

# Video Games to Promote Healthy Behaviour

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## ABSTRACT

In this paper, we discuss the health benefits from physical activity produced by active video games in both young and older people. These health benefits range from improvements in physical attributes as well as improved cognitive abilities and mental health. Obesity is identified as a consequence of the inactive lifestyle of children that technological advances have induced and we examine the potential benefits of active video games on preventing and treating obesity. The requirements for an effective active video game are outlined; each requirement is related to a certain psychological aspect. We also present how these games could aid in the physical rehabilitation of children suffering from cerebral palsy. Finally, we address the potential limitations of active video games and what may need to be present in future work.

## INTRODUCTION

Statistics show there has been a global decline in physical activity especially in the past two decades which has been linked with the obesity epidemic [10]. A sedentary lifestyle for both young and old people can lead to various diseases which are easily preventable with regular exercise, so it is essential to understand how active video games could be utilized or developed in a way to promote physical activity in people. Over the past decade, substantial research has been undertaken to study and analyse the cognitive and physical effects of video games. It has been found that playing video games on a consistent basis improve hand-eye coordination and visual attention, as well as mental flexibility and strategy.

This paper explores how active video games, or *exergames*, may stimulate both physical and mental health in people. More specifically, this refers to full-body motion games supported by technologies such as the Nintendo Wii, Microsoft Kinect and other physical components. We discuss the potential benefits that active video games can provide for young players and developing children.

Exergaming even enable older adults to live healthier lives through physical activity but games must be specifically designed for them to address their physical limitations. Physical activity performed while playing these video games can be comparable to normal exercise and thus we examine how active video games may become an effective approach to a healthy lifestyle for any individual of any age.

People are deterred from exercise due to lack of motivation but this can be overcome by fulfilling certain requirements in video games and these game aspects could provide that motivation.

In addition, this paper also explores how physical movements induced by active video games can aid in the rehabilitation of children with cerebral palsy. Finally, we address the potential limitations of exergames and provide a discussion on the further understanding and research that may be necessary to establish a stronger argument for the health benefits of active video games.

## GENERAL HEALTH BENEFITS

Regular exercise is highly beneficial to physical and mental health and it is an essential requirement to achieving a healthy lifestyle. Regular exercise has been shown to positively affect mood, relieve anxiety and depression and improve cognitive functions, as well as prevent diabetes and coronary heart disease. An active video game can provide similar benefits with the correct level of exertion and an appropriate game design.

'The Acute Cognitive Benefits of Casual Exergame Play' [5] presents the various benefits that exergaming may provide, while comparing it to regular exercise. Casual exergaming has been shown to be equivalent to moderate-intensity aerobic exercise in terms of heart rate, which is a good measure of physical intensity. One significant advantage that exergames have is that they are sufficiently enjoyable, so people are inclined to play those games multiple times in a day and perform moderate-intensity exercise on a daily basis. Two studies were conducted to compare the cognitive effects of a casual exergame with a sedentary version of the game and a normal treadmill exercise. The video games and treadmill exercise were performed for 10 minutes. It was found that the casual exergame had greater cognitive benefits than the sedentary version (this was observed in cognitive tests that participants took after their activities). It was also found that the casual exergame was similar to the treadmill exercise in terms of the level of physical exertion.

'Exergame effectiveness: what the numbers can tell us' [11] examines the quantifiable physical benefits of exergaming and introduces a prototype exergame system called SNAP that involves the use of sensors that are attached to the

player's body. Different active video games available on the market were analysed and it was concluded that they may be inadequate to a certain extent in providing the recommended daily exercise. Due to this limitation, they developed SNAP and various games that go with it; games included track and field exercises and a game where participants had to pose in a specific manner as shown on the game screen. A study was conducted in which fourteen participants were involved and from the observation of heart rate, it was found that SNAP was superior and better than the Nintendo Wii at elevating heart rates to the desired heart range for weight management and also provided a sufficient level of physical exertion for cardiorespiratory benefit. It was concluded that existing market exergames were not as effective as they potentially could be, which suggests there is still opportunity for improvement and game developers perhaps need to take a more effective approach or consider different alternatives in game design.

### **Benefits for Children**

Exergaming is popular with children and there are a wide variety of devices currently available that enable this active form of gaming. 'Acute Effects of Physically Active versus Inactive Video Game Play on Executive Functioning Skills in Children' [4] conveys the speculative idea that active video games may affect the use and development of executive functioning skills, which are related to cognitive processes such as attention, working memory and problem solving. Math and reading abilities were also shown to be affected positively.

'Playing Active Video Games Increases Energy Expenditure in Children' [7] makes a direct assessment of both active video games and traditional exercise, comparing the energy expenditure rates and other physiological responses of children performing a variety of exercises. Dance Dance Revolution (DDR) and Nintendo's Wii Sports were the video games used in the study and was compared with treadmill walking. These physiological properties include heart rate, perceived exertion and arterial elasticity. The study involved twenty three healthy children, 2 laboratory sessions for each child and the video game was played for 30 minutes. It was concluded that a session of gaming is equivalent to moderate-intensity walking in terms of energy expenditure. Hence, active video games can be an effective alternative source of physical activity for children, that provides enjoyment as well as prevent sedentary behaviour. Video games can be more appealing to children than traditional forms of exercise so the introduction of video games to a child could promote healthy behaviour.

### *Tackling Obesity*

'Playing Active Video Games Increases Energy Expenditure in Children' [7] identifies the obesity problem of children and how increased childhood adiposity may lead to a variety of diseases in later life. Recent technological advances in the form of computerised entertainment and

convenient transport have consequently allowed children to be less active and engage in little physical activity. An inactive lifestyle as a result of sedentary activity leads to low energy expenditure [2] and therefore childhood obesity is becoming much more prevalent in developed countries; around 16% of children in the US, 17% in the UK and 12% in Australia suffer from childhood obesity [10].

'Complete Motion Control of a Serious Game against Obesity in Children' [10] provides an overview into the negative implications of obesity. Obesity can lead to diabetes and cardiovascular disease, as well as have a negative psychosocial impact on a child and this can continue into adulthood which poses as a significant problem. The subject of obesity is controversial but a physically inactive lifestyle and an unhealthy diet are considered significant factors. This problem can be approached by taking advantage of children's dependence on video games by integrating physical movement and perhaps even presenting educational content within the game. The paper delves into the complexity of game design and the user interface with regards to the author's own serious game called Tito Bico, which involves the use of a Nintendo Wii-mote controller and a Wii-fit balance board. Although active video games can be used to encourage physical activity in children, it is advised they should not be used as a complete substitute to traditional exercise and should only be considered as a supplement [10, 11].

### **Benefits for Older Adults**

Active video games can be effective for the generally overlooked elderly demographic as it encourages physical activity as well as keep older adults cognitively active. 'Full-Body Motion-Based Game Interaction for Older Adults' [6] shows how active video games may improve the overall well-being and quality of life for elderly people. It also provides key guidelines on developing effective motion games suitable for older adults. This paper addresses the issue of the lack of physical activity in older adults and their sedentary lifestyle. Video games may provide an alternative source of enjoyment while allowing them to be physically active. Commercially available games are not suitable for older adults so a gardening themed gesture-based game involving the Microsoft Kinect was made specifically tailored to an elderly audience. The game incorporated only simple gestures to accommodate for their limited physical abilities. The results were positive overall; the older adults generally enjoyed the game and were satisfied with the theme but they could not play on their own which suggested improved game tutorials were needed for them to get more accustomed to the gestures. The paper suggests a need for more research into different game mechanics and the development of games that are enjoyable while at the same time, accessible for anyone of any age.

Active video games specific to helping the elderly population is also discussed in 'Social exergames to persuade seniors to increase physical activity' [3]. This

paper also addresses the physical and mental limitations that older adults may have, regarding motor skills and cognitive ability. Subsyndromal depression, which is defined as mild depression, is a common condition found in older adults and it has been found that physical exercise from active video games can effectively prevent or be used as treatment for this condition. Thus, exergaming can be seen to be effective for mental health which is equally as important as physical wellbeing.

Several studies concerning Nintendo Wii games have been conducted with elderly and it was found that Wii Sports Bowling was viewed as appropriate and suitable for older adults because of its self-paced nature [3]. However, in general, Wii Sports was considered difficult to play but the elderly players liked the prospect of participating in the game and the social aspect of the game was positively received. Regarding the social aspect of games, there is some evidence that older players do not find multiplayer gaming (over the internet) quite as enjoyable as young people might perceive it as.

In addition, 'Social exergames to persuade seniors to increase physical activity' also outlines the persuasive technology that can be incorporated into active video games. Persuasive technology is defined as "*a set of technologies that attempts to change attitudes and behaviour of people through persuasion and social influence, but without making use of coercion and deception.*" These persuasive strategies include:

- Displaying information of progress to motivate player; clear visual representation of achievements and progress delivers high satisfaction.
- Recording and displaying user history; can help to set new goals.
- Appealing and friendly interface.
- Positive reinforcement to encourage player to improve behaviours.
- Absence of negative feedback to prevent players from being discouraged.
- Social influence; the social aspect gets people more involved and increases involvement.

## EXERCISE MOTIVATION

'Using Games to increase exercise motivation' [12] discusses the requirements that should be met in an active video game to sufficiently engage and motivate sedentary people to perform exercise. Concepts from the sports psychology field were considered to establish the game design and subsequently a computer-aided exercise game called Life is a Village was developed which incorporated these elements that provided the motivation for players. This paper firstly outlines the existing types of exercise games, which include virtual reality and augmented reality

games and explores how physical movement can be effectively added to a game. Secondly, 6 different requirements for an effective game are defined, ranging from the integration of music to providing in-game goals, with each requirement encompassing a certain psychological aspect. The Life of a Village game itself consisted of a game screen, a recumbent bicycle for pedaling and a handheld controller for steering and the player's goal was to build a village. The developers created the game with their defined requirements in mind and also identified that biometric feedback could be appropriate in future versions.

With regards to in-game goals being an important requirement, 'Physical Activity Motivating Games: Be Active and Get Your Own Reward' [2] discusses this in more detail, using their own study as a basis of evaluation. The authors introduce a specific design approach which they termed, PLAY, MATE! (Physical ActivitY MotivATING gamEs), which essentially is a conceptual game design focused on virtual in-game rewards through physical activity. Their game design was applied and integrated in an open-source game called Neverball which was publically available to modify and develop. The main objective for the player was to collect sufficient coins in a limited amount of time. A time-based reward design was considered and players were given extra time for successfully performing a specific physical action, such as jumping. The jumps were registered using a preconfigured triaxial accelerometer. The available time in game levels was reduced as the player progressed to further motivate players to perform physical activity. This design was derived from the application of different motivational theories from behavioural research:

- Operant conditioning, where a person is rewarded whenever he or she displays favourable behaviour and over time, does not require the reward-based reinforcement to demonstrate the desired behaviour.
- Premack's Principle – "*According to it, if two activities have different probabilities of occurring, the high-probability activity can be used to motivate or reinforce the low-probability activity. That is, the high-probability activity motivates the low-probability activity by making the former contingent on the latter.*" [2]

135 young players were involved in the initial trial test which concluded with positive results. An additional 90 players were tested after the game was improved with adaptive techniques to compensate for the variation in individual gaming skills and these techniques were successful in balancing the game. The results were conclusive; it was shown that the PLAY, MATE! design was effective in motivating players to perform physical activity. Thus, it can be deduced that in-game rewards can be a noteworthy feature in active video games and game designers should devise effective methods in integrating a reward-based design into their game.

## PHYSICAL REHABILITATION

Active video games can be seen to be effective for instigating physical exercise in normal people but we should also explore the physical health benefits and rehabilitation of people with physical illnesses, specifically children with cerebral palsy.

### Children with Cerebral Palsy

Cerebral palsy is a group of non-progressive neurological disorders that affect physical movement and posture in a developing child. It contributes to poor motor control, reduced aerobic capacity and poor coordination; essentially, a child diagnosed with cerebral palsy is likely to have poor physical fitness and have a limited range of motion [1, 9].

#### *Active Video Games for Children*

Active exercise video games can be used as an alternative method to traditional rehabilitation therapy. Physical therapy usually only specifically target and isolate one of the many various physical disabilities and therefore can be considered to be not that effective, whereas exergaming could provide a means of satisfying a variety of physical movements while at the same time, provide motivation and enjoyment for the child to consistently improve his/her physical fitness [1]. ‘Active video games and children with cerebral palsy: the future of rehabilitation?’ [1] claims that active video game consoles (AVGC) can be used to provide a safe, motivational environment for children along with essential features such as real-time feedback and task repetition. One significant advantage that AVGC offers is eliminating the need of children having to travel to the specialized rehabilitation centre because the games can be played locally at home [8].

Games would need to be adequately designed and tailored to the child’s physical abilities. ‘Design of an exergaming station for children with cerebral palsy’ [8] introduces a custom built gaming platform that was incrementally designed in collaboration with game developers, medical professionals, therapists, computer scientists and children with cerebral palsy. The paper outlines three aspects that are important in the design of an exergaming station. The usability of the physical equipment and devices, input interpretation of the devices and the overall design of the gaming system have to be carefully considered in order to provide and enable sufficient exercise.

#### *Benefits of Exergaming*

Different studies have been carried out, each involving a different type of gaming device. In ‘Active video games and children with cerebral palsy: the future of rehabilitation?’ [1], the Nintendo Wii Fit was used as the gaming tool in a study to compare postural movements and cardiorespiratory responses in children with and without cerebral palsy. Various physical attributes (e.g. maximal isometric strength at joints, heart rate, and centre of foot pressure) were measured and evaluated and the results showed that the children with cerebral palsy had similar

energy expenditure with the typically developing children. The jogging game was the most efficient in increasing energy expenditure and also met requirements for cardiorespiratory fitness.

‘Low-cost motion interactive video games in home training for children with cerebral palsy: A kinematic evaluation’ [9] involved the use of a Sony Playstation 2 with the EyeToy: Play 3 and primarily focused on arm movements and coordination of children with cerebral palsy. Over a four week period, various kinetic parameters of the movements of participants during gameplay were measured and analysed and it was concluded that the games improved motor control and hand coordination.

## LIMITATIONS

Exergaming does provide many health benefits as suggested throughout this paper but it is not exempt from potential limitations that may hinder those benefits. ‘Physical Activity Motivating Games: Be Active and Get Your Own Reward’ [2] outlines six different potential limitations of active video games in the context of their study regarding their PLAY, MATE! game design. These are:

- Long term health impact; there is little evidence to prove that active video games will provide long term benefits and produce an active lifestyle.
- Game-related activity; the physical movements or activities performed outside of the game may not be logically correlated with the actions within the game (depending on the type of game) and this discrepancy may have adverse effects on the player’s motivation and willingness to play.
- Wide applicability; the integration of the motivating component in a game depends on the genre and game design and therefore may not be appropriate in some situations.
- Activity interface; the peripheral devices and technology used must be easily accessed, available and relatively affordable for the user or this may affect the perceived enjoyment and decrease motivation for the player.
- Balancing activity and enjoyment; the balance between activity and enjoyment needs to be well established and trade-offs may need to be made in order to provide the optimum experience for players.
- Commercial transfer; it may be difficult to integrate the motivational component into commercial games as their source code is proprietary and not free to modify and the interests of the gaming company are not always aligned with what is desired.

## CONCLUSION

Overall, we can see that active video games have a wide variety of health benefits, ranging from cognitive boosts to

cardiorespiratory benefits and can be suitable for all types of people. Results from various studies do show that there is a correlation between health benefits and exergaming, which can be comparable to moderate-intensity exercise to some extent. However, it is important to note that exergaming should not be used in place or as a substitute for traditional exercise. Moreover, commercial active video games currently available on the market may not provide sufficient levels of exertion. In addition, typical commercial active video games may be inaccessible to those with physical disabilities so games may need to be specifically designed with respect to the target audience.

#### FUTURE WORK

All the various studies of the different research groups mentioned in this paper only observed participants over a short time period. We may need to investigate the long term impacts of exergaming over the time span of a year or perhaps several years to produce a higher quality of empirical evidence to provide an accurate evaluation. It would also be a high priority to inform gaming companies that they should also focus on developing game titles suitable for the elderly and people with physical limitations.

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