Video Games to promote healthy behavior

ABSTRACT

The objective of this review is to support the understanding of how active video games (AVG) can help promote healthy behavior by providing an overview of other peer-refereed research papers. We live in a world where rate of obesity keeps rising and children are putting themselves at risk of developing chronic diseases including cardiovascular diseases and diabetes later in life. This paper outlines whether it is feasible we can use active video games to help promote healthy behavior. Active video games are played by interacting with a display and a camera device that detects gestures to process images taken by the camera. This requires players to physically interact with onscreen display including dancing, playing sports etc. The measures of change were focused mainly on the Body Mass Index (BMI), HR, aerobic fitness and body composition. There was not sufficient evidence that children playing the video games were more active in general than children not receiving. Also, it was evident that just providing video games to a person do not automatically promote healthy behavior for that individual but it takes constant playing time as well as a healthy diet and recovery as it does with any type of physical activity.

Author Keywords

Health; physical activity; fitness; active video games; children; measures; controls; playstation; wii

1. INTRODUCTION

The need of being active is important for young overweight individuals to live a long healthy life. To promote healthy behavior, a child is infatuated with video games so what better way to gets kids to be active than allowing them to play active video games. Resources indicate that obese children are diagnosed with chronic diseases including cardiovascular diseases and diabetes and these are a result of kids being inactive [3, 6]. Active video games including EyeToy, allow its players to take part in light to moderate intensity physical activity and now many studies have collected data from the participants to review whether it could promote any healthy behavior [1]. The reviews used BMI, body weight loss and energy expenditure as the baseline for the results.

The body of the report will discuss the health problems caused by being overweight or obese, my methodology and approach for finding resources, results and findings, conclusion and also how future work can be improved.

2. MOTIVATION

Physical inactivity is believed to be the cause of more than estimated 1.9 million premature deaths per year globally due to Physical Activity (PA) levels declining throughout childhood and in some cases below levels recommended. Lack of physical activity leads to obesity and these individuals are susceptible to diseases including heart disease and stroke (more likely if it is a common disease in the family), high blood pressure, diabetes and even cancer. Being overweight and inactive is the main problem; however, it results from reasons like having low energy levels, indoor activities (not physical) including video games or TV, lack of resources including financial security and lack of support from family. [3]

Introducing AVG as an incentive to be physically active indoors for children has been considered by providing a storyline in the AVG although there needs to be sufficient evidence whether it has any positive effect on body composition in obese children [6]. The resources for my literature review have discussed the types of trials/studies that were carried out and explained their findings with respect to AVG effectiveness [1-9].

3. METHODOLOGY AND APPROACH

In this section, the search strategy and selection criteria used for this review is outlined and provides the types of resources reviewed.

3.1. Search strategy:

Relevant research regarding AVG to promote healthy behavior was identified by searching library e-databases including PubMed, IEEE Explore, ACM Digital library or Lecture Notes in Computer Science (LNCS) for primary research material. In order to ensure relevant studies were not missed, the search terms remained broad. These were “active video games”, plus “active video games and physical activity”, plus “active video games and energy expenditure” anywhere in the title or abstract. There were

no location restrictions but the language of the published resource had to be English and the studies were eligible for consideration in this review if the focus of the study was AVG and if there was at least one parenting variable measured relating to physical activity. A number of sites were researched, mostly official journals including Pediatrics and IJBNPA.

3.2. Selection Criteria:

The selection criteria involved a detailed examination of papers and at this point studies were excluded if the parenting or adolescent measure were insufficiently described, or AVG was only a minor part in the study, and therefore the study did not contribute important data to this review. For the studies investigating direct associations between AVG, physical activity and promotion of healthy behavior, the review includes all peer reviewed longitudinal studies investigating AVG and impacts it has on health of participants in the study. Longitudinal studies involving AVG were seen as particularly valuable resources as they helped the testing of relationship between early events including the starting statistics of individual before the trial and compared with later outcomes. This enabled the identification of development patterns and pathways, as well as create a theoretical model which can be validated in future research. Studies with methodological weaknesses arising from small convenience samples, insufficient factors measures, or weak analysis of data were only included when they provided insights not available from more thorough studies [7]. Qualitative studies that contributed new information such as measuring motivation and enjoyment or covered areas that had not been fully explored such as AVG replacing gym class were included. For the review of intervention research, studies were retained if: they employed a control group, randomly assigned to the treatment and non-treatment groups.

4. FINDINGS

The UoA library search of "active video games" keywords returned 21,838 Peer-reviewed Journals, and of those only around 10-15 resources met the selection criteria. About 6 resources were not linked via the e-library database but were still displayed in the result so they had to be excluded. 7 out of 9 remaining resources were literature reviews of studies conducted involving AVG and the other two did not involve AVG as the main focus of the articles so they had to be excluded. I decided to search for some articles via Google Scholar and only used 2 of which had a reputed publisher. All the studies in reference list were identical and involved children as participants and used a relatively small sample size irrespective of the location. Few of the studies involved self-submission of data of AVG play and interaction from the users or their parents on a regular basis and if they failed to do so, they were no longer a part of the study.

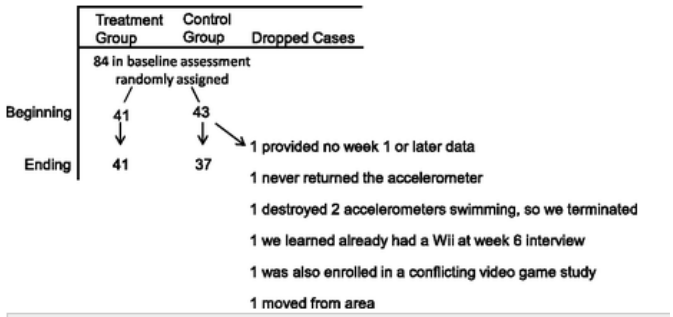
I decided to choose resources that included a study as it would be easier to support the idea of AVG with evidence of those studies but all of them had limitations including measures, controls and conditions (improving discussed later). The 'Discussion' section provides more information on the information found in the resources.

5. DISCUSSION

In this study, I systematically reviewed each of the literature in order to determine whether AVG can be used to promote healthy behavior and below are the findings.

Maddison et al. [1] results were measured at 12 and 14 weeks baseline. Height, weight and body fat was assessed using standardized bio-electrical analysis procedures. Aerobic fitness was measured using the shuttle test of 20 meters and seven day activity was measured using accelerometer. The resource states that aerobic fitness at 24 weeks was a significant mediator and met the conditions of mediation of all treatment outcomes. As shown by Table 1, BMI was reduced approximately 8% including aerobic fitness and about 50% observed group shift in body fat was observed as well. The resource also states that no other variables that were observed had any significance as they had no effect.

The Baranowski et al. [2] states that the study included 84 participants completing baseline assessment but 6 participants from control group were dropped for the reasons shown in the following table.



The results included the ethnicity, age and location of the Wii console in the house with living room and bedroom being the popular choice. The type of physical activity, sedentary behavior and CPS of both groups were recorded and in the 6th week there was a time-related difference in sedentary behaviour. Interviews of the participants concluded that in both groups enjoyed AVG and this was similar after 6th and 12th week. The data collected in the resource suggested that there were no significant benefits of

children playing AVG games versus the children receiving inactive video games in terms of physical activeness.

The third resource reviewed eighteen different article for the quantititave analysis which included invidividuals at the age of 21 and younger. The findings from the eighteen

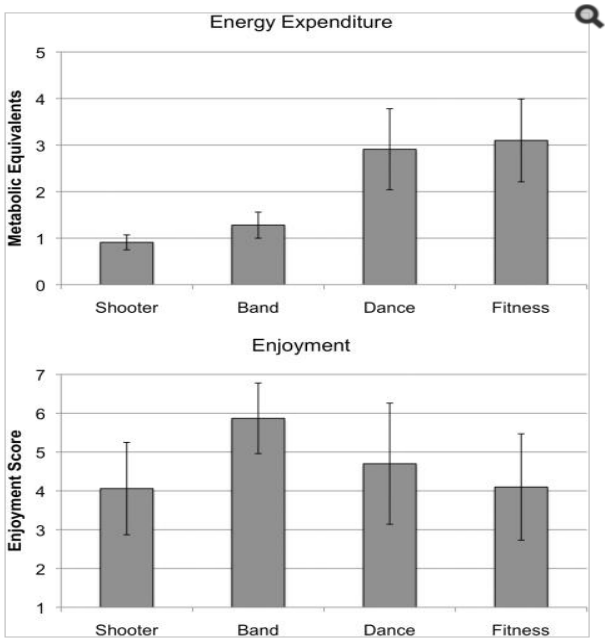
Table 2. Summary of Heart Rates and Energy Expenditures During AVG Play

Movement and Game	Source	Increase in HR From Resting Values, %	Increase in Energy Expenditure From Resting Values, %	Child-Specific Metabolic Equivalent[a]
Primarily upper body, eg, swinging and reaching				
XaviX *Bowling*	Mellecker and McManus,[13] 2008	26	100	2.0
Wii *Bowling*	Graf et al,[31] 2009	49	101	NA
Wii *Bowling*	Graves et al,[34] 2008	47	117	2.2
EyeToy *Nicktoons Movin'*	Lanningham-Foster et al,[38] 2006	NA	110	2.1
EyeToy *Groove*	Maddison et al,[36] 2007	42	129	2.3
Wii *Tennis*	Graves et al,[34] 2008	53	139	2.4
Primarily lower body, eg, stepping and running				
DDR	Lanningham-Foster et al,[38] 2006	NA	167	2.7
DDR, low level	Graf et al,[31] 2009	63	171	NA
DDR, high level	Graf et al,[31] 2009	83	228	NA
DDR	Unnithan et al,[39] 2006	NA	173	2.7
DDR	Tan et al,[40] 2002	51	246	3.5
DDR	Maddison et al,[36] 2007	63	286	3.9
Cateye *GameBike*	Haddock et al,[32] 2009	59	367	4.7
XaviX *J-Mat*	Mellecker and McManus,[13] 2008	98	400	5.0
Upper body + lower body, eg, for ducking, swaying, and running				
EyeToy *Antigrav*	Maddison et al,[36] 2007	41	186	2.9
Wii *Boxing*	Graf et al,[31] 2009	97	205	NA
Wii *Boxing*	Graves et al,[34] 2008	95	218	3.2
Wii *Boxing*	Lanningham-Foster et al,[33] 2009	NA	321	4.2
EyeToy *Cascade*	Straker and Abbott,[37] 2007	59	229	3.3
EyeToy *Homerun*	Maddison et al,[36] 2007	77	369	4.7
EyeToy *Knockout*	Maddison et al,[36] 2007	82	400	5.0

articles confirm that AVG interaction caused increase in energy expenditure when compared to the sendantary or passive video game interaction. The 'Table 2' show the increase in HR and increase in Energy Expenditure for all the types of AVGs used for study. The only problem was that energy expenditure varied a lot from 100% to 400% increase and was slightly dependent on the type of body movement (upper, lower or both). Other measures included anthropometery, HR, perceived exertion, arterial elasticity, $V0_2$ max and body movement. Highest energy expenditure measured was during DDR and Wii Bowling and there was a large elasticity decline during these activities. Exertion levels were close to medium-intensity dance routine during DDR. The evidence collected from those eighteen articles suggested AVG provide some moderate increase in physical activity but evidence was becoming irr elevant as the dropout rates after 12 weeks was 41%. Even though there was a slight positive effect from the AVG, it still does not suggest it will improve any aerobic fitness as the exercise intensity must exceed 80% of the max HR but the average HR was around 50-80% the max. The resource suggested that several articles reported few Wii related injuries and that AVG play can mean the individual is exposted to unknown physiological risks including muscle soreness, acute muscular and myontendinous strain.

In the Dutch study, 22 participants were excluded and descriptive analysis was conducted with the remaining 179 participants. Only 67% of the participants met the physical activity guildelines. The measures and controls were not set properly and focused more on areas including prefered age or game, activities that were replaced by AVG and their time schedule rather than measurement of intensity of physical acitivty, body weight loss or any other relevant information.

In Lyons et al. [6], 55% of the participants were overweight and the evidence shows that it affected the energy expenditure during the dance AVG games as non-overweight particpants expended more energy but no other differences were found due to the weights of the participants. Shooter games did not have a massive impact on the energy expenditure due to the upper body movement only but dance and band simulations involved a higher rate of energy expenditure due to the full body involvement. Enjoyment was a factor dependent on game type and the weight of the participants (shown by Energy exp. and Enjoyment graph). Non-overweight participants found the games less enjoyable than overweight participants.



Sedentary video game interaction was the caused of an increase in food intake in participants and it was associated

with video game play without increased sensations of hunger and appetite. Preidt et al. [7] indicates that AVG can be used for physical activity but more research needs to be done on developing guidelines.

Biddiss et al. is significantly different to the last two resources based on the age of the participants and the technology used to measure is well ahead when compared to the previous resources. The articles used for the literature review involved participants with the ages of 21 years or less. The types of data collected was energy expenditure during play, promotion of PA though AVG, physiological risks and benefits, enjoyment and motivation. There were 2 reviewers per article to verify the integrity in data extracted and interpretation for this literature review. All the data from the studies were summarized including percentage increase of heart rate and energy expense and then compared.

Many of the literature reviews measured the effects of an AVG on an individual but none of them measured energy expenditure and enjoyment together except Lyons et al. [6]. The enjoyment aspect is important as it will affect the intensity and the occurrence of AVG play. This study selected 100 individuals whose ages were 18 to 35 using TV ads and University mailing list to investigate the differences across four game types: shooter, band simulation, dance simulation, and fitness. The trail involved an Ultima CPX indirect calorimetry device and AVG were played in random order for 13 minutes each, with the first three minutes considered a training period. IMI and its subscale was used to measure enjoyment and interest in participants and data was collected when participants ranked their agreement with each statement on a Likert scale of one (not at all true) to seven (very true).

Preidt et al. [7] (article) uses 20 minute AVG play time as direct substitution to the 104 participants' usual gym class sessions. The participants were selected from grades 3 to through grade 8 from public school in Washington DC and the data collected from the AVG interaction was then compared to the gym session energy expenditure. The idea behind the use of AVG was to allow children to be active in school and their own home because many of the participants lived in an unsafe neighborhood. This article did not include any type of information regarding the measures and controls used during the study.

The results of my resources are somewhat similar and seem to have a pattern with the use of AVG for physical activity but none of the articles or studies used in my literature review have sufficient evidence to support the idea of long-term use of AVG to promote healthy behaviour. The "FUTURE WORK" section is a contuinity from the disscussion and outlines many areas to improve for the future.

6. CONCLUSION

The risks of being overweight and the types of chronic conditions that affect many people can likely be solved by a versatile approach which includes education and structured plan with incentive for daily physical activity. AVGs are a new technology in the health area and the groundwork shows that it can be a fun medium for self-directed physical activity of light to moderate intensity. Video games have been applied for physical activity promotion mostly for children and adolescents, whereas they serve mental health objectives in the elderly and disabled people. The resources states that active video games do enable the user to engage in moderate physical activity but the authors are unable to determine the long-efficacy for physical activity promotion [1, 3].

All resources agree that AVG can be used to promote a healthy lifestyle for individuals regardless of age because of the time spent while playing can be considered as time spent doing any other physical activity. Another reason is that participants who spent time on AVG agreed that if not for the time spent on AVG, they would have spent it on activities which would involve them being less active. Another option would be to allow individual to engage in less active video games but enjoyable games and this would allow the reduction in sedentary behavior. The proposal of using AVG in unsafe areas for children is a very clever idea although as mentioned previously that AVG can increase energy expenditure but are less enjoyable than other sedentary games so a less active but enjoyable AVG should be chosen. For the systematic reviews with unsupervised trails, the AVGs were not played with the intensity they were expected to play or compensated for increase intensity by being less active during the day. Overall, AVGs enable light to moderate physical activity but there is not enough evidence to make conclusions on the long-term use of AVG for physical activity promotion.

7. FUTURE WORK

This section is based on the resources I have used for my literature review and the information provided is only based on the information they include.

7.1. Measures and guidelines

The literature used for my review is relevatively new as it has been published only a few years ago but regardless of the publishing date there is space for major improvement. The outcome measures including BMI or weight loss cannot be the only two measures but should also include cardiovascular endurance, muscle strength, body composition and flexibility and change in sedantary behaviours. For Maddison et al. [1], the main mediator of physical activty was aerobic fitness but still future trials shold consider other mediator related to this type of intervention. Few of these examples are mentioned in Biddiss et al. [3] as well but both find it hard to measure attitudes to or preferences for physical acitivty or even

change in sedantary behaviour. In majority of the resources for my literature review, the participants were not given a specific amount of time to play the AVG instead they were allowed to play as little or as much as they wanted but future work would find it beneficial to utilize equal time allocation to each particpant for greater effects on aerobic fitness.

7.2. Real world conditions

A major issue was that the children perform light-to-medium intensity physical activity using AVG withing laboratory conditions but they would never play with that much intensity on a daily basis in a real life scenario so future work should somehow be able consider the motivation factor and develop a study based on real life scenario. The selection criteria for participants should be completely random not just random for people who own a console to play the AVG on. Maddison et al. [1] suggests that future study should consider not include the small size of the participants, no asssesment during game play on consoles other than Wii and the range of ages was way to small and from only one city.

Also, the energy expenditure in the lab environment cannot be used to estimate the real life AVG play energy expenditure because it is often episodic and unsupervised so EE associated with AVG play in a home setting should be considered. None of the resources include a compulsary healthy rest period after a certain amount of play and mentions nothing about interuptions which can affect the constant play data. The type of body movement in the AVG is important and games which involve low-energy usage including Tennis (flick of a wrist) should be the focus of further development.

7.3. Motivation of participants or users

Lack of motivation was also caused by lack of narration or storyline of the AVG and future studies should evaluate whether having that aspect in the game have any benefits to the intensity of physical activity and behaviour. Long-term adherence should be considered as motivation will sustain the engagement in physical activity while playing AVG and therefore, the games should spark natural motivators for all individuals and ages. Diversification of AVG and including a storyline or plot and providing multiple player interface will maintain the interest and motivation of users with AVG play. According to Biddiss et al. [3], the games should enable online play with other users and form virtual and non virtual AVG clubs and also include AVG for schools' physical education programs.

7.4. Physiological risks and disability groups

Physiological risks including muscle soreness and acute musclar and myontendinous were the type of injuries encountered by the participants during the study but AVG interaction cannot be supervised at all times and could lead to unknown physiological risks. Since AVG is becoming popular, research needs to be conducted on injury types and injury rates as well as the impacts of muscle movement while AVG play. This would help developing guidelines for the physical activity, therepy and general public health. In some cases, AVG can be helpful to challenged individuals and they have been used for physical therapies in individuals with cerebral palsy, stroke, burns and spinal cord injuries and syndromes. Research on physiological responses of players during AVG play should help game developers test stages may help develop optimized systems. Future study should include energy expenditure caused by AVG in disabled children and can help develop specific guidelines as well as the appropriate measures for the use of AVG for individuals with disablities.

Limitations of the studies for my literature review does not allow for accurate conclusions to be made based on the current evidence on AVG used to promote healthy bahaviour and physical activity. This can be re-inforced by the lack of structure in the whole process allowing many variations and inaccuracies in the statistics. All resources in my literature review have stated that the future studies will be able to measure every aspect more accurately and hopefully will prove that active video games do have some sort of noticeable positive effect.

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