



An Investigation Into The Physical Health Benefits Of The Nintendo Wii Fit In Comparison To Traditional Exercise

Masana Ikeshima

Matric No: 200601037
BSc (Hons) Games Software Development

Project Supervisor: Robert Law
Second Marker: Jon Sykes

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Signed: _____ Date: _____

Abstract

As a nation that greatly depends on technology for day to day activities it is ironic that it is the main cause for our greatest problem we face today; obesity. With almost all children being gamers, it is unsurprising to note that video games are being labelled as the key factor for this epidemic. In an attempt to prevent this trend professionals have combined video games with exercise to form “exergames”.

Despite its unparalleled popularity in the form of Dance Dance Revolution and the Nintendo Wii Fit, there is much debate regarding exergames effectiveness as a method of exercise. This paper explored this issue by comparing it to traditional exercise. Using a combination of interviews, a four-week experiment and a questionnaire, the results provided interesting findings regarding the Wii Fit.

The results discovered were in line with the majority of research suggesting the Wii Fit is not a capable replacement of traditional exercise. The Wii Fit’s level of intensity was similar to walking at 2 miles per hour, which was less than half of traditional jogging. Whilst, this result implies it is incapable of replacing traditional exercise results findings from the questionnaire suggest that it can provide the initial transition from a sedentary lifestyle into a more active one.

Thus, although the device should not be used as a primary method of exercise it could be used as a secondary method of exercise, such as a warm-up tool. Alternatively, for people already deemed obese this product could provide the foundations for a better lifestyle.

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1. Introduction

Background

With the ever-advancing technology that surrounds us, our bodies have become exposed to a simplistic lifestyle that requires minimal effort and work to complete everyday tasks (Lajunen et al., 2007). This level of dependency on technology has resulted in a combination of both a lack of exercise and a poor unbalanced diet (NHS, 2007a). The impact on our health has been catastrophic, resulting in 1 in 5 male adults and a quarter of women in Scotland being obese (NHS, 2007b). According to reports from the BBC (2006), if this trend continues at this current rate; three quarters of all adults will be obese within ten to fifteen years.

Financially, the costs of obesity related illnesses has risen from £500 million in 2004 (Vass, 2004) to £1 billion (Fletcher, 2007) in just three years. As well as the financial impact, there have been over 30,000 deaths per year – all of which could be prevented by leading a healthier lifestyle.

All that is required to maintain a healthy lifestyle is thirty minutes moderate exercise five times a week (BBC, 2007). Yet not even 4 out of 10 men and 3 out of 10 women get enough exercise. Fentem's (1994) research argues that a lack of exercise can have detrimental mental effects causing the person to experience possible "mild depression and anxiety". It has been further documented (Wiley-Blackwell, 2008) that there is a link between depression and obesity, resulting in unfit persons to experience a downward spiral into obesity.

The games industry has slowly matured from the bedroom programmers to a fully-fledged business worth over £4 billion (Martin, 2009) and is in the process of overtaking the film industry's annual profits (Parfitt, 2009). Following each new console, the games available are taken to a higher standard, improving its addictiveness, game-play and graphics. At present, the average game lasts around ten hours long, excluding replaying and additional content such as online features (West, 2007). As a result gamers are spending an increased amount of time in front of the television in a sedentary state, which has created cause for concern for professionals. Dr Vandewater, an Associate Director at the C.R.T.C.¹, (Anon, 2004) claims that there is, in fact, a link between video games and obesity. This is further supported by similar claims by Goldsmith (2009), who states that the average gamer is around 35 years old, often overweight and may be depressed. In an attempt to cure the sedentary lifestyle that of these gamers, a new genre was formed, named "exergaming".

Exergaming

Exergaming is the concept of combining both exercise and gaming to provide the user with the industry-style gaming experience, whilst providing health benefits (Daley, 2009). This has been achieved by replacing the traditional interactive method of merely pressing buttons, by using the entire body's motion as a form of input instead. Despite its inception since the

¹ Centre for Research on Interactive Technology, Television and Children

early 1980s, exergaming has only just gained massive exposure through the extraordinary sales of the Nintendo Wii Fit (Porcari, 2009).

The earliest form of exergaming took the shape of AutoDesk's *HighCycle* in the early 1980s (Johnson, 2008) with the concept of merging exercise with gaming and virtual reality. In the game *HighCycle* the user pedalled through a virtual landscape and could view the virtual scenery around them. If, however they pedalled fast enough, the bike would take off and allow them to fly about.

By incorporating the ability to fly, the user begins to experience a heightened sense of flow as discovered by Csikszentmihalyi, which absorbs them into the game. During this time, the user is in a trance where time feels distorted and it an effortless task to keep playing. This trance is achieved through pitching the level of challenge at a level where it is neither too easy nor too difficult (Chen, 2008). Such an example for the cycling exergames would be that a casual cyclist can freely observe the surroundings, whereas the cycling enthusiast could decide to work harder and burn more energy to fly about.

The main purpose of the game was to experiment if such a genre of merging exercise and gaming could exist. Although not commercially available, it did pave the way for future exergames.

History of Exergaming

Computrainer in 1986 was the first exergaming that was released to the public. With a primary focus on exercise and gaming as means to motivate, it was an ideal tool for cyclists. The user was displayed statistics on their cycling through the use of the *Nintendo Entertainment System (N.E.S.)* as well as providing the user with a terrain to create the virtual environment. Unfortunately, due to its exceptionally high price point, it was only ideal for the dedicated cyclist.

Exergaming eventually gained mainstream success following the release of *Dance Dance Revolution (D.D.R)* in November 1998. *D.D.R.* featured a big dance platform with four directional arrows to allow the player to hit the corresponding arrow on screen with their foot in time with the music. By making the player interact in time with the music, the game had the ability to make the user appear to be dancing (Behrenshausen, 2007). This social aspect was critical to its success as it made the game enjoyable both on and off the machine.

D.D.R. was the first exergaming title to not be based on a sport, making the player unaware that they were exercising. Despite having no calorie counter or exercise statistics, the gamers were exposed a relatively high level of intensity due to the quickness of the music and speed of the arrows.

Soon after its American release, *D.D.R.* came to Europe and consequently was released for home gaming platforms. With the large spread fan base now being able to play from home, gamers started to realise that it was a possible form of exercise, with some people losing up to

90 pounds of weight as reported on C.N.N. (2004). Following these astonishing weight loss stories, a vast number of schools in West Virginia, U.S. began to adopt them as part of their physical exercise classes (Timmer, 2007) to promote exercise and to try to bridge the gap between the overweight and active students.

Wii Fit

On November the 19th 2006, Nintendo released its eagerly anticipated *Nintendo Wii*. Unlike the other seventh generation games console being released around the same time, Nintendo targeted the console away from the traditional gamer demographic to a new and risky market – non-gamers. Despite initial scepticism towards the console (TVG, 2006), it sold to critical acclaim, breaking fastest seller records around the globe.

Following on from the recent exposure of exergaming, Nintendo released its heavily advertised *Nintendo Wii Fit*. Instead of simply continuing on the success of *D.D.R.*, Nintendo once again maintained its primary focus on exercise over gaming. With the inclusion of a balancing board to accompany the game, their intention is to help any person, of any age and size to become fitter by improving their agility, balance and coordination through mini-games (Robertson, 2007).

The *Wii Fit* has had exceptional sales with over 21 million units sold in less than three years (Ashcraft, 2009), despite its high price, by including the balance board. The purpose of this project is to see how valid exergaming on the *Nintendo Wii Fit* really is in comparison to traditional exercise methods, and whether it can replace traditional exercise methods.

1.2 Project Outline and Research Question

Research Question

The aim of this project will be to investigate the physical benefits of using the *Nintendo Wii Fit* and compare it against traditional exercise methods as stated in the research question below.

“Can the exergame, Nintendo Wii Fit provide physical benefits parallel to traditional exercise methods?”

The section below identifies the objectives that are required to be met in order to ensure the project is focused.

Project Objectives

The results obtained from the experiment will be used to answer the research question. The following objectives are key areas of the project that must be fulfilled to ensure success. Each objective is followed by its reasoning.

1. Investigate the current problem area of an unhealthy population

As the rate of overweight and obese children and adults are escalating at an alarming rate, it is important to discover what is causing the problem. Only by understanding the cause, can we then identify potential solutions.

2. Establish what an exergame is and review previous research on exergames

In order to answer the research question, it is important to establish what is an exergame. After defining exergames, analysis on previous research will be on exergames, as this will provide an insight into their findings and main conclusions.

3. Establish evaluation techniques on exergames and traditional exercise methods based on previous research

Through the literature review, the techniques used by other researches will be noted and examined. It is essential that any technique intended to be used must meet the financial and time constraints of this project.

4. Review the physical benefits of the *Nintendo Wii Fit Jog* compared to traditional jogging outside

This will be used to determine the effectiveness of the *Nintendo Wii Fit Jog* in comparison to traditional jogging. This will be done through an experiment, interview and questionnaire using techniques determined in the literature review.

1.3 Hypotheses

Through the findings of the literature review, the researcher has determined the following hypotheses. After each hypothesis there is a justification as to why it has been stated.

1. The *Nintendo Wii Fit Jog* cannot provide the same physical health benefits provided by traditional jogging

It has been noted by Carroll (2009) that even the most intensive *Wii Fit* activities are equivalent to a mild workout. Thus, the *Wii Fit* cannot feasibly provide the same benefits such as high heart rate and increased caloric expenditure.

2. The novelty of the *Nintendo Wii Fit Jog* will wear off, thus the overall workout by the user will decrease over time

Due to the lack of long-term research on the *Nintendo Wii Fit* there is not much evidence supporting this hypothesis. However, Mellecker (2008) states that children who play games can become over familiar with the game and find short cuts whilst playing the game.

By successfully completing the research objectives, this will then provide the foundations to which the above hypotheses can be approved or disproved.

1.4 Rationale

The *Nintendo Wii Fit* is currently one of the highest selling video games in the history of the video game industry (CVG, 2010) and is about to be followed by a new iteration – *Wii Fit Plus*. This experimental research could benefit a variety of sectors ranging from health professionals to exercise enthusiasts as well as people in the gaming industry.

Video Game Developers

Developers will be able to take advantage of this experimental project as it will allow them to understand how the leading competitor in exergaming is doing. Using the results of this project, they will then be able to conduct their own experiments of their upcoming product and evaluate, which is better and how they can improve their product.

Video Game Publishers

The data gained from the results of the developer's upcoming product, could be used as part of a promotional opportunity to demonstrate how much more effective their product is in contrast to the *Wii Fit*.

Virtual Gyms

Virtual Gyms are physical gyms that target unfit children and adults by using exergaming to tackle the problem. With virtual gyms, the user becomes fitter by playing exergaming titles and is intended to encourage them to join a traditional gym for more strenuous exercise.

This project will be important to Virtual Gyms as it will provide an insight into the longer-term effects of using the *Wii Fit* both physically and mentally. The results obtained from this project will also help to decide whether they should include the *Wii Fit* as part of their gym.

Health Professionals

Despite a large number of professionals debating the positive and negative aspects of the *Wii*, there has been little research to prove either argument. This research can assist professionals to see both; positive and negative aspects of the exergame and how it can be used as part of a rehabilitation scheme (Rauscher, 2008).

Prospective Wii Fit Users

This study will also be beneficial to prospective exergaming users. It will allow them to gain an understanding of the effectiveness of exergames and how it could play a part in their lifestyle.

Current Wii Fit Users

It is possible that users of the *Nintendo Wii Fit* could become dependent on it and use it as their only means of exercise. This study will help this target audience by analysing how much exercise is necessary and if they are not achieving the number of calories burnt, it will investigate what could be done to meet the daily targets.

2. Literature Review

Overview

The purpose of this literature review is to provide knowledge and lay the foundations of this research by exploring research done by experts in the domain.

The literature review is split into sections starting with the problem area, which aims to explain the relevance of the research. After establishing the problem area, the researcher aims to explore exergames, by discovering who plays video games and what makes exergames unique from video games. The sections that follow aim to explain what an exergame is and which exergames are currently available as well as future developments that are being researched.

After a broad look at exergames, the next section looks more specifically at the *Nintendo Wii*. The researcher will then analyse and explore the *Nintendo Wii Fit*'s capabilities as a physical exercise tool with the aid of expert research.

2.2 Problem Area

Currently, the British Department of Health (2004) recommends that adults participate in at least 30 minutes of moderate intensity exercise 5 days a week in order to maintain general health. This recommendation of exercise is further increased to 45 - 60 minutes to prevent obesity.

Moderate intensity exercise is defined as an activity that increases breathing rate, as well as increasing heart rate to a level where the pulse can be felt and the subject has a general feeling of warmth. By exercising regularly at moderate level intensity the benefits of regular exercise are noted to reduce the likelihood of premature death, some forms of cancer, type 2 diabetes, as well as improving psychological well-being (Department of Health, 2004).

Despite the clear advantages of exercising, almost more than half of all adults fail to reach the recommended amount, which is particularly evident as people get older (Lampila, 2007). One of the possible reasons behind the lack of exercise is due to lifestyle based on sedentary activities.

It is reported that around every single child (ages 6 to 10 years old) and 97% of children (aged 11 to 15) play video games (BBC, 2005). It has been reported that when a person is playing a traditional video game, they have a raised heart rate and experience a minor increase in their energy expenditure (Graves, 2008). Despite this the player is experiencing an effective level of intensity as when they are resting. With so many of the younger generation playing video games (effectively resting all day), it is unsurprising to note that obesity has begun to affect more children each year (Duckworth, 2002).

The main concern is that children will continue this lifestyle into their adulthood and repeat this for their own children. This link between childhood and adulthood health has been shown in Boreham's research (2001) and if this is the case, then the future certainly looks bleak. Racette's (2005) research further supports Boreham by noting that only half of the students in America are actively exercising with 30% of students doing no exercise at all. The British Heart Foundation (2009) reported that only one in five children were getting the recommended daily exercise. This is particularly true amongst lower social classes (Stamatakis, 2002). Hillman (1991) suggests that lower class families having a higher number of overweight and obese cases is due to parents being reluctant to let children play outside, due to strangers and traffic.

Exercise, however, is only half the battle. It is imperative that everyone gets their 5 fruit and vegetables a day in order to maintain a healthy body such helping the digestive system (NHS, 2009). Swinburn (2009) further argues that the benefits obtained from physical exercise is limited and the cure to obesity is down to the quantity that is eaten. Lowry (2002) supports Swinburn's argument by commenting that as over 75% of children in the United States do not consume enough fruit and vegetables and more than half were overweight.

It is unsurprising that the resulting combination of a lack of exercise and a proper diet is overweight and obesity, as visually represented in Figure 1.

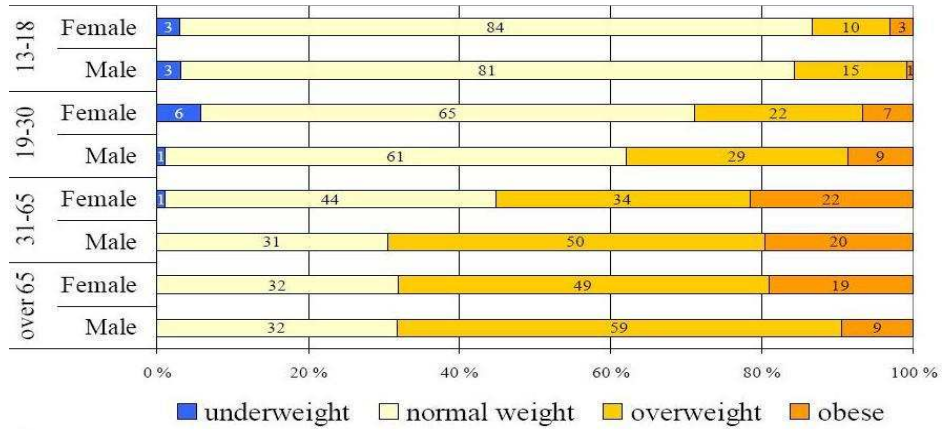


Figure 1 – Body mass index (Lampila 2007)

With the recent emergence of exergames in the public eye it could potentially be used to prevent this sedentary epidemic by encourage people of all ages to become more active. The following section defines exergames and the types of exergames available.

2.3 Exergames

Who Plays Video Games?

Lenhart (2008) surveyed over 2000 adults in America to discover which demographic was the most likely to play video games. Both male and females were just as likely to play video games, whilst people in the age group of 18 to 29 were the most likely to play video games (81%). However, older age groups 30 to 49 (60%) and 50 to 64 (40%) were known to play video games as well.

Lenhart's (2008) research also noted that regardless of race and financial income, video games were popular amongst all people, with more than half being gamers. People located in a rural setting were the least likely to play video games – at 47%, which could suggest safety issues concerning urban (56%) and suburban (53%) areas cause them to game more frequently (Hillman, 1991). Interestingly, students at college and college graduates were the most likely to play video games at 57%. With the average gamer spending at least a few times a week playing games.

With such a vast majority of the population playing video games, there has been research on the possibilities of using video games as part of the solution to sedentary lifestyles, terming the new phrase “exergames”.

Enjoyment of Exergames

Hoffman (2007) believes the key concept of exergames is to put the enjoyment of video games at the primary focus of the activity. By doing so, participants are motivated to exercise in longer sessions and potentially exercise more intensely than exercising purely for the health benefits. This is reflected in a recent experiment carried out in Southampton, which allowed children to have access to either exercise, a video game or an exergame for as long as they wanted. The most popular format was the exergame, which was utilized for 85% of the time (out of 1.5 hours) and accumulated 531 calories (Anon, 2007).

Categories of Exergames

With such a vast selection of exergaming genres, it is unsurprising that exergames can be found almost anywhere, ranging from gyms to schools and at home (Mohr, 2009). The exergame network's (TEN) (2009) press release currently categorises exergames into 5 types, using the acronym C.R.E.W.S. as listed below.

Camera exergaming

The user's body movement is captured by camera and is used as the controller. The first major instance of this form of exergaming was the *Sony EyeToy*, which is already in its second iteration, dubbed the *Playstation Eye*. It features a wide library of games that supported the input, such as *AntiGrav*, *Groove* and *Kinetic*.

In more recent times, Microsoft and Sony have created more responsive and intuitive version with their respective upcoming platform *Project Natal* and *Playstation Move*. It is their intention to allow gamers to interact completely with their current console

and its titles using only the body and some accessories. The intention of *Natal* is to provide a game experience by making the “technology invisible” (USA Today, 2009).

Rhythm exergaming

This category of exergaming has had the highest exposure in terms of recent success. The games within this genre make the user perform tasks in sync with the audio being played, this can be either through the use of instrument-shaped controllers or by dancing.

Dance Dance Revolution is deemed as the first major exergame to have a large impact on the gaming industry with over 6.5 million units sold (Gamespot, 2003) as well as spurring on many spin off titles. Within this category, *Guitar Hero* and *Rock Band* are also included.

Exergaming machines

Exergaming machines are dedicated fitness machines that are used to take the user’s focus off the actual task. Unlike the previous two categories, exergaming machines have a primary focus on the exercise itself rather than masking the activity with the video game. Most of the games in this genre are based around stationary cycling to play games such as *Smugglers Run* and *Extreme G Racing* (Williams, 2004). Examples of this genre are *GameBike*, *GameCycle* and *Gamercize*.

Workout exergaming

Workout exergaming titles are used to provide the user a workout by following the instructions given by a virtual trainer. Unlike exergaming machines, workout exergaming is used for activities such as aerobics and yoga. Titles in this genre are *EA Sports Active*, *Nintendo Wii Fit* and *Your Shape*.

Sensory exergaming

Sensory gaming requires the user to move in order for the game to sense the user’s action and responds accordingly to it. Examples in this genre are *Lightspace Play*, *BodyPad: Tekken 5* and *TWall*.

BodyPad: Tekken 5 allows gamers to equip motion sensitive pads to become a fighter within the game. *TWall* makes players test their reaction speeds to hit the red lights on a pressure-sensitive wall.

2.4 Research on Exergames

Having established what an exergame is, this sections aims to review the research on exergames that are currently available on the market. This section will be divided into four areas; the first will determine who plays exergames, the second examines how exergames have been used in the public sector. The third area will review its effectiveness. Lastly, the fourth area will explore exergame projects that are currently making new improvements and concepts.

Who plays Exergames?

Exergames are not only enjoyed by video gamers but also by the non-gamers, with exergaming devices being used from school children to adults and parents as well as teachers (Lampila, 2007). Figure 2 illustrates the opinion of people of different age ranges towards exergames. This ranges from male pensioners being borderline positive towards exergames, to the majority of people believing exergames can be a positive experience.

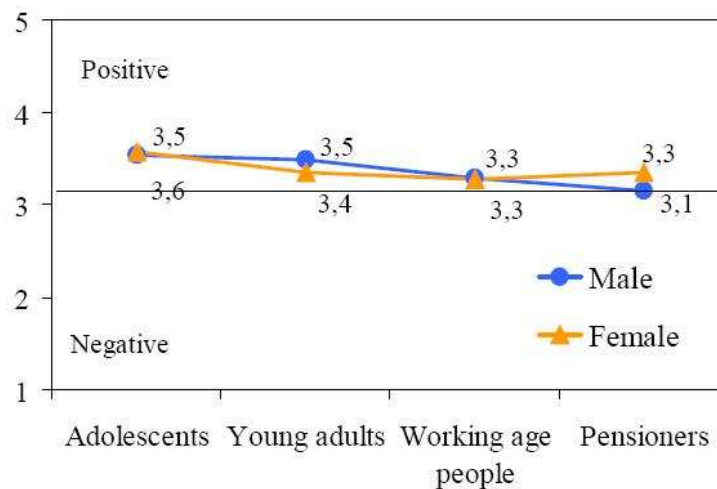


Figure 2 – Opinion on exergames (Lampila, 2007)

Application of Exergames in the Public Sector

In 2008 West Virginia was reported to have the current highest level of obesity cases in America in comparison to any other state (CDC, 2008). In an attempt to prevent this epidemic rising, over 100 schools participated in a pilot scheme to introduce *D.D.R.* to replace traditional physical education (Guardian, 2006). The intention of this scheme was to encourage youths to participate in more exercise and aimed to maintain the lifestyle through to adulthood (Yahoo, 2006). Depending on the success of this pilot project, the intention was to provide all 765 schools in the state with *D.D.R.*.

Dr Carson (Stewart, 2005) states that some early trends were already developing, with children losing body weight and increased blood flow. However, more importantly he states that these children were happy to maintain the exercise for 20 minutes, 5 days a week.

Shasek (2005) used a similar game to *D.D.R.* in a 5 month pilot program and discovered that absenteeism dropped by more than 50% and the students demonstrated increased leadership skills, confidence and academic success. This suggested that exergames do have a positive impact on children and can motivate them to keep on exercising for long periods of time.

Despite its immediate success, there is much debate regarding its long-term impact on fitness and activity levels (Booth, 2007) and whether it should replace traditional physical education (BBC, 2009).

Research from Leininger (2008) supports Booth's argument by concluding that *D.D.R.* had almost no difference on the participants' rate of perceived energy compared to walking on a treadmill, which was also reflected in their maximal oxygen consumption (VO₂). This is a serious finding, as it suggests that children in the Virginia state are only walking and not exerting enough energy to gain the benefits which would be available through traditional physical education.

Effectiveness of Exergames

Due to the recent exposure of exergames through *D.D.R.* and *Wii Fit*, it is interesting to find that exergames have become appreciated by more than just gamers. Recent research has explored the usefulness of the devices as it has begun to enter schools, gyms and even dedicated centres for exergames (Williams, 2008).

Exergames have been noted to be the preferred choice amongst children compared to traditional exercise and video games themselves (Anon, 2007). This is also reflected in Warburton's (2006) work, which showed a 30% higher frequency of attendance. Lawler (2009) states that children who were previously not comfortable playing sports in class suddenly worked harder than ever before, which could be attributed to the diverse selection of exergames available to gamers.

The positive attributes of exergames have been shown in Haddock's (2009) experiment, which resulted in higher energy expenditure (from 98.7 Kcal to 113 Kcal) using video games. Ahn (2009) also notes similar results that participants were unaware of increased treadmill running speeds whilst gaming (from 4 to 10 km/h). Using the *XaviX* system, Mellecker's (2008) results suggested that exergames were capable of providing an intensity equivalent to vigorous exercise and if continued, could meet the activity recommendations set out for children.

However, like all video games there is a problem of over-familiarization (Mellecker, 2008). This is supported by Lenhart (2008), who noted that around a third of all children have used cheats in previous games. It could be argued that once the initial fascination of the game is worn out, children would not be expending as much energy or potentially lose interest completely in the exergame.

Despite all the research that has been carried out, there is few research to suggest the longer term impact of exergames, with most research being carried out over one or two sessions.

The only research carried out over a substantial time was Warburton's (2006) which suggests that exergames are useful by providing greater fitness to the exergaming group. However this cannot be used as a comparison as neither group underwent the same number of sessions, thus naturally the exergaming group, which undertook more sessions showed greater benefits.

Future of Exergames

Although TEN categorises exergames within these five domains, there have been many developments in recent times to expand the genre. Such new categories of exergames range from mobile to long-distance as well as educational-exergaming and medical exergaming.

Mobile-exergaming appears to be a hot prospect as explored by Misund (2009) who created an application called *Fox-Hunt*. Players would try to catch foxes using the mobile device and its embedded GPS feature, thus requiring physical activity to track virtual foxes and catch them. By combining an everyday device such as the mobile phone, users worldwide could use such a product to improve their fitness by playing with users in the near vicinity whilst also promoting social interaction.

Another branch of exergames is long-distance exergaming, which involves exergaming with people from all over the world using the internet. Mueller (2005) created an adapted version of *Breakout*, where the users used a football to destroy blocks projected on a screen. By allowing the users to interact physically through the computer, it allowed for long distance gaming. This was highly appealing as it not only provided visual gaming but also social interactions with friends from across the globe.

There have also been experiments to incorporate exergames as a method of education. Herpers (2008) experimented the use of combining a stationary bike within a virtual environment to provide traffic education of the local area. Rosser (2007) notes that surgeons who played video games for over three hours a week were 27% faster with 37% fewer errors in simulations than non-gamers.

2.5 Nintendo Wii

Overview

The *Nintendo Wii* has been chosen for this project chosen due to its notable success and consequently propelling exergaming to the forefront of the seventh generation of gaming. Despite this, there has been very little research regarding the effectiveness of the platform and how it compares to traditional exercise methods. There is currently only anecdotal evidence suggesting its effectiveness (wiinintendo.com, 2007).

What is the Nintendo Wii?

The *Nintendo Wii* is a seventh generation console that has managed to sell over 67 million units within 4 years of release, breaking best-selling and fastest-selling console records previously held in America and Australia respectively (CVG, 2010). The reason for its success has been attributed to its unique interaction method (Figure 3) and its low price point (CNN, 2006), which makes it accessible for most families, especially in comparison to Microsoft's *Xbox 360* and the Sony's *Playstation 3*.



Figure 3 – Wii Mote (DynamicPatents, N.D.)

The primary method of interaction is via the handheld pointer controller, which is a motion sensitive device with buttons. By allowing the user to physically interact with the device, rather than using a traditional controller, it allows a more intuitive interaction, which has appealed to children and adults. Included with the console is a disc containing the game *Wii Sports*, which consists of five separate mini-games: baseball, bowling, boxing, golf and tennis.

Due to a combination of its innovative design and its unparalleled success, there has been much debate regarding its effectiveness of the *Wii's* ability to provide energy exertion that is helpful to the user.

Research on the Nintendo Wii

Porcari (2008) tested subjects with each of the activities available in *Wii Sports* and reported that *Wii Boxing* was the only game that could be considered to improve cardio respiratory endurance. He argued that playing the *Wii* was definitely better than sitting around, as it burns 5 to 6 times the calories in comparison to a sedentary state.

Porcari's findings are in line with Grave's (et al., 2008) and Stratton's (et al., 2008) work. Graves conducted a 15 minutes experiment of the *Wii Sports* versus a sedentary game – *Project Gotham Racing 3*. He reported that compared to *Project Gotham Racing 3*, the energy expenditure on the *Wii* was significantly greater and if it replaced the time spent on sedentary games the energy spent would be sizeable and useful for weight control.

Stratton combined the *jOG* system – a device that encourages players to step on the spot to use the d-pad – with the *Nintendo Wii*. The results were impressive – tripling energy expenditure and increasing heart rate by 40%. 10 minutes alone on the combination of *jOG* and *Wii* accumulated to 15% of the recommended 10,000 steps a day.

It was noted that in all three experiments, only a single session was executed that lasted up to 60 minutes at most, which is clearly not enough to determine the longer effects of the exergame. Graves, Porcari and Stratton's research could be seen as further limited as all experiments were conducted within a controlled environment. Within this controlled environment the player may not be as relaxed as within their own comfort, thus work harder than usual.

2.6 Nintendo Wii Fit

What is the Nintendo Wii Fit?

The *Nintendo Wii Fit* is a game bundle that is only compatible with the *Nintendo Wii*, which features both the game and a balance board (Figure 4). The game itself has four categories of training – aerobic, balance, yoga and strength training – each with several mini games.



Figure 4 – *Wii Fit Balance Board* (Wordpress, 2008)

During the setup-phase of *Wii Fit*, users are asked to create a Mii which is a virtual representation of the user. Upon starting *Wii Fit* for the first time the game asks the user to input their age and height. Following this the balance board is used to determine the user's weight and their centre of gravity. Using the formula below, the player's body mass index (B.M.I.) is calculated (weight divided by height squared):

$$BMI = \frac{kg}{m^2}$$

Figure 5 – *Body Mass Index Equation* (WHO, 2010)

Depending on their B.M.I., they are classified into underweight, ideal, overweight or obese; their Mii is then altered to reflect their B.M.I. rating visually. In the mini-games (apart from strength training) the player's Miis are used to virtually visualise them working out or playing in the chosen environment.

Games are interacted with one of two methods; entirely balance board orientated or with the hand-held controller. Balance board games check to see where pressure is being applied on the sensitive board as a means of input. Jogging games require the Wii Mote to be placed in the users pocket whilst they jog to act as an pedometer.

Like most recent games the *Nintendo Wii Fit* includes an achievement based system to motivate players to keep playing. Players are rewarded in one of two ways – time spent playing or task competition. Each time the user plays the *Wii Fit* for each minute played, they are given one coin to their "Fit Bank" which is a virtual piggy bank used to unlock new mini-

games. The other method is by task completion – most of the mini-games feature a rating system after the task is done out of stars, when the player has done well they are rewarded with new activities.

Research on the Nintendo Wii Fit

Despite its sales and public exposure there has been little research on the effects of the *Wii Fit*. Of the literature reviewed, only two experiments tested the *Wii Fit* and reported its usefulness.

Carroll (2009) tested six mini-games on the *Wii Fit* and discovered that *Island Run* and *Free Run* were the most intensive, burning 5.5 Kcal per minute and raising the heart rate to 60% of the maximum. In all instances of the activities included in the *Wii Fit*, the real and traditional activity had a higher level of caloric expenditure. Porcari states (Carroll, 2009) that the *Wii Fit* should not be anyone's sole method of exercise and will only provide a very mild workout at best. Such an example of the comparison between real life exercise and *Wii Fit* is the step up mode, where the height of the step up block is only 1.5 inches compared to 6 inches in traditional methods.

Nitz (2009) explored the possibilities of the *Wii Fit* becoming a next-generation tool for improving balance and health. He did this by carrying out a 10 week program with each participant undertaking 30 minutes of exercise on the *Wii Fit* twice a week in each of the *Wii Fit* activities – aerobics, balance, strengthening and yoga. After the 10 weeks, Nitz reported that the participants had significant improvement in balance and strength but had no significant changes in fitness level.

The results of Carroll and Nitz's experiment contradict the anecdotal evidence given by a plethora of *Wii Fit* users, a leading example being Mickey DeLorenzo (wiinintendo.com, 2007). DeLorenzo claimed to have lost 15 lbs in a mere 41 days by making the *Wii Fit* his core method of exercise in his lifestyle. He played the game constantly between 30 to 60 minutes each day. A difference to be considered was that the participants in the professionals research could have been playing the game rather than exercising, whereas DeLorenzo stated that he "played each game with as much intensity as possible", thus gaining the maximum potential from the *Wii Fit* (ibid).

Conclusion

The literature review has defined the problem area and explored previous solutions to this problem through the use of exergames. It has also served to identify potential research techniques, results as well as problems that may occur during the intended experiment for this research.

The following methodology section (Chapter 3) describes how the experiment is intended to be undertaken. This is followed by a full justification in terms of research techniques, location, duration, population sample and reasoning behind techniques that were omitted.

3. Methodology

Overview

The project objective is to determine whether the *Nintendo Wii Fit* can be used to provide physical benefits that are parallel to traditional exercise methods. It has been determined to use an experimental approach to evaluate the effectiveness of the *Wii Fit* supported by statistics obtained using a secondary research method.

Research Objectives

The following experiment objectives aimed to:

- Evaluate the physical benefits obtained from the *Wii Fit Jog* and compare it to jogging.
- Interview the participants to gain an understanding on the user's opinions of the exergame before and after the experiment.
- Use a questionnaire to provide large-scale feedback to support the findings of the research.

Research Types

This research project will undertake both primary and secondary research in order to gain results.

Primary research is defined as collection data that does not already exist. It can be categorised into two types – qualitative or quantitative. Qualitative data is used to help the research understand what the test subjects feel and why they feel as they do (DJS Research, 2009a). This is usually undertaken by method such as direct observation, focus groups and interviews (RDSU, 2004). Quantitative data is a measurable form of data gathering usually preformed in mass numbers. Such examples of this technique are controlled experiments, questionnaires and surveys.

Secondary research can be defined as information gathered from other researchers' primary research. The information can be gathered from sources such as books, journals, newspaper and online sources (Girolami, N.D). In this project, the primary research will be carried out to support the findings of the secondary research.

Ethics

As a project that is driven by human test subjects, it is paramount that the research is carried out in line with strict adherence to the ethics approval obtained. The key aspects of the ethics approval are highlighted below.

- All participants will be over the age of 18 and provide evidence.
- All participants will require a consent form to confirm they approve of the research being undertaken.
- Participants are completely free to withdraw from the experiment at any time.
- All participants will remain completely anonymous throughout the experiment and the reporting.

3.2 Primary Research Methods

Overview

The primary research method will involve three methods of data gathering – two interviews, the experiment and a questionnaire. Subjects will be asked to do an initial interview to provide their opinion on the *Wii Fit*, jogging and their stance towards exergaming. Following the interview, the subjects will be asked to undergo a four-week training session on the *Wii Fit*, Jogging or both for 15 minutes a week, three times a week. After the four-week training period, a post-experimental interview will be undertaken to provide hindsight into the experiment. The questionnaire will then be used to support the evidence on a wider scale.

Justification of Experiment

Despite vast research into exergames over the past decade, there has been little research that compares exergames and traditional exercise methods. Research that has been done in this sector has been exclusively related to stationary bikes (Warburton, 2007; Haddock, 2009).

Furthermore, any research that has been done on the physical effectiveness of exergames has been performed over a very short time period, often for only two hour-long sessions (Anon, 2007; Carroll, 2009; Graves, 2008; Haddock, 2009; Hämäläinen, 2005; Mellecker, 2008; Porcari, 2008; Stratton, 2008; Wittman, 2009).

An experiment can be defined as a test that is done in order to learn something or discover if something works or is true (Cambridge Dictionary, 2010). In relation to this project, an experimental approach has been chosen to answer the project hypotheses and the aims set out in the introduction chapter of this report.

The reason for undertaking an experiment of this nature is due to the lack of research available covering a substantial period. The two researchers that did meet this criteria – Nitz (2009) and Warburton (2007) – undertook vastly different aims than the one proposed for this project. Warburton examined the appealing nature of exergames and how it affected attendance among students. Nitz, on the other hand, let participants exercise on their own *Wii Fits* for 10 weeks, with each participant playing all of the *Wii* activities twice a week for 30 minutes. The results of Nitz's experiment suggested the ability to provide balance and fitness, but there was no control group for the traditional exercise. Thus the objective of this experiment is to determine if the *Nintendo Wii Fit Jog* can provide similar health benefits provided by traditional jogging outside over four weeks.

3.3 Justification of chosen methods

This section explains the chosen primary methods of research that is intended to be carried out. Whilst explaining the reasoning for each primary method, arguments against methods that were not selected are highlighted below.

Personal Structured Interview

As the project is going to be undertaken for 4 consecutive weeks, three times a week for 15 minutes the sample size is expected to be few. As a result personal interview structure was chosen allowing the researcher to ask follow up questions and to allow the participants to familiarise themselves with whom they would be working with. The reason for a structure interview is to allow all participants to provide feedback that can be contrasted between each other as well as in hindsight of the experiment.

Questionnaire

As a means of wide-range data gathering, a questionnaire was chosen due to its simplicity and its ability to present the results statistically. In terms of simplicity once the questionnaire is created it requires minimal maintenance, which allows research time to be used effectively and only requires the use of online forums to request users to complete it.

Alternative methods such as face-to-face, telephone and postal interviews were considered but deemed unpractical. The cost and time required for the first two methods would disrupt the overall execution of the experiment. Furthermore postal questionnaires may not be received back in time for the deadline specified by the university.

Eliminated Techniques

Focus groups, telephone interviews and observations techniques were considered to be used for the primary research method. However, the above techniques would require substantial planning and potential costs to cover subject participation such as incentive and travelling costs.

3.4 Experiment Details

The following section is used to justify key aspects of the experiment. The aspects discussed are the population sample, justification of using the *Wii Fit Jog*, the location, duration of the experiment and how the experiment will be controlled.

Population Sample

It has been noted by Lenhart (2008) that students of the age group 18 to 29 are the most likely to play video games. Furthermore, it has also been reported that students are the least likely to exercise with over 30% doing no exercise at all (Racette, 2005).

Using these findings this experiment aims to conduct an experiment using students of the age group between 18 and 29 to see if exergames can be a viable form of exercise for such a sedentary group. The ideal participant would be a frequent gamer who does moderate exercise and is within a B.M.I. range of ideal weight.

The ideal participant will also have little or no experience with the *Wii Fit*; this is due to player's finding cheats and being able to cut corners in the experiment.

Wii Fit Jog

The *Nintendo Wii Fit Jog* was selected ahead of the other activities within the *Wii Fit* primarily due to reports by Carroll (2009) that state *Island Run* and *Free Run* were the most intensive activities in the game. More reasons for the use of *Wii Fit Jog* is due to its transferability to a real life comparison, for example hula hoops can be difficult to ensure the experiment is fair. Furthermore, as jogging is one of the most traditional methods of exercise and can be undertaken by the vast majority of the public, it increases the probability of ensuring that an adequate sample criteria is met.

Location

The experiment will be undertaken in two separate locations; indoors and outdoors. The indoor setting will be used for the *Wii Fit*, whilst the outdoor setting of a sand-based football pitch will be used for the outdoor jogging. The indoor environment will be the user's own living room to provide the most realistic home environment setting, with the research present. The reason for undertaking the experiment in two different locations is due to the lack of research done in a realistic environment that the respective activity would be undertaken.

From the literature review, only Nitz (2009) conducted a *Wii Fit* based experiment within a realistic home environment. However, the training was unsupervised during the 6 week period, which could suggest the benefit gained from the *Wii Fit* could have been from other activities that were being pursued by participants. Furthermore, there were no comparisons being made between the *Wii Fit* and traditional exercise methods. The research by Nitz was solely to determine how effective the device was over a longer period of time.

Exercising within an outdoor environment provides various benefits. As stated by Bryant (Larsen, 2006) chief psychologist of the American Council of Exercise "it tends to be more

engaging... mentally stimulating due to changing scenery and terrain... mood boost... from being outside". Bird (2009) further encourages the use of outdoor exercising by stating that it can benefit the musculoskeletal system by being on a natural uneven surface.

Within an indoor environment Bryant stated that the option of working out indoors can be "more appealing and feasible during inclement weather" (Larsenm, 2006). He went on to say that the indoor workout machines can "provide consistent, well controlled and lower-impact activity" (ibid).

Despite the advantages of exercising indoors, this can also include the air being constantly contaminated by dust, animal fur, chemicals, etc. (headacheexpert.org, 2010). It is also argued that there is greater distraction within a home environment, which could lead to a lesser intensity workout than being outside.

Duration

As previously stated in the literature review the research on long term effects of exergames and the *Wii Fit* has been explored by very few researchers (Nitz, 2009; Warburton, 2007). Exergames as a medium, are meant to provide an absorbing and flow-like experience that must be addictive for prolonged sessions. However, as most experiments were conducted for around two sessions, the novelty of the device would not have worn off. Thus this experiment seeks to discover if the device can provide a last enjoyment to keep the players playing and exercising on the device.

It has been decided that the experiment will be executed over a four week period with 15 minutes of user-defined levels of intensity.

A four week period of testing was chosen, as Cheung (2005) reported that within the same timeframe, her participants improved trunk muscle mass and reduced their body mass. She noted further that if this was extended to an eight week experiment the findings would continue to improve. It is based on this that the experiment will run for the stated duration.

The Department of Health (2004) released a document stating that by exercising 30 minutes a day at a moderate-intensity level, current levels of fitness can be maintained. This experiment will not be undertaken for this duration for two reasons. The first reason is the possibility of not finding sufficient test subjects for such frequent sessions, particularly for students who are often busy at the end of the academic year. Secondly it is highly probable that the participant will be undertaking some of the time required in exercise by commuting to university and/or other extracurricular activities.

As a result of the adobe, it has been decided to test the subjects for 15 minutes, three times a week for four weeks.

The 15 minute testing will be broken down into three 5 minute sessions with a 5 minute break. Schmidt (2001) reports that exercise executed over multiple sessions or a single bout

has similar effects on the outcome. By having the single session split into mini-bursts it will allow the subjects to have a break before exercising again.

Controlled Experiment

To ensure the experiment is reliable and to minimize the number of variables the research will be executed within a controlled environment. The participants will be recruited via word of mouth and will then undergo a screening process. During the screening process participants that do not meet the criteria below will be omitted from the experiment:

Figure 6 – Participant Criteria

Criteria	Range Required
Age	18 to 29
Gender	Male or Female
BMI	18.5 to 24.9
Diet	Relatively healthy – moderately meets 5 a day fruit intake
Employment Status	Student
Leisure Activities	Gamer on a daily basis
Previous Wii Experience	None or little

Once the participants have been chosen, they will be asked to undertake an interview using the same questions for each of the participants. Following the interview, there will be a familiarisation session for the subjects that will be using the *Nintendo Wii Fit* to ensure that they know how to correctly undertake the experiment. All participants will be given a chance to understand how the measuring instruments work to allow identification of any malfunction that could occur.

During the experiment, certain regulations will be asked to be followed by all participants. In terms of dieting, the participants will be given complete freedom over their eating habits. The only change that is required is that participants do not eat 3 hours prior to the experiment and are allowed only to drink water during the testing.

All participants will be asked to wear shorts and a tee shirt during testing. Although the experiment outside could be colder, it would be ideal for this regulation to be followed to ensure the overall weight of clothing doesn't force participants to work harder by carrying more mass.

Finally, during the experiment the participant will be given positive feedback at approximately every two minutes to encourage participants to maintain the workload.

3.5 Experiment Evaluation Techniques

The following evaluation techniques are the main forms of evaluation that were discovered during the literature review. For each technique there is a description of how it is used and a justification for either using or omitting it from the project.

Body Mass Index

The body mass (B.M.I.) index (as described in the literature review) will be used to determine how much of the participants' body mass changes during the four weeks. B.M.I. can be categorised into four categories as show in Figure 7.

Figure 7 – Body Mass Index Grouping (CDC, 2009b)

BMI Range	Weight Status
Below 18.5	Underweight
18.5 to 24.9	Normal
25 to 29.9	Overweight
30 and above	Obese

Justification

The B.M.I. calculation is cited as the most widely-used, inexpensive and easy method for calculating and comparing against previous research due to its popularity (CDC, 2009b). Another possible technique for measuring participant fat is with the use of callipers, however the cost and time for delivery makes this method unfeasible for this research. Furthermore, the expert knowledge required to use the device could hinder the schedule already planned out.

There has been some debate regarding the use of B.M.I. as a means of determining a person's weights status as it does not consider muscle mass (Teeple, 2008). However, as all participants will be measured using the same method it will provide an even basis for the results.

Borg's Rate of Perceived Expenditure

It is important to gain a comparison between how intensely the user believes they are working to the actual statistics of their work rate. The Borg Rating of Perceived Expenditure is a method to measure how intensely a participant believes their body is working. Below is a table of rate of perceived expenditure – Figure 8.

Figure 8 – Borg's Rate of Perceived Expenditure (CDC, 2009a)

Rating	Perceived Expenditure
6	No exertion at all
7	Extremely light
9	Very light
11	Light
13	Somewhat hard
15	Heavy
17	Very hard
19	Extremely hard
20	Maximal exertion

Justification

The use of the Borg scale will be an integral part of the research as it will allow the project to quantify the exertion of participants. This method also allows the research to compare results obtained with researchers that used this technique in the literature review (Carroll, 2009; Porcari, 2008; Warburton, 2007; Wittman, 2009).

Maximum Heart rate

In the literature review, numerous methods were identified to measure the heart rate of participants during the experiment. In almost all experiments, heart rate was monitored to identify the intensity that the participants were working at (Carroll, 2009; Graves, 2008; Haddock, 2009; Stratton, 2008; Wittman, 2009; Warburton, 2007).

The importance of tracking the user's heart rate is, to track how intensely the user's heart is working. Although there are many methods to calculate the maximum heart rate, Tanaka's (2001) method of deriving HR max has been noted as the most accurate – as shown in Figure 9.

$$HR_{max} = 208 - (age * 0.7)$$

Figure 9 – Equation of Determining Maximum Heart Rate (Tanaka, 2001)

By determining the maximum heart rate, it is then possible to clarify what zone of training their work can be classified as. The RAF (2007) published a document, which categorises levels based on the percentage of the maximum heart rate, as displayed in Figure 10.

Figure 10 – Heart Rate Training Zones (RAF, 2007)

Zone	Intensity
Recovery	60-65%
Extensive endurance	66-70%
Intensive endurance	71-75%
Threshold zone	76-85%
Anaerobic endurance	86-95%
Power	96-100%

Measuring Heart Rate

Heart rate can be measured using various techniques ranging from manually counting the beats felt per minute or by using an electronic device. Regardless of the technique, it can be argued that either technique has a substantial error margin due to the difficulty of counting faint pulsing.

For the purpose of this experiment, it has been decided to use a strapless heart rate monitor for health and safety reasons and to meet the financial budget. By having a strapless heart rate monitor users will be able to freely use the device without having to wash it after each use to keep it hygienic.

Justification

As a technique that is used by the majority of researchers in the literature review, it is a validated method to quantify how intensely a test subject is working. Thus it is intended that this technique will be used within this experiment.

Pedometer

A pedometer is a device used to count the number of steps a person takes by measuring the motion of the user. It is a small device that clips on to the user's trousers at hip height. It is suggested that the average person should undertake 10,000 steps per day as suggested by Dr Hanato (AccuStep10000, 2003). The reasoning behind the 10,000 steps is that it usually takes around 30 minutes in order to complete the goal, which is the daily recommendation by the Department of Health (2004).

Justification

This device has been widely-used for reference by various researchers in the literature review (Epstein, 2005; Stratton, 2008; Wittman, 2009). It is considered a validated form of measurement. This will be used to determine, which method produces the most number of steps over the same duration.

V.O.2 Max

V.O.2 Max is defined as measuring the highest rate of oxygen consumption during maximal exercise, a rate which is dependent on gender and current athletic ability. This method of measuring cardio respiratory fitness is often cited as the most effective (sport-fitness-advisor.com, N.D), yet is also the most difficult to measure. The method is difficult due to the complex apparatus and the technical knowledge required as well as the possible dangerous associated with it without the expert knowledge.

Justification

As a technique that requires careful expert information to execute effectively, this technique will be omitted from the project. The dangers of incorrectly executing it far-outweigh the benefits obtained from undertaking such a risky method (Mac, 1997). Furthermore, the time and financial constrains make this method nearly impossible to undertake.

4. Results

Screening Process

Using the results obtained from the primary research, this section aims to identify any trends through a graphical representation. The results on the pre-experiment interview, the main experiment and the post-experiment interview as well as the questionnaire. All data is presented in a chronological order.

All participants were 21 years old and met the criteria that was previously stated in the methodology section and agreed to the ethical consent form found in Appendix A. It should be noted that all participants were students who actively walked to university that was around 2 to 3 km away. Furthermore, it should also be noted that all subjects were of a gaming background as per the requirements. The participants chose which method of exercise they preferred; Subject A undertook traditional exercise, Subject B chose the *Wii Fit* and subject C chose a combination of both. Below in Figure 11 is a table with their attributes prior to the experiment.

Figure 11 – Participant Attributes

Subject	A	B	C
Gender	Male	Male	Male
Height	5ft 9	6ft	5ft 8
Weight	73kg	73kg	60kg
Idle Heart Rate	49	56	65
B.M.I.	23.8	21.8	20.1

During the four-week experiment all three participants undertook every session of the experiment without failure of attendance or injuries, which permitted a complete set of results for each participant.

4.2 Pre-Experiment Interview Results

The purpose of the pre-experiment interview is to determine the initial beliefs and opinions of the test subjects prior to undertaking the experiment. By having both a before and after experiment interview, this provides the researcher to compare and contrast the changes in the opinion of the user.

The interview was carried out with one test subject at a time. The aim was to encourage the participants to fully express themselves regarding their opinion on the *Wii Fit* without pressure from the other participants. Below are the highlighted responses for each question taken from the full interview transcript, which can be found in Appendix B.

Question 1: What are your initial impressions of the Nintendo Wii Fit?

Given the high exposure of the product, this question served the purpose of identifying what the average gamer thought of Nintendo's approach to exergames. There was a highlight of the graphics being too childish ("*Graphics are too cartoony*"), which resulted in the subjects feeling that they were not the target audience ("*I don't feel like I am the target audience*").

Question 2: Do you think the Wii Fit alone can provide enough fitness?

This question was part of a before and after question, whereby the researcher intended to see if the users' opinion of the product changed since using it in the experiment. The initial reaction was that the product would not be good enough for the average person ("*ideal for unfit people*"). There was a suggestion that it could ideal as a warm-up tool prior to more intense exercise rather than the primary method of exercise ("*maybe as a warm-up tool*").

Question 3: Do you think you can lose weight through using the Wii Fit?

It is important to have the test subjects' opinion on the device's effectiveness. There were mixed replies with Subject A believing that the product's usefulness would be limited to the person's diet ("*eating healthier... bigger gain*"). Subject B on the other hand believed that if it was done often enough it could be beneficial ("*if done religiously for long durations*"). Subject C believed that the Yoga feature would be useful for posture but was sceptical about its overall usefulness to lose weight ("*I'm a bit sceptical to be honest*").

It is clear from the above interview that all three participants had a relatively negative perception towards exergaming and the *Nintendo Wii Fit* in particular. As the test subjects were all gamers, it is clear that despite being one of the main areas that is affected by obesity, they do not feel that they are target demographic. The participants also believe that the product could not offer them the same degree of exercise as given by traditional exercise, which may affect their performance on the *Wii Fit*.

4.3 Experiment Results

Having established the participants initial impressions towards the *Nintendo Wii Fit* and traditional exercise, the experiment aimed to see how each of the exercise method would perform over a four-week period.

The experiment as underlined in the methodology section was undertaken in two separate areas – outside at a local park and indoors within a home environment. The experiment was carried out for four weeks, with three sessions per week. Each session was scheduled for fifteen minutes, which was further split into five-minute sessions with a five-minute break in between.

Each of the three participants undertook a designated activity for the entire duration, such as *Wii Fit* only, traditional exercise only or a combination of five minutes on the *Wii Fit* followed by ten minutes traditional exercise.

In order to reduce the number of variables that could affect the result, all participants were asked to fast for 2 hours prior to undertaking the experiment and were only permitted to drink water for the duration of the exercise. In terms of clothing, participants were asked to wear shorts and t-shirts to minimise weight differences. For each of the sessions readings refer to Appendix C.

Heart Rate

A heart rate monitor was required to measure the level of intensity the participants worked at over the course of the experiment. To determine the category of intensity the participants worked at, it was required to calculate their maximum heart rate using the equation concluded in the literature review (Tanaka 2001). As all participants were of the age of 21, only one heart rate value was calculated as the formula contains only a single variable - age (Figure 12).

$$HR_{max} = 208 - (21 * 0.7) = 193$$

Figure 12 – Participants' Maximum Heart Rate using Tanaka's (2001) Equation

Using the equation detailed above (Figure 12), the researcher calculated that the maximum heart rate for the participants is 193 beats per minute. The participant's heart rate was measured at the end of each five-minute session using an *Oregon SE138* – a strapless heart rate monitor (Oregon, 2010). The product tracks the user's heart rate by having the user press their thumb and index finger on the sensitive metal strip along the bottom of the device. Figure 13 shows the average heart rate for the participants for the entire duration of the experiment.

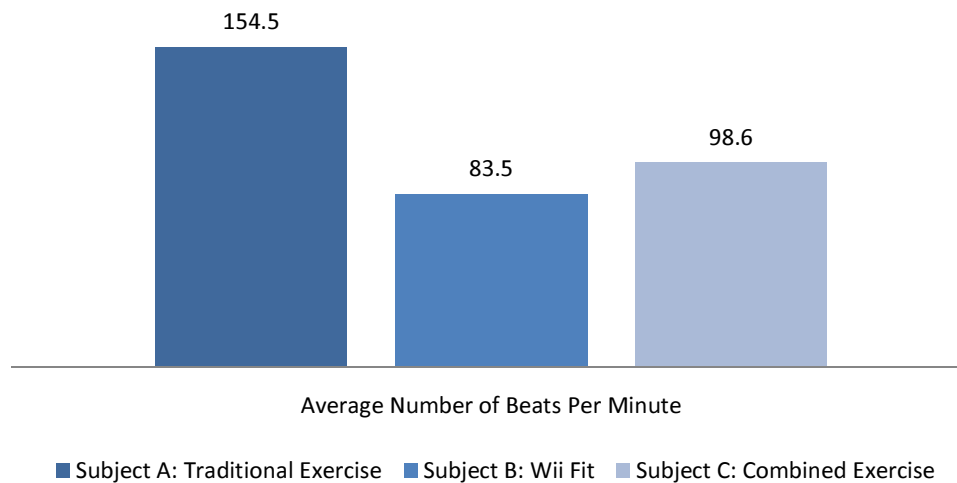


Figure 13 – Participants' Average Heart Rate

It is clear that that the subject A had the most intense workout by having an average heart rate of 154.5 beats per minute whilst the *Wii Fit* had the least intense, averaging at 83.5 beats per minute – almost half of the traditional exercise (45%). The combination of the two exercise methods produced results that were in-between Subject A and B's exercise methods and the result in Figure 13 reflects this. The graph on the following page (Figure 14) illustrates how Subject C's exercise method was broken down, this serves to determine, which method was more effective.

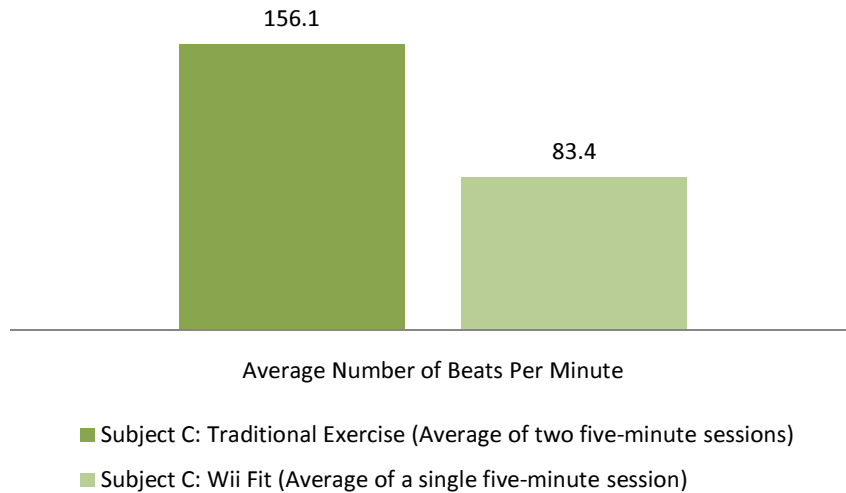


Figure 14 – Subject C’s Average Heart Rate per Exercise Method

Interestingly, Subject C who undertook both the *Wii Fit* and traditional exercise had an average of 98.6 beats per minute, however when split up it results in 83.4 beats per minute on the *Wii Fit* and 153.8 beats per minute whilst undertaking traditional exercise. This echoes the result obtained from Figure 13, which shows that the heart rate is almost double (46%) through traditional exercise in contrast to the *Wii Fit*.

Figure 15 on the following page illustrates the difference between the three methods of exercise over the course of the entire four weeks in a graphical representation.

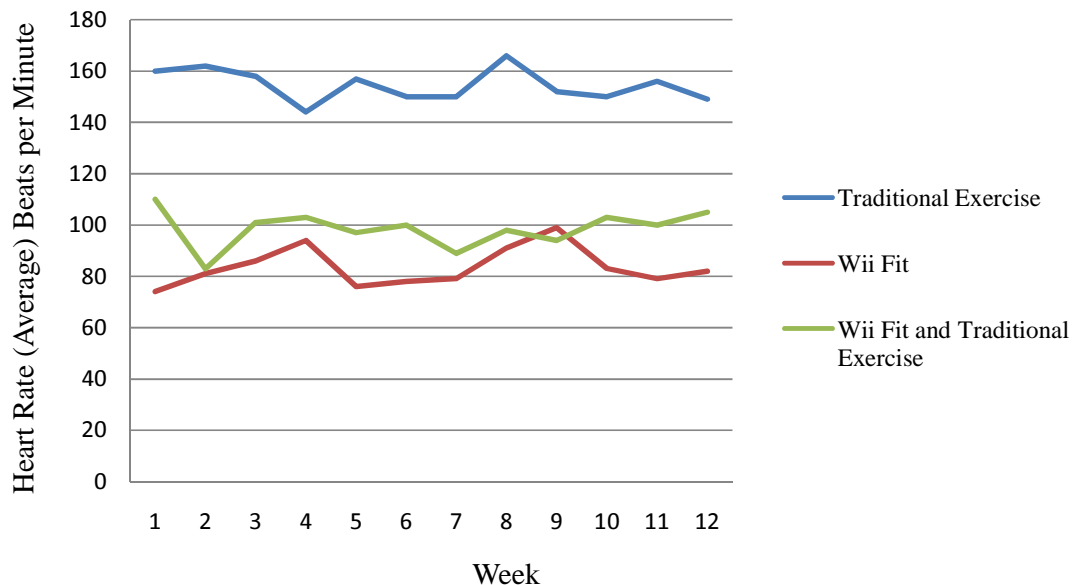


Figure 15 – Experiment Results: Heart Rate

The Centers of Disease Control and Prevention (CDC, 2010) defines moderate-intensity as 50% to 70% of the maximum heart rate, whilst vigorous exercise is 70% to 85% of the maximum heart rate. Given that the maximum heart rate was determined to be 193 beats per minute (Figure 12), moderate intensity would lie within the range of 96 to 135 beats per minute, whilst vigorous exercise would lie between 135 to 164 beats per minute.

Figure 15 suggests that traditional exercise manages to maintain a high level of heart rate that is classed as vigorous exercise. The *Nintendo Wii Fit* at best achieves a heart rate of 99 beats per minute, which meets the threshold for moderate intensity exercise. However, for the most part the heart rate remains around high 70s to low 80s beats per minute, equating to under moderate-intensity. A combination of both traditional exercise and the *Wii Fit* attains a slightly higher average in contrast to the *Wii Fit* as expected.

It is interesting to also note that from Figure 15 that only Subject C's combination of traditional exercise and *Wii Fit* managed to maintain a heart rate average that increased as time went on. This could suggest that using the *Nintendo Wii Fit* as a device to warm-up before undertaking traditional exercise for ten minutes is more enjoyable than doing the other methods for fifteen methods continuously. It could, perhaps suggest that it is easier to work out when there is a gradual build up of tasks or that by only exercising intensely for ten minutes as opposed to fifteen is easier and thus can maintain the same workload.

Calories Burned

The importance of counting the calories burned is to determine how beneficial each form of exercise is. The calories burned were calculated using an *Omron Walking Style II* (Omron, 2010), which calculates the calories burned by using the number of steps performed and how long a person's stride is. The table below (Figure 16) shows the average calories burned throughout the entire experiment.

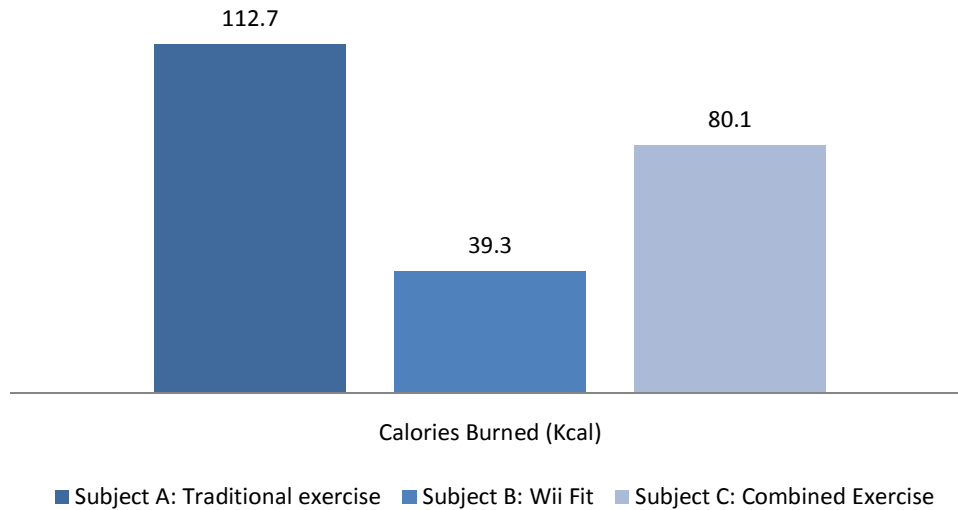


Figure 16 – Participants' Average Calories Burned

Unsurprisingly, exercise through the traditional exercise burned the most number of calories in comparison to the other two methods. It is interesting to note that on average, the *Nintendo Wii Fit* provides around a third (34%) of the calories burnt through traditional exercise. It was expected that the combined method of exercise would perform in between the *Wii Fit* and traditional exercise, with an average of 80 Kcal burned. Figure 17 sees how Subject C's caloric expenditure was broken down per exercise.

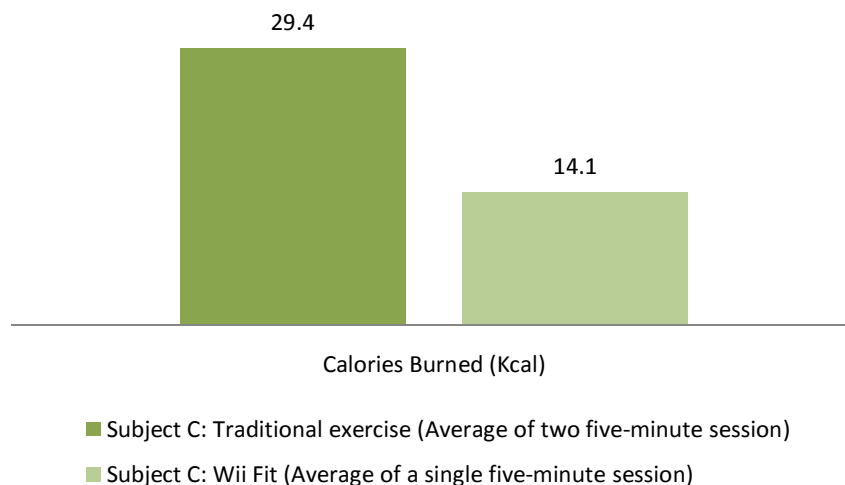


Figure 17 – Subject C's Average Calories Burned per Exercise Method

What was interesting was the fact that traditional exercise would, on average, achieve 30 Kcal yet the *Wii Fit* would only burn 14 Kcal less than half (46%) in contrast. The following graph (Figure 18) shows how many calories were burned throughout the experiment cycle.

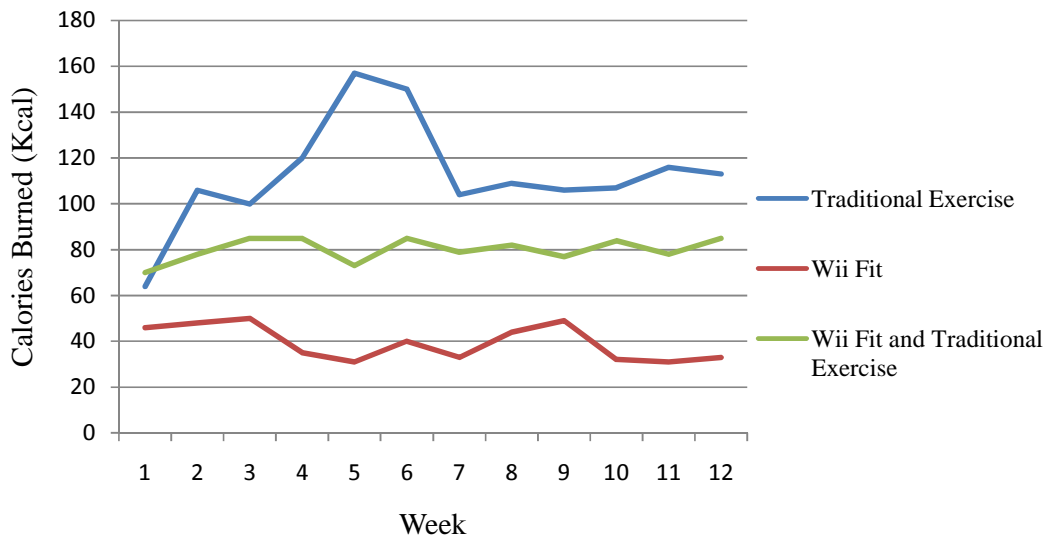


Figure 18 – Experiment Results: Calories Burned

As expected, traditional exercise is the most effective ranging between 67 to 157 Kcal burned whilst exercising. This figure is in line with walking at 4.5 miles per hour to jogging at 5.5 miles per hour (Aspen, 1998). It is surprising to note that the *Wii Fit* only managed to provide a range of 31 to 50 Kcal, which is less than walking at 2 miles per hour (Aspen, 1998).

Subject C’s combination of both methods of exercise is the only method to maintain a steady number of calories burned and is the only method to have a rise in caloric expenditure towards the end. In contrast, both traditional exercise and the *Wii Fit* drop significantly after week 9 in the experiment. This could suggest that exercise using both mediums is potentially more beneficial in the long term than the other methods.

Steps Counted

The number of steps taken was calculated using the same *Omron Walking Style II* as previously used to determine the calories burned. With the government heavily pushing to persuade people to opt for a healthier lifestyle, they introduced a 10,000-step program, which aims to have everyone perform 10,000 steps a day (NHS, 2010). This method aims to see how much each form of exercise can contribute towards this goal. The table below (Figure 19) shows how many steps were performed on average for the duration of the experiment.

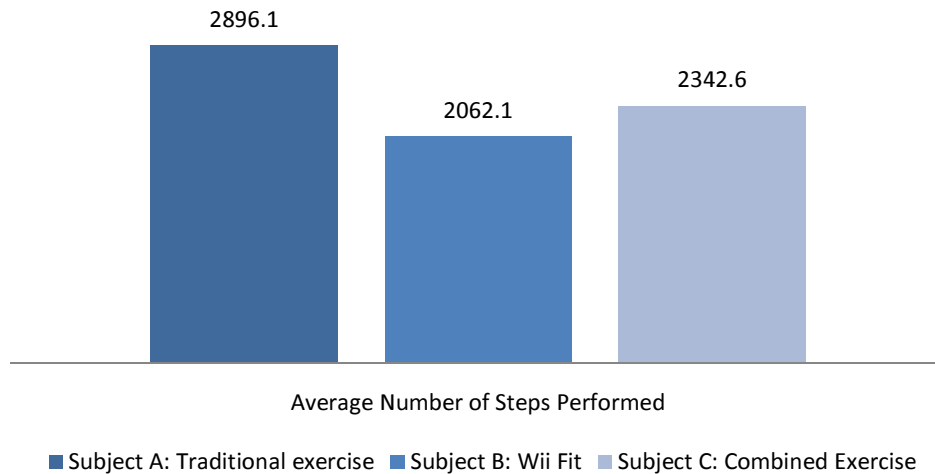


Figure 19 – Participants' Average Number of Steps Performed

The table suggests that albeit traditional exercise providing greater than 800 steps compared to the other methods of exercise, they all surpass 2000 steps. It is clear that these forms of exercise are not sufficient alone, however when used in conjunction with daily walking it will meet a fair portion of the daily requirements. The graph below (Figure 20) shows the difference between the *Wii Fit* and traditional exercise's steps performed per exercise through Subject C's performance.

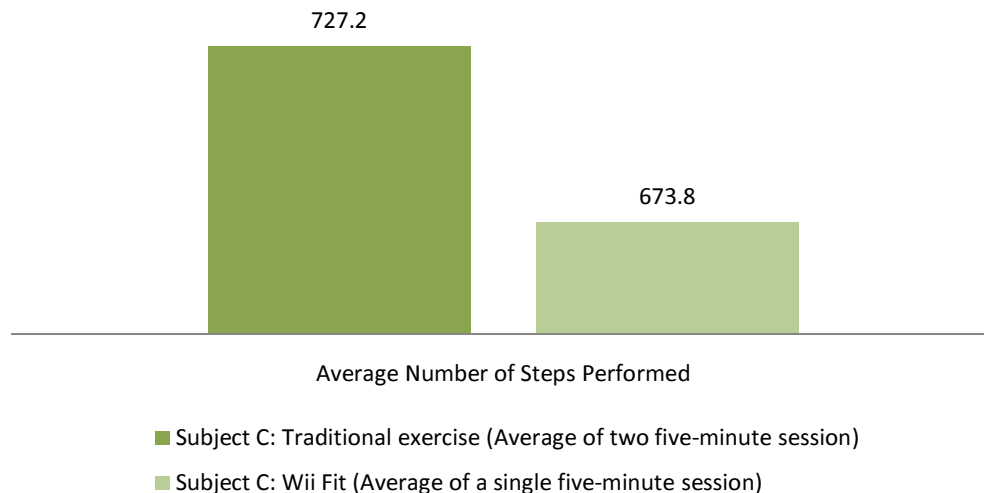


Figure 20 – Subject C's Average Number of Steps per Exercise

The results in the above graph reflect the results seen in Figure 19, with traditional exercise encouraging the user to expend 50 more steps than the *Nintendo Wii Fit*. This result potentially suggests that the *Wii Fit* can provide health benefits that are parallel to traditional exercise. The graph below (Figure 21) shows how the participants performed over the entire experiment duration.

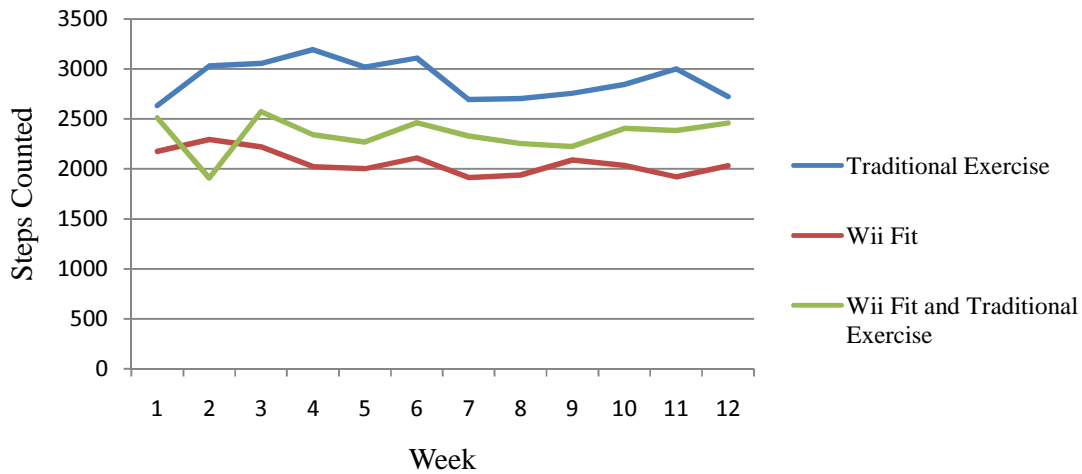


Figure 21 – Experiment Results: Steps Counted

The results show all three forms of exercise have performed relatively similar throughout the experiment. It should be noted that despite the *Wii Fit* providing step counts in the region of two thousand, the movement involved to perform the task is vastly different. For the most part in the experiment, the participants undertaking the *Wii Fit Jog* moved in a stationary jog almost performing stationary exercise (i.e. no forward momentum), unlike jogging whereby the participant was constantly moving forwards during the exercise.

Distance Travelled

The distance travelled is an important aspect to the measure of the amount of work each subject undertook. This was calculated using the same *Omron Walking Style II* that was used previously for determining calories burned and steps performed. Each participant had their stride length measured to ensure accuracy of distance travelled. The graph below (Figure 22) represents the distance travelled for each subject.

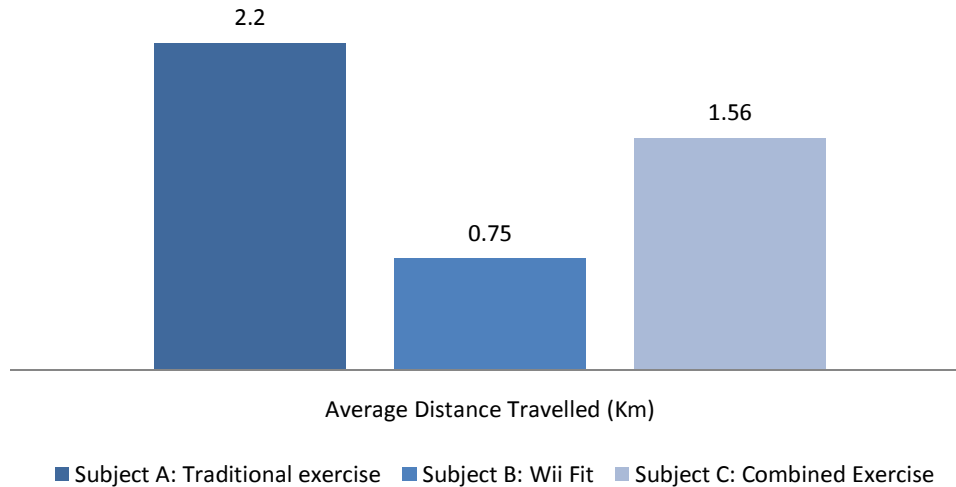


Figure 22 – Participants' Average Distance Travelled

Over the course of the four-week experiment the participant travel for around 2 kilometres per session whilst undertaking traditional exercise. In contrast, exercise using the *Wii Fit* equates to 0.75 kilometres, around a third (34%) of the traditional exercise. Again, the combination of the two exercises lies in-between the two at 1.56 kilometres per session. The figure below (Figure 23) shows how Subject C's exercise was split up based on exercise method.

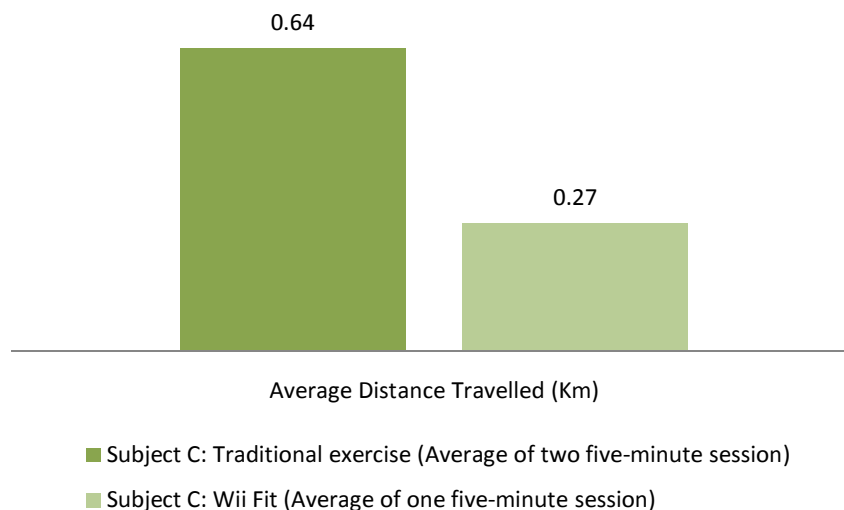


Figure 23 – Subject C's Distance Travelled per Exercise

The difference as seen in figure 22 is reflected in the graph above, with the *Wii Fit* providing two-fifths (42%) of that of the *Wii Fit*, in terms of distance travelled. The following graph (Figure 24) looks to see how the performance of each exercise method ranges over the four week testing period.

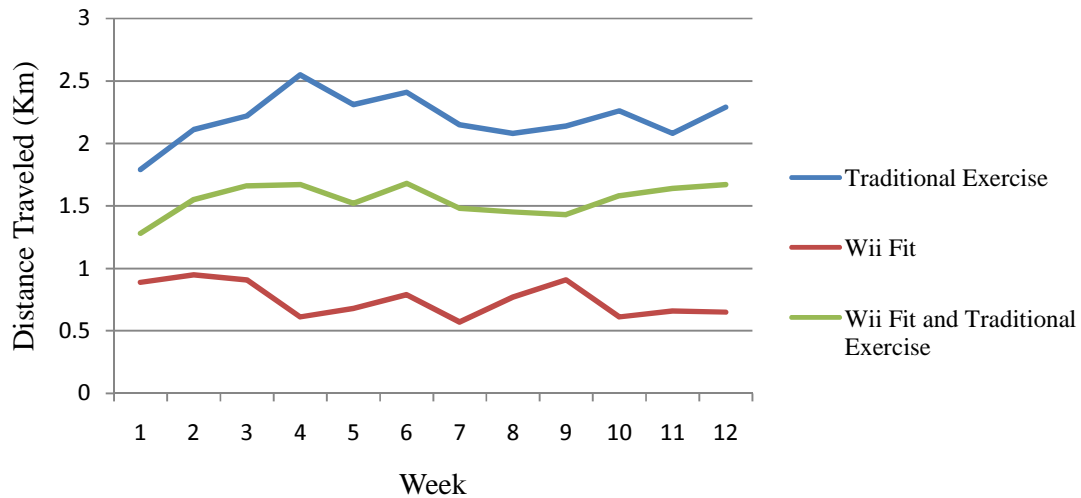


Figure 24 – Experiment Results: Distance Travelled

The distance travelled using traditional exercise is at one point four times that of the *Wii Fit* (2.55 kilometres compared to 0.61 kilometres) at week four. During the other weeks, traditional exercise achieves triple the distance travelled on six occasions, whilst maintaining a minimum of double the distance on the remaining weeks. This massive difference between the two could further suggest that the impact of exergames are minimal in contrast to traditional exercise.

Before and After Contrast

Following the completion of the experiment, the success of each participant's chosen exercise method can be reported through a before and after contrast to determine if the participants have gained any physical benefits from undertaking the exercise methods chosen.

Borg's Rate of Perceived Energy Expenditure

Borg's rate of perceived energy expenditure is a measure of how intensely participants believe they are working on a given task. The participants were asked at the end of their second five-minute session in their first and last week, how intensely they believe they were exercising ranging from 6 (being no exertion at all) to 20 (maximal exertion). Figure 25 represents how each of the participants would rate their exercise in this research and how it changed from the first and last week.

Figure 25 – Before and After: Participants' Rate of Perceived Energy Expenditure

Subject	Week 1 Reading	Week 4 Reading
A	15	14
B	11	9
C	14	12

Figure 25 suggests that all the participants found overtime that their task was easier the more they undertook the exercise. Although all participants found it easier, it is interesting to note that the level of intensity is significantly higher in traditional exercise and the combination of traditional exercise and the *Wii Fit*.

Body Mass Index

The body mass index is a measure of how much weight the body has in relation to height of the subject. This method was used at the start of the experiment and at the end to determine whether participants had managed to lose weight in the process of the experiment. The graph below (Figure 26) represents the change between the participants.

Figure 26 – Before and After: Participants' Body Mass Index

Subject	Week 1 Reading	Week 4 Reading
A	23.8	23.7
B	21.8	21.8
C	20.1	20.3

The above table (Figure 26) suggests that undertaking traditional exercise reduced the participant's body mass index, yet Subject C's exercise of both increased their B.M.I. figure. The difference is minimal, which suggests that the exercise did not have a huge impact, this could be due to a lack of change in diet. However this also does suggest that each of the participant's fitness was maintained, which was the desired effect of each exercise.

4.4 Post-Experiment Interview Results

Results were gained after establishing the participants' initial impressions of both traditional exercise and the *Nintendo Wii Fit* and subsequently undertaken the experiment. The purpose of the post-experiment interview is to provide a contrast or reflection between the subject's initial impression and actual impressions of the experiment undertaken. Subject A undertook traditional exercise, whilst Subject B undertook exercise using the *Nintendo Wii Fit* and, finally, Subject C undertook a combination of both for the four-week period. A full transcript of the interview can be viewed in Appendix D.

Question 1: Do you believe from your chosen method of exercise that you have improved physically?

Subject A thought there were minor improvements (*"I feel slightly fitter, not a huge difference"*). Subject B stated that the results were minimal stating (*"I feel the same since I started"*). Subject C believes they had notable improvement than the rest stating (*"my stamina is better at jogging"*).

Question 2: What is your opinion of your chosen exercise method?

Subject A who undertook traditional exercise believed the method was *"enjoyable"* and *"felt good... having been in all day"*. This could be attributed to the reasons stated by the website headacheexpert.org (2010), which state that being indoors with contaminated air could cause fatigue. Subject B felt the *Wii Fit* became *"tedious"* and the participant was doubtful over its benefits *"not sure how beneficial it was."* Subject C enjoyed a combination of the two stating, *"I didn't feel exhausted and enjoyed doing it."*

Question 3: Will you continue your chosen method of exercise after this experiment?

Traditional exercise appealed to Subject A as he was happy *"continuing it"* but there were doubts about finding *"time and motivation"*. However, he notes that in days with bad weather it would be further difficult to persuade himself. Subject B evaluates the cost required to get the *Wii Fit* and states that for the same price he could get *"5 months at the gym... more beneficial."* The combination of both devices appealed to Subject C (*"if it were available... good for warm-ups"*) but the cost was the only downfall.

Question 4: Did being indoors/outdoors enhance or reduce your workout?

Being outside was a good experience for Subject A who stated that it was *"refreshing"* and made the overall exercise feel *"easy"*. Subject B believed his experience on the *Wii Fit* was *"strange"* as jogging in front of other people in a room designed for relaxation made him feel *"stupid"*. Subject B described exercising within a home-environment as *"unpractical"* as it resulted in a reduced workout because people living below the flat may have been disturbed, so he could not exert the intended force.

Subject C reflected on both answers by stating being indoors *"took a while to adjust"*, whereas being outside meant that he was *"mentally prepared"* and *"got the most out of the exercise."*

Question 5: Did you change your diet whilst you were exercising?

Subject A stated that he didn't intentionally change his diet but he may have opted to eat less "*now and again*". Subject B felt that his diet was fine as it was and merely "*maintained*" it throughout the experiment. Subject C stated that he may have "*subconsciously*" changed his diet, but wasn't intentionally changing it.

4.5 Questionnaire Results

The purpose of the questionnaire is to validate the findings from the experiment and the interviews previously carried out due to the small sample size. In order to ensure that all respondents owned a *Wii Fit* and met the ethical guideline as stated by the University Ethics Committee, a screening process prevented anyone under the age of 18 and who did not own a *Nintendo Wii Fit* to answer.

Section 1 of the questionnaire served to purge any respondents who did not meet the above criteria, and a total of 117 respondents were eligible to complete the questionnaire. Out of the 117 respondents, 77 people replied to every question in the questionnaire. As participants were able to leave part way through the questionnaire, the number of respondents per questions does slowly decline.

The questionnaire layout is divided into five sections; the screening process, how frequently the public used the *Nintendo Wii Fit*, their opinion on the *Wii Fit*, their review of the product and finally their opinion on other exercise. The graphs that follow are created based on the data gathered using the website www.surveymonkey.com, with all results being available in this report in Appendix E.

Section 2 – Using the Wii Fit

This section serves to ask the participants questions regarding their current usage of the *Nintendo Wii Fit*. The questions begin at number three due to the first two being part of the screening process of section one.

Question 3: How long have you owned the Nintendo Wii Fit?

The first question in this section (Figure 27) was to determine how long the users of the questionnaire had owned the product.

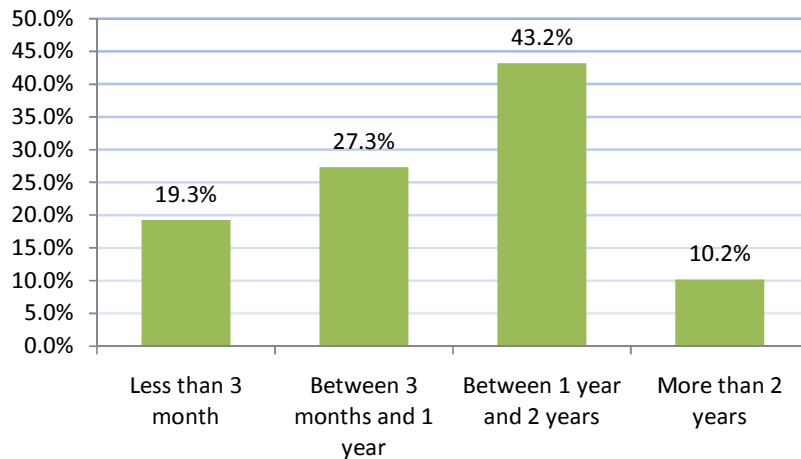


Figure 27 – Ownership of the Nintendo Wii Fit

From the eighty-eight respondents, 90% had owned the product for over 3 months, with 70% owning it for over a year. With the majority of the participants being long-term users, this questionnaire can help verify the longer-term effects of the *Nintendo Wii Fit*.

Question 4: In the last four weeks how often, have you played the Nintendo Wii Fit?

As made evident in the literature review, the amount of research on longer-term exergaming has been scarce. This question (Figure 28) aims to seek how long the average *Wii Fit* players used their console for within the last four weeks.

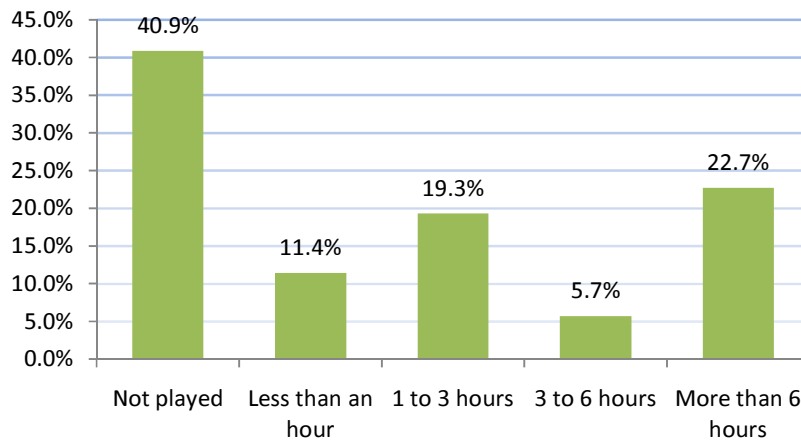


Figure 28 – Usage of the Wii Fit

Noting that over 90% of the respondents owned the product for over 3 months. It is surprising to find that over half of the users have played for less than an hour. When put into perspective, over three quarters (77%) of the respondents had spent less than 2 hours a week exergaming. This could suggest that exergames were considered a novelty and after a certain duration, the motivation for these products provide would wear off.

Question 5: Have you used the Wii Fit more or less frequently than during the initial four weeks since purchase?

As previously stated the number of research on long-term *Wii Fit* user-experience is almost non-existent. Only Carroll (2009) experimented the intensity of the *Wii Fit* over a couple of sessions. The purpose of this question (Figure 29) is to support the previous question and determine if the users used the product more or less frequently since purchase.

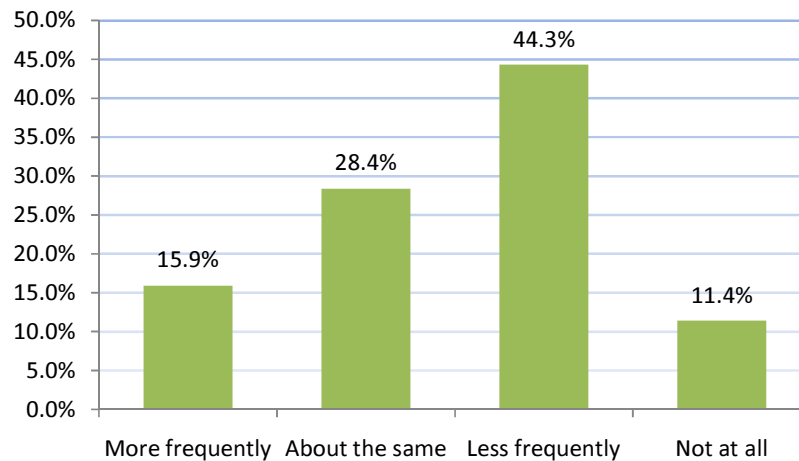


Figure 29 – Current usage compared to initial usage

More than half (55%) of the respondents do not continue the same enthusiasm to maintain the frequency of playing the *Nintendo Wii Fit* after the initial four-week period. With only 16% playing the game more frequently and around a quarter (28%) maintaining the gaming frequency it is surprising that the same level of game addiction does not encourage the exergamers.

Question 6: Whilst using the Nintendo Wii Fit, how long does an average session take?

In the majority of the research carried out on the *Nintendo Wii Fit*, the test subjects were made to play for a specified duration. This question (Figure 30 on the following page) aimed to ask how long the average person play given the complete freedom within the comfort of their own living room.

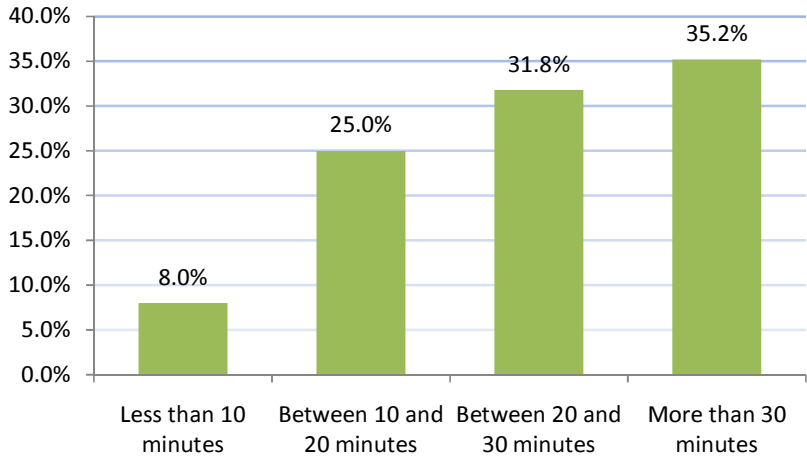


Figure 30 – Average Wii Fit session

Encouragingly, over a third (35%) of the players in this project played the game for a substantial duration of 30 minutes. The majority of gamers (56%) spent approximately 10 to 30 minutes on average exercising, which is encouraging. However, this statistic will only be effective if they are working at an intense rate frequently.

Question 7: On a scale of 1 to 5, how intensely would you rate your exercise on the Wii Fit? (1: same as resting, 3: walking, 5: moderate-intensity workout)

As stated by the Department of Health (2004) an average adult is required to do 30 minutes exercise five times a week at moderate-intensity. Using a similar method to Borg’s rate of perceived energy expenditure, this Richter scale (Figure 31) will provide how intensely the public believe they are working on the *Wii Fit*.

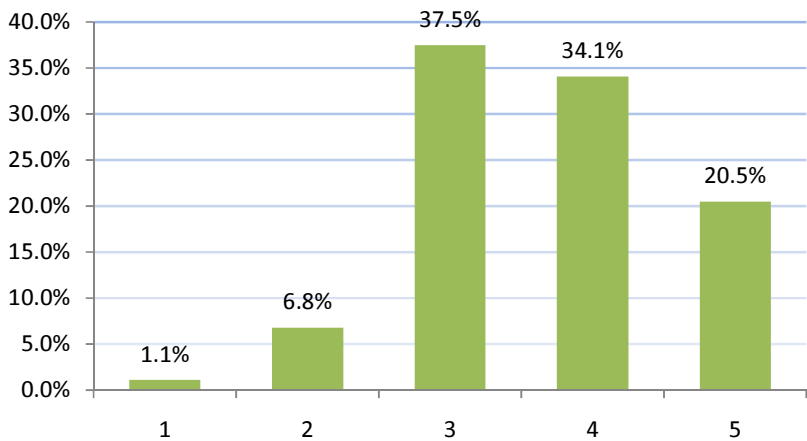


Figure 31 – Wii Fit workout intensity

It is encouraging to note that the majority of gamers believed they were doing the equivalent of walking to moderate-intensity exercise whilst playing the *Wii Fit*. It can be safely determined that the respondents believe the *Wii Fit* was more strenuous in comparison to traditional video games.

Section 3: Wii Fit Opinion

This sections purpose is to determine the public opinion regarding the *Wii Fit*. Despite its unparallel success not only as an exergame but as a videogame as well, it will be interesting to see what aspects appeal to the public. By understanding what they want, only then can an improve version be created.

Question 8: What were your initial health goals from using the Wii Fit? (Select all that apply)

The *Wii Fit* is heavily advertised through numerous case studies reporting weight loss (Wiinintendo.com, 2007) and is known for its reputation as a device that can provide health benefits. The aim of this question (Figure 32) was to determine what the primary reasons were for the user purchasing it.

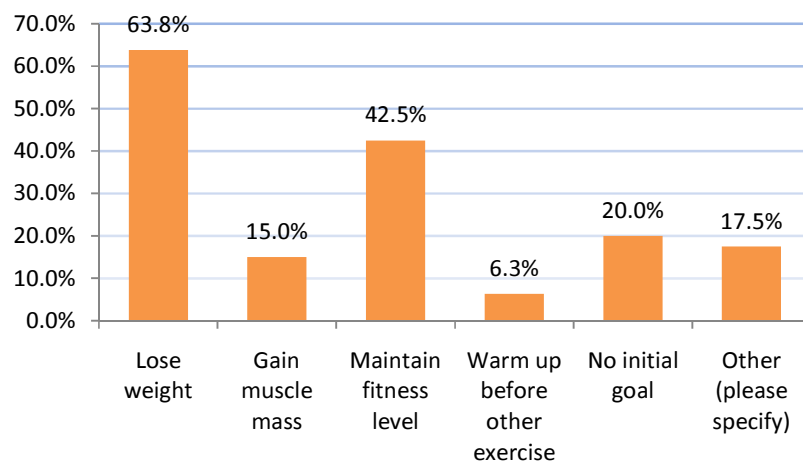


Figure 32 – Initial health goals

It is unsurprising that the majority (63%) of users bought the product to lose weight. However, in order for the product to achieve this goal, it must be practised on a daily basis of intense exercise combined with a healthy diet.

The participants who chose “other” specified that the reason they chose the *Wii Fit* was to improve their health, balance, and body toning. One participant chose it purely based on its fun factor.

Question 9: What aspects of the Wii Fit appeal to you? (Select all that apply)

With so many attractive attributes of the *Wii Fit*, the purpose of this question (Figure 33 on the following page) is to determine why users are keen to continue using the product.

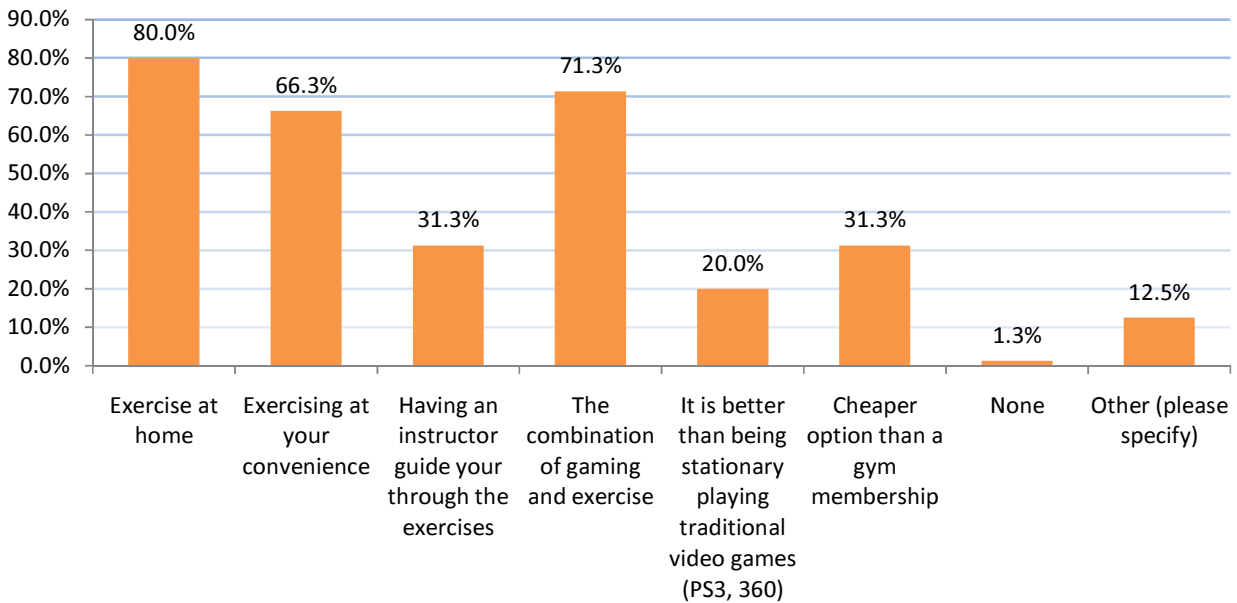


Figure 33 – Appealing aspects of the Nintendo Wii Fit

Unsurprisingly the two most appealing attributes of the *Wii Fit* is the ability to exercise at home whilst combining the experience with gaming. On the basis of the replies it suggests that the majority of the users are serious about using it as an alternative method of exercise. Only three of the respondents who selected “other” stated that the mini-games were enjoyable and appealed to them.

Question 10: When exercising on the Wii Fit do you feel you are mainly gaming or exercising?

As an exergame that has been marketed as an exercise device with the gaming elements being an addition, the purpose of the question (Figure 34) is to determine if this is reflected in the replies obtained from the questionnaire.

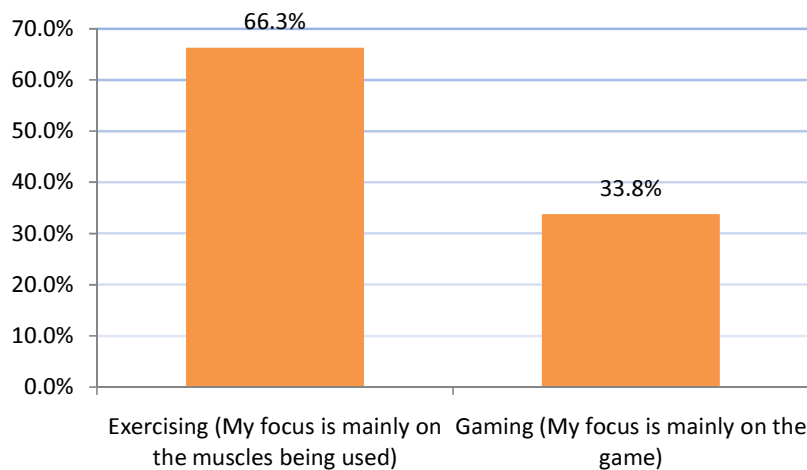
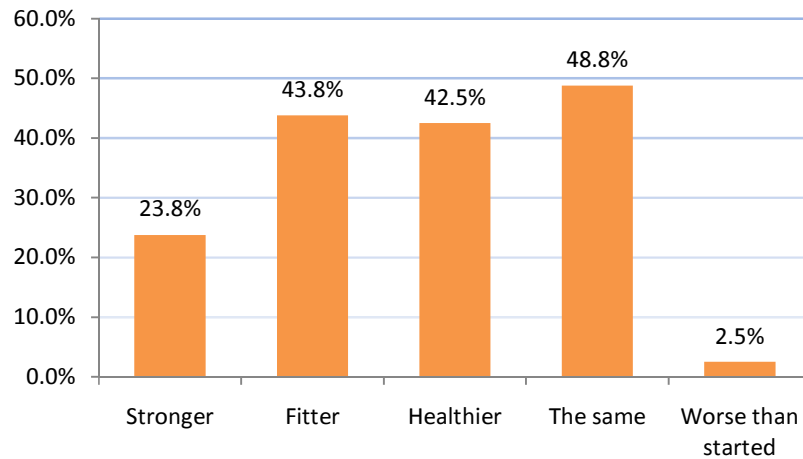


Figure 34 – Wii Fit: gaming or exercise

Unsurprisingly, only a third of the respondents believed that they were primarily gaming whilst they were playing the *Wii Fit*. This could imply that when gamers are play the *Wii Fit*, they are using it primarily using for exercise.

Question 11: Since using the *Wii Fit* do you feel any of the below? (Select all that apply)

As previously stated, the amount of research on longer-term *Wii Fit* usage has not been documented before; only in the form of anecdotes. This question (Figure 35) serves to determine the benefits the users feel since using the product.



*Figure 35 – *Wii Fit* benefits*

It is interesting to note that almost a quarter of the users feel stronger and, more impressively, almost half feel they are stronger and healthier. Only 2.5%, (two people) felt they were in a worse state than when they started. Just under a quarter of the users felt they were stronger, which is impressive. This suggests that the *Wii Fit* is effective at providing their users with some health benefits.

Section 4: Review of the Wii Fit

Having obtained the user's opinion on the product, this section aims to question their experience of the product.

Question 12: Before being able to exercise on the Wii Fit, did you have to move your furniture?

An aspect that is often overlooked is the accessibility of the product within a real life home environment. In order for an average person to undertake activities such as jogging or push ups a significant area of space is required, which may require moving furniture before use. It could be argued that this hinder the motivation of the user. This question (Figure 36) seeks to find how many users found that their furniture obstructed their workout experience.

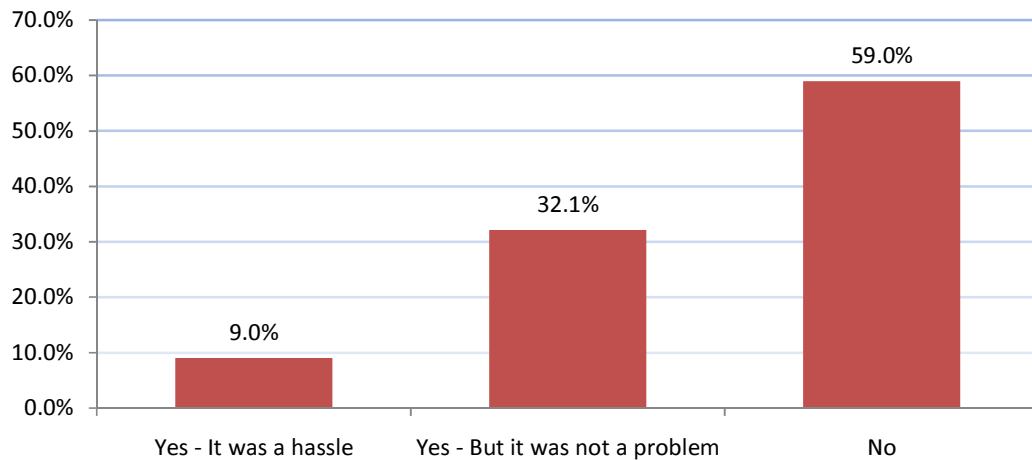


Figure 36 – Furniture obstruction

Only 9% of the replies reflected the hypothesis above, thus suggesting that movement of furniture prior to exercising is not a problem that affects the majority.

Question 13: When exercising on the Wii Fit, did you find yourself getting distracted resulting in a reduced workout? (E.g. phone calls, television, etc.)

Within a real home environment, there are multiple distractions that could potentially disrupt a work session. The results obtained in the literature review were all from a controlled environment, where the player was fully focused on the given task. The purpose of this question (Figure 37 on the following page) is to explore if being in a home environment caused distractions and reduced the overall workout of respondents.

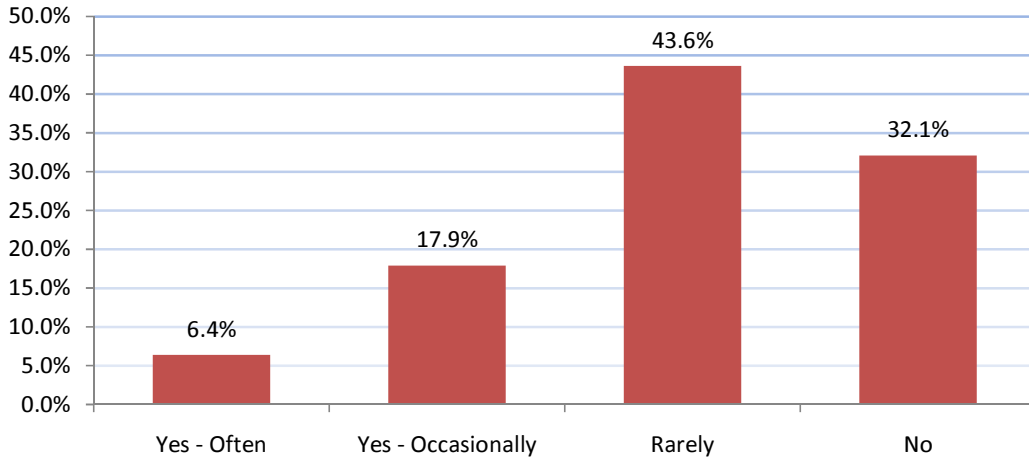


Figure 37– Wii Fit distractions

With 6.4% stating that they were often distracted, it appears that this is a factor that could affect ones training regime. This number increases to around a quarter (25%) when including players who were occasionally distracted. Although the majority (43.6%) rarely got distracted, the remaining respondents (56.4%) faces some disruption to their work session. This proves that distractions in a real home environment have a significant effect and therefore should be taken into consideration in other experiments.

Question 14: From you experience of using the Wii Fit, do you believe it is possible to become fitter by using the Wii Fit?

Having played the product, this question’s (Figure 38) purpose was to determine whether the users believe the product by itself could improve their physical attributes as suggested through the advertisements of the *Nintendo Wii Fit*.

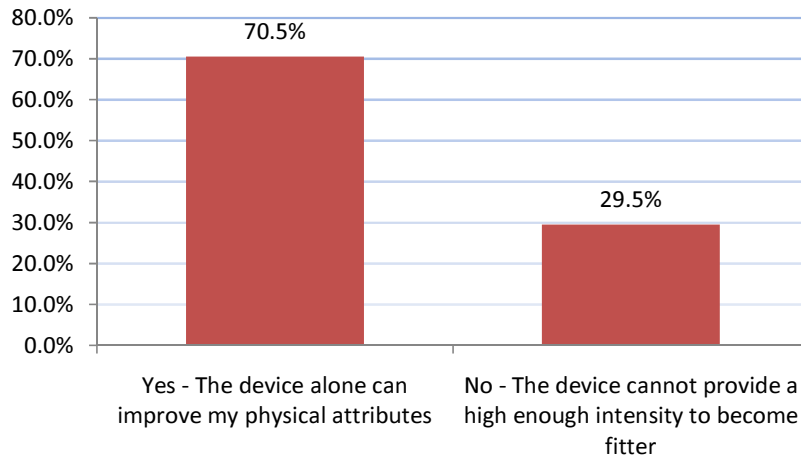


Figure 38 – User opinion on Wii Fit benefits

It is interesting to note that over two-thirds (70%) of the respondents believed that the device could improve their physical attributes, whilst only around a third (29%) believed it could not.

Question 15: When using the Wii Fit did, you incur any injuries?

An aspect that has been highlighted are the injuries caused by the *Nintendo Wii Fit* through over use (Fox News, 2008). Injuries are sustained often through repetition, as the product does not prevent you from over playing a particular mini-game resulting in over exertion of a particular muscle group. Figure 39 represents the participant feedback which, to determines whether this was common as suggested.

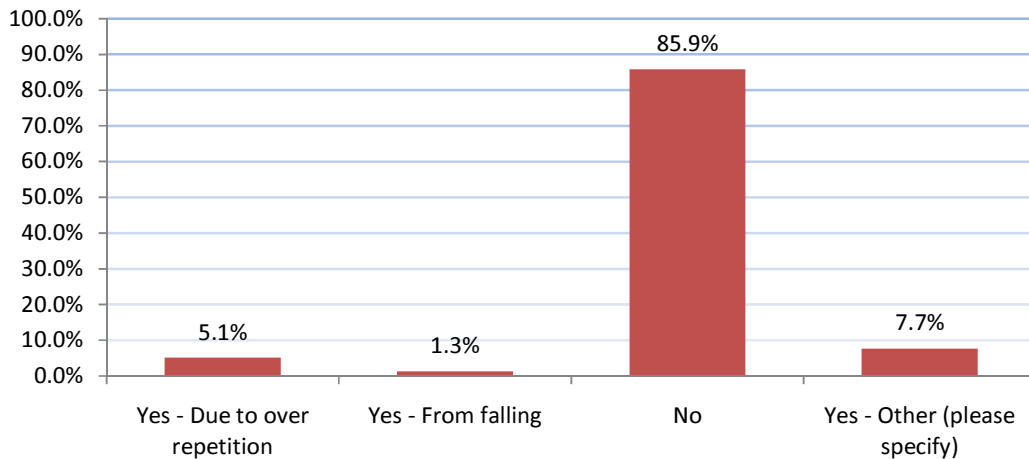


Figure 39 – Injuries whilst playing the Wii Fit

Although anticipated that the number of injuries would be low, it appears that just under 15% of *Wii Fit* users faced some form of injury whilst playing. The majority of users who selected “Yes – Other” complained that the injury they faced was muscle strain. When put into perspective, around 14% of the users experienced a form injury whilst playing.

Question 16: The injuries you faced using the Wii Fit, were they preventable with proper instructions from a real instructor?

Following from the previous question this question (Figure 40 on the following page) aims to seek if the injuries occurred were preventable had they opted for a real instructor rather than a virtual automated instructor who can’t tell exactly what is being done wrong.

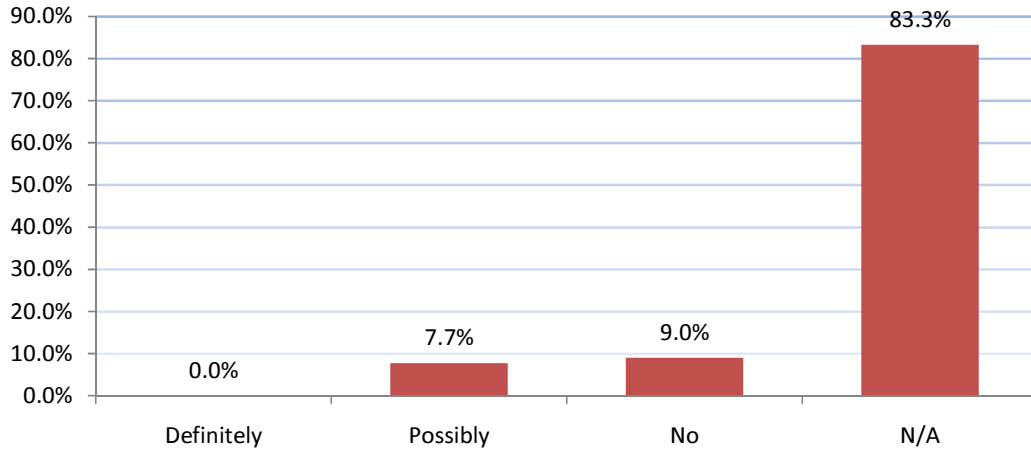


Figure 40 – Preventable injuries sustained through exergaming

The results are low due to only 15% being eligible to respond to the question. Over 7 percent believed that it was possible that a real instructor may have helped prevent the problem, but the results were too low to be concrete evidence of this.

Question 17: Since using the Wii Fit have you changed your diet?

When it comes to losing weight an area that is often overlooked is changing the persons diet to help reduce the amount of energy their body. This question (Figure 41) aims to ask if users of the *Wii Fit* reduce their food intake and opted for a healthier diet since using the product.

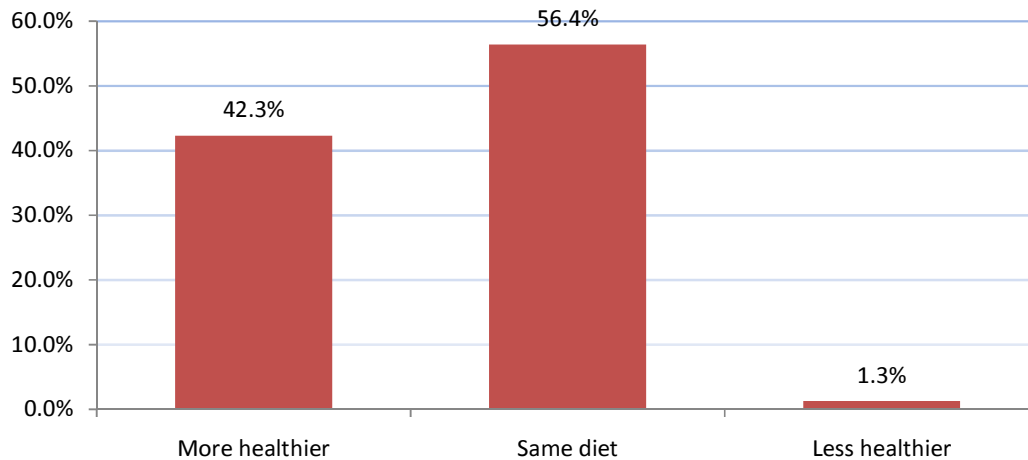


Figure 41 – Dietary changes since using *Wii Fit*

Impressively, since using the *Wii Fit*, over two-fifths (42%) improved their diet and only around one percent suffered a worsened diet. This is encouraging news, as having a healthy diet is a different improvement that may be attributed to use of the device.

Question 18: After a session on the Wii Fit do you feel you can reward yourself with a snack?

Given that there is a habit of rewarding one's self after exercise in the form of snacks or takeaways, this could lead to a potential problem if players gain more weight than they burned off. The diagram (Figure 42) below visually represents whether the respondents snacked after performing exercise on the *Nintendo Wii Fit*.

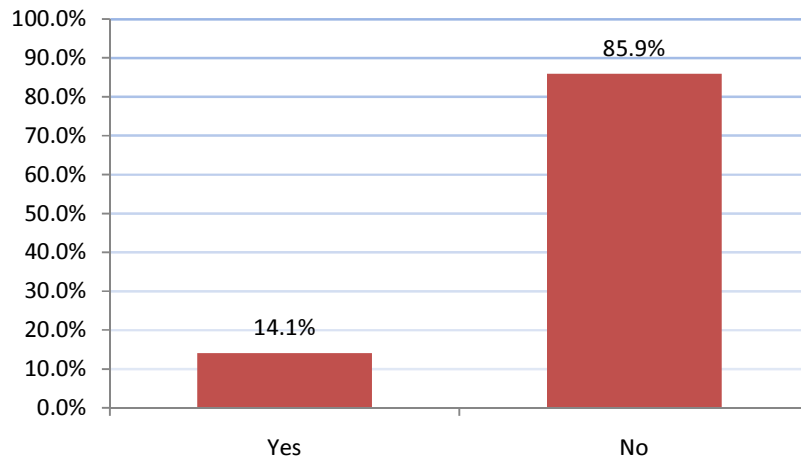


Figure 42 – Snacking after exercise

It is interesting to note that under 15% felt their exercise had assured them a snack after exercising on the Wii Fit. A high figure of 85% did not snack. Thus contrary to popular habits of snacking after exercise, the majority of *Wii Fit* users did not. However, 14.1% is still a substantial figure and if they snack on heavy food it could cause a problem due to the mild workout achieved through the Wii Fit.

Section 5: Other Exercise

In this section, participants were asked questions regarding exercise they undertook other than the *Nintendo Wii Fit*.

Question 19: Do you exercise using other methods than the Wii Fit? (Select all that apply)

It could be argued that the *Wii Fit* alone is not sufficient to provide the 10,000 steps and/or enough exercise to be deemed intense enough. Only when it is combined with other exercise could the device meet the exercise requirement specified by the government (Department of Health, 2004). The question below (Figure 43) asked the respondents if they undertook exercise other than using the *Nintendo Wii Fit*.

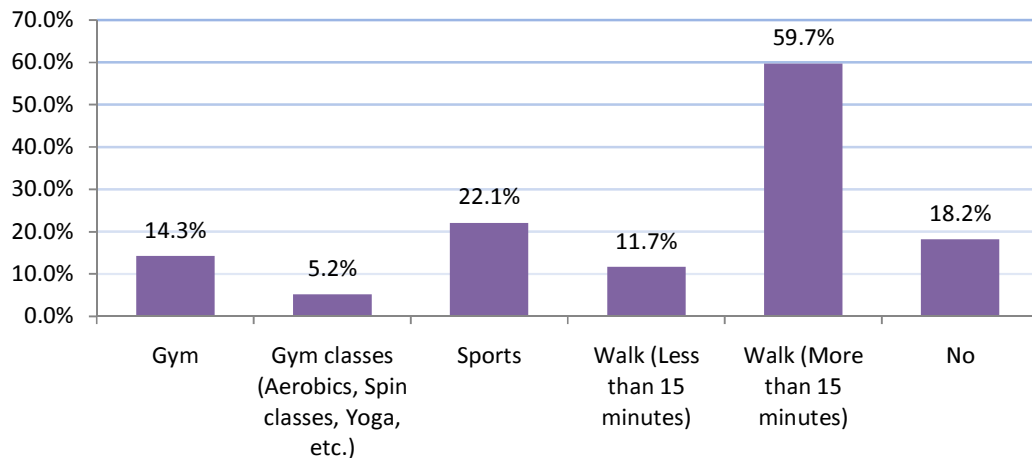


Figure 43 – Other Exercise

It is encouraging to see that the majority (81.2%) undertook activities outside of using the *Nintendo Wii Fit*. However, with almost a fifth (18%) not participating in any other exercise, it is possible that they will be using the *Wii Fit* as their only medium for exercise.

Question 20: How frequently do you exercise, excluding the Wii Fit?

With any exercise, if it is not performed on a regular basis, the user cannot reap the benefits. This question serves to see how often the respondents exercise excluding using the *Wii Fit* (Figure 44 on the following page).

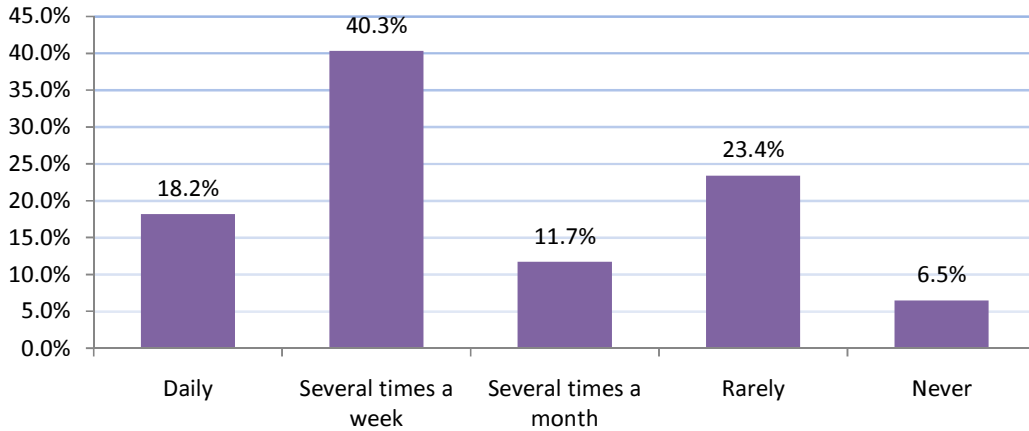


Figure 44 – Frequency of other exercise

Over 40% of the participants only exercised several times a month at most. Around a quarter (23%) of the participants stated that they exercise rarely and around five percent stated that they never exercise. This suggests that there is a reliance on the *Wii Fit* to provide the users' main source of exercise.

Question 21: Has using the *Wii Fit* inspired you to undertake new activities, such as Football, Gym classes, Running, etc.

Ultimately, the goal of exergames is to encourage the user to make the transition from video game to actual sport. This question (Figure 45) aims to see if users of the *Wii Fit* have become more active since using the product.

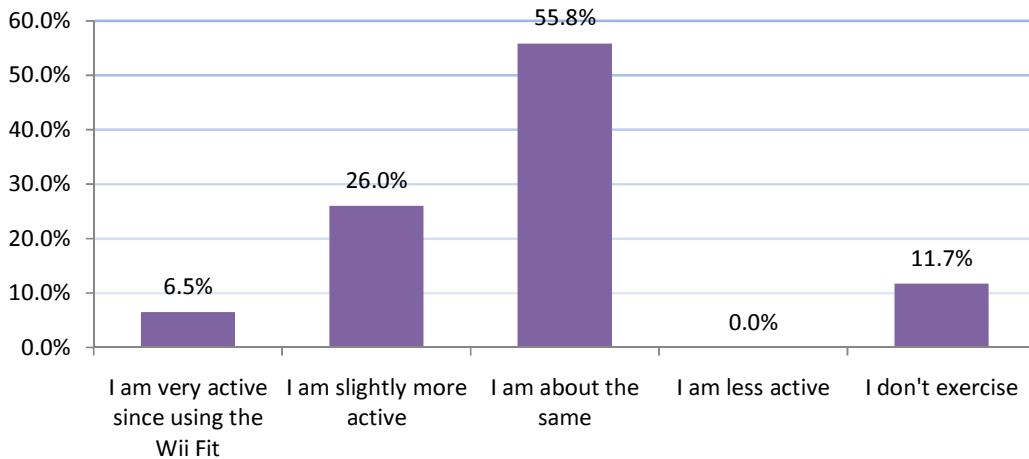


Figure 45 – *Wii Fit* inspiring new exercise activities

The results here are promising with just under a third (32%) of *Wii Fit* users stating that they became more active since adopting it into their lifestyle. Slightly over half of the users (55%) stated that they are the same and only 10% say they don't exercise at all.

Question 22: Has using the Wii Fit replaced any physical activity you used to do?

A potential problem with the *Wii Fit* is that it may be used as a replacement of traditional exercise. This question (Figure 46) aims to find out how the *Wii Fit* is being used as part of their routine.

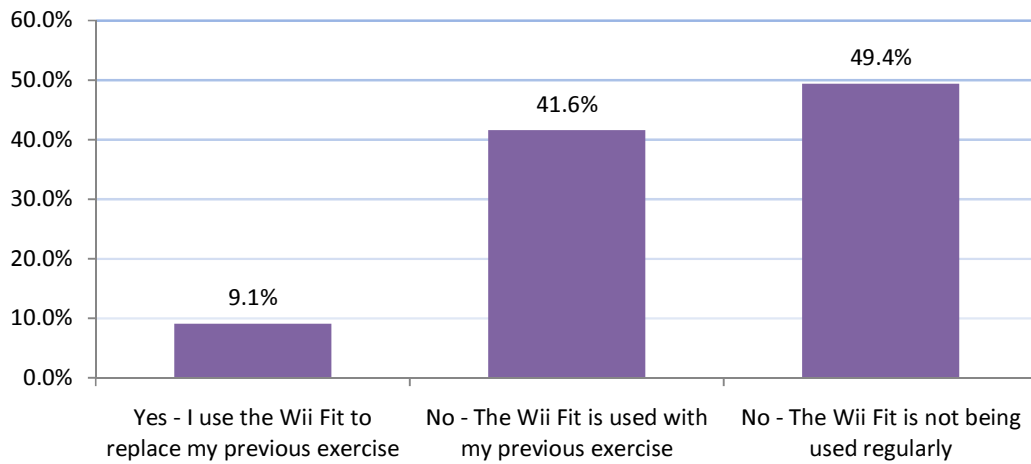


Figure 46 – Wii Fit replacing physical activity

The graph above shows that only around a tenth of the participants (9%) replaced their exercise with the *Wii Fit*, whilst 41% use it in conjunction with other exercise. Almost half (49%) of the survey user stated that they did not use the *Wii Fit* on a regular basis.

5. Discussion and Conclusions

The purpose of this section is to provide a summary of the aims of the project previously stated and will draw conclusions based on the results and findings obtained in the results section. Following the validation of the hypotheses a section designated to detail project limitations as well as improvement for future work will follow. Finally, this section will conclude with a conclusion for the report in its entirety.

5.2 Research Hypothesis: The Nintendo Wii Fit Jog cannot provide the same physical benefits provided by traditional jogging

As highlighted in the literature review, an average adult should undertake 30 minutes of moderate-intensity exercise five times a week in order to maintain their general health (Department of Health, 2004). For the *Nintendo Wii Fit* to be included as part of the solution to the obesity epidemic, it must provide the user with at least moderate-intensity exercise. With a large number of schools beginning to implement exergames to replace traditional physical education, this research aimed to seek how the *Wii Fit* device compared against traditional exercise over a four-week period.

During the research previously carried out in the literature review phase, Carroll (2009) discovered that the *Nintendo Wii Fit* was limited to providing around 5.5 Kcal per minute at an intensity of around 60% of the maximum heart rate. The results obtained in the experiment were similar to Carroll's research, which demonstrated that the heart rate varied between 38% to 51% of the maximum heart rate. In terms of calories burned, the range was around 2 to 3.4 Kcal per minute, which is considerably less than what Carroll reported. This caloric expenditure was deemed as the equivalent of walking at 2 miles per hour and in contrast to traditional exercise is incomparably less, which was effectively jogging at 4.5 miles per hour.

A possible reason for the low results of the *Wii Fit* could be due to the location of the experiment. With this research being carried out in a realistic home environment with residents above and below the flat used, the participants had to be wary of the surrounding environment to ensure they were not bothered with thudding sounds of the participant's feet. As a result, the participants had to minimize their enthusiasm when exercising. As already stated, Carroll's research was carried out in a controlled room whilst in reality, the user may not have the same freedom to jog as they would outside as reflected in the post-experimental interview.

Given the low exercise intensity of the product, it is important to determine how intensely the users believed they were working at. In the experiment, Subject A rated his exercise method to be 15, which translates to being heavy exercise (CDC, 2009a), whereas the *Wii Fit* user, Subject B, stated that it felt like light exercise (CDC, 2009a). However, from the questionnaire, it was surprising to note that the majority believed they were exercising between walking and moderate level intensity whilst using the *Wii Fit*. This may be the reason why they have stated that the majority believe the device alone is capable of improving their fitness levels.

With so many of the users firmly believing that the device would provide moderate-intensity exercise and improve their fitness levels, there is room for concern. A potential problem with this belief is that there is chance that current *Wii Fit* users may replace their current existing exercise routines with the device, as they may believe it is just as beneficial.

There is a problem with over-encouraging the user by making the user feel as though they had performed strenuous exercise, when in reality they had not. This is highlighted through the use of the *Wii Fit* Miles, which is the measure of unit that Nintendo adopted for the *Wii Fit Jog* to represent how far the user ran. The results showed that the distance in *Wii Fit* Miles was not equivalent to the actual distance ran. It was a unit that was purely designed to make users feel as though they had ran further than a traditional mile. This has also created a lot of ambiguity for their users over the distance actually travelled (GameFAQs, 2008).

The results obtained suggest that using the *Wii Fit* had induced a similar number of steps, yet covered only a third of distance. The reason for this was due to the step size of the pedometer being a minimum of 30 centimetres. In reality, the user is merely lifting one foot off the ground and placing the other without any forward momentum, whilst in traditional exercise, the user is required to move forwards. Although it is important to encourage the users by impressing them with statistics they can feel proud about, over-exaggeration has the potential to be more harmful.

With *Wii Fit* users firmly believing the products benefits, there is a possibility that they may indulge in snacks and takeaways as a reward for their exercise session. In the questionnaire 15% stated that they felt they had earned a snack after having played the *Wii Fit*, which may result in weight gain due given the mellow level of exercise.

Over the course of the experiment, the participants showed a minimal change in their body mass index. By contrast, around half of the participants of the questionnaire believed that they were fitter and healthier, with almost a quarter stating that they felt stronger since using the *Wii Fit*.

A possible reason for the *Wii Fit* users to achieve these gains could be a change of diet. As previously noted in the literature review, Swinburn (2009) stated that the benefits of exercise were limited and that a change of diet could have a larger impact. Interestingly, around the same half of the questionnaire respondents claimed to have become more healthier since using the product, which could suggest that may not have only been the device that was improving their health, but also the dietary changes. This is further highlighted by the experiment; when each of the participants maintaining a similar diet throughout achieved little or no physical benefit through their chosen exercise method.

It is clear that through the experiments, that the *Nintendo Wii Fit* cannot be a replacement for traditional exercise methods. It is concerning that the majority of schools in Virginia have now fully adopted exergames as part of their physical education. Not all have used the *Wii Fit*, however the number of users who have the device at home and use it as their only means of exercise should be warned regarding its effectiveness.

Unless the *Wii Fit* notifies how much calories the user has burned in a session, it is not clear how much exercise the person has undertaken. Without such measurements, the user must

guess how intensely they have exercised. Ultimately, for a device that is intended to improve the overall fitness of the user, it could have an opposite effect.

5.3 Research Hypothesis: The novelty of the Nintendo Wii Fit Jog will wear off, thus the overall workout by the user will decrease over time

An exergame's purpose is to attract the same level of enjoyment found in current traditional video games and combines them with player participation, which will result in an active and beneficial gaming experience. However, the researcher believes that in contrast to leading traditional sedentary video games such as Call of Duty: Modern Warfare 2 exergames cannot sustain the same appeal.

Despite the low intensity of the *Wii Fit*, it is interesting to note that a third of the users used the device for 20 to 30 minutes and another third used the device for over 30 minutes per session. This, however, is only useful if this level of dedication can be maintained and incorporated into a person's lifestyle. In the experiment undertaken it was evident that users of either traditional exercise alone or the *Wii Fit* alone had reduced their work load over time. If this trend were to continue, the *Wii Fit* would result in an exercise session less than that of walking at 2 miles per hour, which is too lacking in intensity to be a valid form of exercise.

In the last four weeks the majority of *Wii Fit* owners had not played the game and around a third of the participants stated that they had used up to 6 hours over the same period. Only twenty-two percent stated that they played the game for more than 6 hours. When asked if this was more or less than during the initial four weeks since purchase, around half stated they played less and more than a quarter stated it was about the same, with ten percent saying they didn't play it all. Given the decreasing use of the product, it could be argued that the novelty of the *Wii Fit* wears off and that the product cannot maintain the initial enjoyment of exercise.

Although the duration and the frequency played was relatively low, the Nintendo Wii Fit can become a cause for concern if it is used as the only means of exercise. When asked if the questionnaire participants undertook other methods of exercise, over three-quarters replied that they did, ranging from sports to gym classes to walking. Using the Wii Fit as an additional method of exercise would be beneficial to maintain fitness levels, especially on days with poor weather.

A problem is evident when the primary method of exercise is not done on a regular basis. Just under a half of the respondents stated that they exercised several times a month. More than a quarter stated that they rarely exercise, and may rely on the *Wii Fit* as their primary method of exercise. This is shown in the questionnaire with the question "Has the *Wii Fit* replaced any physical activity you used to do?" Around ten percent responded, saying the *Wii Fit* had replaced their previous exercise.

With *Wii Fit* users becoming over-reliant on the device to provide fitness, we turn to the potential problem of over-familiarisation and injuries that could be caused. Mellecker (2008) suggested that a potential problem with using exergames is over-familiarisation of the

product and that the user may be able to trick or cheat the system. Subject B discovered that they could trick the system that they were exercising by merely moving the controller up and down by hand without having to actually move the rest of the body. Of course, during the experiment this was not permitted, however it showed that as an exercise, it may be over sensitive to the slightest movement, which could cause the over-calculation in *Wii Fit Miles*.

Another problem of using this device is a potential cause for injuries. The *Wii Fit* does not prevent the user from playing the same mini-game repeatedly, which would allow the user to over exert a particular muscle group. 7.7% of questionnaire participants stated that they were possibly injured during use of the device, which could have been prevented with real professional help. As a result of the injuries players may no longer take up the device if they find it is causing them problems, which may lead them back to a sedentary lifestyle. If this number is reflected with the mass users of the *Wii Fit*, there could be a large number of users turning away from using the product.

An aspect that was highlighted in the literature review was the problematic use of using the *Wii Fit* within a home environment, which is plagued with distractions. A possible distraction that was highlighted was the need to alter living arrangements prior to each *Wii Fit* workout, consequently reducing the overall workout. This is reflected in the questionnaire, with forty percent stating that they had to move their furniture. Just under ten percent saying it was a hassle.

Further to the prevention of use, other distractions such as mobile phones, televisions and other games consoles. May have an impact on their *Wii Fit* workouts. Nearly a quarter confirmed this happened between often and occasionally, whilst just under half said it affected them rarely. With so many distractions that could hamper the exercise, the user may find that they have a reduced workout, in contrast to exercising in a designated area (such as a gym where the user can fully concentrate on their exercise).

Despite its low intensity, the device has succeeded in promoting the user to undertake new activities since using the device. Around a third of users reported that they have become more active, with no-one reporting that they do less exercise. By encouraging the user to take up new sports and exercise, it shows that the device may encourage progress from a sedentary to an active lifestyle.

The results from the experiment showed that the *Nintendo Wii Fit* cannot provide exercise benefits on par with traditional exercise. The results from the questionnaire suggested that use of the device decays rapidly over time. It could be suggested that the *Wii Fit* is not ideal for maintaining ones physical fitness levels unless the same enthusiasm and dedication is maintained. However, despite the questionable benefits of the device alone, it can provide the user with the initial inspiration required to make a transition from a lifestyle of only playing video games to one that may incorporate a gym membership or undertaking new activities such as football.

5.4 Project Limitations

Due to several limitations of the project the results obtained could be deemed biased. The limitations range from few participants, budget reading tools as well as financial limitations and lack of experience undertaking experimental research.

The experiment undertaken was done using only three participants, thus any results obtained may not be representative of the majority and may not represent all of the aspects of the *Nintendo Wii Fit* user experience. It can also be said that some participants were not owners of the *Wii Fit* device, nor were they keen on the product initially. In contrast, owners of the actual product could meet the exercise tasks with possibly more enthusiasm, thus producing a higher workload.

During the execution of the experiment, there were reading errors that occurred, such as the heart rate monitor, which failed to read the participants heart rate immediately. By not having the reading done at the moment of stopping, the participants heart rate dropped significantly, thus altering the results gathered. Such instances happened occasionally throughout the experiment and only with highly expensive cardiac measurement tools, could the results be accurate.

This project would have greatly benefited from a longer testing period and financial backing to improve the results. A longer duration to test would have removed anomalies and allow for more concrete evidence regarding the effects of the *Nintendo Wii Fit*. Furthermore, by having an extended duration, it would have enabled the researcher to validate claims by Cheung (2005) to see further improvement over an eight-week period. By having financial support, it would enable the researcher to use better equipment as well as being able to recruit more test subjects.

Due to the researcher's lack of experience in questionnaires, the questions asked could be seen as biased, thus producing biased results. Furthermore, this could also be said regarding the interviews carried out, as the researcher had only used literature to create the questions required. Because of the combination above, the results obtained may not fully represent what the participants believed during the experiment and the questionnaire.

5.5 Future Work

In the future, this research could be improved by involving a larger test sample for a realistic representation of *Wii Fit* users. The researcher opted for subjects without previous experience using the device to remove the possibility of cheating, however by having users without experience they may also be less interested in the benefits of the device. A possible room for improvement in this respect would be to include active *Wii Fit* users as they may be more inclined to work at improving themselves with the device.

Another aspect that may be improved in the future would be the tools used to gather the data. Due to the number of reading errors that occurred during the experiment, the use of better facilities with more accurate results could be obtained resulting in far accurate conclusions over the effectiveness of the *Wii Fit*.

A section of further research that could also be undertaken is to discover why players of traditional video games do not lose their interest over a prolonged period of time in contrast to exergames. If exergames could manage to implement this level of enjoyment then it could potentially provide the user with more substantial exercise, even if it is at a low intensity. In this respect, future work could be done on enhancing the exergame experience of the *Wii Fit* by incorporating elements of the leading games in the traditional video game market.

Another aspect which could be investigated, similar to the research done by Ahn (2009), would be a combination of greater intensity exercise such as treadmill to encourage higher rates of exertion.

With the release of the next iteration of the Nintendo *Wii Fit* during the execution of this research, a similar form of research could be carried out on the new release. By reviewing the next version, conclusions could be drawn regarding the effectiveness of the new version and how it may potentially improve the users' experience and fitness levels.

5.6 Conclusion

This project is in partial agreement with the results produced in the literature review. The *Nintendo Wii Fit* alone cannot provide the exercise required for an average adult to maintain their fitness levels, due to its low workout intensities. With obesity affecting more people each day, this research suggests that people should not turn turning to the *Wii Fit* as a method to prevent or reduce current weight problems may not be an effective solution.

As a method to solve the low intensity workout, the developers of the *Wii Fit* could employ the heart rate monitor control technique suggested by Stach (2009). At present, the device is a one-size-fits-all whereby the difficult of each game is set at a generic 'difficulty' thus what may be deemed as hard for some may be easy for fitter opponents. By including this technique, the developers can alter the difficulty of the game dependent upon the user's heart rate to ensure they are working at a recommended level of moderate-intensity.

Furthermore, the longer term benefits of the device suggest that the performance of the user may reduce over time. This may be due to the design of the *Wii Fit* focusing primarily on the exercise portion rather than the gaming aspect, which was the basis of *Dance Dance Revolution's* success. A possible solution to this would be for the developers to blend the differences of exercise and gaming and to provide an exercise experience closer to what casual and hardcore gamers are used to.

With the advent of the *Playstation Move* and Microsoft's *Natal Project* that allow more advanced methods of interaction with consoles (that have greater power), this could be another breakthrough of exergames. As most casual or hardcore gamers do not find the *Wii Fit* appealing due to its visual design, combining high definition graphics with more intense gaming could provide a progressive solution to sedentary lifestyle.

Despite the relatively poor performance of the *Nintendo Wii Fit*, this research notes the users of the device started to take up other exercise. With traditional gamers slowly making the transition from the couch to sports or the gym, there definitely is some aspect of exergames that appeal to them. Thus while it is not advised to be the sole method of exercise, it could still be used as part of a healthier lifestyle.

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Appendix A: Ethical Consent Form



An Investigation Into The Physical Health Benefits Of The Nintendo Wii Fit In Comparison To Traditional Exercise

Ethical Consent Form

Researcher: Masana Ikeshima
Matriculation No: 200601037
BSc (Hons) Games Software Development

Project Supervisor: Robert Law || Second Marker: Jon Sykes

This experiment will be undertaken in three sections, a pre-experimental interview followed by undertaking the experiment with a post-experimental interview reviewing the experiment.

During the pre-experimental interview you will be asked various questions regarding your opinion on exergames as well as be asked some questions regarding your lifestyle with a few personal questions such as height and weight. The experiment itself is a four-week experiment, which will be done three times a week. Each of the three sessions will require you to exercise on either the Wii Fit, jogging outside or a combination of both. The post-experimental interview will be similar to the pre-experimental interview with some more questions regarding your opinion on the experiment.

During the execution of the project you are free to withdraw at any point and all the data gathered will be reported as anonymous.

“By signing this form I agree I have read the above paragraphs and fully understand my role and rights of my involvement in this experiment. I also confirm I am between the age of 18 and 65.”

Signed: _____

Date: _____

Appendix B: Pre-Experimental Interview Transcript

Q1: What are your initial impressions of the Nintendo Wii Fit?

Subject A:

“I feel that the graphics are too cartoony and that I am not the target audience. I prefer next-gen graphics. Saying that the graphics do suit the game but reminds me that it’s not aimed for serious gamers.”

Subject B:

“The simple cartoony graphics are nice for all generations, however I don’t feel like the game is aimed for me.”

Subject C:

“The simplistic graphics makes the game feel gimmicky”

Q2: Do you think the Wii Fit alone can provide enough fitness?

Subject A:

“I don’t think so, maybe as a warm-up tool.”

Subject B:

“Yes if it’s done a lot by unfit people, the yoga could be useful for flexibility overall it seems a bit too basic.”

Subject C:

“Probably more ideal for the elderly than someone in their 20s; I’m not sure if it could work all the muscle groups though.”

Q 3: Do you think you can lose weight through using the Wii Fit?

Subject A:

“If you incorporate it as part of a healthy lifestyle as well possibly but eating healthier will have a bigger gain than the actual game itself”

Subject B:

“Possibly if done religiously for long durations.”

Subject C:

“The Yoga looks like it could help posture, but I’m a bit sceptical to be honest.”

Appendix C: Experiment Results

Subject A: Traditional Exercise

Week 1, Session 1	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	162	158	162	160.6666667
Calories	35	15	14	64
Steps	1001	835	796	2632
Distance (Km)	0.82	0.65	0.32	1.79
Week 1, Session 2	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	158	167	162	162.3333333
Calories	40	34	32	106
Steps	1060	795	1175	3030
Distance (Km)	0.82	0.63	0.66	2.11
Week 1, Session 3	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	153	167	155	158.3333333
Calories	34	36	30	100
Steps	1210	892	952	3054
Distance (Km)	0.85	0.71	0.66	2.22

Week 2, Session 1	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	109	158	167	144.6666667
Calories	47	32	41	120
Steps	1267	822	1104	3193
Distance (Km)	1	0.67	0.88	2.55
Week 2, Session 2	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	148	160	164	157.3333333
Calories	39	32	35	106
Steps	1038	878	1102	3018
Distance (Km)	0.86	0.74	0.71	2.31
Week 2, Session 3	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	130	154	168	150.6666667
Calories	36	33	42	111
Steps	1095	899	1115	3109
Distance (Km)	0.84	0.76	0.81	2.41

Week 3, Session 1	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	128	160	162	150
Calories	40	32	32	104
Steps	1070	800	823	2693
Distance (Km)	0.85	0.64	0.66	2.15

Week 3, Session 2	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	158	171	171	166.6666667
Calories	42	33	34	109
Steps	1075	822	803	2700
Distance (Km)	0.86	0.55	0.67	2.08
Week 3, Session 2	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	134	156	166	152
Calories	34	38	34	106
Steps	1023	902	832	2757
Distance (Km)	0.81	0.68	0.65	2.14

Week 4, Session 1	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	150	145	156	150.3333333
Calories	41	34	32	107
Steps	1110	919	814	2843
Distance (Km)	0.88	0.73	0.65	2.26
Week 4, Session 2	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	154	154	162	156.6666667
Calories	48	36	32	116
Steps	1324	871	806	3001
Distance (Km)	0.71	0.73	0.64	2.08
Week 4, Session 3	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	135	155	158	149.3333333
Calories	49	38	26	113
Steps	1024	899	800	2723
Distance (Km)	0.82	0.77	0.7	2.29

Subject B: Wii Fit Exercise

Week 1, Session 1	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	70	82	72	74.66666667
Calories	15	18	13	46
Steps	755	760	662	2177
Distance (Km)	0.31	0.3	0.28	0.89
Wii Fit Miles	0.92	0.91	0.82	2.65
Week 1, Session 2	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	72	84	89	81.66666667
Calories	14	18	16	48
Steps	768	766	759	2293
Distance (Km)	0.33	0.31	0.31	0.95
Wii Fit Miles	0.93	0.91	0.92	2.76
Week 1, Session 3	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	88	76	95	86.33333333
Calories	16	15	19	50
Steps	755	720	745	2220
Distance (Km)	0.31	0.28	0.32	0.91
Wii Fit Miles	0.91	0.88	0.86	2.65

Week 2, Session 1	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	100	85	98	94.33333333
Calories	12	13	10	35
Steps	691	677	654	2022
Distance (Km)	0.2	0.21	0.2	0.61
Wii Fit Miles	0.8	0.88	0.86	2.54
Week 2, Session 2	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	85	70	75	76.66666667
Calories	10	11	10	31
Steps	690	678	632	2000
Distance (Km)	0.27	0.21	0.2	0.68
Wii Fit Miles	0.87	0.88	0.82	2.57
Week 2, Session 3	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	78	85	72	78.33333333
Calories	13	13	14	40
Steps	692	679	740	2111
Distance (Km)	0.3	0.21	0.28	0.79
Wii Fit Miles	0.91	0.89	0.88	2.68

Week 3, Session 1	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	80	85	74	79.66666667
Calories	10	13	10	33
Steps	644	634	636	1914
Distance (Km)	0.19	0.19	0.19	0.57
Wii Fit Miles	0.75	0.88	0.86	2.49
Week 3, Session 2	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	80	109	85	91.33333333
Calories	14	15	15	44
Steps	643	644	650	1937
Distance (Km)	0.25	0.26	0.26	0.77
Wii Fit Miles	0.75	0.88	0.86	2.49
Week 3, Session 3	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	94	115	88	99
Calories	15	18	16	49
Steps	656	765	667	2088
Distance (Km)	0.32	0.32	0.27	0.91
Wii Fit Miles	0.82	0.93	0.87	2.62

Week 4, Session 1	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	87	77	86	83.33333333
Calories	11	10	11	32
Steps	706	659	669	2034
Distance (Km)	0.21	0.2	0.2	0.61
Wii Fit Miles	0.51	0.5	0.5	1.51
Week 4, Session 2	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	85	79	75	79.66666667
Calories	11	10	10	31
Steps	637	649	634	1920
Distance (Km)	0.29	0.19	0.18	0.66
Wii Fit Miles	0.79	0.69	0.68	2.16
Week 4, Session 3	5 minutes	5 minutes	5 minutes	Combined
Heart Rate	78	83	86	82.33333333
Calories	10	11	12	33
Steps	659	662	710	2031
Distance (Km)	0.18	0.21	0.26	0.65
Wii Fit Miles	0.68	0.71	0.76	2.15

Subject C: Traditional and Wii Fit Exercise

Note: WF denotes Wii Fit

Week 1, Session 1	5 minutes WF	5 minutes	5 minutes	Combined
Heart Rate	107	171	165	110.75
Calories	15	30	25	70
Steps	787	865	860	2512
Distance (Km)	0.31	0.52	0.45	1.28
Week 1, Session 2	5 minutes WF	5 minutes	5 minutes	Combined
Heart Rate	82	94	158	83.5
Calories	17	31	30	78
Steps	712	788	406	1906
Distance (Km)	0.3	0.64	0.61	1.55
Week 1, Session 3	5 minutes WF	5 minutes	5 minutes	Combined
Heart Rate	70	170	165	101.25
Calories	12	33	40	85
Steps	630	940	1003	2573
Distance (Km)	0.2	0.68	0.78	1.66

Week 2, Session 1	5 minutes WF	5 minutes	5 minutes	Combined
Heart Rate	85	165	162	103
Calories	18	32	35	85
Steps	725	789	826	2340
Distance (Km)	0.32	0.64	0.71	1.67
Week 2, Session 2	5 minutes WF	5 minutes	5 minutes	Combined
Heart Rate	75	158	158	97.75
Calories	11	32	30	73
Steps	645	823	800	2268
Distance (Km)	0.25	0.66	0.61	1.52
Week 2, Session 3	5 minutes WF	5 minutes	5 minutes	Combined
Heart Rate	82	152	166	100
Calories	17	32	36	85
Steps	712	880	868	2460
Distance (Km)	0.3	0.67	0.71	1.68

Week 3, Session 1	5 minutes WF	5 minutes	5 minutes	Combined
Heart Rate	82	145	130	89.25
Calories	16	31	32	79
Steps	763	777	790	2330
Distance (Km)	0.23	0.62	0.63	1.48
Week 3, Session 2	5 minutes WF	5 minutes	5 minutes	Combined
Heart Rate	87	165	140	98
Calories	17	34	31	82
Steps	784	787	682	2253
Distance (Km)	0.28	0.62	0.55	1.45
Week 3, Session 3	5 minutes WF	5 minutes	5 minutes	Combined
Heart Rate	78	148	152	94.5
Calories	14	30	33	77
Steps	685	735	803	2223
Distance (Km)	0.2	0.62	0.61	1.43

Week 4, Session 1	5 minutes WF	5 minutes	5 minutes	Combined
Heart Rate	85	158	171	103.5
Calories	16	32	36	84
Steps	762	792	851	2405
Distance (Km)	0.26	0.64	0.68	1.58
Week 4, Session 2	5 minutes WF	5 minutes	5 minutes	Combined
Heart Rate	83	152	165	100
Calories	14	32	32	78
Steps	725	814	845	2384
Distance (Km)	0.25	0.71	0.68	1.64
Week 4, Session 3	5 minutes WF	5 minutes	5 minutes	Combined
Heart Rate	85	168	169	105.5
Calories	14	32	39	85
Steps	786	792	879	2457
Distance (Km)	0.3	0.64	0.73	1.67

Appendix D: Post-Experimental Interview Transcript

Q1: Do you believe from your chosen method of exercise that you have improved physically?

Subject A: *"I feel slightly fitter, not a huge difference"*

Subject B: *"I feel the same since I started"*

Subject C: *"Slightly, yeah, I feel as though my stamina is better at jogging"*

Q2: What is your opinion of your chosen exercise method?

Subject A: *"It was quite enjoyable, it felt good when exercising outside having been inside all day"*

Subject B: *"It was okay, got quite repetitive and tedious towards the end and I'm not sure how beneficial it was"*

Subject C: *"The combination of a light workout followed by a more intense workout was good. I didn't feel exhausted and enjoyed doing it"*

Q3: Given the choice, would you continue your chosen method of exercise after this exercise?

Subject A: *"I could see myself continuing it, but finding the time and motivation could be difficult. During the days with bad weather I don't see myself getting up and going for a jog"*

Subject B: *"For the cost of the device and the game it could equate to around 5 months at the gym, which for me would be a lot more beneficial. I'm not sure even if I had the game I would continue using it"*

Subject C: *"Possibly, the cost of the device puts me off, but if it were available I think it's a good device for warm-ups"*

Q4: Did being indoors/outdoors enhance or reduce your workout?

Subject A: *"Being outside was great, the exercise felt easy and refreshing after a day's work at Uni."*

Subject B: *"Exercising indoors felt strange, I felt stupid jogging when everyone else was just watching or doing other things in the same room. I got distracted a few times with phone calls and trying to exercise in a flat was unpractical due to surrounding environments."*

Subject C: *"Indoors was okay, exercising in the living room took a while to adjust. I preferred being outside where I was more mentally prepared to work hard and get the most out of the exercise."*

Q5: Did you change your diet whilst you were exercising?

Subject A: *"I don't think so, I may have opted to eat less food now and again, but I didn't feel compelled to do so. I enjoyed the exercise but I also enjoy eating!"*

Subject B: *"I just maintained eating the same diet I pretty much always have."*

Subject C: *"Maybe subconsciously but I just ate whatever I wanted to be honest."*

Appendix E: Questionnaire Results

Sample: n = 117 adults over 18 and older all who own Nintendo Wii Fit
Data for February 23 to March 23, 2010

Q1 *Are you over the age of 18?*

Answer Options	Response Percent	Response Count
Yes	96.6%	113
No	3.4%	4
	Answered question	117
	Skipped question	0

Q2 *Do you own the game - Nintendo Wii Fit?*

Answer Options	Response Percent	Response Count
Yes	85.5%	100
No	14.5%	17
	Answered question	117
	Skipped question	0

Q3 *How long have you owned Nintendo Wii Fit?*

Answer Options	Response Percent	Response Count
Less than 3 month	19.3%	17
Between 3 months and 1 year	27.3%	24
Between 1 year and 2 years	43.2%	38
More than 2 years	10.2%	9
	Answered question	88
	Skipped question	29

Q4 *In the last four weeks how often have you played the Nintendo Wii Fit?*

Answer Options	Response Percent	Response Count
Not played	40.9%	36
Less than an hour	11.4%	10
1 to 3 hours	19.3%	17
3 to 6 hours	5.7%	5
More than 6 hours	22.7%	20
	Answered question	88
	Skipped question	29

Q5 *Have you used the Wii Fit more or less frequently than during the initial four weeks since purchase?*

Answer Options	Response Percent	Response Count
More frequently	15.9%	14
About the same	28.4%	25
Less frequently	44.3%	39
Not at all	11.4%	10
	Answered question	88
	Skipped question	29

Q6 *Whilst using the Wii Fit how long does an average session take?*

Answer Options	Response Percent	Response Count
Less than 10 minutes	8.0%	7
Between 10 and 20 minutes	25.0%	22
Between 20 and 30 minutes	31.8%	28
More than 30 minutes	35.2%	31
	Answered question	88
	Skipped question	29

Q7 *On a scale of 1 to 5 how intensely would you rate your exercise on the Wii Fit?*

(1 being the same as resting, 3 being the same as walking, 5 being moderate-intensity workout)

Answer Options	Response Percent	Response Count
1	1.1%	1
2	6.8%	6
3	37.5%	33
4	34.1%	30
5	20.5%	18
	Answered question	88
	Skipped question	29

Q8 *What were your initial health goals from using the Wii Fit? (Select all that apply)*

Answer Options	Response Percent	Response Count
Lose weight	63.8%	51
Gain muscle mass	15.0%	12
Maintain fitness level	42.5%	34
Warm up before other exercise	6.3%	5
No initial goal	20.0%	16
Other (please specify)	17.5%	14
	Answered question	80
	Skipped question	37

Q9 *What aspects of the Wii Fit appeal to you? (Select all that apply)*

Answer Options	Response Percent	Response Count
Exercise at home	80.0%	64
Exercising at your convenience	66.3%	53
Having an instructor guide you through the exercises	31.3%	25
The combination of gaming and exercise	71.3%	57
It is better than being stationary playing traditional video games (PS3, 360)	20.0%	16
Cheaper option than a gym membership	31.3%	25
None	1.3%	1
Other (please specify)	12.5%	10
	Answered question	80
	Skipped question	37

Q10 *When exercising on the Wii Fit do you feel you are mainly gaming or exercising?*

Answer Options	Response Percent	Response Count
Exercising (My focus is mainly on the muscles being used)	66.3%	53
Gaming (My focus is mainly on the game)	33.8%	27
	Answered question	80
	Skipped question	37

Q11 *Since using the Wii Fit do you feel any of the below? (Select all that apply)*

Answer Options	Response Percent	Response Count
Stronger	23.8%	19
Fitter	43.8%	35
Healthier	42.5%	34
The same	48.8%	39
Worse than started	2.5%	2
	Answered question	80
	Skipped question	37

Q12 *Before being able to exercise on the Wii Fit did you have to move your furniture?*

Answer Options	Response Percent	Response Count
Yes - It was a hassle	9.0%	7
Yes - But it was not a problem	32.1%	25
No	59.0%	46
	Answered question	78
	Skipped question	39

Q13 *When exercising on the Wii Fit, did you find yourself getting distracted resulting in a reduced*

workout? (E.g. phone calls, television, etc.)

Answer Options	Response Percent	Response Count
Yes - Often	6.4%	5
Yes - Occasionally	17.9%	14
Rarely	43.6%	34
No	32.1%	25
	Answered question	78
	Skipped question	39

Q14 *From your experience of using the Wii Fit, do you believe it is possible to become fitter using the*

Wii Fit?

Answer Options	Response Percent	Response Count
Yes - The device alone can improve my physical attributes	70.5%	55
No - The device cannot provide a high enough intensity to become fitter	29.5%	23
	Answered question	78
	Skipped question	39

Q15 *When using the Wii Fit did you incur any injuries?*

Answer Options	Response Percent	Response Count
Yes - Due to over repetition	5.1%	4
Yes - From falling	1.3%	1
No	85.9%	67
Yes - Other (please specify)	7.7%	6
	Answered question	78
	Skipped question	39

Q16 *The injuries you faced using the Wii Fit, were they preventable with proper instructions from a real instructor?*

Answer Options	Response Percent	Response Count
Definitely	0.0%	0
Possibly	7.7%	6
No	9.0%	7
N/A	83.3%	65
	Answered question	78
	Skipped question	39

Q17 *Since using the Wii Fit have you changed your diet?*

Answer Options	Response Percent	Response Count
More healthier	42.3%	33
Same diet	56.4%	44
Less healthier	1.3%	1
	Answered question	78
	Skipped question	39

Q18 *After a session on the Wii Fit do you feel you can reward yourself with a snack?*

Answer Options	Response Percent	Response Count
Yes	14.1%	11
No	85.9%	67
	Answered question	78
	Skipped question	39

Q19 *Do you exercise using other methods than the Wii Fit? (Select all that apply)*

Answer Options	Response Percent	Response Count
Gym	14.3%	11
Gym classes (Aerobics, Spin classes, Yoga, etc.)	5.2%	4
Sports	22.1%	17
Walk (Less than 15 minutes)	11.7%	9
Walk (More than 15 minutes)	59.7%	46
No	18.2%	14
	Answered question	77
	Skipped question	40

Q20 *How frequently do you exercise, excluding the Wii Fit?*

Answer Options	Response Percent	Response Count
Daily	18.2%	14
Several times a week	40.3%	31
Several times a month	11.7%	9
Rarely	23.4%	18
Never	6.5%	5
	Answered question	77
	Skipped question	40

Q20 *Has using the Wii Fit inspired you to undertake new activities, such as Football, Gym classes,*

Running, etc.?

Answer Options	Response Percent	Response Count
I am very active since using the Wii Fit	6.5%	5
I am slightly more active	26.0%	20
I am about the same	55.8%	43
I am less active	0.0%	0
I don't exercise	11.7%	9
	Answered question	77
	Skipped question	40

Q22 *Has using the Wii Fit replaced any physical activity you used to do?*

Answer Options	Response Percent	Response Count
Yes - I use the Wii Fit to replace my previous exercise	9.1%	7
No - The Wii Fit is used with my previous exercise	41.6%	32
No - The Wii Fit is not being used regularly	49.4%	38
	Answered question	77
	Skipped question	40