exception of enjoyment.

Conclusions: Differences in the efficacy of EVG versus Standard exercise interventions were mediated by several psychosocial constructs suggesting that qualities specific to game play may enhance adherence to physical activity both in and outside the lab environment.

Keywords

Video games; physical activity; self-efficacy theory; self-determination theory; adults

Introduction

Physical activity

Physical inactivity is a leading preventable cause of death among Americans (Bauer, Briss, Goodman, & Bowman, 2014). Despite the health benefits associated with physical activity and health risks associated with inactivity (Jakicic, 2009; Jefferis, Whincup, Lennon, & Wannamethee, 2012; Moore et al., 2016; Samitz, Egger, & Zwahlen, 2011), only about half of American adults report being sufficiently active to meet national guidelines (Katzmarzyk, Lee, Martin, & Blair, 2017; National Center for Health Statistics (NCHS), 2017). Moreover, long-term adherence remains a challenge, with approximately half of those who take up a new exercise program stopping within the first six months (Fjeldsoe, Neuhaus, Winkler, & Eakin, 2011; Spark, Reeves, Fjeldsoe, & Eakin, 2013). There is a continuing need to discover effective approaches that promote both physical activity uptake and continued maintenance of regular physical activity.

Active video games

A growing body of research has begun to examine the effects of physically interactive video games that require substantial body movement and exertion for continued play. These exercise video games (EVGs) also called “active video games,” include games that imitate sports (e.g., *Wii Sports*), dance simulation (e.g., *Dance Central*) and fitness workout games that include a variety of activities such as calisthenics, yoga and kickboxing (e.g., *The Biggest Loser*), and stationary cycling (e.g., GameBike^{tm}). While many studies have been conducted concerning EVGs (Peng, Crouse, & Lin, 2013), the majority focus on children or focus on EVGs as therapy for adults with specific disorders such as balance and coordination problems, medical conditions or cognitive deficits (Mansor, Chow, & Halaki, 2019; Simmich, Deacon, & Russell, 2019).

Laboratory studies demonstrate that EVGs can produce energy expenditure commensurate with moderate-to-vigorous physical activity (MVPA) similar to walking or cycling, at approximately 3-6 Metabolic Equivalents (METs; Bosch, Poloni, Thornton, & Lynskey, 2012; Miyachi, Yamamoto, Ohkawara, & Tanaka, 2010),although, as with other forms of

physical activity, EVGs can be played at higher or lower intensities. Randomized controlled trials (RCTs) that compare EVGs with standard exercise for physical activity outcomes (e.g., exercise intensity or adherence) in healthy adult populations are rare and tend to have small sample sizes. We were able to identify only four such studies. A laboratory study by Rhodes, Warburton and Bredin (2009) randomized 29 inactive men to use either stationary cycling (SC) or an SC equipped with an EVG (GameBike[tm]). Adherence and affective attitude across six weeks significantly favored the EVG condition. Warburton, Bredin, Horita et al. (2007) used a similar design among 14 young men and found higher attendance during the 6-week trial among those randomized to the EVG condition versus SC. Mark and Rhodes (2013) found no difference in use frequency of SC with and without EVGs among 59 parents during a 6-week trial in the home setting. A similar study (Rhodes et al., 2018) found no difference in home use frequency between a SC placed in front of the TV and an SC equipped with an EVG among 68 parents of young children. Use of both systems declined over the 3-month study. Similar to standard exercise interventions (Fjeldsoe, et al., 2011), studies of EVGs show a consistent problem of weak longer-term adherence (Bock et al., 2019; LeBlanc et al., 2013; Peng, et al., 2013; Rhodes, et al., 2018). To date, there has been no randomized controlled clinical trial examining the use of EVGs compared to standard exercise among healthy adults with a sample size sufficient to examine mediators of behavior change.

EVGs result in an enjoyable and pleasant experience even when working at higher intensities and when compared to traditional exercise modalities (Barry, van Schaik, MacSween, Dixon, & Martin, 2016; Glen, Eston, Loetscher, & Parfitt, 2017). Playing EVGs has been associated with psychological benefits such as improved mood (Bronner, Pinsker, Naik, & Noah, 2016; Li, Theng, & Foo, 2016). Thus, EVGs may present a viable, practical, and attractive alternative to traditional modes of exercise. However, additional studies are needed to examine patterns and predictors of EVG use and adherence among adults, and to understand the factors that differentiate them from standard exercise modes.

Theoretical framework

Both Self-Determination Theory (SDT; Deci & Ryan, 2002) and Self-Efficacy Theory (SET; Bandura, 1997) have been studied in the promotion of physical activity (Ahn, Johnsen, & Ball, 2019; Buman et al., 2011; Dewar et al., 2014; Dishman, McIver, Dowda, Saunders, & Pate, 2019; Olson & McAuley, 2015; Short, James, & Plotnikoff, 2013; Smith et al., 2014) and may provide a foundation for understanding the role of EVGs in physical activity.

Self-efficacy (Marcus, Selby, Niaura, & Rossi, 1992; McAuley & Blissmer, 2000; McAuley et al., 2007), self-regulation (Conn, Valentine, & Cooper, 2002) and outcome expectancies (Williams, Anderson, & Winett, 2005) have each been shown to predict physical activity participation. Important contributors to self-efficacy in SET include performance outcomes, verbal persuasion and physiological feedback (Bandura, 1997). A central feature of games is the providing of rewards and positive acknowledgement of performance (e.g., unlocking higher game levels, awarding badges or points, etc.). Verbal encouragement is provided through positive statements during game play and at its completion (e.g., congratulatory

banners saying, “You Win!” etc.). These features may enable games to promote self-efficacy more efficiently than standard exercise formats.

SDT proposes that people are likely to persist in a behavior that satisfies psychological needs (i.e., autonomy, competence, relatedness) resulting in intrinsic motivation (Deci & Ryan, 2002; Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997). Intrinsic motivation is posited to produce more dedication to goal attainment and to maintaining behavior over time. Enjoyment is an important contributor to intrinsic motivation, and enjoyment of physical activity predicts physical activity participation (Lewis, Williams, Frayeh, & Marcus, 2016; Williams et al., 2006). Intrinsic motivation indicates that when an individual engages in a behavior based on their perceived enjoyment and interest, they are more likely to adopt that behavior and maintain it overtime (Ryan, et al., 1997). Research on non-active video games indicates that perceived in-game competence and autonomy predict game enjoyment, game preferences, and duration of play, as well as post-play feelings of well-being (Ryan, Rigby, & Przybylski, 2006). A recent study of an EVG with enhanced features designed to support competence, autonomy and relatedness, found that playing the EVG with these features based on SDT resulted in greater MVPA at 4-week follow up compared to controls who did not play EVGs (Peng, Pfeiffer, Winn, Lin, & Suton, 2015). These constructs may help to explain motivation to play EVGs and to maintain physical activity over time.

Purpose

This study examines psychosocial constructs posited to mediate differences in MVPA outcomes (minutes/week of MVPA)among 189 healthy adults randomized to a 12-week program of EVGs or Standard exercise interventions. It is hypothesized that exercise enjoyment, self-efficacy, and intrinsic motivation will mediate MVPA outcomes.

Methods

Study Design

This study focuses on a specific aim of the parent trial to examine mediators for physical activity outcomes. Full details of the design, methodology and primary outcomes are published (Bock, et al., 2019; Bock, et al., 2015). In brief, 283 adults were randomized to 12-weeks of Standard exercise (e.g., treadmill walking, stationary cycling), EVGs, or a control condition. EVG and Standard participants attended three 50-minute exercise sessions weekly in our lab. All materials and procedures were approved by the Miriam Hospital Institutional Review Board.

Measures

Demographics.—Demographic information collected at baseline included age, gender, race/ethnicity, marital status, education, employment status and household income.

Physical Activity Assessments.—The primary outcome was self-reported minutes per week of MVPA measured using the interviewer-administered 7-day Physical Activity Recall interview (PAR) conducted by study staff blind to participant randomization assignment

(Blair et al., 1985; Sallis et al., 1985). The PAR collects data on total time spent in light, moderate and vigorous activity as well as time spent sleeping and in sedentary activities throughout each 24-hour period across seven days. The PAR is a reliable, well validated instrument sensitive to change in physical activity. (Conway, Seale, Jacobs, Irwin, & Ainsworth, 2002; Dubbert, Vander Weg, Kirchner, & Shaw, 2004; Hayden-Wade, Coleman, Sallis, & Armstrong, 2003; Washburn, Jacobsen, Sonko, Hill, & Donnelly, 2003). PAR data were conducted at baseline, week 12 (EOT) and follow up (3- and 6-month) assessments. All participants wore an Actigraph Motion Monitor (model GTX3: Actigraph, LLC) for a 7-day period prior to each assessment point.

Theory-based assessments.—Survey instruments were chosen that were relevant to SDT and SET theories. Eight subscales (Stress management, Revitalization, Affiliation, Positive health, Health pressures, Ill health avoidance, Nimbleness, and Strength & endurance) of the Exercise Motivations Inventory (EMI-2; Markland & Ingledew, 1997) assessed the functional significance of exercise motivations from the perspective of SDT. The 19-item Behavioral Regulation in Exercise Questionnaire (BREQ-2) assessed self-determined motivational regulation in physical activity. BREQ-2 subscales include External-, Interjected-, Identified-, Intrinsic- and Amotivational-regulation (Ingledew, Markland, & Sheppard, 2004; Markland & Tobin, 2004). The intrinsic regulation subscale of the BREQ-2 is somewhat limited, being comprised of only four items addressing enjoyment using the terms “fun”, “enjoy”, “pleasurable” and “satisfaction”. Therefore, we also included two additional instruments to provide a richer representation of the construct of enjoyment. The 8-item Physical Activity Enjoyment Scale (PACES) which includes terms such as “invigorating”, “stimulating” and “refreshing” (Kendzierski & DeCarlo, 1991), and the 12-item Exercise-Induced Feeling Inventory (EFI) which assesses four distinct feeling states including Revitalization (e.g., “refreshed”), Positive Engagement (e.g., “enthusiastic”), Tranquility (e.g., “calm”) and Physical exhaustion (e.g., “worn out”) that participants perceive occurring in response to physical activity (Gauvin & Rejeski, 1993).

Two key constructs based in SET include self-efficacy, the belief that an individual can perform a behavior, and expectancies, which are beliefs regarding the outcomes of behavior change (Bandura, 1997). We assessed self-efficacy for physical activity using a 5-item instrument developed by Marcus and colleagues (Marcus, et al., 1992), and outcome expectations for exercise using a 9-item scale that assesses the individual’s expectations regarding the likely outcome of exercising (Williams, et al., 2005). In addition to theory-based constructs, symptoms of depression were assessed using the 9-item Patient Health Questionnaire (PHQ-9; Kroenke, Spitzer, & Williams, 2001).

Interventions

The goal for both exercise interventions was to increase MVPA to meet national guidelines for aerobic physical activity (Piercy et al., 2018). Study staff supervised all sessions to ensure that participant exertion was within the recommended target heart rate range for MVPA. Heart rate (HR) was recorded using a HR monitor (Polar RS400) worn by each participant at all sessions. The target HR range was calculated using the Karvonen Formula

(Karvonen, 1957). If HR fell below the moderate-intensity range study staff encouraged the participant to increase their speed and/or intensity.

Exercise Video games.—Each 50-minute EVG session included 5-10 minute warm-up and cool-down components in addition to exercise within the target HR range, using a variety of EVGs available for the Xbox (*Kinect*) and Wii platforms. Participants selected games from those offered by the study and were permitted up to two changes of game within each session. All games were identical for both platforms and focused on aerobic exercise training to produce a moderate-to-vigorous intensity exercise response during game play.

Standard Exercise.—Participants in the Standard arm attended sessions in our lab that was equipped with treadmills and stationary bicycles. Sessions followed the same protocol EVG for HR monitoring and session frequency and duration, including warm up and cool down periods.

Analyses

Previous Analyses.—Analyses of the parent trial showed that participants were predominately female (79.1%), employed (79.6%), white (81.5%), and married/partnered (60.8%). The average age of participants was 46.2 years (SD=13.5, range=20-79) and median MVPA was (30 min/week, inter-quartile range: 90). There were no significant between-group effects on baseline demographics or physical activity levels (p's>.05). Details are presented in Table 1. Participants in EVG (n = 93) and Standard (n= 96) conditions did not differ with respect to number of sessions attended (EVG: M = 27.11 [SD=9.81]; Standard: M = 27.45 [SD=7.85]) or length of exercise sessions (p's>.05). Participant retention was 88%, with no difference between groups.

The primary outcome analyses revealed significant between-group differences in median min/week of self-reported MVPA at end-of-treatment (EOT=Week12) (Bock, et al., 2019). Median min/week of MVPA among EVG participants at EOT was 85 mins greater than Controls (b=85.67, 95% CI: 36.97-134.38). Standard participants also engaged in significantly greater MVPA at EOT compared to Control (b=55.67, 95% CI: 7.66-103.70). Moreover, EVG participants had significantly greater median weekly MVPA compared to Standard at EOT (b=30.00, 95% CI: 4.46-64.46).

Analyses for the Present Study.—Since the goal of this study is to examine differences between the two exercise conditions, data from controls are not presented. These analyses test the hypothesis that differences in physical activity outcomes (i.e., MVPA minutes per week) between EVG and Standard interventions is mediated by SET and SDT constructs.

First, descriptive statistics were used to summarize baseline demographics, outcomes (self-reported min/week of MVPA), and baseline values of the mediators. Between group differences have been tested elsewhere (Bock, et al., 2019) but are reported in Table 1.

Next, univariate mediation models were used to identify potential mechanisms through which the intervention (EVG vs. Standard) was associated with MVPA outcomes. Specifically, a product of coefficients approach with bootstrapped standard errors (5000

replications) was used to test the *a* path (effect of intervention on mediator at EOT controlling for baseline), *b* path (effect of mediator at EOT on MVPA outcomes at EOT controlling for baseline) and the indirect effect (*ab* path: effect of intervention on outcomes through the mediator). As MVPA outcomes were significantly skewed, quantile regression models were used in the analysis. This model is similar to the Preacher and Hayes approach to mediation, but allowing for modeling median (instead of mean) outcomes (Preacher & Hayes, 2008).

Finally, a multiple mediation model was tested using a similar approach in which any variable with significant/trending indirect effects ($p<.10$ for *ab* path) from the univariate models, were included in the multiple mediation model. Variables identified for this model were examined for potential multicollinearity using correlation analyses (Spearman rank correlations). As none of the variables had large ($>|0.60|$) correlations between them, they were included in the final model together. Since our intervention targets multiple theoretical constructs, it is unlikely that any of the individual constructs would completely mediate the intervention effect on their own, thus, it is important to consider the multiple mediation model.

All analyses were conducted on the intent-to-treat sample, with all randomized participants (EVG and Standard) included in the analysis. Models using a likelihood-based approach to estimation and making use of all available data without directly imputing missing outcomes. Analysis was carried out using SAS 9.3 and significance value set at alpha=.05.

Results

Mediators of the Intervention Effect: Univariate Models

Analysis of *a path* coefficients (effects of EVG vs. Standard on mediators) suggested significant effects favoring EVG with respect to enjoyment, self-efficacy, depressive symptoms, intrinsic regulation (BREQ-2 subscale), stress management (EMI subscale), and EFI scores at EOT, controlling for baseline (*a path* coefficients are presented in Table 2).

Analysis of the mediator-PA outcome association (*b path*) suggested significant effects of enjoyment, self-efficacy, stress management, depressive symptoms and positive engagement (EFI subscale). See complete details of *b paths* in Table 2.

Taken together, univariate models suggest significant indirect effects of treatment, (EVG vs Standard) *ab path* on MVPA outcomes at EOT through enjoyment, self-efficacy, stress management, depressive symptoms and positive engagement. Indirect effects (*ab*) and corresponding 95% confidence intervals are presented in Table 2.

Multivariate Model

Similar to its univariate counterpart, multivariate models showed significant *a paths* for self-efficacy (a=.28, se=.13, p=.03), enjoyment (a=5.28, SE=1.58, p=.001) stress management (a=1.06, SE=.59, p=.04), depressive symptoms (a=−1.77, SE=1.03, p=.05) and positive engagement (a=.85, SE=.39, p=.03). After controlling for each of the mediators, there were significant *b paths* for self-efficacy (b=60.69, SE=20.57, p=.004), depressive symptoms

(b=8.38, SE=2.91, p=.004) and positive engagement (b=12.56, SE=7.74, p=.01). Taken together, results suggest significant indirect effects of self-efficacy (ab=16.69, 95% CI: 2.27-44.95), depressive symptoms (ab= −14.85, 95% CI: −54.67, −.79), stress management (ab= −1.02, 95% CI: −10.45, −.83) and positive engagement (ab=10.70, 95% CI: 2.41-40.74).

Discussion

Results of the parent study showed that those randomized to EVGs engaged in more minutes of MVPA at EOT, and continued to outperform in the follow-up period, compared to those given a standard exercise intervention and controls. This study examined whether these differences in intervention efficacy (EVG vs. Standard) on MVPA were mediated by theorized constructs from SDT and SET. Consistent with the study hypotheses, results indicated that changes in several psychosocial constructs mediated the intervention effects on MVPA between the two conditions, with EVG showing greater changes across self-efficacy, stress management, positive engagement, enjoyment, and depressive symptoms. Numerous studies outside the video game literature have shown that self-efficacy (Dishman, et al., 2019), enjoyment (Lewis, Marcus, Pate, & Dunn, 2002), and depressive symptoms (Bernstein & McNally, 2018; Dinas, Koutedakis, & Flouris, 2011) are predictive of physical activity participation. These findings extend the current knowledge of the ways in which these constructs influence the efficacy of EVGs on physical activity uptake among previously inactive adults.

Self-efficacy has a robust association with physical activity uptake in both standard (Dishman, et al., 2019; McAuley & Blissmer, 2000) and active video game research (Pakarinen, Parisod, Smed, & Salantera, 2017). In the present study, self-efficacy was a consistent mediator in the uptake of physical activity in both univariate and multivariate analyses. Other research has shown evidence that positive experiences through successful completion of an EVG fosters higher levels of self-efficacy regarding the player's abilities and promotes future participation in gaming behaviors (Rogers, 2017; Song, Peng, & Lee, 2011). Computer video game play has great appeal to many individuals and players can become highly motivated to engage in game playing. Ryan and colleagues (Ryan, et al., 2006) argue that the psychological attraction of games is largely due to their capacity to engender feelings of competency and autonomy, constructs that are similar to self-efficacy.

In the *Wii Heart Fitness* trial, participants played a variety of EVGs and while the content of each game differed, the basic actions needed to interact with the game interface (e.g. body movements) were similar. The skills learned from playing one game likely enhance their capabilities to successfully master the next game and advance through levels becoming more engaged (Song, et al., 2011; Starks, 2014; Tamborini, Bowman, Eden, Grizzard, & Organ, 2010). As players master the skills needed to advance through different levels of a game, these new skills may also be applied to problem-solve and overcome barriers to physical activity in non-gaming contexts. Research is needed to understand whether these new skills may also be applied to problem-solve and overcome barriers to physical activity in other non-gaming contexts.

Enjoyment is highly predictive of physical activity (Lewis, et al., 2016; Williams, et al., 2006). Studies using EVGs have found effects of enjoyment on total body motion during game play (Aymerich-Franch, 2010; Skalski, Tamborini, Shelton, Buncher, & Lindmark, 2011) and higher energy expenditure (Lyons et al., 2014). Findings of this study are consistent with past studies that have found engagement and enjoyment predictive of physical activity using EVGs (Lyons, et al., 2014). It has been suggested that failure of some studies using active games may be due to low levels of enjoyment of the particular games used (Peng, et al., 2013) possibly resulting in lower adherence and/or energy expenditure during game play.

Enjoyment is situated within SDT as a significant contributor to intrinsic motivation. Since enjoyment has been a robust predictor of exercise adherence in previous studies, it is prudent for researchers to use multiple assessment instruments to capture a richer, broader picture of enjoyment. This was done in this study and results demonstrated unique contributions and more colorful picture of “enjoyment by use of both the BREQ-2 and PACES. Successful completion of games can lead players to associate the gaming experience as positive or as a *positive engagement* (Crutzen, van ‘t Riet, & Short, 2016). Positive engagement is a motivational factor that drives the player’s attention to continue to engage EVG based on anticipatory enjoyment. Lyons et al., (2014) found that among young adults, enjoyment mediates the relationship between engagement in game play and resulting energy expenditure. While research on EVG interventions are in early stages and knowledge of how these interventions work is developing, there is evidence to show both exercise enjoyment and positive engagement in exercise as central drivers in intrinsic motivation for behavior change; and therefore, critical to examine both independently and in relationship. Future EVG studies should include these constructs as part of their strategies to increase MVPA. It also remains to be seen whether newer technologies such as multi-player online games and/or virtual reality games may enhance positive engagement compared to one-player games such as those used in this study.

In future research, great attention is needed toward clearly defining and assessing constructs, which have often tended to overlap. Crutzen et al., have argued that the terms “engagement” and “enjoyment” are often co-mingled within the serious games literature and they have noted a need for more precise use of terminology. In the present study, enjoyment was predictive in the univariate model, but dropped from significance in the multivariate analysis in the presence of engagement, suggesting that the positive engagement subscale of the EFI and enjoyment as measured by the PACES may be measuring overlapping constructs.

Physical activity has long been associated with improved emotional regulation and stress management (Bernstein & McNally, 2018). Physical activity improves depressive symptoms (Dinas, et al., 2011) and, may be a beneficial tool in improving mental health and overall well-being (Sharma, Madaan, & Petty, 2006). Engagement in physical activity facilitates the release of various brain chemicals such as endorphins, serotonins and dopamine, that are linked to improved mood (Hearing et al., 2016). It is unsurprising therefore, that the entertaining playing experience of EVG coupled with the energy expenditure may lead to positive changes in affect and a reduction in depression symptoms. While few studies of EVGs have examined depressive symptoms, a recent meta-analysis of eight published

studies showed significant depression-reducing effects across a variety of active video game studies (Li, et al., 2016). More rigorous, controlled studies are needed to understand the relative effects of depression on physical activity participation using EVGs as well as the role of depression severity.

Limitations

In this study all EVG and Standard exercise sessions were conducted in a controlled lab environment supervised by study staff. Thus, while the lab-based portion of the intervention provided a controlled research environment, it also provided a supportive environment for the uptake of physical activity in a structured setting. It is unknown whether and to what extent individuals might adopt regular exercise using EVGs in a different or less structured environment (e.g., at home). Thus, it is unclear whether results obtained in this study would generalize to individuals who use EVGs at home.

Conclusions

This study found several psychosocial factors mediated the difference in intervention efficacy between EVGs and Standard exercise formats. Additional work is needed to disentangle some constructs, such as engagement and enjoyment. Work is also needed to examine whether these constructs differentially affect the initiation versus the continued maintenance of physical activity in the longer term. Greater attention to those factors that predict uptake, adherence/maintenance, and exertion (energy expenditure) during EVG play will help elucidate the causes of disappointing results in EVG research and importantly, help to refine games to enhance those features that encourage physical activity participation.

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Table 1.

Baseline Descriptives by Group

	SE (n = 96)	EVG (n = 93)	All (n = 189)
	Mean (SD) or No. (%)	Mean (SD) or No. (%)	Mean (SD) or No. (%)
Age (years)	45.7 (15.0)	45.1 (14.0)	46.2 (13.5)
Gender (female)	74 (77.9%)	75 (80.6%)	223 (79.1%)
Employed	72 (77.4%) *	70 (76.9%)	219 (79.6%)
Marital Status (married or partnered)	54 (60.7%)	52 (56.5%)	164 (60.8%)
Education (at least some college)	79 (89.8%)	83 (91.2%)	242 (90.0%)
Ethnicity (Hispanic)	8.6%	10.5%	8.4%
Race (white)	82.8%	76.1%	81.5%
MVPA (min/week)	54.9 (±90.9)	63.8 (±72.5)	56.7 (±80.4)
(PAR)	Median = 30	Median = 40	Median = 30

Note: SE = standard exercise; EVG = exercise videogames; MVPA = moderate to vigorous physical activity; PAR = physical activity recall

* $p<.05$

Table 2.

Univariate Mediation Models

	a	b	ab
Self-efficacy	.24 (.11)*	33.66 (17.44)*	8.19 (.03 - 23.36)*
Enjoyment	3.47 (1.39)*	1.24 (1.45)	4.24 (4.07 - 16.57)*
Intrinsic Regulations (BREQ-2)	−.26 (.10)*	−16.31 (19.18)	4.26 (4.02 - 23.72)*
Amotivation (BREQ-2)	−.12 (.08)	15.25 (25.09)	−1.81 (−14.34 - 2.28)
External Regulation (BREQ-2)	.25 (.13)	8.15 (15.36)	2.03 (−6.10 - 15.97)*
Introjected Regulation (BREQ-2)	.02 (.12)	−3.17 (15.82)	−.06 (−5.27 - 2.76)
Identified Regulation (BREQ-2)	−.08 (.11)	−5.35 (18.95)	.45 (−3.57 - 11.09)
Stress Management (EMI)	1.20 (.53)*	−1.96 (4.18)	−2.33 (−22.12 - 6.49)*
Revitalization (EMI)	.74 (.37)	3.83 (5.33)	2.83 (−8.11 - 16.81)
Affiliation (EMI)	−.09 (.49)	1.98 (4.04)	−.18 (−6.44 - 3.37)
Health Pressures (EMI)	.13 (.31)	−3.16 (6.37)	−.42 (−7.91 - 2.64)
Ill Health Avoidance (EMI)	−.08 (.33)	−4.76 (5.96)	.37 (−2.49 - 11.38)
Positive Health (EMI)	−.07 (.29)	.20 (.98)	−.01 (−5.89 - 4.58)
Strength/Endurance (EMI)	−.06 (.48)	5.77 (3.64)	−.36 (−6.06 - 6.02)
Nimbleness (EMI)	−.46 (.44)	1.05 (4.48)	−.48 (−8.11 - 3.13)
Positive Engagement(EFI)	.69 (.36)*	8.27 (5.48)*	5.68 (.13 - 18.83)*
Revitalization (EFI)	.87 (.39)*	7.95 (5.05)	6.89 (−.93 - 21.81)
Tranquility (EFI)	.19 (.33)	.03 (5.91)	.01 (−4.98 - 5.43)
Physical Exhaustion (EFI)	−.22 (.41)	−6.16 (4.80)	1.38(−1.90 - 12.86)
CES-D	−1.19 (.92)*	2.11 (2.13)	−2.53 (−20.11 - 2.71)*
PHQ-9	−.23 (.03)*	−14.92 (8.02)*	−34.44 (−15.53 - 2.35)

Note: BREQ-2 = behavioral regulation in exercise questionnaire; EMI = exercise motivations inventory; CES-D = Center for Epidemiologic Studies Depression Scale; PHQ-9 = patient health questionnaire. For a and b paths, effects notes are unstandardized regression coefficients (standard errors). For ab path, effects are unstandardized (95% confidence intervals for indirect effects). Models were run separately for each potential mediator and control for baseline value of the mediator and PA level.

*p<.05