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Original article

# The effects of a bike active video game on players' physical activity and motivation

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**Abstract**

*Background*: Players may not acquire adequate levels of moderate-to-vigorous physical activity (MVPA) when playing commercial video games. This study's goal was to evaluate the effects of an exercise bike video game played by using a mobile application-based exergame that was designed exclusively to promote participants' MVPA, with additional attention paid to this game's ability to promote greater situational interest.
*Methods*: An experimental design was used with 163 students (aged 20.31 ± 1.30, 18–26 years, 61.3% male), all of whom were randomly allocated into an experimental group and a control group. Physical activity (PA) levels were assessed with ActiGraph GT3X+ (ActiGraph Inc., Fort Walton Beach, FL, USA) accelerometers. The situational interest scale was used to evaluate students' situational interest in both groups. Multivariate analysis of variance was conducted to examine the differences between sedentary behavior, PA levels, and situational interest between groups. Regression analyses were also used, with the purpose being to evaluate the strength of the relationship between PA and situational interest.
*Results*: Results revealed that the experimental group had higher degrees of sedentary behavior, light PA, total interest, instant enjoyment, exploration intention, attention demand, novelty, and challenge, whereas the control group received higher scores for MVPA (control 95.01% *vs*. experimental group 89.94%). Regression analysis indicated that instant enjoyment ($\beta = 0.49$, $p < 0.01$), exploration intention ($\beta = 0.18$, $p < 0.05$), and attention demand ($\beta = 0.17$, $p < 0.05$) were positive predictors for total interest, explaining 43% of its variance.
*Conclusion*: A newly designed mobile application-based exergame played via an exercise bike may enhance situational interest and provide a decent level of PA for players.


*Keywords:* Design; Exergame; Moderate-to-vigorous physical activity; Sedentary behavior; Situational interest; Young adults

## 1. Introduction

From 1975 to 2014, researchers from the Non-Communicable Diseases Risk Factor Collaboration Consortium reviewed population studies from approximately 200 countries in adults aged ≥18 years to determine body mass index (BMI) changes over time.[1] Findings from this comprehensive review indicated that average BMI increased from 21.7 kg/m$^2$ in 1975 to 24.2 kg/m$^2$ in 2014 in men, and from 22.1 kg/m$^2$ to 24.4 kg/m$^2$ in women. The study also revealed that if the post-2000 trends continue, by 2025, global obesity prevalence will reach 18% in men and surpass 21% in women, with severe obesity (i.e., BMI ≥ 35 kg/m$^2$) surpassing 6% in men and 9% in women. To mitigate this trend, researchers have focused on promoting proper health behaviors in youth and young adults to improve BMI values and reduce potential adverse health consequences associated with overweight or obesity.[2,3]

The current generation's youth and young adults are highly involved in social media[4] and video games.[5–7] Lenhart et al.[5] reported that 65% of males and 35% of females aged 12–17 years are daily gamers, whereas Gentille[6] found that 88% of American youth aged 8–18 years play video games at least once a month. According to Ream et al.,[7] this trend in video game play and social media interaction starts in early childhood and continues through adulthood. As such, leveraging the technology that most interests the current generation's youth and young adults in an

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effort to improve health outcomes in later life has become the focus of a growing body of research and practice.

In 2005, Nintendo (Redmond, WA, USA) launched the Wii, the first video game console in which players interacted with games through bodily movement. These types of games and gaming consoles would later be termed "exergames" (as known as active video games), which in contrast to sedentary video games have been defined as "video games that are also a form of exercise".[8] Exergames have received increasing attention among researchers because they offer a unique opportunity to build on youth and young adults' interest in video games, with the objective being to address the obesity crisis through increased physical activity (PA). Over the past 10 years, numerous studies have been published related to the effect of exergames on youth and adults' PA levels.[9–13] Indeed, Peng et al.[14] published a meta-analysis regarding the use of exergames for PA promotion among youth (6–17 years old) and adults (≥18 years old). Findings indicated that exergames (1) significantly increased heart rate, oxygen consumption, and energy expenditure compared with sedentary behaviors; (2) produce a similar magnitude of effect as light- to moderate-intensity PA; (3) have a similar impact for youth and adults with regard to PA intensity; and (4) are more attractive and enjoyable for youth and adults in comparison to traditional PA. Taken together, these findings suggest exergames to be a viable option to promote youth and adults' PA and health.

Despite the aforementioned benefits, youth and adults may still not acquire adequate levels of moderate-to-vigorous PA (MVPA) when playing commercial exergames (e.g., Wii Sports, Wii Fit, Dance Dance Revolution, Xbox Kinect, *etc.*). According to Beaudoin,[15] designers in the commercial exergames industry focus more on the fun and entertaining features of exergames—as opposed to aspects of game design that might increase PA intensity and subsequent health benefits—given the fact that the goal of commercial exergames is still primarily to entertain.

### *1.1. (Exer)games design*

Despite knowing that video games can be effective educational tools,[16–18] it is still unclear how and under what conditions these games are effective. According to Gaydos,[19] video game design remains poorly understood. Indeed, designing a good video game is difficult. One way to improve the design process is to share design plans. In the literature, researchers have shared video game designs via journal articles that present design principles or a list of steps that one must follow to create or recreate a game.[20–25] Briefly, these literature reports indicate the importance of designing games that immerse the player in a virtual world where competition and autonomy are present, real-world social norms can be temporarily ignored, and there is a need to find solutions to within-game problems to achieve success.[20]

In line with these design needs, Wang and Hannafin[21] introduced a design-based research perspective defined as "a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually sensitive design principles and theories". Simply put, researchers should ensure that every aspect of game design is consistent with the intended user population and overall objective of the game (e.g., to educate players on a subject, or to increase PA in players)—with the result being a more effective video game. Among the best examples of the use of the aforementioned design principles and design-based methodology comes from the Quest Atlantis team,[22] who successfully developed a video game that enhanced children's engagement in educational tasks. Given the proven effectiveness of these design principles and this methodology, these factors also need to be at the forefront of researchers' minds when developing video games for noneducational purposes (e.g., MVPA promotion among youth and/or young adults) to ensure achievement of the intended outcome.

### *1.2. Designing a mobile application-based exergame for an exercise bike*

Despite the attractiveness of exergames among youth and adults,[14] few studies have investigated players' situational interest during exergame play.[26–29] Situational interest has been defined as an activity's appealing effect on an individual(s)[30] and emerges from an instant person–activity interaction in which the person recognizes a specific intriguing feature of this activity while being engaged in the activity.[31] According to Hidi and Harackiewicz,[32] a highly interesting activity can immediately attract individuals' attention and provide positive feelings about the activity. Within the context of PA, Chen et al.[33,34] identified 5 sources of situational interest: novelty, challenge, attention demand, exploration intention, and instant enjoyment. The aforementioned sources of situational interest have been investigated among children while playing exergames.

Sun[26,27] found that elementary school students' situational interest during an exergaming unit was higher than their situational interest in a traditional fitness unit, with their situational interest decreasing significantly over time during the latter fitness unit. Additionally, Huang and Gao[28] found that novelty was a significant predictor of MVPA during exergame play in middle school students. Finally, Roure et al.[29] found that high school students displayed a higher level of MVPA when they believed that the activity demanded greater attention and demonstrated a higher level of light PA when they deemed the activity to only provide novelty.

Therefore, to promote players' MVPA and situational interest throughout game play, Vescape GmbH (Berlin, Germany) designed a mobile application called Greedy Rabbit based on the design principles of trial-and-error and progressive challenges and feedback.[35] Broadly, the mobile application-based exergame encompasses 10 sets of 10 stages representing progressively harder challenges. In detail, Greedy Rabbit is a maze game in which a rabbit makes its way through a maze, collecting flowers and avoiding hedgehogs in chase, with the goal being to obtain a carrot placed at the end of each maze (i.e., game stage). The video game is compatible with any mobile device (e.g., tablet, smartphone) and is paired with an exercise bike via a Bluetooth (Bluetooth SIG Inc., Kirkland, WA, USA) connection to match the speed of the rabbit with the player's