12-2013

Effects of Wii Fit™ Plus Cardiovascular Exercises on Cognitive Function in Older Adults: Feasibility Study.

Ifeanyichukwu Chinedozi
East Tennessee State University

Effects of Wii Fit™ Plus Cardiovascular Exercises on Cognitive Function in Older Adults: Feasibility Study

Ifeanyichukwu Chinedozi

An Honors Thesis Submitted in Partial Fulfillment of the Requirements for the University Honors-in-Discipline Program

College of Nursing

East Tennessee State University

December 2013

Approval Page

This thesis was submitted by Ifeanyichukwu Chinedozi under the direction of the persons listed below. It was submitted to the College of Nursing and Honors College in partial fulfillment of the requirements for the Honors-in-Discipline Program of East Tennessee State University.

Kimberly Sell, Ph.D, MSN, RN — 12/5/2013 Date
Faculty Mentor

Florence Weierbach, Ph.D, MSN, MPH, RN — 12/5/2013 Date
Honors-in-Discipline Coordinator, College of Nursing

Dr. Joyce Duncan — 12/6/2013 Date
Joyce Duncan, Ed.D
Instructor, Counselling and Human Services

Stacey Wild, Ph.D. — 12/5/2013 Date
Lecturer, Department of Biological Sciences

Ifeanyichukwu Chinedozi — 12/5/2013 Date
Author, College of Nursing

Acknowledgement

I wish to express my appreciation to Dr. Foster Levy in the Office of Sponsored Research and Programs and to the Honors College of East Tennessee State University for sponsoring this research. Special thanks to Dr. Kimberly Sell who solidly stood by me as a mentor and provided encouragement in many of the obstacles I faced as an Honors student. Thank you Mrs. Terri Schreiner and Dr. Joyce Duncan for helping to shape my undergraduate career. I am grateful to Dr. Karen Kornweibel for making sure that finances did not interrupt my studies. Thank you Dr. Weierbach for your leadership and tremendous help in this study. I profoundly appreciate Mr. Rafie Boghozian for helping with the analysis of my data. Thank you Dr. Stacey Wild for challenging me to produce a quality thesis. Tears of joy stream my eyes when I think about my mom and dad, Elder and Mrs. Emmanuel Chinedozi Dibia, and my aunties Mercy Nwakamma and Cecilia Nwauche. By facilitating my coming to the United States, they helped fulfil my dream of a quality education. My beloved wife, Imaobong Isang, has truly been my backbone in my journey here in America. Her love and encouragement have been a constant support throughout my academic endeavor.

Abstract

Cognitive decline increasingly plague older adults. Although various studies have correlated aerobic exercises with decreased incidence of the development and progression of cognitive deterioration in older adults, there is no evidence as to whether or not the Wii Fit Plus Rhythm Kung-Fu, Hula-Hoop and the Wii Just Dance can improve the cognitive function of older adults as measured by the Standardized Mini Mental State Examination (SMMSE) instrument. A descriptive study design was used to explore the feasibility of implementing an aerobic exercise program for older adults in an assisted living facility using these Wii games, and evaluating whether or not older adults enjoyed playing the games. A sample of N =5 participants in the East Tennessee region of Appalachia completed the study in an assisted living facility. The games lasted from 5-20 minutes per session, twice a week for four weeks. Pre/post descriptive analysis of survey questions suggested that the sample enjoyed playing the games and these games may be feasible to implement in future studies. However, a larger, randomized, controlled research study is needed to further investigate the effect of these games on the cognitive status of this population.

Background

The alarming rate of age-related cognitive decline poses a major threat to older adults (Manly, Tang, Schupf, Stern, Vonsattel, and Mayeux, 2008; Snowden, Steinman, Mochan, Grodstein, Prohaska, Thurman, et al., 2011). According to Ahlskog, Graff-Radford and Petersen (2011), cognitive decline in older adults often precedes the development of Alzheimer's disease (AD), which accounts for approximately 10% of all cognitive impairment in persons aged 70 and above. Cognitive debility has been linked to the aging process and many older adults without a definite diagnosis of dementia still experience lower quality of life due to age-related cognitive deterioration (Killeen & Steven, 2006; Larson, Wang, Bowen, McCormick, Teri, Crane et al., 2006; Sofi, Valecchi, Bacchi, Abbate, Gensini, Casini et al., 2010; Jernigan, Archibald, Fennema-Notestine, Gamst, Stout, Bonner et al., 2001). Explanations for this finding include the presence of vascular diseases related to the aging process, overall sedentary lifestyles common in this population, as well as the lack of or insufficient participation in aerobic exercises by older persons (Chodzko-Zajko, Proctor, Singh, Minson, Nigg, Skinner, et al., 2009; Yong, Soon, Xu,Thia, Pei, Kuah and Kong, 2010).

In 2013, it was estimated that more than 35 million people worldwide live with dementia, about 8% higher than the total number of people living with HIV/AIDS globally (Alzheimer's Association, [AA], 2013). In the United States, more than five million people suffer from dementia and other forms of cognitive decline and in Tennessee, the number of older adults diagnosed with Alzheimer's disease is approximately 120,000 (AA, 2013). Dementia creates an average annual financial burden of more than six million dollars in Tennessee, and the cost of providing care for a Tennessee older adult with AD is approximately $36,000 for 44 hours per week for 52 weeks (Tennessee Commission on Aging and Disability, 2009). Currently, Alzheimer's disease ranks as the 7th leading cause of death among all Tennesseans and the 5th

top cause of death among all senior citizens of Tennessee (Tennessee Commission on Aging and Disability, 2009). Given that cognitive decline in older adults often progresses into Alzheimer's disease (Manly et al., 2008), it is imperative to seek effective measures to improve the cognitive function of this population.

Evidence shows that aerobic exercises in older adults can prevent or slow the progression of various forms of dementia and Alzheimer's disease (Gillum & Obissean, 2010; Snowden et al., 2011; Sofi, 2010). According to the 2011 position statement of the American College of Sports Medicine (ACSM), physical exercise preserves bone mass in older adults, reduces the risk of falls, fosters feelings of energy, and improves the cognitive health of older adults. Unfortunately, older adults often do not participate in physical exercises due to fear of falling, lack of knowledge about the importance of exercise, lack of access to exercise facilities and equipment, perceived unavailability of group exercise programs, inclination to remain sedentary, inability to view exercise as fun, and lack of encouragement by healthcare professionals (Yong et al., 2010). Therefore, facilitating a fun aerobic exercise program in this population could increase their motivation to participate with the resultant effect of possibly decreasing their cognitive decline.

According to Daniel (2012), the use of Wii exercises offers physical benefits similar to traditional fitness program in older adults. Daniel (2012) reported that older adults who engaged in Wii exercises increased their motivation to exercise, experienced lower fall rates, achieved better balance, and lost measurable caloric weight. Another study by Betker, Szturm, Moussavi, and Nett (2006) showed a significant decrease in loss of balance and an increase in dynamic motor control in older adults who utilized Wii game exercises. Schultheis and Rizzo (2001) cited the benefits of using virtual technology-based exercises (VTBE) such as the Wii for rehabilitation purposes. They include: 1) participants can be immersed into an environment

wherein they are challenged cognitively; 2) VBTE enables the demonstrator or examiner to assess the participants' performances and evaluate potential hazards; 3) this method of exercise facilitates the generalization of learning because the supervisor can pause the session to provide feedback to the users; and 4) VBTE increases participation because they are generally deemed as being fun.

Research Aim and Questions

Aim

The goals of this study were to explore the feasibility of implementing an aerobic exercise program using three Wii exercises and to study the effect of such programs on the cognitive status of older adults. Specifically, the objective was to assess the appropriateness of the protocol, sample size, and measurement instruments of the current research for potential use in a larger, randomized, controlled study in the future. The pertinent questions in this study were as follows:

1. Do the Wii Fit ™ Plus Rhythm Kung-Fu, Hula Hoop, and Wii Just dance improve the cognitive function of older adults as measured by the Standardized Mini Mental State Examination (SMMSE) instrument?
2. Do older adults enjoy playing these game exercises?

Definitions

This study uses the terms *aerobic exercise* and *cardiovascular exercise* interchangeably. Generally speaking, aerobic exercises include physical activities that produce cardiorespiratory responses, such as increased blood pressure, heart rate, breathing, and maximal oxygen capacity ($V'O_{2max)}$ (American College of Sports Medicine, 2011). In 2008, the U.S. Department of Health and Human Services issued guidelines for physical activity in older adults that suggest that older adults should perform 150 minutes of moderate-intensity aerobic exercises or 75 minutes of

vigorous-intensity aerobic activities per week. They also recommended the breakdown of these exercises in 10-minute sessions throughout the day. Similarly, the American Heart Association (AHA) recommended 3-5 sessions of vigorous intensity aerobic exercises per week in split doses of 10-15 minutes per day (AHA, 2013). However, the American College of Sports Medicine (ACSM) warned against the use of generalized exercise regimen for older adults. They cautioned that older adults' prescribed activity levels should be individualized to reflect personal ability, disability, current activity level, and overall health status of each person (ACSM, 2008).

The definition of *cognitive function* is broad and includes such mental domains as short and long term memory, thinking, judgment, higher cortical functions and personality (Knopman, DeKosky, Cummings, Chui, Corey-Bloom, Relkin, et al., 2001). Although numerous physiological changes accompany the aging process, cognition should normally remain stable in older adults, except for an occasional inability for older adults to remember common nouns quickly (Palker, Barr-Silk, and Lender, 2004). However, older adults are often physically inactive, have decreased cardiovascular performance, and experience higher incidence of chronic diseases. As a result, they have an increased risk for health problems including cognitive deterioration (Chodzko-Zajko et al., 2009).

The term *older adult* has been defined by different age parameters in literature. Chodzko-Zajko et al. (2009) suggests that old age generally refers to persons over 65 years, and this position was adopted by the American College of Sports Medicine and the American Heart Association. Nevertheless, Chodzko-Zajko et al. (2009) acknowledged that individuals aged 50-64 years with physical disability, decreased functional levels, or chronic illness may be referred to as older adults. Based on the foregoing premise, this study did not limit its age brackets to people 65 years and above.

Literature Review

The benefits of physical activity in older adults are well documented. A study by Paterson, Jones and Rice (2007) established epidemiological evidence showing that, although decreased cardiorespiratory function is often age-related, aerobic physical activity can improve cardiorespiratory performance in older persons. Recent findings by Seco, Echevarria, Barbero, Torres-Unda and Calvo (2013) suggest that cardiovascular exercises in older adults are a major determinant of functional level. This study, conducted in Spain, involved 227 independent older adults recruited to complete a nine-month exercise program that consisted of walking and running for 50-55 minutes per session twice weekly. At the end of the trial period, the authors found that the heart rate, balance, and muscular strength of the intervention group statistically improved compared to the control group.

In a systematic review of randomized controlled trials evaluating the applicability and effects of physical exercise on the cognitive status of people with dementia, Littbrand, Stenvall and Rosendahl (2011) found that people with cognitive impairment benefitted from physical activity despite their fears of adverse effects and were more likely to participate when the exercise period was short in duration. Another study by Killeen and Stevens (2006) showed that regular exercise could slow the progression of cognitive decline in persons diagnosed with dementia and demonstrated improvement in their daily living activities. Although cardiorespiratory exercises are the focus of the this study, other forms of physical activity, such as strength training, muscle building, flexibility, and balance training have also been shown to offer tremendous benefits to the health status of older adults (Senguin and Nelson, 2003).

De Souza and Vendrusculo (2010) identified that older adults would adhere to any physical activity program that was age-appropriate, enjoyable, and structured in such a way to facilitate socialization. Another exploratory study by Chen (2010) evaluated the perceived

barriers to physical activity in 90 older nursing home residents in Taiwan. Chen (2010) concluded that the hindrances to physical activity in community-dwelling older adults include the fear of falling or injury, past sedentary lifestyle, lack of knowledge about the physical activity, and environmental restrictions.

Many studies documented the effectiveness of implementing various Wii games as exercise programs in various settings. A recent eight-week study by Park, Lee and Ko (2013) showed that the use of Nintendo Wii games in factory workers diagnosed with low back pain resulted in significant decreases in self-reported pain as well as improved overall physical and emotional wellbeing. Another study reported a higher motivation to participate and the relative ease of using of using Wii games in a group of rehabilitation participants compared to the control group who used traditional exercise methods (Meldrum, Glennon, Herdman, Murray and McConn-Walsh, 2012).

Although various studies have pointed out the significant effects of aerobic physical activity on the memory outcome of older adults and the effectiveness of employing virtual technology-based exercises in community living older adults, there is no evidence that the Wii Fit Plus aerobic exercise games positively affect cognitive function in older adults (Gillum and Obisesan, 2010; Snowden et al., 2011; Sofi et al., 2010). While many studies with the Wii focus on improving coordination, balance, and chronic pain (Heick, Flewelling, Blau, Geller, and Lynsky, 2012; Meldrum et al., 2012; Park et al., 2013), there is a lack of research evidence on the effect of the Wii Fit ™ Plus on cognitive function; studies on cognitive effects in older adults were in foreign countries, and many of these studies consisted of participants that were less than 65 years of age (Lam, Chau, Wong, Fung, Lui, and Tam, 2011). The demographic differences in locality and age limit the generalizability of the findings of these studies to the current project.

The objective of this study, therefore, was to identify the feasibility of using three Wii Fit ™ aerobic exercises as a program intervention to elicit cognitive function changes in older adults. The aim was to assess the appropriateness of the protocol, recruitment and retention strategies, measurement tools, and sample size. The ultimate goal was to evaluate the effectiveness of using these games in future studies.

Methodology

A non-randomized descriptive research design was used to gather both quantitative and qualitative data. The rationale for collecting both types of data using this design was to better answer the research questions (Creswell, 2010). The outcome measures included participants' systolic and diastolic blood pressures, heart rate (pulse), oxygen saturation, breathing rate, and pre/post Standardized Mini Mental State Exam (SMMSE) scores. Qualitative data from the survey questions were used to assess whether or not the participants enjoyed the game.

Ethical Consideration

Formal ethical approval was obtained from the Institutional Review Board of East Tennessee State University. Two modification requests received approval following the initial submission. The first modification request was to change the research site due to changes in the previously approved facility that would otherwise have affected the ethical standing of the study. The second request was to recruit participants younger than 65 years of age. In addition to increasing the sample size, the inclusion of younger groups in the study provided a means to compare the results between the different ages. Prior to the study, all potential participants received detailed written and verbal information regarding the purpose of the study, the associated risks, and their right to give, decline, and withdraw consent. Detailed information was also provided regarding the confidentiality and anonymity of their personal data, results, and

responses. Written consent was obtained before the initial cognitive function and health history screening. Participants did not receive gifts or reimbursement for participation in the study.

Participants

Originally, the protocol allowed only the inclusion of older adults aged 65 years and above in an assisted living facility in East Tennessee. However, recruitment constraints necessitated the widening of the age bracket to include adults aged 50 and above. This modification resulted in a total sample of N=8. Two of the initial eight participants were excluded from the study due to their results upon the completion of the pretest cognitive function and health history assessments, leaving a total of *N*=6 eligible subjects. After the first week of the study, a third subject was excluded due to a fall incident, which was unrelated to this study. The final sample of *N*=5 consisted of three participants aged 65 and above and two younger than 65. The mean age of the participants was 68 years (SD±11.07). Of the five participants who successfully completed the study, females comprised 60% of the sample.

Table 1: Baseline Sample Size and Subsequent Exclusions

Age groups	Original number of sample	Number excluded due to baseline health and SMMSE scores	Number excluded after first week of study
50 -60	2	0	1
60-70	4	1	0
70-80	1	1	0
Above 80	1	0	0
Total	8	2	1

Protocol

Upon obtaining the participants' informed consent, each subject had an assessment for baseline cognitive function using the *Standardized Mini Mental Examination (SMMSE)* instrument (Folstein, Folstein, and McHugh, 1975). The SMMSE is the most popular instrument used to assess changes in cognitive status in dementia and delirium (Folstein, et al., 1975; Fayers, Hjerstad, Ranhoff, Kaasa, Skogstad, Klepstad and Loge, 2005). This instrument consists of 11 questions with a maximum score of 30. Scores between 26 and 30 are considered normal in the general population. Older adults with scores between 20 and 25 are considered to have mild cognitive impairment and usually have problems with activities of daily living such as shopping, use of medication, etc. However, these individuals can generally support themselves at home. Scores between 10 and 20 indicate moderate impairment with associated problems in performing basic functions such as grooming, dressing and the use of the toilet. Affected individuals cannot usually live independently. Furthermore, scores between 0 and 9 indicate severe cognitive impairments, and individuals with these low scores usually lose the ability to perform all activities of daily living, such as feeding and walking (Vertesi, Lever, Molloy, Sanderson, Tuttle, Pokoradi et al., 2001).

The original version of the SMMSE has been modified since its creation in 1975 (Kurlowicz and Wallace, 1999). The modified version, called the Standardized Mini Mental State Examination (SMMSE) has been reported to have an intra-class correlation coefficient of 0.90 compared to 0.69 for the traditional MMSE. The intra-rater variance was lower by 86% and the inter-rater variance by 76% in the studies comparing the SMMSE to the MMSE. When used in a clinic setting, the intra-class correlation coefficient for the SMMSE is estimated at 0.92 compared to 0.86 when used at home (Kurlowicz and Wallace, 1999). The validity of the SMMSE has been verified in two different studies. In the first study, 184 older adults were

evaluated using the SMMSE and the Dysfunctional Behavior Rating Instrument (DBRI). The results showed a negative moderate correlation of r = -0.43 between SMMSE and DBRI. The second study consisted of 96 older adults in which the capacity to complete an advance directive was assessed using five measurement tools: two reference standards and three screening tools. In the end, the validity of SMMSE was shown to be 0.94 compared to 0.82 for the generic instrument and 0.90 for the specific instrument.

To be included in the study, participants had to score at least 27/30 on the SMMSE, possess no history of the medical conditions listed in Table 2 below, and speak and understand English as a primary language. The SMMSE cut-off of 27 (considered normal) was used because the university's Institution Review Board (IRB) would not approve of studies allowing lower scores. Evaluation of the health history of each subject was through an author- developed survey called, *Survey of Cardio-Respiratory History Pertinent to Potential Risks of Complications during Aerobic Exercises* (Appendix A). This eight-item survey instructed study participants to identify any known history of health conditions such as heart attack, fainting, asthma, chronic obstructive pulmonary disease (COPD), difficulty breathing, falls (within the past 30 days), other respiratory and cardiac problems, and other health problems. The chief nursing director helped to identify potential participants who were deemed cognitively intact. Due to the guideline received from the IRB, the subjects had to sign an informed consent before any measurement can be made. As a result, assessments of participants' cognitive function and health history occurred on the same day following the documentation of informed consent.

Another survey entitled, *Post-Exercise Participant Rating Survey*, developed by the principal investigator, assessed the participants' perception of the strenuous level of each exercise type, their view on how long each game lasted, the level of enjoyment for each exercise, how well they felt after playing each game, their perceived desire to try each exercise again, and

their willingness to recommend the specific game to someone else (Appendix B). Participants' ratings ranged from 0 (indicating no effect/not at all) to 3 (indicating maximum/high effect). The space left below the survey was for feedback from subjects. Subjects were also instructed to use the back page for further comments. The principal investigator (PI) also noted observations made during each game. The demographic data gathered on each participant included name, age, gender, and level of education attained. However, each individual's name received a code and the codes were unknown to the participants for confidentiality and anonymity. With the exception of the Data Master Log (Appendix C), none of the participants' demographic information appeared in the data collection instrument (Appendix D) and surveys used.

The three game exercises used in the study were the Wii Fit Plus™ Hula Hoop, Rhythm Kung Fu, and the Wii Dance™, also known as the Wii Just Dance™. These games were chosen because of their varying intensity levels. The Rhythm Kung Fu has an intensity of 3 out of 5, the Hula Hoop follows next with a rating of 2, and the Wii Dance is rated at 1 out of 5 (Nintendo, 2009). Prior to each exercise session, there was an assessment of participants' systolic and diastolic blood pressure, heart rate (pulse), breathing (respiratory) rate, and oxygen saturation. All participants sat in a central area from which they took turns playing the games. Supervision was individualized during the course of each exercise. Participants held onto a nearby chair, placed beside them for balance and rest if needed. Additionally, the principal investigator stood beside each person during each exercise and demonstrated the moves throughout the course of each game. The duration of exercise ranged from 5-20 minutes with breaks between rounds, per the ability of each subject. Post-test vital signs were reassessed immediately after each game to measure the participants' peak cardiorespiratory responses to the exercises.

The exercise sessions occurred twice per week for four weeks. At the end of each week, the post-exercise survey was given to the subjects to describe their perceptions of each game's

enjoyment level. During the first week, the Hula Hoop was played twice for sessions 1 and 2. Rhythm Kung Fu and Wii Dance were used for weeks 2 and 3, respectively. However, during the last week (week 4), each subject was asked to choose any game to replay in the last two sessions. At the end of the four-week trial period, the researcher conducted the post-intervention cognitive assessment of each participant. The qualitative results provided a secondary explanation of the quantitative results obtained.

Data Analysis

Descriptive data analyses was conducted using IBM® SPSS® Statistics version 22. First, analysis measured the paired t-test of the pre/posttest results for each participant's vital signs (systolic and diastolic blood pressure, pulse, oxygen saturation, and breathing rate) and the Standardized Mini Mental State Exam scores. These analyses provided the mean, standard deviation, error, and the 2-tailed significance of each paired sample. Subsequently, an independent equal-variance 2-sample t-test compared the means of the participants' perception of each game exercise (viz. Hula Hoop, Rhythm Kung Fu, and Wii Just Dance). These analyses provided an insight into the strength of the subjects' responses about the games. Third, another independent 2-sample t-test compared the differences between the responses of both genders about their perception of the games. The last analysis evaluated the differences in the cognitive function tests between male and female participants.

Results

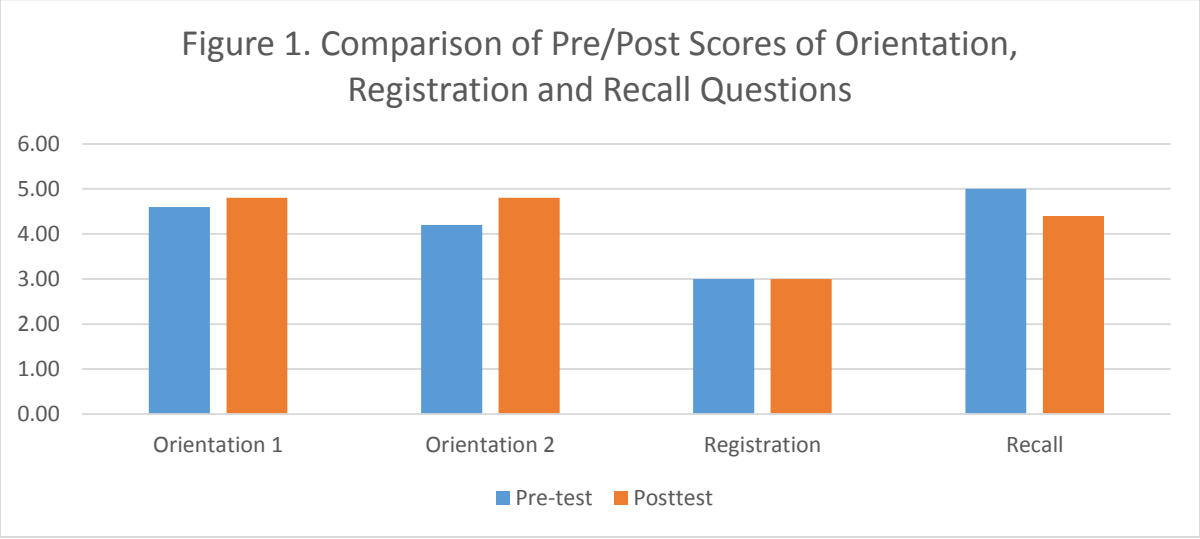
The study took place in an assisted living facility in the East Tennessee region of Appalachia. Five of the initial eight participants completed the study, resulting in a 62.5% completion rate. Sixty percent of the participants were female and the mean age was 68 (SD±11.07) years. Table 2 below provides a summary of the participants' demographics.

Table 2. Demographic Information
N = 5.

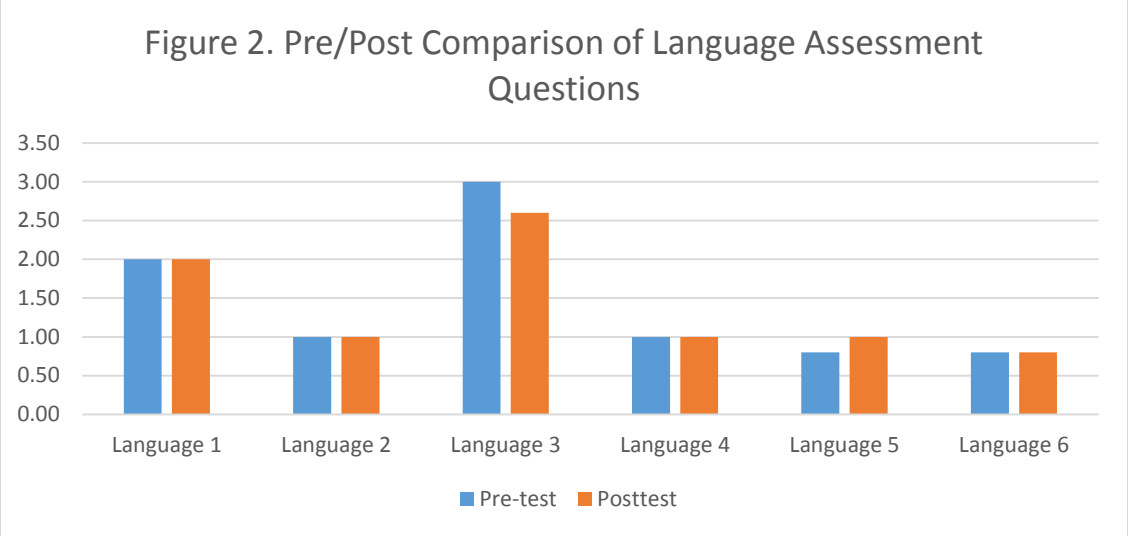
	Age (years)	Education	Gender
Minimum:	58	1-yr high school	
Maximum:	86	4-yr college	
Std. deviation:	±11.07	-	Male: 2 (40%) Female: 3 (60%)

The proportion of subjects with a high school education was 40%, whereas 20% and 40% completed some 2-year and 4-year college courses, respectively.

During the initial cognitive function assessment, sixty percent of the subjects achieved a perfect score on orientation question 1 on the SMMSE, while 40% scored 4 of 5. For the same question, however, eighty percent of the participants made perfect scores in the posttest. There was an appreciable difference between the subjects' pre/post performance in orientation question 2. No differences was found between the pre/post assessments for registration and attention/calculation. However, there was a 20% decrease in recall scores between the pre/post measurements (see figure 1).

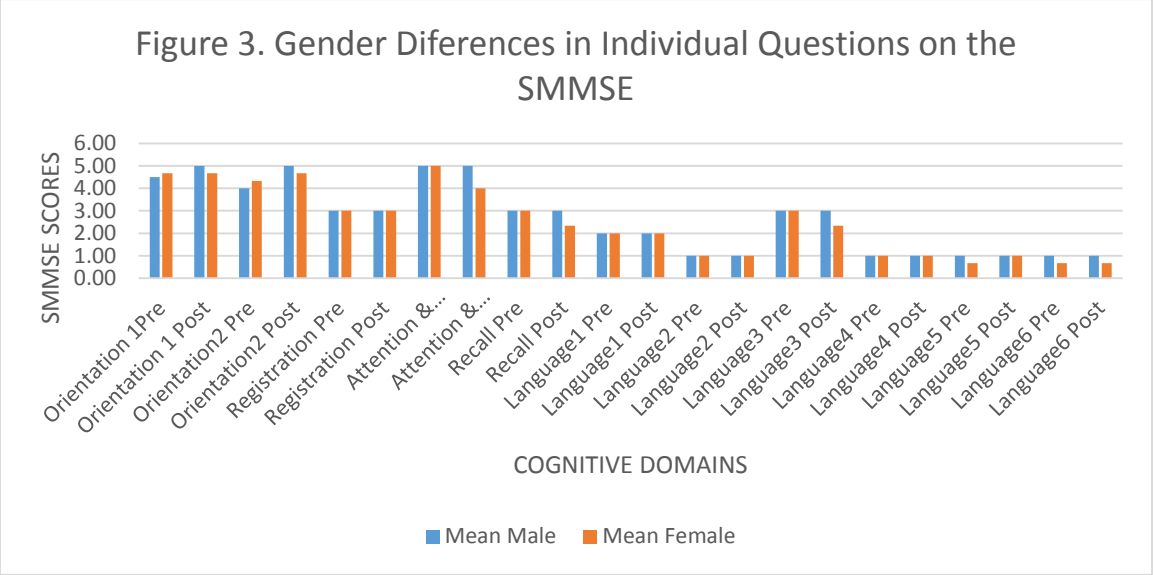


In terms of language, all of the participants scored 100% on the pretest assessment of language questions 1 – 4, with one participant scoring zero on language questions 5 and 6. The posttest scores for attention and calculation showed a 20% decrease due to one subject scoring 2 of 5 on the question that assessed this cognitive domain. With the exception of language questions 3 and 6, all participants made perfect scores on the posttest language assessment. Figure 2 below presents the pre/post-test language measurements.



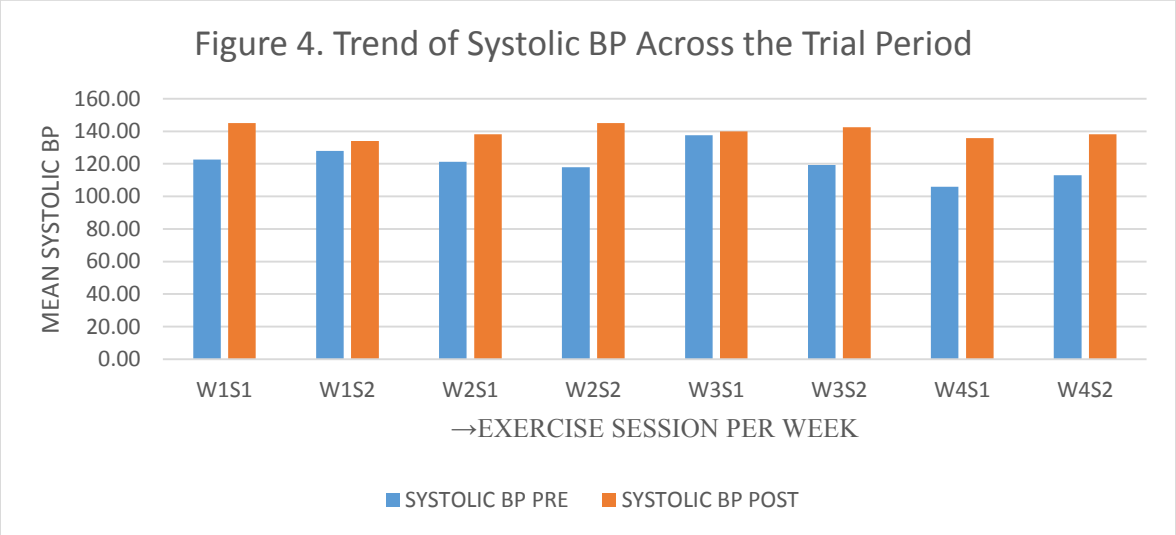
Although there appears to be differences in the graph above, they are not statistically significant due to the limited sample size.

Three people scored 29 out of 30 with two others scoring 27 and 28, respectively, on the pretest cognitive measurement (SD±0.894). After the four-week trial period, the average SMMSE score was 28.4 with three individuals scoring perfect 30s and two others totaling 23 and 29, respectively. As can be seen from Figure 3, the comparison of participants' average SMMSE scores showed that males scored slightly higher than their female counterparts. However, a t-test analysis of these differences did not show them to be statistically significant.

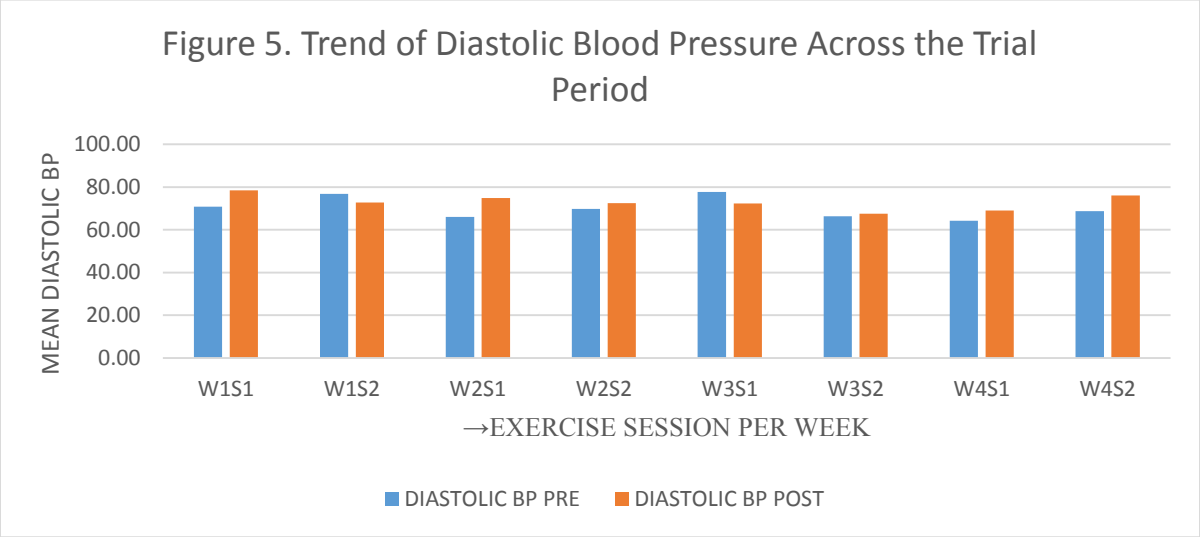


The clustered bar chart above shows that males did comparatively better than their female counterparts. Despite these apparent differences, none are statistically significant.

Throughout the trial period, there were consistent increases in participants' systolic and diastolic blood pressures, pulse, breathing rate, and oxygen saturation. As illustrated in Figure 4, the average posttest systolic blood pressure increased throughout the intervention period with the lowest and highest average systolic blood pressure occurring in week 1, session 2 (W1S2) and week 2, session 2 (W2S2), respectively. It is expedient to note that the game exercise used during this period (week 2) was the Rhythm Kung Fu.



With the exception of W1S2 and W3S1, the average diastolic blood pressure also increased between the pre and posttest assessments. The game exercise used for these sessions were the Hula Hoop and Wii Just Dance, respectively.



The average heart rate (pulse) was also consistently higher in posttest measurements except in W2S2 where there was a 0.20 beats/minute decrease. It is also important to mention that the highest mean heart rate occurred in W3S1 with the Wii Just Dance (Figure 6).

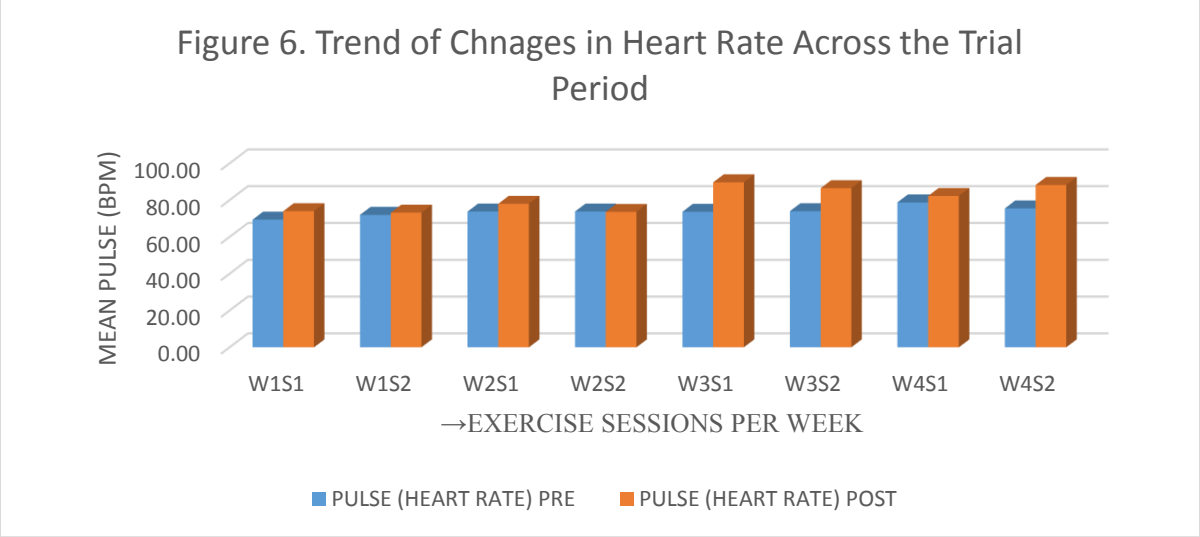


Figure 6 above shows consistent increases in subjects' pre/post heart rate throughout the trial period, suggesting that the exercises were able to raise their pulses.

Pre/post oxygen saturation scores had the most modal distribution with the lowest mean oxygen saturation results occurring in the first week of the program. Again, this finding coincided with the use of the Hula Hoop. Consistently higher average respiratory rates occurred throughout the interventional period (Figures 7 and 8).

Figure 7. Trend of Oxygen Saturation Across the Trial Period

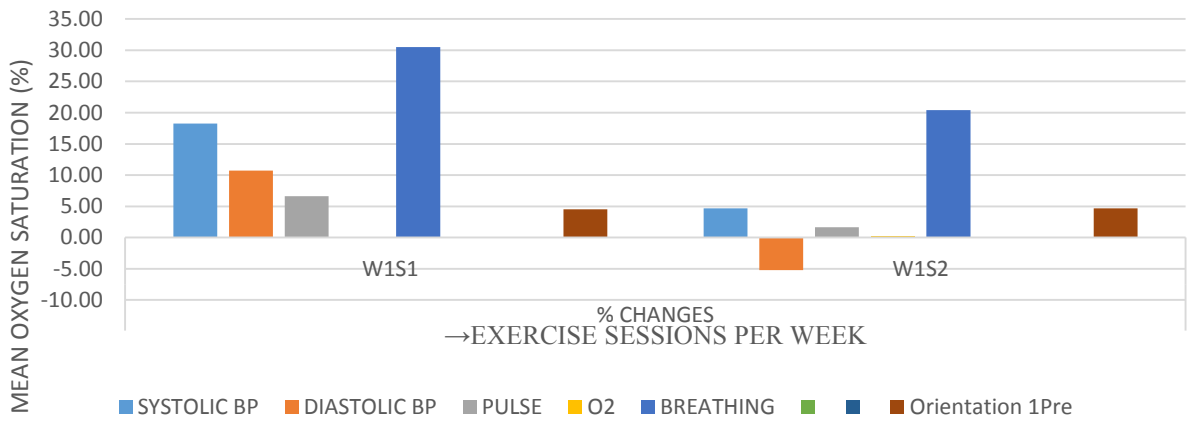
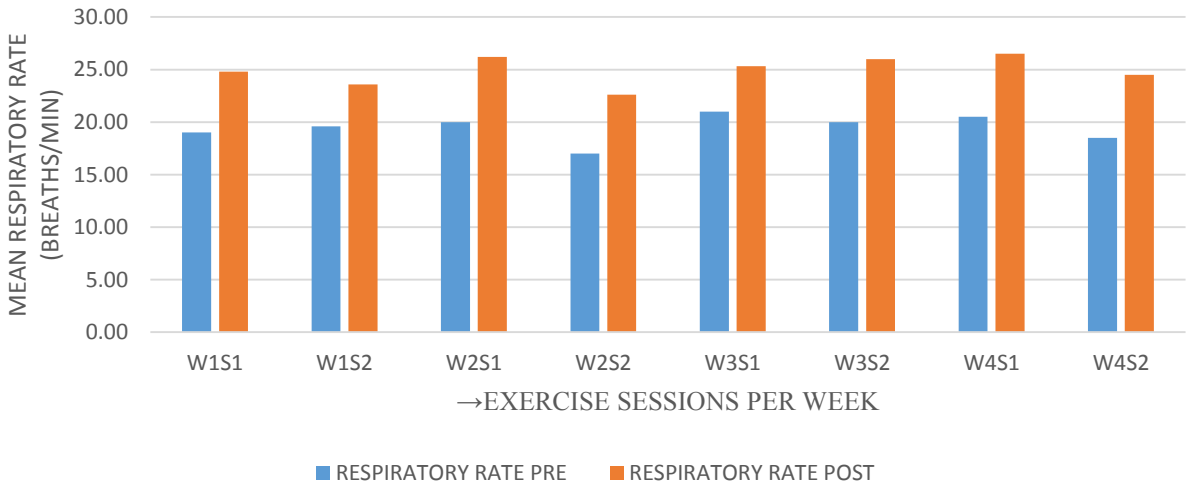


Figure 8. Trends in Respiratory Rate



Figures 7 and 8 above show significant differences in pre/post oxygen saturation and breathing rate, respectively. As can be seen, O_2 saturation increased the most in Week 3 session 1 (Wii Dance) and the least in Week 1 session 1 (Hula Hoop). On the other hand, subjects' breathing

rates increased consistently across the trial period with the least increase in Week 2 session 2 (Rhythm Kung Fu).

The use of the Hula Hoop in week 1 correlated with pre/post systolic blood pressure and respiratory rate at p=0.001 and 0.013, respectively. The p-value for the pre/post diastolic blood pressures was p=0.040 in week 1. Paired sample t-test showed pre/post differences in systolic blood pressure (p=0.029) and respiratory rate (p=0.021) in the first game session of week 2 (n=4). Interestingly, similar observations were made in the second game session of week 2 with p= 0.023 and 0.011 for average systolic blood pressure and respiratory rate, respectively. It is crucial to reiterate that the Rhythm Kung Fu was the game exercise used in week 2. Due to the severely limited sample size, statistical significance cannot be inferred from these analyses.

In week 3, the p-value for the pre/post systolic blood pressures was p=0.003 for the first session and 0.002 for session 2. Pre/post oxygen saturation and respiratory rate showed p-values of 0.004 and 0.014 in week 3, session 2, respectively. The most significant differences in pre/post measurements occurred in the final week of the intervention. 2 tailed t-test of pre/post systolic and diastolic blood pressures were computed at p=0.028 and 0.019 with oxygen and respiratory rate being significant at p=0.058 and 0.024, respectively in the first session of week 4. Furthermore, pre/post systolic and diastolic blood pressures produced p=0.077 and 0.027 in the second session. The p-value for oxygen was 0.092 and respiratory rate stood at p=0.069 for week 4, session 2. Appendix E provides a summary of the pre/posttest vital signs' p-values, standard deviations and sample sizes.

Table 3 and Figure 9 present the percentage changes in subjects' mean vital signs. As can be seen, week 4 has the highest overall percent increases between pre/post vital signs. This suggests that the participants experienced the most changes in their cardiorespiratory functions when they played the game that they wanted, rather than playing the game assigned to them.

Table 3. Summary of Percent Changes in Vital Signs

	% CHANGES							
	W1S1	W1S2	W2S1	W2S2	W3S1	W3S2	W4S1	W4S2
SYSTOLIC BP	18.27	4.69	14.03	22.88	1.69	19.5	28.07	22.35
DIASTOLIC BP	10.73	-5.21	13.33	3.72	-6.88	1.89	7.39	10.55
PULSE	6.62	1.67	5.69	-0.27	21.75	16.89	4.44	16.89
O2	0.00	0.21	0.84	1.9	1.39	0	2.38	2.11
BREATHING	30.53	20.41	31	32.94	20.62	30	29.27	32.43

The % changes of Week 1 correlates with the Hula Hoop; Week 2=Rhythm Kung-Fu; Week 3= Wii Dance; and Week 4 correlates with any choice of the three games.

From the table above, there was no change in oxygen saturation in week 1 session 1 which correlated with the use of the Hula Hoop. Further, the use of the Hula Hoop produced negligible changes in oxygen saturation in session 2 of week 1. Oxygen saturation remained unchanged in week 3 session 2 (Wii Dance). Diastolic blood pressure declined across pre/post measurements in week 1 session 2 (Hula Hoop) and in week 3 session 1 (Wii Dance). The average heart rate also dwindled between pre/post-test in week 2 session 2 which correlates with the use of the Rhythm Kung Fu. Figure 8 below provides a better visual representation of the changes in participants' cardiorespiratory functions.

Figure 9. Percent Changes in Vital Signs

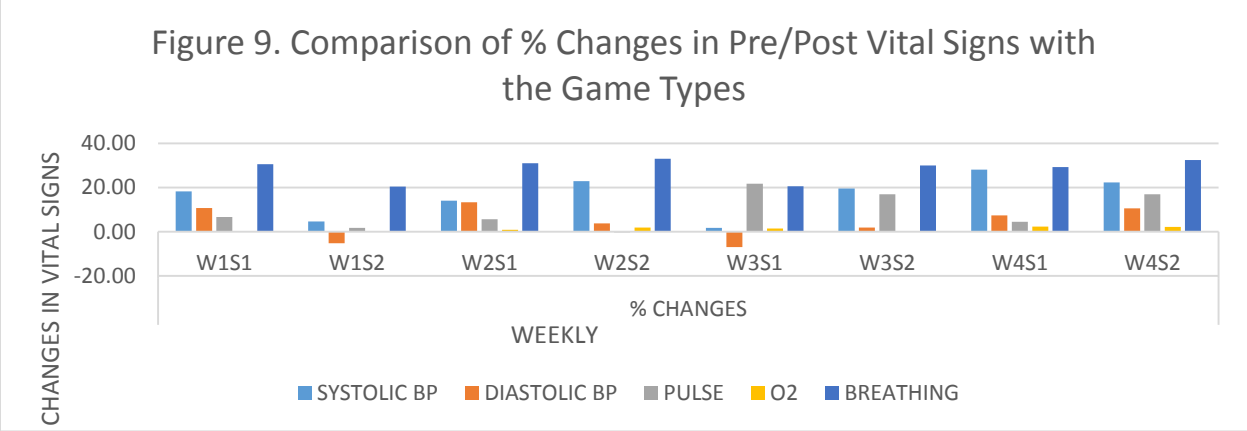


Figure 9 above is a graphical illustration of the information presented in Table 3.

The subjects' perceptions of each game exercise were recorded using a scale that ranged from 0 to 3. For each of the survey questions, a response of 0 meant no effect/not at all; 1 =

minimal/little effect; 2 = moderate/average effect; and 3 = maximum/high effect. The average strenuous level assigned to the Hula Hoop was 1.60 (SD±0.89) out of a 3-point intensity level. Similarly, the duration of time spent on the Hula Hoop was perceived to be minimal at 1.20 (SD±0.84). Furthermore, 100% of the subjects rated the Hula Hoop with a maximum level of enjoyment. They also indicated a high likelihood of playing the game again and recommending it to someone else. The results of the independent 2-sample analysis comparing the means of participants' responses about the Hula Hoop proved statistically significant in five out of the six survey questions. Figure 10 below presents the survey responses for all three games.

Figure 10. Survey Responses for all Three Games

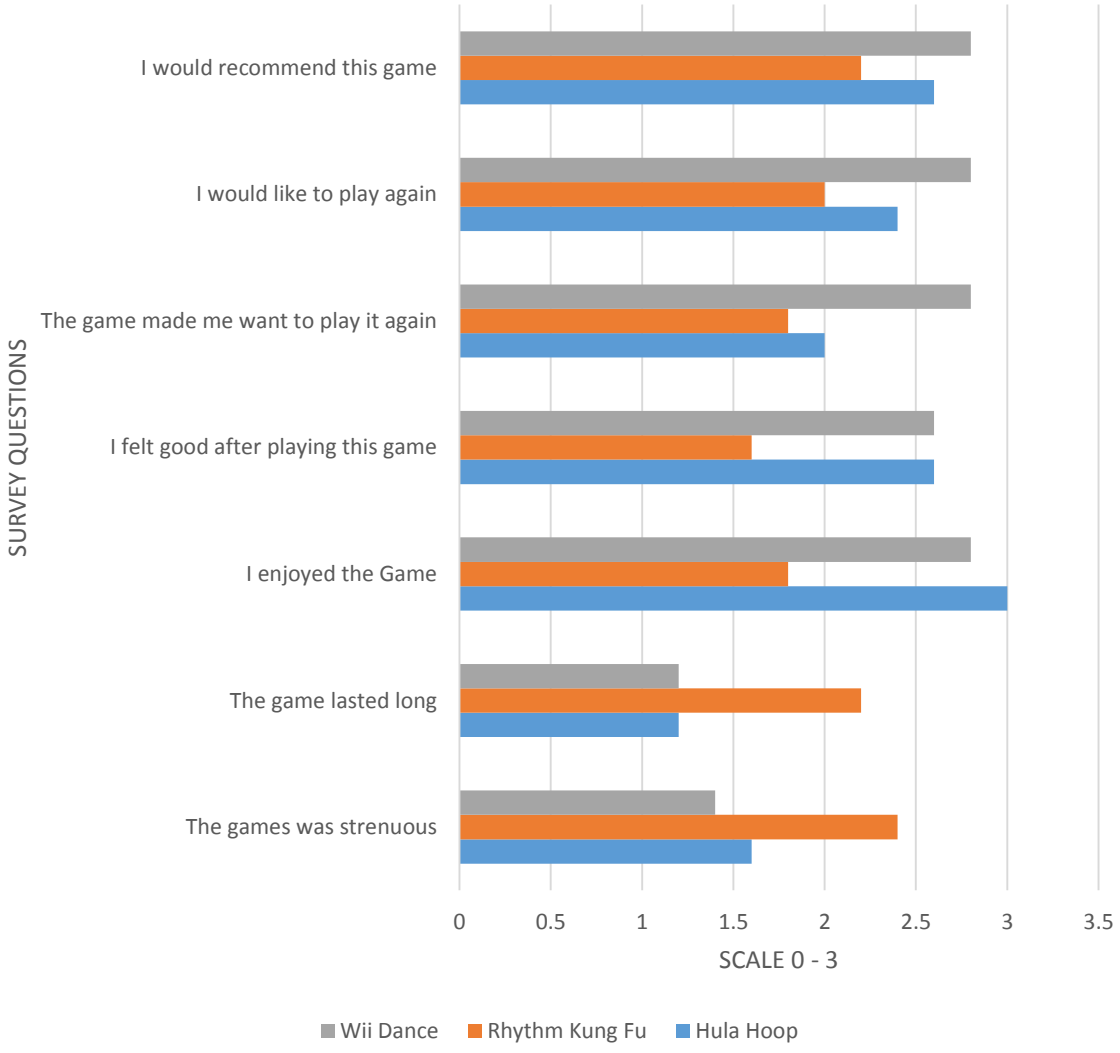
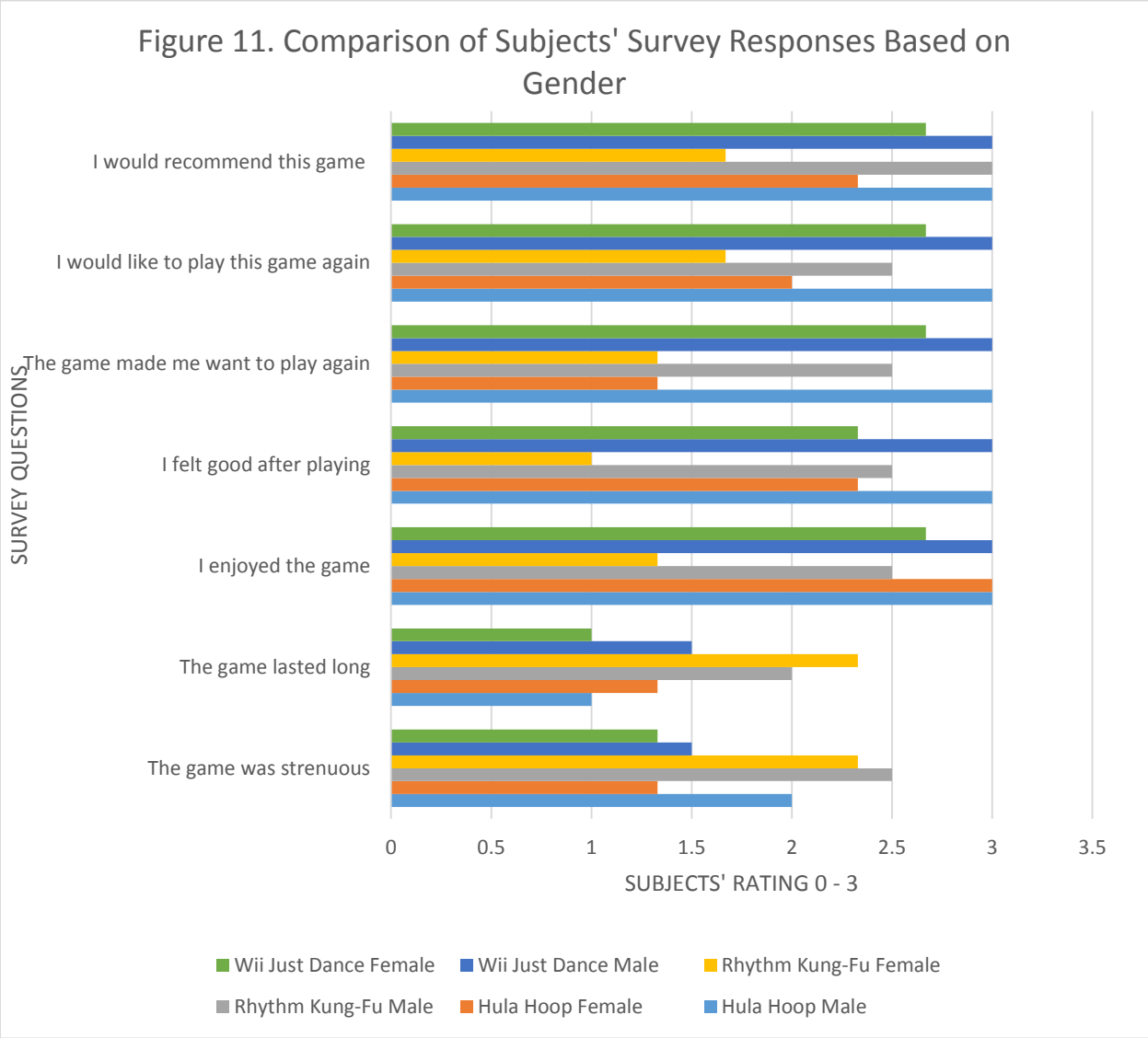


Figure 11 below summarizes the gender differences in participants' survey responses.



As shown in Figure 11, on the average, male participants slightly rated the intensity level of the Wii Dance higher than females. Nevertheless, the average enjoyment level reported by both genders was similar. Ironically, however, although females viewed the Wii Just Dance to be less strenuous compared to male assessment, and the average female rating for feeling good after playing the game as well as their desire to play the game again were relatively lower than those reported by male players. Table 4 below presents the summary the participants' feedback (qualitative data) on all three games.

Table 4. Summary of Participants' Feedback on Specific Games

Comments on the Three Game Types		
Hula Hoop	Rhythm Kung-Fu	Wii Dance
I like the game. But I'd like to change the music to country music (F, 006).	The game is pretty good, but I was not familiar with the moves. So, I had a hard time following the demonstrations. (M, 008)	I enjoyed the game, but my knee hurt. So, I had to stop midway and could not do any better. (F, 001)

As can be seen from Table 4, the participants mainly gave favorable ratings to all three games. However, choice of music, unfamiliarity with the moves, and pain while exercising were the major issues raised by the subjects. Participants also provided an overall evaluation of the program. Highlights of their comments are summarized in Table 5 below.

Table 5. Participants' Perception of the Enjoyment of All Three Games

Enjoyability of Games
This is a good exercise. They aren't stressful. But they require concentration. I recommend them for older adults as an exercise program. (M, 005).
These games seem interesting. But on the other hand, they are not intense aerobic exercises. The games seem good for improving mind and hand coordination and timing. (M, 008).
I liked the exercises. I thought they were fun. I think the exercises were good for our age group, especially for those who don't exercise much. I also liked that each person played individually. It was good that attention was given to each person. The big TV also made it easy to see the demonstrations. (F, 001).

Table 6 summarizes participants' responses addressing the feasibility of playing these games in future studies.

Table 6. Participants' Perception of the Feasibility of Future Use

Feasibility of Playing These Games in the Future
Everything is fun, but the music is no good. Next time, it should be done in a group setting with each person having a chair in front of him or her in case someone loses balance. The coordinator should stand in front of the group to demonstrate the exercises, instead of the TV. We should also be given sneakers and not shoes, to avoid falling. (F, 006). In the future, I'd like the presenter to show what we are doing a little bit more before we do it (001) I felt like the exercises were long. I preferred the shorter version of the dance. The exercise is not good for people over 80. I liked the short version of the dance because it doesn't bother my back like the Hula Hoop does. (F, 007).

The feedback received mostly suggests that the participants enjoyed playing the games. Their comments indicate that they would be willing to play these games again with some modifications such as providing balance support, sport shoes, a large TV and modifying the sessions so that the demonstrator stands in front of the group to instruct them on the moves before the perform them. Since the majority of the music on the Wii Dance was hip hop, the feedback suggests that the subjects may prefer a more traditional genre such as country music.

Discussions

Research Question 1: Cognitive Effects of these Games

For the most part, participants' pre/posttest SMMSE scores increased across many domains of the Standardized Mini Mental State Exam (SMMSE) instrument. Two of the participants missed multiple sessions due to illnesses unrelated to the study. The participant whose SMMSE scores decreased in the posttest missed three sessions. During the posttest cognitive assessment, the principal investigator observed an obvious decline in this subject's cognition. Further inquiry suggested that the client might have some form of infection that affected her cognitive status. Whereas all participants with 100% attendance showed increases in their posttest SMMSE scores, the other participant who missed two sessions maintained her baseline SMMSE score. Although there were more women than men, male participants scored relatively higher on the pre/post SMMSE. Between genders, the orientation questions scored higher, while the language questions, 5 and 6, proved more difficult for the subjects. Again, given the lower proportion of male participants, their higher average pre/post SMMSE results calls for further investigation. Altogether, the cognitive function scores improved in participants who successfully followed through with the study. However, the small sample size of this study lacks the power to determine the cognitive effect of these games on the participants. Such inquiry will be the focus of a future study.

Although no correlation can be made between participants' cognitive functions and these games, the pre/post-test changes in vital signs observed among all the subjects are worth noting. Participants' systolic blood pressure and breathing consistently increased with the use of the three Wii games. The little changes or decline in diastolic blood pressure is normal because during an upright exercise, blood vessels dilate, thereby reducing venous return which invariably reduces diastolic blood pressure. Therefore, whereas the systolic blood pressure is

expected to rise during aerobic exercises, the diastolic blood pressure during an upright aerobic exercise can remain unchanged, decrease or increase slightly to no more than 10mmHg above resting diastolic pressure. The pre/post average decrease in pulse observed in week 2 session 2 suggests that the Rhythm Kung-Fu did not elicit any changes in heart rate during that exercise session. This finding might be because, the Rhythm Kung-Fu did not involve as much movements as the Wii Dance. However, this game was also noted to be the hardest among all the subjects. The higher intensity might also have prevented the participants from pushing themselves harder compared to efforts they put into the Hula Hoop and the dance. Nevertheless, a larger, controlled study could fully study the effects of these games on cognition.

Research Question 2: Enjoyability of Games

Abundant evidence established that Wii games were enjoyable and perceived as fun by older adults in community-dwelling settings (Chao et al, 2013; Heick et al., 2012; Wollersheim et al., 2010). The quantitative and qualitative data from this study corroborated the literature. Although each game exercise received favorable average enjoyment ratings, the dance exercise dominated in average preference among all three games. The Rhythm Kung-Fu received the highest rating for intensity level, seemed more appealing to men than to women, and was the overall least liked game. The Hula Hoop, on the other hand, had similar ratings as the Wii Just Dance. One participant did not like the Hula Hoop because it involves “twirling the hip and back” (F, 007). This complaint of pain may be related to preexisting chronic pain, which is common in older adults (Park et al., 2013). It is noteworthy to highlight that on average, the male participants in this study rated the Hula Hoop at a higher intensity level, viewed it as lasting shorter in duration, felt better after playing this game, and were more likely to recommend the Hula Hoop to someone else than were their female counterparts.

Measurement Instruments: SMMSE and Surveys

In this study, the SMMSE (Appendix F) provided a quick and easy way to assess the cognitive function of the sample. The non-invasive, quick and easy to comprehend nature of this instrument makes it ideal for future studies in this area. The surveys were useful in gathering the qualitative aspect of this study. However, the lack of validity and reliability analysis for the surveys was a limitation that needs to be addressed in future studies.

Recruitment and Retention

Recruitment posed a significant challenge in this study. Due to the lengthy process of obtaining ethical approval, effective communication dwindled between the previously designated research site and the principal investigator to the point that it was necessary to find a new facility just days prior to the start of the study. Not only did this change affect recruitment, it presented the challenge of having to build rapport with the new potential subjects and administrators. However, the research team made relentless efforts to ensure the progress of the project. After meeting with the facility administrator and nursing director, the principal investigator met with potential candidates to explain the purpose of the study. Participants were told that exercise has been shown to improve cognitive health but no benefits were promised to them. Interested individuals were given the informed consent on a different day and the document was read and explained to each person.

Although the sample size was small, this study retained all eligible subjects, except the participant excluded due to a fall unrelated to the study. The two participants who missed sessions impacted the attendance level. Although both cited illness as the reason for being absent, motivation might have been an underlying factor.

Implications for Nursing Education and Practice

Physical activities, especially those that are aerobic in nature, are immensely beneficial to older adults. Given that Wii games have received favorable reviews and support from research, clinicians, caregivers, nursing educators, and researchers should invest more resources into finding ways to enhance the use of these exercise models within this age group. Although interesting results were derived from the current study, the small sample size diminishes the generalizability of these findings. Therefore, there is need for a larger, controlled clinical trial on this subject matter. Nursing educators at all levels should continue to instruct patients, students, and families on the importance of staying active even in older age. In future studies, participants should be encouraged to choose which games they prefer and adequate coaching should be provided as they engage in the selected games. For the purpose of education, the findings of this research will be shared with the administrator and nursing director of the facility in which it was conducted.

Limitations and Recommendations

Sample Size and Retention

The major limitation in this study was the limited sample size. Due to the severely small sample, these findings lack the power to be used for any statistical inferences. However, the physiological changes in subjects' cardiorespiratory functions, coupled with the survey responses from participants, suggest that these games may be feasible for use in future studies. To facilitate a larger sample size, multiple research sites should be used and a strong collaboration should be established between the research team, the facility and the potential participants. Altogether, the idea of playing a scheduled game for certain weeks and having a period where participants were free to play their game of choice proved effective. Elongating the interventional period and not necessarily the amount of time spent exercising might produce

more profound effects on the physical, and possibly the cognitive, state of this population (ACSM, 2008; Larson et al., 2006).

In future studies, a solid collaboration should exist between the research team, the administration and staff of the selected facility, and the participants prior to and throughout the course of the study. A strong partnership between the research team and the facility' staff may promote the motivation of the participants who are already familiar with the staff members.

High Cut-off Score for SMMSE Criterion

An important issue worth addressing in future studies is the SMMSE inclusion criterion. Currently, the East Tennessee State University Institutional Review Board's cut-off score for the SMMSE is 27. With such a high criterion, studies on cognitive functions are restricted to individuals that are deemed cognitively intact. This makes it practically difficult, if not impossible, to study the effects of proposed interventions on the cognitive status of individuals with any form of cognitive impairment. Even with a larger, controlled study, it would be difficult to effectively appreciate any differences in cognitive functions within a group of persons with normal baseline SMMSE scores.

Author-Developed Measurement Instruments

The lack of validity and reliability information for the surveys used in this study needs to be corrected in future studies. Validating these instruments would help to assess for potential problems with the survey questions and would determine whether or not the questions are actually measuring what they are intended to.

Age of the Participants

Age was a limitation in this study because adequate sample size could not be obtained using the originally planned age bracket of older adults aged 65 years and above. In future

studies, efforts should be made to include younger persons. This would help with the sample size and also provide the means to compare the results between different age groups.

Conclusions

The primary goal of this study was to evaluate the feasibility of implementing an interventional aerobic exercise program using three Wii games: the Hula Hoop, Rhythm Kung-Fu and Wii Just Dance. The author inquired into the appropriateness of the protocol, measurement instrument, sample size, and outcome measures for possible use in future projects studying the effects of these games on the cognitive function of older adults. The findings demonstrated that the protocol, measurement instruments and outcome measures described are feasible and that the selected exercises may have elicited cardiorespiratory changes in the sample. The findings also supported research evidence that Wii games were enjoyable and viewed as fun by older adults. Overall, the goal of this study was met because the findings suggest that a larger, well-controlled, randomized study is feasible to investigate the effects of the Wii Fit™ Plus Hula Hoop, Rhythm Kung Fu and Wii Just Dance on the cognitive function of older adults.

References

Ahlskog, J., Geda, Y., Graff-Radford, N., & Petersen, R. (2011). Physical exercise as a preventive or disease-modifying treatment of dementia and brain aging. *Mayo Clinic Proceedings, 86*(9), 867-884.

American College of Sports Medicine [ACSM] (2011). Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: Guidance for prescribing exercise. *Medicine & Science, 43*(7), 1334-1359.

American Heart Association [AHA] (2013). *Recommendations for physical activity in adults*. Retrieved from http://www.heart.org/heartorg/GettingHealthy/PhysicalActivity/StartWalking/American-Heart-Association-Guidelines_UCM_307976_Article.jsp

Betker, A., Szturm, T., Moussavi, Z., & Nett, C. (2006). Video game–based exercises for balance rehabilitation: A single-subject design. *Archives of Physical Medicine and Rehabilitation, 87*, 1149-1149.

Chao, Y., Scherer, Y., Wu, Y., Lucke, K., & Montgomery, C. (2013). The feasibility of an intervention combining self-efficacy theory and Wii Fit exergames in assisted living residents: A pilot study. *Geriatric Nursing, 30*, 377-382.

Chen, Y. (2010). Perceived barriers to physical activity among older adults residing in long-term care institutions. *Journal of Clinical Nursing, 19*, 432-439.

Chodzko-Zajko, W., Proctor, D., Singh, M., Minson, C., Nigg, C., Salem, G., & Skinner, J. (2009). Exercise and physical activity for older adults. *Sports and Exercise 41*(7), 1510-1530.

Creswell, J. (2010). Mapping the developing landscape of mixed methods research. In Sage Handbook of Mixed Methods in Social & Behavioral Research, Tashakkori, A. and Teddlie, C. (2010), Sage, California, 45-68.

Daniel, K. (2012). Wii-hab for pre-frail older adults. Rehabilitation Nursing, 37(4):195-201.

De Souza, D., & Vendrusculo, R. (2010). Adherence to a physical activity program by older adults in Brazil. *Physical Educator, 67*(2), 101-112.

Fayers, P., Hjerstad, M., Ranhoff, A., Kaasa, S., Skogstad, L., Klepstad, P., & Loge, J. (2012). Which mini mental state exam can be used to screen for delirium and cognitive impairment. *Journal of Pain and Symptom Management, 30*(1), 41-50.

Folstein, M., Folstein, S. & McHugh, P. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. Journal of Psychiatric Research, 12(3),189-98.

Gillum, R., & Obisesan, T. (2010). Physical activity, cognitive function, and mortality in a US national cohort. *Annals of Epidemiology, 20*, 251-257.

Heick, J., Flewelling, S., Blau, R., Geller, J., & Lynskey, J. (2012). Wii fit and balance: Does the Wii fit improve balance in community-dwelling older adults. *Topics in Rehabilitation, 28*(3), 217-222.

Jernigan, T., Archibald, S., Fennema-Notestine, C., Gamst, A., Stout, J., Bonner, J., Hesselink, J. (2001). Effects of age on tisues and regions of the cerebrum and the cerebellum. *Neurobiology of Aging*, 22, 581 -594.

Killeen, M., & Stevens, J. (2006). A randomized controlled trial testing the impact of exercise on cognitive symptoms and disability of residents with dementia. *Contemporary Nurse*, 32.

Knopman, D., DeKosky, S., Cummings, J., Chui, H., Corey-Bloom, J., Relkin, N., Small, G., Miller, B., & Stevens, J. (2001). Practice parameter: Diagnosis of dementia (an evidence-based review). Report of the quality standards subcommittee of the American Academy of Neurology. *Neurology, 56*(9), 1143 -1153.

Kurlowicz, L., & Wallace, M. (1999). The standardized mini mental state examination (SMMSE): Try this. *Hartford Institute for Geriatric Nursing*. Retrieved from http://www.dhs.state.or.us/spd/tools/cm/aps/assessment/mini_mental.pdf

Lam, C., Chau, R., Wong, B., Fung, A., Lui, V., & Tam, C. (2011). Interim follow-up of a randomized controlled trial comparing Chinese style mind body (Tai Chi) and stretching exercise on cognitive function in subjects at risk of progressive cognitive decline. *International Journal of Geriatric Psychiatry, 26*, 733-740.

Larson, E., Wang, L., Bowen, J., McCormick, W., Teri, L., Crane, P. & Kukull, W. (2006). Exercise is associated with reduced risk for incident dementia among persons 65 years of age and older. *Annals of Internal Medicine, 144*(2), 73-81.

Littbrand, H., Stenvall, M., & Rosendahl, E. (2011). Applicability and effects of physical exercise on physical and cognitive functions and activities of daily living among people with dementia: a systematic review. American Journal of Medical Rehabilitation, 90(6), 495-518.

Manly, J., Tang, M., Schupf, N., Stern, Y., Vonsattel, J. & Mayeux, R. (2008). Frequency and course of mild cognitive impairment in a multiethnic community. Annals of Neurology, 63(4), 494-506.

Meldrum, D., Glennon, A., Herdman, S., Murray, D., & McConn-Walsh, R. (2012). Virtual reality rehabilitation of balance: Assessment of the usability of the Nintendo Wii® Fit Plus. *Disability and Rehabilitation: Assistive Technology*, *7*(3), 205-210.

Palker, N., Barr-Silk, M. & Lender, N. (2004). Fun and games help aging brains: Memory enhancement training in older adults. *The American Journal of Nurse Practitioners, 8*(2), 21-28.

Park, J., Lee, S., & Ko, D. (2013). The effects of the Nintendo Wii exercise program on chronic work-related low back pain in industrial workers. *Journal of Physical Therapy Science, 25*(8), 985-988.

Paterson D., Jones G., & Rice C. (2007) Ageing and physical activity: evidence to develop exercise recommendations for older adults. *Applied Physiology, Nutrition and Metabolism, 32*, 69–108.

Schultheis, M., Rizzo, A. (2001). The application of virtual reality technology in rehabilitation. Rehabilitation Psychology, 46(3), 296-311.

Seco, J., Abecia, L., Echevarrıa, E., Barbero, I., Torres-Unda, J., & Calvo, J. (2013). A long-term physical activity training program increases strength and flexibility, and improves balance in older adults. *Rehabilitation Nursing, 38*, 37-47.

Senguin, R., & Nelson, M. (2003). The benefits of strength training for older adults. *American Journal of Preventive Medicine, 25*(3.2), 141-149.

Snowden, M., Steinman, L., Mochan, K., Grodstein, F., Prohaska, T., Thurman, D., Brown, D., Laditka, J., Soares, J., Zweiback, D., Little, D., & Anderson L. (2011). Effect of exercise on cognitive performance in community-dwelling older adults: Review of intervention trial and recommendations for public practice and research. The *American Geriatric Society, 59,* 704-716.

Sofi, F., Valecchi, D., Bacci, D., Abbate, R., Gensini, G., Casini, A., & Macchi, C. (2010). Physical activity and risks of cognitive decline: A meta-analysis of prospective studies. *Journal of Internal Medicine*, *269*(1), 107 -117.

Tennessee Commission on Aging and Disability (2009).Tennessee Alzheimer's disease task force final report. Accessed July 9, 2012 at http://www.alz.org/national/documents/tennessee_state_plan.pdf

U.S. Department of Health & Human Services. (2008). Physical activity guidelines for Americans. Retrieved from http://www.health.gov/paguidelines/guidelines/chapter5.aspx

Vertesi, A., Lever, J., Molloy, W., Sanderson, B., Tuttle, I., Pokoradi, L., & Principi, E. (2001). *Standardized mini-mental state examination: Use and interpretation*. Retrieved from http://www.cfp.ca/content/47/10/2018.full.pdf

Wollersheim, D., Merkes, M., & Shields, N. (2010). Physical and psychosocial effects of Wii video game use among older women. *International Journal of Emerging Technologies Society, 8*(2), 85-98.

Yong, J., Soon, Y., Xu, T., Thia, E., Pei, F., Kuah, C., & Kong, K. (2010). A feasibility study using interactive commercial off-the-shelf computer gaming in upper limb rehabilitation in patients after stroke. *Journal of Rehabilitative Medicine, 42*(5), 437-441.

Appendix A: Survey of Cardio-Respiratory History Pertinent to Potential Risks of Complications during Aerobic Exercises

Participant Code: _____ Date: _____

Instructions to Potential Participant

It is important that you answer the following questions honestly and completely. If you have experienced any of these symptoms within the past 30 days or are currently experiencing any of these symptoms, you must indicate such on this survey. You may be at risk for cardiac and respiratory complications and/or physical injuries during an aerobic activity if you have any of these conditions/symptoms. This list is not exhaustive; therefore, you should indicate any other health issues you may have or have experienced within the past 30 days that may result in problems during the course of your participation in the proposed Wii Fit Plus aerobic exercises. If you have any questions, please be sure to ask the Principal Investigator, Ify Chinedozi. Use the extra space included for any comments.

Please indicate your response about whether or not you are currently experiencing or have experienced any of the following conditions within the past 30 days. Use the symbol (□) for 'Yes' and (□**)** for 'No' under the appropriate rows and columns below.

Condition	**Yes (□)**	**No (□)**
Heart attack or MI		
Fainting or dizziness		
Asthma attack		
COPD exacerbation (COPD crisis)		
Difficulty breathing/shortness of breath		
Falls (falling)		
Any other lung or respiratory problems		
Any other cardiac problems		
Comment:		

Participant's Initials: _____ Date: _____

Appendix B: Post-Exercise Participant Rating Survey

Participant's Code: _____ Date: _____ Exercise Name: _____

Instructions:

This survey is for those who have completed an exercise session. You are asked to rate the game you just participated in on a scale of 0-3 using the descriptors highlighted below.

0 = least or not at all

1 = minimum or very little

2 = moderate or average

3 = most or very much

Yes/No responses will be coded as Yes = 1, and No = 0.

Mark your response under the appropriate rows and columns using the symbol (✓). Your responses will be coded for interpretation at the end of the study and your identifying information (name, age, etc.) will not appear on this form and the computed results.

Descriptors	0 (no effect/ not at all)	1 (minimal/very little effect)	2 (moderate/average effect)	3 (maximum/high effect)
The games was strenuous				
The game session lasted long				
I enjoyed the game				
I feel good emotionally after this playing this game				
The game made me want to play it again				
I would like to play this game again				
I would recommend this game to someone else				

Principal Investigator's Comment/ Initials:

Appendix C: Data Master Log

ETSU IRB Approval #: _____

Data Master Log

Assigned Code	Matching Name	Age	Sex	Educational level

PI's Initials: _____

Appendix D: Data Collection Instrument

Participant Code: _____ Date: _____

Pre-test SMMSE: _____ Date obtained: _____
Post-test SMMSE: _____ Date obtained: _____

	Pre-Exercise Vital Signs							
	W1S1	W1S2	W2S1	W2S2	W3S1	W3S2	W4S1	W4S2
Blood pressure (mmHg)								
Pulse (bpm)								
Saturated Oxygen (%)								
Respiratory rate (per min)								

	Post-Exercise Vital Signs							
	W1S1	W1S2	W2S1	W2S2	W3S1	W3S2	W4S1	W4S2
Blood pressure (mmHg)								
Pulse (bpm)								
Saturated Oxygen (%)								
Respiratory rate (per min)								

Note: W and S symbolize the week number and session number, respectively. For example W1S1 indicates Week 1, Session 1, given that there are two exercise sessions per week, for a total of four weeks.

Appendix E. Table of P-Values, Means, Standard Deviations of Participants' Vital Signs

Table 5: Summary of Pre/Post Vital Signs' P-Values, Standard Deviations and Sample Sizes

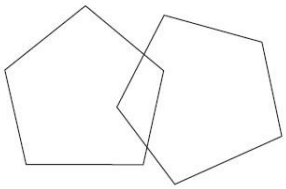
Vital Signs	Exercise Sessions															
	W1S1 n=5		W1S2 n=5		W2S1 n=5		W2S2 n=5		W3S1 n=3		W3S2 n=4		W4S1 n=4		W4S2 n=4	
	P-	SD	P-	SD	P-	SD	P-	SD	P-	SD	P-	SD	P-	SD	P-	SD
Systolic BP (mmHg)	0.001*	5.550	0.160	7.78	0.029*	11.45	0.023*	16.81	0.250	2.52	0.002*	4.35	0.028*	14.86	0.077	19.02
Diastolic BP (mmHg)	0.040*	5.68	0.746	25.78	0.178	12.07	0.523	8.33	0.251	5.77	0.877	14.82	0.019*	2.06	0.027*	3.59
Pulse (bpm)	0.259	7.83	0.663	5.72	0.533	13.77	0.958	7.95	0.117	10.44	0.068	8.96	0.358	6.46	0.314	21.11
Oxygen Sat. (%)	1.000	1.23	0.704	1.10	0.405	1.92	0.181	2.49	0.270	1.53	1.00	0.82	0.058	1.50	0.092	1.63
Resp. rate/min	0.013*	3.03	0.034*	2.83	0.021*	3.77	0.011*	2.79	0.145	3.32	0.014*	2.31	0.024*	2.83	0.069	4.32

Note: Week 1=Hula Hoop, Week 2=Rhythm Kung Fu; Week 3=Wii Just Dance; and Week 4= one self-selected game exercise chosen from the previous three. * Indicates statistically significant results per SPSS analysis.

Appendix F: The Standardized Mini Mental State Exam Instrument

STANDARDIZED MINI-MENTAL STATE EXAMINATION (SMMSE)

	QUESTION	TIME ALLOWED	SCORE
1	a. ***What year is this?***	10 seconds	/1
	b. ***Which season is this?***	10 seconds	/1
	c. ***What month is this?***	10 seconds	/1
	d. ***What is today's date?***	10 seconds	/1
	e. ***What day of the week is this?***	10 seconds	/1
2	a. ***What country are we in?***	10 seconds	/1
	b. ***What province are we in?***	10 seconds	/1
	c. ***What city/town are we in?***	10 seconds	/1
	d. ***IN HOME – What is the street address of this house?*** ***IN FACILITY – What is the name of this building?***	10 seconds	/1
	e. ***IN HOME – What room are we in? IN FACILITY – What floor are we on?***	10 seconds	/1
3	**SAY:** ***I am going to name three objects. When I am finished, I want you to repeat them. Remember what they are because I am going to ask you to name them again in a few minutes.*** Say the following words slowly at 1-second intervals **- ball/ car/ man**	20 seconds	/3
4	***Spell the word WORLD. Now spell it backwards.***	30 seconds	/5
5	***Now what were the three objects I asked you to remember?***	10 seconds	/3
6	**SHOW** wristwatch. **ASK:** ***What is this called?***	10 seconds	/1
7	**SHOW** pencil. **ASK**: ***What is this called?***	10 seconds	/1
8	**SAY:** ***I would like you to repeat this phrase after me: No ifs, ands or buts.***	10 seconds	/1
9	**SAY:** ***Read the words on the page and then do what it says.*** Then hand the person the sheet with CLOSE YOUR EYES on it. If the subject reads and does not close their eyes, repeat up to three times. Score only if subject closes eyes	10 seconds	/1
10	**HAND** the person a pencil and paper. **SAY:** ***Write any complete sentence on that piece of paper.*** (Note: The sentence must make sense. Ignore spelling errors)	30 seconds	/1

11	**PLACE** design, eraser and pencil in front of the person. **SAY**: ***Copy this design please.***  Allow multiple tries. Wait until person is finished and hands it back. Score only for correctly copied diagram with a 4-sided figure between two 5-sided figures.	1 minute	/1
12	**ASK** the person if he is right or left-handed. Take a piece of paper and hold it up in front of the person. **SAY**: ***Take this paper in your right/left hand*** (whichever is nondominant), ***fold the paper in half once with both hands and put the paper down on the floor*** . Score 1 point for each instruction executed correctly. Takes paper correctly in hand Folds it in half Puts it on the floor	30 seconds	 /1 /1 /1
	TOTAL TEST SCORE		**/30**

Source: The Alzheimer's Drug Therapy Initiative. Retrieved December 4, 2013 from http://www.health.gov.bc.ca/pharmacare/adti/clinician/pdf/ADTI%20SMMSE-GDS%20Reference%20Card.pdf