**Video Games to Promote Healthy Behavior**

**Ji Hun Ha**University of Auckland, New Zealand
jha015@aucklanduni.ac.nz

**ABSTRACT**

**Background**

Video games are known to involve a wide range of individuals, therefore showing its potential to deliver healthy behaviour as it is seen as more entertaining than ordinary physical activities, and it is a well-known factor in preventing many chronic conditions, such as cardiovascular disease.

**Purpose**

The purpose is to promote the healthy behavior using active video games, and to (1) observe if physical activity from active video games can increase sufficient energy expenditure to be useful, (2) if physical activity from active video games is sufficient enough, could the effect last in the long term.

**Methods**

20 studies were acknowledged. The searches were conducted using relevant keywords for ‘active video games to promote healthy behavior’. Those key words were ‘*game, active video games, physical activity, healthy behavior* and *motivation’.*

**Results**

Many of the studies' results showed that active video games do increase the energy expenditure from resting value (varying from 41% to 400%) and increase the heart rate from resting value (varying from 26% to 97%). The value of energy expenditure and involvement increased when participants enjoy the active video game given, and also when participants were paired up with individuals’ friend.

**Conclusion**

Active video games can improve the physical activity of individuals and activity levels from active video games are significant enough to be considered as exercising, however because of limitations of the study such as having minimal number of participants per study (below 50) and the study being carried out in a short term (below 24 weeks), there is not enough evidence to conclude that active video games promote healthier behavior in the future.

**BACKGROUND**

Physical activity is a well-established factor to prevent many chronic conditions, such as cardiovascular disease, diabetes and obesity [18]. However, physical activity is declining in all age groups but more noticeable to younger age groups as individuals prefer sedentary video games over physical activity [18].

The main reason sedentary video games are more popular than physical activity is because sedentary video games are much more appealing than physical activity because of the entertainment value; hence individuals are willing to spend a lot of more time on it [13]. By combining physical activity and video games sufficiently, individuals can conceive them as a game, rather than conceiving them as ordinary physical activity. This will make active video games much more appealing than ordinary physical activity, providing them with physical activities that individuals desperately need.

What is the definition of a game? Why is playing games much more appealing to individuals than ordinary physical activity? Humans have been playing games before any signs of written history to fulfill their physiological needs [1]. A game can be specified in two different categories; physical or mental. The game must have an objective and be played according to the set-up, rules and restrictions. A video game is any game played on a digital device such as personal computers or game consoles.

The main reason why individuals play games is primarily for entertainment and "fun". However "fun" is a very ambiguous term and hence cannot be expressed or explained in anyway, as the definition of ‘fun’ could be different to each individual. However in one study, seven major factors of fun in action video games included: novelty, powerfulness, appealing presentation, interactivity, challenges, sense of control and rewarding [8]. Other genres of games individuals may enjoy would be fantasy (e.g. imaginary characters, virtual world) and interactivity.

If a video game can bring all those components together, require physical activity to control the game rather than using conventional hand-controlled games, replacing passive screen time with active screen time, we have what is called active video games [2].

Active video gaming is ever growing technology with infinite potential especially for younger audiences lacking physical activity [4]. There exists many video games that would promote healthy behavior but this report will review active video games on physical health, hence promoting individuals to get more physical activity and whether there are ways to let individuals continue to be physically active in long term.

**METHODS**

A systematic review of the literature via JAMA Pediatrics and PubMed was conducted using relevant keywords for the topic, ‘active video games to promote healthy behaviors’. Those keywords were: *game, active video games, physical activity, healthy behaviour, motivation*.

The studies that were reviewed were limited to be written in English with peer-reviewed journals, thesis papers that were published in between 2002 to 2012. The first active video game came to shine when *Komani* released *Dance Dance Revolution (DDR)*. [16] The studies chosen for this review consider many different things, (1) work rate or energy expenditure during active video game play, (2) enjoyment and motivation variance, (3) effects of physical activity on different body times (4) promotion of healthier behaviour (5) risk and benefits of active video games. These studies featured many different methods to promote healthier behaviour, but this review concentrates on 'easy to access' and 'reasonably affordable' consoles as that will be a massive factor when it comes to availability. In result, the studies that were reviewed had experimental results with mainstream active video games and consoles, such as *Wii*.

Individuals were chosen to be part of the experiment by controlled trials, after they were chosen experiments were under controlled condition; this means that participants were required to commit to the experience at a certain time and for a certain amount per week or month. If the experiments were carried out at home, studies relied on self-reported activity logs and self-reported playing time, while monitoring them using accelerometer and such tools as heart monitor.

Note that all the studies were fairly short-term studies, varying up to 24 weeks.

**RESULTS**

Few studies compared overweight youth (youth referred to individuals who were under 21 of age) against non-overweight youth. Whether the participants were overweight or not was determined by BMI, 85th body mass index or below being non-overweight, and over 95th BMI being the overweighed youth, leaving out between 85th and 95th BMI percentile to provide separation between the overweight and non-overweight groups. The weight between participants showed difference in work rate in few exercises. In a dance game (*DDR)*, non-overweight participants achieved over 100% more counts on the accelerometer after 15 seconds than the overweight participants (overweight participants recorded 17 counts where non-overweight participants recorded 40). On the bicycle, non-overweight participants were able to cycle 11% more miles than overweight participants during a given time (non-overweight participants recorded just over 1.2 miles whereas overweight participants recorded just below 1.1 miles). [5]

Many studies used two different kinds of games, either one sedentary video game against an active video game to contrast the increase in work rate or two active video games to see the difference between the two. From this study, the active video game uses the ordinary cycling machine which is designed to be plugged into *Playstation 2* (*Cateye**stationary cycle*) and *Konami*’s *Dance Dance Revolution* which is plugged into *Playstation 2* and you dance on the dance pad according to what the screen shows. *When* the equipment was an ordinary well-known exercise machine (e.g. stationary bike), the participants did not find it as appealing as equipments that are not ordinary machines (e.g. *Dance Dance Revolution*). The *DDR* was played 25% more than Interactive Bicycle Video Games in one particular study over the stationary bike. [5]

Many studies identify that active video games increase energy expenditure. One study identified that during active video game play energy expenditure was significantly higher during active video game play (97.4 kcal) vs. inactive gaming (64.7 kcal), [10] and the highest energy expenditure was measured during *Dance Dance Revolution****,*** recording 3 times higher than at rest [6]. Many other studies support this result, one study also showing energy expenditure increased significantly during *Wii Boxing* vs other activities. From many different studies, we can gather the different results according to which body muscles were used. Games using consoles like *XaviX, Wii, Sony Playstation Eyetoy* and Komani’s *Dance Dance Revolution* were used in experiments. From upper body primarily (e.g. swinging and reaching), the increase in heart-rate from resting values varied from 26% to 53% and the increase in energy expenditure from resting values varied from 100% to 139% where *Wii Tennis* was leading both of the values. For primarily lower body (e.g. stepping and running), increase in heart-rate from resting values varied from 51% to 98% and increase in energy expenditure from resting values varied from 167% to 400% where *XaviX J-Mat* leading both of the values. For upper and lower body (e.g. ducking, swaying, and running) increase in heart-rate from resting values varied from 41% to 97%, and increase in energy expenditure from resting values varied from 186% to 400%. [2, 6, 7, 12, 13, 19, 20]

From studies that were carried out at home with controlled trials, many key findings were made. They were given all the required equipment and software to play the active video games at home, with paper relying on them to self-report playing time, logs and uses. Accelerometers and heart rate monitors were used to measure the difference in value from the resting value. One of the study reported that changes in BMI after 24 weeks were minimal and only 2 participants out of 30 were of use were following the schedule that were given to the participants. This particular study suffered 30% dropout rate with only 40% reporting correctly. The another study also carried out 12 weeks experiment with 16 participants, dividing them to either play alone or play in group. Multiplayer group logged 901 minutes of play vs. 376 minutes of play by the non-multiplayer group. The dropout rate was significantly lower for multiplayer group (15%) vs. non-multiplayer group (64%). [3, 11]

One study carried out to see if exercising (without active video game) or exercising with friends or peers (that they have never met before) and also depending on body type (whether they were overweight or non-overweight) would increase work rate. When exercise was carried out with a friend, both overweight and non-overweight participants saw the increase in work rate (42% for overweight and 53% for non-overweight) however, when they were matched up with a random peer, overweight participants work rate increased by 32% where as non-overweight participants work rate went down by 10%. [5, 17]

**DISCUSSIONS**

From the experiments carried out, many key findings were made and it will influence the potential of promoting healthy behavior through active video games.

**Overweight participants compared to non-overweight participants**

From the result above, it is clear to see that non-overweight participants were completing more repetitions and cycling more miles than the overweight participants. However this is not necessarily a problem as when the result was adjusted for body weight and stature, heart-rate intensity level were equal, meaning that even though overweight did not completed many reps or covered as much miles than non-overweight participants, the work rate was sufficient enough for developing and maintaining cardiorespiratory fitness according to minimum standards. [5]

**The short-term experiments rather than long-term**

As stated above, the studies were short-term experiments, and it was too short to conclude any findings with certainty. Even though studies may have shown that work-rate, energy expenditure and heart-rate from rest has increased, by participating in active video games, we cannot assume that it would stay that way in long term. [12, 14]

**The sample size of participants**

The sample sizes of participants were below 50 for most of the studies, which is not significant enough to conclude any findings with certainty as variance could occur. Even though studies have shown that work-rate, energy expenditure and heart-rate from rest has increased by participating in active video games, we cannot assume that it would stay that way in long term. [12, 14]

**Participants finding 'minimum movements' to achieve the full motion**

This was identified especially for the *Wii* console, where participants could just 'flick' their wrist to achieve the full swing motion in *Wii Sports* tennis. This could be a major issue as participants could find a 'loophole' to play the active video games, as the major objective of active video games is for individuals get as much exercise as they can while they are having 'fun', but this 'loophole' will allow them to get minimum possible physical activity during this active video game play, hence not benefiting them at all.

[15]

However, camera-tracking based equipment (e.g. *Microsoft Kinect*) can resolve problem. Few studies concluded that Kinects’ elicited greater energy expenditure as you use more part of the body to control the game and also it is harder to find a 'loophole' like wrist flicks. However, there was very limited data available for studies, and also it was not freely available to public hence it could not be reviewed fully. [15]

**Participants being under controlled environment**

Many studies were carried out in a controlled environment, meaning that they had to be at a certain place at a certain time, but otherwise it was carried out at home under ‘controlled’ conditions. When the experiment was carried out at their home as an on-going, participant trust-based study relying on self-reported logs and self-reported playing time, they have suffered massive drop-out percentage. This shows that participants either forgot to participate on the certain day or they did not have motivation to play the active video games. One of the drop-out percentages reached up to 41%, meaning almost half has dropped out of the study. [3, 11]

As participants are dropping out of the study voluntarily subjects cannot force participants to carry out particular exercises (in this case it would be active video games) Instead, participants should be willing to play the game hence they are interested to play the active video game. If participants are interested to play, they will perceive that activity as 'fun' rather than perceiving it as ordinary ‘physical activity’ which will lower their motivation to play the game. Hence the games that participants playing must have good entertainment value or must be able to make participant have ‘fun’, rather than making them feel that they are obligated to this physical activity. [1]

**Injuries sustained during active video game play**

From studies that this report has reviewed, injuries sustained during the experiment were minimal to none. There was very limited data available on injury rates during active video game play. Several case studies have reported injuries that were retained due to over aggressive or extended game play. Study from Sports Medicine and Research Centre, Singapore Sports Council, showed that no injuries occurred during 201 hours of dance time while using *Dance Dance Revolution*. As no mass data is available to compare, it is hard to conclude. However, it compares favorably with injury rates of runners which occurs 2.44 per 100 hours of running. No suggestion to problem is necessary as it does not seem to have significant impact on the matter. [2]

**The availability of equipment necessary for active video gaming and affordability**

As technology advances, the equipment necessary to run active video games has become widely available; however affordability still can be an issue. The consoles required to operate these games are not cheap, putting pressure on lower class to middle class individuals to purchase these equipment for a sole purpose; to keep physically active.

**CONCLUSION**

To promote healthy behavior by active video gaming, we can view it from a short-term perspective and long term perspective. In short-term, you can conclude that active video gaming can promote healthy behavior as the result shows; increase in heart rate and increase in energy expenditure is enough to be considered as ‘moderate’ activity.

However in long-term perspective, there is not enough evidence to conclude that active video gaming would promote physical activity as the experiments were fairly short-term based, and when it was not a fully controlled environment, participants drop rate went up to 41%, hence showing that the participants has lost interest and motivations to continue playing the active video games.

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