THE EFFECTS OF THE WII FIT PLUS ON BONE MINERAL DENSITY AND FLEXIBILITY IN ADULTS

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Master of Science

Nicholas T. Potenzini

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THE EFFECTS OF THE WII FIT PLUS ON BONE MINERAL DENSITY AND FLEXIBILITY IN ADULTS

Nicholas T. Potenzini

Thesis

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TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>LIST OF TABLES</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>v</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>vi</td>
</tr>
<tr>
<td>CHAPTER</td>
<td></td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>II. REVIEW OF LITERATURE</td>
<td>4</td>
</tr>
<tr>
<td>III. METHODS</td>
<td>8</td>
</tr>
<tr>
<td>Participants</td>
<td>8</td>
</tr>
<tr>
<td>Program Design</td>
<td>11</td>
</tr>
<tr>
<td>Statistical Design</td>
<td>13</td>
</tr>
<tr>
<td>IV. RESULTS</td>
<td>14</td>
</tr>
<tr>
<td>V. SUMMARY</td>
<td>18</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>21</td>
</tr>
<tr>
<td>APPENDICES</td>
<td>24</td>
</tr>
<tr>
<td>Appendix A. Human Subjects Approval Form</td>
<td>26</td>
</tr>
<tr>
<td>Appendix B. ZipFit Email</td>
<td>28</td>
</tr>
<tr>
<td>Appendix C. Informed Consent</td>
<td>31</td>
</tr>
<tr>
<td>Appendix D. Physical Activity Readiness Questionnaire (Par-Q)</td>
<td>35</td>
</tr>
</tbody>
</table>
Appendix E. Weekly Diet Questionnaire........................................37
Appendix F. Godin Leisure Time Physical Activity Questionnaire ............39
Appendix G. Exercise Logs ..................................................................41
Appendix H. Borg Scale......................................................................46
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Descriptive Statistics</td>
<td>15</td>
</tr>
<tr>
<td>2. Mean Difference in Dependent Variables</td>
<td>16</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pre and Post Sit and Reach Test Means</td>
<td>16</td>
</tr>
<tr>
<td>2. Pre and Post Bone Mineral Density T-Scores</td>
<td>17</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

By the year 2030 the number of individuals 65 years of age and older will be 70 million, this being the fastest growing segment of our population in the United States (Mazzeo et. al., 1998). Decreases in bone mineral density and flexibility are normal physiological changes that occur with aging. Physical inactivity can greatly exacerbate these changes thereby manifesting themselves earlier in life. With advances in technology, physical activity is becoming less and less of a necessity with sedentary lifestyles becoming more common (Hoeger, & Hoeger, 2008). The American College of Sports Medicine recommends that adults participate in 30 minutes of daily physical activity to aid in preventing the early manifestation of chronic conditions such as losses in bone mineral density (Mazzeo et. al., 1998)

Although more common among postmenopausal women, decreases in bone mineral density can occur in males as well (Hurley & Roth, 2000). Low bone mineral density can lead to osteoporotic bone fractures resulting in painful injuries (Martyn-St. James & Carroll, 2006). These painful injuries may result in decreased quality of life, making activities of daily living a struggle. However, with the inclusion of weight bearing activity, bone mineral density can be maintained especially in the female
population, greatly reducing the risk of osteoporotic fractures (Martyn-St. James, & Carroll, 2006).

It is well documented that a loss of flexibility and joint range of motion occurs with aging (Hurley, & Roth, 2000). With this loss of flexibility and joint mobility comes more difficulty performing activities of daily living such as walking up and down the stairs, sitting and standing from a chair, getting in and out of bed, often necessitating the use of a walking aid (Hurley, & Roth, 2000). With the incorporation of physical activity and regular stretching exercises, losses in flexibility can be delayed thereby increasing quality of life in the adult population and decreasing dependence on walking aids (Hurley, & Roth, 2000).

As previously discussed, research has demonstrated that regular physical activity has tremendous benefits on maintaining bone mineral density and joint range of motion. With the many obligations of life such as work and family responsibilities, finding time to exercise may be difficult for some individuals. However, if an alternative mode of exercise can be developed that is economical and time efficient, it may afford individuals the opportunity to receive an effective workout decreasing the risk of developing osteoporosis and decreased joint range of motion.

Within the past 5 years video game entertainment companies have been making significant strides in creating video game systems that involve physical activity. The Nintendo Wii was the first of these motion controlled video games. Following Nintendo’s
release of the Wii, Microsoft and Sony have since released their own interactive gaming add-ons to Xbox 360 and Playstation 3.

Research examining the physiological response of the Wii Fit in youth concludes that the exercise intensity of the Wii Fit is classified as light to moderate (3-6 METS) according to the American College of Sports Medicine’s Guidelines for Exercise Testing and Prescription (Williford, Gaston, Esco, & Olson 2010). Currently, no research exists examining the physiological responses of the adult population using this piece of equipment (Williford et. al., 2010). The American College of Sports Medicine strongly recommends that adults meet daily fitness requirements of at least thirty minutes to enjoy longer, healthier lives (Mazzeo et. al., 1998). Can the Wii Fit Plus be a viable alternative to meet physical activity guidelines resulting in a healthier aging process?

A dearth of research exists examining the effectiveness of the Wii Fit Plus as an alternative option for meeting daily physical activity requirements. We hypothesized that after an eight week exercise intervention using the Wii Fit Plus, increases in flexibility and bone mineral density will be observed.
CHAPTER II

REVIEW OF LITERATURE

This study was very unique not only because research on the Wii Fit Plus is still extremely new, but because bone mineral density has not yet been studied while flexibility has only briefly been studied by Odland, Adams, Woods, & Sears (2010).

Regular weight-bearing activity has been recommended for adult women to help to preserve bone mineral density (Pruitt, Taaffe, & Marcus, 1995). In a recent study conducted on post-menopausal women, it was found that high intensity resistance training was an effective means of preserving bone mineral density in this population (Pruitt et. al.,1995). However, not all women may be interested in resistance training and it might not be a practical means of proactive prevention against this condition. The above study used dual-energy X-ray absorptiometry (DEXA) to analyze bone mineral density. The current study used the QUS-2 Calcaneal Ultrasonometer (Mountainview, CA) to analyze bone mineral density. Dual X-ray absorptiometry uses X-ray technology to scan the entire body to gather information about bone mineral density. While the QUS-2 uses ultrasound technology to assess bone mineral density in the calcaneus to estimate bone mineral density. The calcaneus demonstrates similar
properties to the bones found in the hip and spine, where most osteoporotic fractures occur (Jenkins, 2001). Therefore, calcaneus bone strength measurements can be confidently used to portray the bone density found in alternate regions of the body. Additionally, in the adult population (≥ age 36) a mixture of impact exercises such as jumping and resistance training elicited the best results (Guadalupe-Grau, Fuentes, Guerra, & Calbet, 2009).

Osteoporosis affects primarily women; few studies exist on examining the effectiveness of exercise to preserve bone density on men (Looker et. al., 1997). One study suggests that a mixture of resistance training and aerobic activity appears to be the most effective in maintaining bone mineral density in older males (Guadalupe-Grau et. al., 2009).

A study of 32 healthy women aged 60 to 72, completed 2 months of flexibility training followed by 9 months of structured weight-bearing activity. Increases seen in bone mineral density in the exercise group were significantly greater than changes to the control group in the lumbar spine, femoral neck, trochanter, and Ward’s angle (Kohrt, Snead, Slatpolsky, & Birge, 1995). Little research exists examining the effects of exercise using the Wii Fit Plus as a means of increasing flexibility. In a recent study by Rogers, Slimmer, Amini, & Park (2010), it was concluded that the original Nintendo Wii Fit did not have a significant effect on flexibility of older adults. However, it is important to note that this study was completed using the Nintendo Wii Fit and not the Nintendo Wii Fit Plus.
Another study suggests that as long as exercises are performed through a full range of motion and both agonist and antagonist muscle groups are utilized, strength training can improve overall flexibility (Hurley, & Roth, 2000). There are many other ways to improve overall flexibility; one of those ways is by performing various yoga activities (Ryba, 2006). Yoga is an ancient Indian practice of exercises that utilize different poses, postures, breathing exercises and meditation techniques. Yoga is becoming widely used in training because of its benefits in core stability, flexibility, joint range of motion and relaxation (Ryba, 2006)

Considering the aforementioned findings, it is important to also know that the study of effectiveness of active video games has also been increasingly popular in recent years. Rogers et al. (2010) compared the Wii Fit to a traditional exercise program with older adults. The study concluded that the Wii Fit appears to be an effective exercise tool especially for improving balance. However, investigators noted that further research is needed to validate other components of physical fitness. The study was limited to overweight sedentary females. Additional research is warranted examining the effectiveness on both genders, lean and overweight and individuals of differing ages.

Since the Wii Fit Plus is the newest in the line of Nintendo Wii exercise games, it was interesting to see if the new additions to the series were able to elicit a positive response in these components of physical fitness.

We were hoping that by combining flexibility and strength training together in our protocol we would be able to see similar, if not more improved results in
our adult population similar to the previous studies discussed above. The current study was among the first not only to analyze the Wii Fit Plus, but also among the first to analyze the chronic effects of exercise using the Wii Fit Plus system.
CHAPTER III

METHODS

This study was approved by The University of Akron Institutional Review Board for the Protection of Human Subjects (IRB) (Appendix A). A paucity of information exists regarding the effectiveness of the Wii Fit Plus on physical fitness. The aim of this study was to build on current knowledge and examine the effects of the Wii Fit Plus on bone mineral density and flexibility in an adult population.

Research Hypothesis: The experimental population will exhibit gains in flexibility and overall bone mineral density after the eight week exercise program using the Wii Fit Plus.

Participants: Participants were recruited via email (Appendix B) from individuals participating in the University of Akron program called ZipFit. Twenty-Eight individuals, males (n= 4) and females (n= 24), ages 40-63 years old, participated in the study. Volunteers were excluded from the study if they had contraindications to exercise, orthopedic injuries, or were unable to commit to the time frame of the study. The participants were informed of the risks and benefits of the study prior to signing the informed consent (Appendix C). Participants were disqualified from the study if they
missed three or more sessions. The participants were given a Physical Activity Readiness Questionnaire (PAR-Q) (Appendix D) to assess if they were physically able to perform exercise or if they would need to have a physician’s release to participate in the study. A Weekly Dietary Form (Appendix E), created by the study investigators was used to monitor the diets of the participants to ensure that they were not consuming excessive amounts of calcium during the study which could affect the bone mineral density results. The log consisted of a check list of calcium rich foods and an area to record servings of each food item eaten. The form also contained questions regarding dietary supplements and medications.

The participants were randomly placed into either the control group (n=14) or the experimental group (n=14). The study coordinators stratified the randomly selected exercise group by analyzing the Godin Leisure-Time Activity Form (Godin & Shepard, 1995) (Appendix F). This form was a gauge of participant physical activity levels prior to the study. Study coordinators paired an active participant with another active participant and then randomly selected one to be in the control group and one to be in the exercise group. The same process was completed with sedentary participants. Both of these groups underwent pre and post testing on the dependent variables: bone density and flexibility. However, only the experimental group completed the exercise protocol.

Bone mineral density was measured using the QUS-2 Calcaneal Ultrasoundometer (Mountainview, CA). The QUS-2 uses ultrasound technology to measure and determine the bone strength in the calcaneus. This was assessed by placing
ultrasound gel on both the lateral and medial sides of the ankle and placing the foot between the two ultrasound arms of the machine. The calcaneus demonstrates similar properties to the bones found in the hip and spine, where most osteoporotic fractures occur (Jenkins, 2001). Therefore, calcaneus bone strength measurements can be confidently used to portray the bone density found in alternate regions of the body. The results were given in a T-Score, this is a measure of how different heel bone mass is from the average young, healthy person. If the bone density is similar to a young healthy person, a T-Score of near zero will be expected. If the bone mass was lower it would have a minus sign (-). A T-Score that is above -1 was considered normal. Lower than -1 indicates there is a risk for fractures (National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), 2009).

The YMCA Sit and Reach test is a relatively simple method for measuring an individual’s flexibility. This test evaluates the flexibility of the hamstrings, lower back and hips as well as the hamstring and shoulder muscle groups. This test was performed by instructing the participant to sit on the ground with their shoes off on both feet with both legs completely straight. The participant would then slide their feet to touch the back of the Sit and Reach Box (measuring apparatus). After they were in position they were instructed to extend both arms and overlap their hands to push the measuring dial on the box as far forward as possible. Participants were each given three trials and the best result of the three trials was recorded. The results were recorded in inches (Tsang, & Mak, 2004).
Program Design: The study was performed over a 10 week period. During weeks 1 and 10 pre- and post exercise dependent variables were collected. During weeks 2-9 the experimental group exercised using the Wii Fit Plus. The participants in the experimental group were split into smaller groups that exercised on Monday and Wednesday (Group 1) or Tuesday and Thursday (Group 2) depending on their availability. The protocol consisted of strength training, cardiovascular training, flexibility training and balance games. The two experimental groups performed the same exercise protocol, just on different days of the week. The control group did not participate in the exercise intervention. Both the experimental and control groups were encouraged to maintain their current activities of daily living including physical activity and diet outside of the study.

For the exercise intervention, the first day of each week consisted of a 5 minute warm-up and followed by 15 minutes of yoga and 15 minutes of strength training exercise. The second day consisted of a 5 minute warm-up followed by 15 minutes of aerobic training followed by 15 minutes of balance games. An exercise log was provided to participants to record their workouts (Appendix G).

During the experimental group exercise days, multiple variables were recorded. Following each segment (warm-up, yoga/aerobics, strength training/balance, cool down) the investigators recorded participants Rate of Perceived Exertion (RPE) and heart rate. RPE is a valuable indicator for monitoring an individual’s exercise tolerance. The scale that was used in this study was the Borg Scale (Appendix H). The Borg Scale
was developed to allow the exerciser to subjectively rate his or her feelings during exercise, taking into account personal fitness level, environmental conditions, and general fatigue levels (Dunbar et al., 1992). Heart rate was measured to validate the RPE number given by the participant to ensure that intensity did not become exceedingly intense.

On the second exercise day each week participants were required to complete a Godin-Leisure-Time Physical Activity and a Weekly Diet Form. These variables were recorded because they were not controlled by the study investigators and needed to be monitored to establish if any improvements observed were from the Wii Fit Plus protocol or might be influenced by diet or additional physical activity performed. The control group was encouraged to continue with their normal daily activities and instructed to return for the post-testing in week ten.

Time spent in each of the Wii Fit Plus exercise categories was constant throughout the duration of the study. The exercises that were performed by the participants were selected by the study coordinators. For the initial two weeks the exercises were relatively simple and were chosen in order to allow participants to become familiar with the Wii Fit Plus controls and interface. After observing the participants, comparing RPE results, and reviewing exercise heart rate levels, the study coordinators slightly modified the exercise selections bi-weekly for all participants in order to increase the intensity of exercise to compensate for physiological adaptations. This was performed to ensure that the exercises would progressively become more intense as the study
progressed. Different aerobic activities were chosen on a bi-weekly basis for warm up and cool down, however, all warm up and cool down activities required users to perform the same total body motions as the “Basic Run” activity. The “Basic Run” is an aerobic game included in the Wii Fit Plus. This game simulates running while having the participant jog in place while holding the motion sensor game remote. Participants were instructed to work at self-determined intensity levels following directions given by the game.

The data from one member of the exercise group was not considered due to lack of attendance. There were also two members from the control group who were unable to attend post-testing and were not measured due to time constraints. Data from the remaining control (n=12) and exercise (n =13) participants were analyzed.

**Statistical Design:** Pre-Post test, quasi-experimental design. Pre-Post test differences between and within groups over time were analyzed using an Independent Sample T-test as well as a Repeated Measures ANOVA with SPSS V.18.0 software. Significance was set *a priori* at $p < 0.05$.  

13
CHAPTER IV
RESULTS

The purpose of the present investigation was to analyze the effects of an eight week exercise protocol using the Nintendo Wii Fit Plus and how it affects flexibility and bone mineral density. Participants were stratified by using the Godin Leisure Time Physical Activity Form as being either active or sedentary. The exercise group participated in the eight week Wii Fit Plus protocol, while the control group was encouraged to continue on with their normal activities of daily living. Pre and post intervention assessments were collected for bone mineral density and flexibility.

Participants consisted of twenty-five male \((n = 3)\) and female \((n = 22)\) with a mean age of \(51.6 \pm 5.9\) years old. The exercise group consisted of 2 males and 11 females, while the control group consisted of 1 male and 11 females. No significant differences were observed between groups regarding participant’s age \(F (1, 23) = 2.78, p= 0.11\), gender \(F (1, 23) = 0.27, p= 0.61\) and activity level \(F (1,23)= 0.00, p = 1.00\). Descriptive statistics are presented in Table 1.
Table 1 *Descriptive Statistics*

<table>
<thead>
<tr>
<th>Group</th>
<th>Flexibility (Inches)</th>
<th>Bone Density (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Control</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>Control</td>
<td>16</td>
<td>14.5</td>
</tr>
<tr>
<td>Control</td>
<td>18</td>
<td>17.5</td>
</tr>
<tr>
<td>Control</td>
<td>18</td>
<td>18.75</td>
</tr>
<tr>
<td>Control</td>
<td>16</td>
<td>15.5</td>
</tr>
<tr>
<td>Control</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Control</td>
<td>16.75</td>
<td>17.75</td>
</tr>
<tr>
<td>Control</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Control</td>
<td>15.25</td>
<td>18</td>
</tr>
<tr>
<td>Control</td>
<td>17.5</td>
<td>17.75</td>
</tr>
<tr>
<td>Control</td>
<td>10.5</td>
<td>14</td>
</tr>
<tr>
<td>WiiFit Plus</td>
<td>20</td>
<td>21</td>
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<tr>
<td>WiiFit Plus</td>
<td>16.75</td>
<td>18.5</td>
</tr>
<tr>
<td>WiiFit Plus</td>
<td>11</td>
<td>10.75</td>
</tr>
<tr>
<td>WiiFit Plus</td>
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<tr>
<td>WiiFit Plus</td>
<td>0</td>
<td>11.75</td>
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</table>

Independent samples *t*-tests were conducted to evaluate the differences in bone mineral density and flexibility from week one to week ten between the control group and exercise group. The post-test changes are presented in Table 2. No significant differences in flexibility *t* (23) = -0.65, *p* = 0.52, were observed between groups although the exercise group did exhibit a mean increase nearly two times as large as the control group.
No significant differences in bone mineral density $t(23) = 1.67, p = 0.11$, were observed between groups.

Table 2 *Mean Difference in Dependent Variables*

<table>
<thead>
<tr>
<th>Group</th>
<th>Sit &amp; Reach (in)</th>
<th>Bone Mineral Density (t-score)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise</td>
<td>1.62 ± 3.14</td>
<td>-0.30 ± 0.71</td>
</tr>
<tr>
<td>Control</td>
<td>0.98 ± 1.27</td>
<td>0.34 ± 1.17</td>
</tr>
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</table>

Repeated measures ANOVA revealed no significant main or interaction effects for flexibility $p \geq 0.06$, or bone mineral density $p \geq 0.11$.

*Figure 1* Pre and Post Sit and Reach Test Means
Figure 2 Pre and Post Bone Mineral Density T-Scores
The purpose of this study was to examine the effects of an eight week, two sessions per week, Wii Fit Plus exercise program on bone mineral density and flexibility. Results show that no significant changes were observed between the control and exercise group. The most likely cause of this is the small sample size. Also, the study was only performed for eight weeks total, which may not be long enough to see significant changes in flexibility and bone density.

The participants performed the exercise protocol two days per week. However, they only performed the categories of strength training, aerobic training, yoga, and balance games one time per week each because Day 1 consisted of yoga and strength training and Day 2 consisted of balance games and aerobic training. Flexibility exercises should be incorporated into the overall fitness program sufficient to develop and maintain range of motion (ROM). These exercises should stretch the major muscle groups and be performed a minimum of 2-3 days per week. Stretching should include appropriate static and/or dynamic techniques (Pollock et. al., 1998). Due time constraints, the protocol did not meet the American College of Sports Medicine recommendations for flexibility.
training of minimum of two days per week.

Eleven females and only two males participated in the exercise group. While bone mineral density and osteoporosis mainly affect women, as men age, losses in bone mineral density can still become a health concern (Looker et. al., 1997). It would be beneficial for future research to study specifically how bone mineral density is affected in male participants using the Wii Fit Plus.

When looking at the overall results for bone mineral density and flexibility, the Wii Fit Plus can be a beneficial addition to regular exercise, but does not appear to be effective as a sole means of exercise when looking to significantly improve flexibility and bone mineral density. While the increases in flexibility were not statistically significant, that does not mean that the increases observed were not beneficial to the participants. Any gain in flexibility is always beneficial especially as one begins to age, because of the natural loss of flexibility over time (Hurley and Roth, 2000). If future research can continue to show any consistent improvements in flexibility the Wii Fit Plus could be a beneficial rehabilitation tool in clinical settings.

Participants in the study frequently mentioned how the Wii Fit Plus was an entertaining and more enjoyable way to exercise. Many participants also mentioned that they would be purchasing a Nintendo Wii and the Wii Fit Plus to continue with the program even after the study was completed. Positive benefits were observed in the exercise group when compared to the control group, additionally, this study motivated
participants to begin exercising again and to help them continue exercising even after the study was completed.

Based on the results of the current study, the following recommendations are made for future research:

1. Increase the duration and frequency of the exercise protocol to enhance physiological benefits of exercise.
2. Include more males in the study to more accurately identify increases or decreases in bone mineral density.
3. Compare the exercise response of sedentary individuals to physically active individuals to observe who elicits the greater benefits.
REFERENCES


APPENDIX A

HUMAN SUBJECTS APPROVAL FORM
NOTICE OF APPROVAL

November 30, 2010

Brandon Pollock
876 Mt. Pleasant Road
Clinton, Ohio 44416

From: Sharon McWhorter, IRB Administrator

Re: IRB Number 20101111 “Physiological Effects and Practicality of the Wii Fit Plus as an Exercise Program for Adults”

Thank you for submitting an IRB Application for Review of Research Involving Human Subjects for the referenced project. Your protocol represents minimal risk to subjects and has been approved under Expedited Categories #4/7.

Approval Date: November 29, 2010
Expiration Date: November 29, 2011
Continuation Application Due: November 15, 2011

In addition, the following is/are approved:

- Waiver of documentation of consent
- Waiver or alteration of consent
- Research involving children
- Research Involving prisoners

Please adhere to the following IRB policies:

- IRB approval is given for no more than 12 months. If your project will be active for longer than one year, it is your responsibility to submit a continuation application prior to the expiration date. We request submission two weeks prior to expiration to ensure sufficient time for review.
- A copy of the approved consent form must be submitted with any continuation application.
- If you plan to make any changes to the approved protocol you must submit a continuation application for change and it must be approved by the IRB before being implemented.
- Any adverse reactions/incidents must be reported immediately to the IRB.
- If this research is being conducted for a master’s thesis or doctoral dissertation, you must file a copy of this letter with the thesis or dissertation.
- When your project terminates you must submit a Final Report Form in order to close your IRB file.

Additional information and all IRB forms can be accessed on the IRB website at:
http://www.uakron.edu/research/crssp/compliance/IRBHome.php

Cc: Judith A. Juwancic-Heltzel - Advisor
Cc: Renee DeSalvo/Nick Ponzinini - Co PI’s
Cc: Stephanie Woods - IRB Chair

Approved consent form/s enclosed

Office of Research Services and Sponsored Programs
Akron, OH 44325-2102
330-972-7066 • 330-972-6281 Fax

The University of Akron is an Equal Education and Employment Institution

26
Greetings participants of ZipFit!

The graduate assistants in UA’s Sport Science and Wellness Education Department in coordination with Student Recreation and Wellness Services (SRWS), who sponsor ZipFit, are seeking your help to identify individuals such as yourself who have been part of ZipFit and may be interested in participating in a study involving the Nintendo Wii Fit Plus interactive game system. The study is going to be used as a Master’s Thesis for three graduate assistants in the Sport Science and Wellness Department. The Wii Fit Plus is an exciting new follow-up to the original Wii Fit released in 2009. The Wii Fit Plus is a video game system that makes exercise fun! Players will use a combination of the Wii’s joysticks and balance board as a means to exercise, while at the same time enjoying the fun on-screen aspects of a video game. Currently, little research exists pertaining to the Wii Fit Plus, so participants will be among the first to study the fun and fitness capabilities of the Wii Fit Plus.

For more information regarding the Nintendo Wii Fit Plus, please visit: http://www.wiifit.com/

The Wii Fit Plus Study:

The purpose of the study is to evaluate the WiiFit Plus as a practical alternative to traditional exercise. The study will begin the week of January 3rd, 2011 and progress through early March (10 Weeks). The intensity of exercise associated with the Wii Fit Plus is light. All qualifying participants will be given 2 FREE assessments from SSWE graduate assistants at InfoCision Stadium 407 (once at the beginning and once at the end of the study). The tests will be conducted using advanced laboratory equipment. Note that these tests will provide you will valuable information regarding your overall health and risk factors for related conditions/diseases. Here is a list of the tests that you will be receiving:

- Body Composition
- Resting Blood Pressure
- Leg Strength
- Balance Capability
- Flexibility
- Bone Density

Participant Qualifications:

In order to participate in the study, individuals must meet the following criteria:

- Aged 45 or above.
- Have no contraindications to exercise such as diagnosed heart disease, osteoporosis, osteopenia, uncontrolled metabolic disease, neuromuscular disease, current musculoskeletal or rheumatoid disorders that are exacerbated by exercise.
- Can commit just 40 minutes a day, two scheduled days a week (Further details below).

Upon admittance into the study you will be required to sign an informed consent form, a Physical Activity Readiness Questionnaire (PAR-Q), Godin Leisure Time Physical Activity Questionnaire and a weekly dietary log. Participants will be placed into the experimental (exercise) group or the control group.
During weeks one and ten both groups will have the following assessed: body composition, resting blood pressure, balance, leg strength, flexibility and bone mineral density.

If you are in the experimental group you will then be assigned to either a Monday / Wednesday group or a Tuesday / Thursday group. During weeks 2 – 9 participants in the experimental group will report to the 4th floor of InfoCision Stadium and participate in 40 minutes of Wii Fit Plus activity on your assigned days. We will try to accommodate your schedules. During week 10, the experimental group will have repeat measurements of the six variables. If you are assigned to the control group, the following will be measured during weeks one and ten: body composition, resting blood pressure, balance, leg strength, flexibility and bone mineral density. The control group will not participate in the Wii Fit Plus protocol during weeks 2 – 9.

**Participants in both groups are PERMITTED to continue normal daily activities including regular exercise or physical activity. NO dietary or exercise restrictions will be imposed.**

**The Schedule:**
- **Week 1:** January 3rd 2011. (Pre-test data collection for both groups)
- **Week 2:** January 10th 2011.
- **Week 3:** January 17th 2011.
- **Week 4:** January 24th 2011.
- **Week 5:** January 31st 2011.
- **Week 6:** February 7th 2011.
- **Week 7:** February 14th 2011.
- **Week 8:** February 21st 2011.
- **Week 9:** February 28th 2011.
- **Week 10:** March 7th 2011. (Post-test results collection for both groups)

**Selection:**
- The Wii Fit Plus study has IRB approval and is currently enrolling qualifying participants. Study participation is limited; participants will be recruited on a first-come first serve basis. The study requires 40 participants (20 per group). We will be taking the names of the first 60 individuals who contact us; the first 40 individuals who qualify for the study will be contacted with further information.

What a great way to start the New Year! If you are interested please contact:

Brandon Pollock     bsp12@zips.uakron.edu     330 – 575 – 9348

‘Wii’ would love your help, and thank you!
APPENDIX C

INFORMED CONSENT
Informed Consent Form – Wii Fit Plus Study

Title of Study: “Physiological Effects and Practicality of the Wii Fit Plus as an Exercise Program for Adults”

Introduction: Welcome to the Wii Fit Plus Study conducted by graduate assistants of the Sport Science and Wellness Department!

Purpose: The purpose of the study is to determine if the Wii Fit Plus can be used to show improvements in the fitness of an adult population following a 10-week exercise program.

Procedure: You will be assigned to either the exercise group or the control group. On your initial visit we will perform a variety of tests to obtain baseline information so that we will be able to compare the results from before the exercise protocol to the results after the exercise protocol. Upon arriving at the laboratory, your body composition will be assessed using a tool called the BOD POD. This machine is very simple and uses air displacement to estimate body composition. Once inside the Body composition machine you will be sitting for two short 45 second tests as motionless as you can sit. Blood pressure will be assessed just like in a doctor’s office using sphygmomanometer and stethoscope on your arm. Flexibility will be assessed using a test called the Sit-and-Reach. All you will be doing is simply sitting on the ground and placing your feet up against the back of the equipment with you knees in a locked position you will bend forward at the waist moving a metal piece forward as far as you can to measure flexibility. Bone mineral density will be measured using the QUS-2 Calcaneal Ultrasonometer. The QUS-2 uses ultrasound technology to measure and determine the bone strength in the calcaneus (heel bone). Leg strength will be measured using the Biodex Multi-Joint System Pro; static contractions of the lower leg will be performed. Balance will be measured using the Biodex Balance System SD. You will be asked to perform the designated test while stabilizing yourself on a balance plate. The balance plate is an unstable surface and there will always be a technician and a balance bar in case you experience loss of balance and added support is needed. Strength and balance will be assessed by qualified technicians. These measurements will be assessed during Week 1 and Week 10 of the program. If you are assigned to the experimental group, you will complete two 30 minute exercise sessions per week (Group 1 will be Monday/Wednesday and Group 2 will be Tuesday/Thursday). If you are assigned to the control group, you will not be performing the exercise sessions. You will be permitted to continue your regular exercise and daily activities outside of the study. If you are in the exercise group you may continue your regular exercises in addition to the Wii Fit Plus.

You are eligible for this study if you are ≥ age 45, have no contraindications to exercise testing such as heart disease, uncontrolled metabolic disease, neuromuscular, current musculoskeletal, or rheumatoid disorders that are exacerbated by exercise. Additionally you must be able to commit just 30 minutes a day, two scheduled days a week. You will also be required to complete a Par-Q and Godin Leisure Time questionnaire. The Par-Q is
simply used for assessing your ability to participate in physically demanding activities. The Godin Leisure Time questionnaire is used for determining your current physical activity level.

Risk and Discomfort:
If at anytime you feel uncomfortable while having your body composition measured let us know, we will take all the steps possible to ensure your comfort in this process. Minimal, skin tight clothing is required while undergoing the Body composition protocol. This will occur twice throughout the study (week one and week ten). You may also feel a little discomfort if you are uncomfortable in small spaces. There is a small risk for muscle soreness or muscular injury with flexibility testing and strength testing, if the test is not performed correctly. With proper instruction, injury is unlikely. Both tests take place during week one and week ten of the study.

When testing for bone mineral density you will be at no risk for any injury of any kind. This is primarily because you will be in a sitting position for the duration while a machine takes ultrasound measurements of your ankle.

The Wii Fit Plus exercise protocol poses a small risk of injury among the experimental population. You may experience muscular soreness or muscle injury. The chance of injury is unlikely considering the exercise intensity associated with the Wii Fit Plus is low.

Benefits: Information will be gathered about your flexibility, bone mineral density, strength, balance, body composition, and blood pressure. These variables are very important for maintaining a healthy lifestyle. These components are especially important in the adult population to diagnose risks for specific conditions such as: osteoporosis, cardiovascular disease and orthopedic injuries of the lower body. If you are planning to begin an exercise program these components are also helpful to establish a baseline and help you identify areas that need improvement.

Payments for Participation: There will be no payment for participation.

Right to refuse or withdraw: You may withdraw from the study at any time. There is no penalty if you decide to withdraw.

Anonymous and Confidential Data Collection: Data will be password protected and stored / accessed electronically only by the study investigators. Any hardcopy form of data such as measurement print-outs will be stored in a locked cabinet in Infocision Stadium, 307J. Only the study investigators have access to this information.

Confidentiality of records: Your records will be password protected and stored / accessed electronically only by the study investigators. Any hardcopy form of your records will be stored in a locked cabinet in Infocision Stadium, 307J. Only the study investigators have access to this information.
If you agree to have your information used as part of the research data, you will be asked to sign this informed consent document.

Who to contact with questions: If you have any questions at any time, you may contact any of the following:

Brandon Pollock: (330) – 575 – 9348 or bsp12@zips.uakron.edu

Renee DeSalvo:  (440) – 781 – 1689 or rmd18@zips.uakron.edu

Nick Potenzini:  (740) – 317 – 5250 or ntp2@zips.uakron.edu

This study has been reviewed and approved by The University of Akron Institutional Review Board (IRB). If you have any questions about your rights as a research participant, you may call the IRB at (330) 972-7666 or 1-888-232-8790.

I have read the information provided above and all of my questions have been answered. I voluntarily agree to participate in this study. I will receive a copy of this consent form for my information.

Signature: __________________________           Date:______________________

Witness: __________________________           Date: ______________________
APPENDIX D

PHYSICAL ACTIVITY READINESS QUESTIONNAIRE

(PAR-Q)
Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their physician before they start becoming more physically active. Please complete this form as accurately and completely as possible.

PAR-Q FORM Please mark YES or No to the following: YES NO
Has your doctor ever said that you have a heart condition and recommended only medically supervised physical activity? ____ ____
Do you frequently have pains in your chest when you perform physical activity? ____ __
Have you had chest pain when you were not doing physical activity? ____ ____
Have you had a stroke? ____ ____
Do you lose your balance due to dizziness or do you ever lose consciousness? ____ ____
Do you have a bone, joint or any other health problem that causes you pain or limitations that must be addressed when developing an exercise program (i.e. diabetes, osteoporosis, high blood pressure, high cholesterol, arthritis, anorexia, bulimia, anemia, epilepsy, respiratory ailments, back problems, etc.)? ____ ____
Are you pregnant now or have given birth within the last 6 months? ____ ____
Do you have asthma or exercise induced asthma? ______
Do you have low blood sugar levels (hypoglycemia)? ____ ____
Do you have diabetes? ____ ____
Have you had a recent surgery? ____ ____
If you have marked YES to any of the above, please elaborate below:
________________________________________________________________________
________________________________________________________________________
______________________________

Do you take any medications, either prescription or non-prescription, on a regular basis? Yes/No
What is the medication for?
How does this medication affect your ability to exercise or achieve your fitness goals?
________________________________________________________________________
________________________________________________________________________
___________________________

Please note: If your health changes such that you could then answer YES to any of the above questions, tell your trainer/coach. Ask whether you should change your physical activity plan.
I have read, understood, and completed the questionnaire. Any questions I had were answered to my full satisfaction.
Print Name: _________________________________
Signature: _____________________________________
Date: _________________________________
Weekly Dietary Questionnaire

Participant Number: __________________________ Date: ___________________

Check any of the following foods if they have been consumed in the past week:

<table>
<thead>
<tr>
<th>Foods (Include servings for all checked foods)</th>
<th>Servings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skim Milk</td>
<td></td>
</tr>
<tr>
<td>Whole Milk</td>
<td></td>
</tr>
<tr>
<td>Ice Cream</td>
<td></td>
</tr>
<tr>
<td>Feta Cheese</td>
<td></td>
</tr>
<tr>
<td>Tofu</td>
<td></td>
</tr>
<tr>
<td>Soy Beans</td>
<td></td>
</tr>
<tr>
<td>Instant Oats</td>
<td></td>
</tr>
<tr>
<td>Roasted Almonds</td>
<td></td>
</tr>
<tr>
<td>Almond Butter</td>
<td></td>
</tr>
<tr>
<td>Broccoli</td>
<td></td>
</tr>
<tr>
<td>Orange Juice</td>
<td></td>
</tr>
<tr>
<td>Sardines</td>
<td></td>
</tr>
<tr>
<td>Lasagna</td>
<td></td>
</tr>
<tr>
<td>Pizza w/cheese</td>
<td></td>
</tr>
<tr>
<td>Yogurt</td>
<td></td>
</tr>
</tbody>
</table>

Do you take a multivitamin or calcium supplement?  
Yes / No

If you circled yes, please list the brand(s) and amount per day.

__________________________________________________________________

Has your diet undergone any dramatic changes within the past week?  
(Such as: deciding to become a vegetarian, consuming an unusually high / low amount of food relative to a typical week (maybe an eating contest), become ill or injured restricting nutritional capabilities, restricting any macronutrient (carbohydrate, fat, protein), starting a diet plan, etc.)

Yes / No

If you circled yes, please provide a brief explanation with regards to how:
APPENDIX F

GODIN LEISURE TIME PHYSICAL ACTIVITY FORM
Godin Leisure Time Physical Activity Questionnaire

Considering a 7-Day Period (a week), how many times on the average do you do the following kinds of exercise for more than 15 minutes during your free time? (Write on each line the approximate number)

<table>
<thead>
<tr>
<th>Times Per Week</th>
<th>1. Strenuous Exercise</th>
<th>2. Moderate Exercise</th>
<th>3. Mild Exercise</th>
<th>4. Considering a 7-Day period, during your leisure-time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a. (Heart beats rapidly)</td>
<td>a. (Not Exhausting)</td>
<td>a. (Minimal Effort)</td>
<td>a. Often &lt;br&gt;b. Sometimes &lt;br&gt;c. Never/Rarely</td>
</tr>
<tr>
<td></td>
<td>b. Examples: running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling</td>
<td>b. Examples: fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing</td>
<td>b. Examples: yoga, archery, fishing from river band, bowling, horseshoes, golf, snow-mobiling, easy walking</td>
<td></td>
</tr>
</tbody>
</table>
Exercise Log (Weeks 2 – 3)

<table>
<thead>
<tr>
<th>Exercise Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
</tr>
<tr>
<td>Warm Up (5 Minutes)</td>
</tr>
<tr>
<td>Monday / Tuesday</td>
</tr>
<tr>
<td>5 Minutes of ‘Basic Run’ Activity.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exercise Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
</tr>
<tr>
<td>Warm Up (5 Minutes)</td>
</tr>
<tr>
<td>Wednesday / Thursday</td>
</tr>
<tr>
<td>5 Minutes of ‘Basic Run’ Activity.</td>
</tr>
</tbody>
</table>

Instructions:
- Perform each Wii Fit Plus activity to the best of your ability.
- You MUST spend the noted time limit performing each specific category of exercises. Study conductors will be monitoring time.
- If you happen to finish the list of exercises in a certain category before the required time limit, you should continue to exercise until the study conductor notifies you that time has been reached. At this point you may choose what exercises you wish to perform, however they must fall under your current exercise category.
Exercise Log (Weeks 4 – 5)

<table>
<thead>
<tr>
<th>Exercise Category</th>
<th>Day</th>
<th>Warm Up (5 Minutes)</th>
<th>Yoga (15 Minutes)</th>
<th>Strength Training (15 Minutes)</th>
<th>Cool Down (5 Minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise Category</td>
<td>Wednesday / Thursday</td>
<td>5 Minutes of ‘FREE RUN’ Activity.</td>
<td>1) Rhythm Kung Fu (1 round) 2) Advanced Island Cycling (Get as many flags possible in 5 minutes) 3) Rhythm Boxing (1 round)</td>
<td>1) Segway Circuit (1 round) 2) Tilt City (1 round) 3) Table Tilt Plus (5 minutes) 4) Tightrope Walk (5 Minutes)</td>
<td>5 Minutes of ‘FREE RUN’ Activity.</td>
</tr>
</tbody>
</table>

*Instructions:*
- Perform each Wii Fit Plus activity to the best of your ability.
- You MUST spend the noted time limit performing each specific category of exercises. Study conductors will be monitoring time.
- If you happen to finish the list of exercises in a certain category before the required time limit, you should continue to exercise until the study conductor notifies you that time has been reached. At this point you may choose what exercises you wish to perform, however they must fall under your current exercise category.
### Exercise Log (Weeks 6 – 7)

<table>
<thead>
<tr>
<th>Exercise Category</th>
<th>Day</th>
<th>Warm Up (5 Minutes)</th>
<th>Yoga (15 Minutes)</th>
<th>Strength Training (15 Minutes)</th>
<th>Cool Down (5 Minutes)</th>
</tr>
</thead>
</table>
|                   | Monday / Tuesday | 5 Minutes of Obstacle Course Activity. | 1) Sun Salutation Pose  
2) Chair  
3) The Warrior’s Pose  
4) Standing Knee Pose  
5) The Tree Pose  
6) Sun Salutation Pose | 1) Torso Twists (6 REPS)  
2) Lunge (15 PER LEG)  
3) Side Lunge (15 PER LEG)  
4) Single-Leg Twists (20 PER LEG)  
5) Plank | 5 Minutes of Obstacle Course Activity. |

<table>
<thead>
<tr>
<th>Exercise Category</th>
<th>Day</th>
<th>Warm Up (5 Minutes)</th>
<th>Aerobics (15 Minutes)</th>
<th>Balance (15 Minutes)</th>
<th>Cool Down (5 Minutes)</th>
</tr>
</thead>
</table>
|                   | Wednesday / Thursday | 5 Minutes of Obstacle Course Activity. | 1) Birds Eye Bulls Eye (ADVANCED setting)  
2) Rhythm Kung Fu (ADVANCED setting)  
3) Rhythm Boxing (ADVANCED setting)  
4) Island Cycling (ADVANCED setting) | 1) Big Top Juggling (2 ROUNDS)  
2) Penguin Slide (2 ROUNDS)  
3) Tilt City (ADVANCED SETTING – 2 ROUNDS)  
4) Table Tilt Plus | 5 Minutes of Obstacle Course Activity. |
# Exercise Log (Weeks 8 – 9)

<table>
<thead>
<tr>
<th>Exercise Category</th>
<th>Day</th>
<th>Warm Up (5 Minutes)</th>
<th>Yoga (15 Minutes)</th>
<th>Strength Training (15 Minutes)</th>
<th>Cool Down (5 Minutes)</th>
</tr>
</thead>
</table>
|                   | Monday / Tuesday | 1 Round Rhythm Parade. 2 Minutes Island Cycling (Advanced). | 1) Cobra  
2) Spine Extension  
3) The Warrior’s Pose  
4) Gate  
5) The Tree Pose  
6) Sun Salutation Pose | 1) Torso Twists (6 REPS)  
2) Arm and Leg Lift (10 REPS)  
3) Side Lunge (15 PER LEG)  
4) Single-Leg Twists (20 PER LEG)  
5) Plank | 1 Round Rhythm Parade. 2 Minutes Basic Run. |

<table>
<thead>
<tr>
<th>Exercise Category</th>
<th>Day</th>
<th>Warm Up (5 Minutes)</th>
<th>Aerobics (15 Minutes)</th>
<th>Balance (15 Minutes)</th>
<th>Cool Down (5 Minutes)</th>
</tr>
</thead>
</table>
|                   | Wednesday / Thursday | 1 Round Rhythm Parade. 2 Minutes Island Cycling (Advanced). | 1) 5 Minutes Obstacle Course. (ADVANCED setting)  
2) 2 Rounds Rhythm Kung Fu (ADVANCED setting)  
3) Super Hula Hoop. (ADVANCED setting) | 1) 5 Minutes Bubble Balance Plus.  
2) 2 Rounds Penguin Slide.  
3) 1 Round Big Top Juggling. (ADVANCED setting)  
4) Table Tilt Plus. | 1 Round Rhythm Parade. 2 Minutes Basic Run. |
APPENDIX H

BORG SCALE
### The Borg Scale

<table>
<thead>
<tr>
<th>6</th>
<th>No exertion at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Extremely light</td>
</tr>
<tr>
<td>8</td>
<td>Very light</td>
</tr>
<tr>
<td>9</td>
<td>Light</td>
</tr>
<tr>
<td>10</td>
<td>Somewhat hard</td>
</tr>
<tr>
<td>11</td>
<td>Hard (heavy)</td>
</tr>
<tr>
<td>12</td>
<td>Very hard</td>
</tr>
<tr>
<td>13</td>
<td>Extremely hard</td>
</tr>
<tr>
<td>14</td>
<td>Maximal exertion</td>
</tr>
</tbody>
</table>