Comparison of Traditional Balance Training to Nintendo Wii Balance Training in Collegiate Athletes

A THESIS

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THESIS APPROVAL

Graduate Athletic Training Education

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INTRODUCTION

Balance is defined as the ability to maintain equilibrium, through the combination of three neural pathways, oculomotor, vestibular, and proprioceptive. The oculomotor system utilizes visual feedback to help maintain equilibrium.[1] The vestibular pathway is comprised of the utricle, saccule, and three semicircular canals within the ear that act together to detect linear and rotational movement, and vertical orientation. Proprioception is provided by receptors located within the skin, muscles, tendons, and joints of the body.[1,2] Two types of balance have been identified as responsible for maintaining and performing day-to-day activities are static and dynamic balance.[3-6] Static balance is defined as the sense of an individual to maintain a still posture while maintaining balance on a stable surface; whereas, dynamic balance is an individual's ability to maintain balance in an unstable environment.[7] A combination of three systems, the proprioceptive, visual and vestibular work together, as well as compensate for one another, to maintain each type of balance.

Many factors influence balance including the age of the individual, type of sport being played, and skill level of competition of the individual. Based on the information of the

athlete in these three areas, the clinician can prescribe appropriate balance training. For example, a gymnast has higher balance ability than a basketball player, thus may not require additional balance training predicated on proprioception.[11]

To date there has been considerable research done comparing different balance training regimens, specifically looking into "traditional" methods such as discs or foam pads as unstable surfaces.[8-13] According to the review done by Hrysomallis,[11] balance training has been shown to significantly reduce injury rates in the ankle and knee.[11,14-18] Traditional balance training exercises that include the Star Excursion Balance Test (SEBT), Dynadiscs, wobble boards, and Indo Boards, have been found to increase postural control of both static and dynamic balance.[19]

Research is lacking however, in comparing these traditional methods of balance training to the use of exergames (video games) particularly in college-aged populations.[20,21] A potential benefit of using exergame balance training is the increased psychological stimulation caused by the game interaction.[21] This interaction is referred to as "flow". Flow is defined as tasks in everyday life where an individual is fully immersed in an activity characterized by energized focus, intense attention, full involvement, and perceived skill or success in the process

of encountering challenges by a task.[20,22,25] Traditional balance exercises can be perceived as boring and repetitive compared to exergames which provide a more interactive component that is engaging to the athlete.[20-22,24-27] Another potential beneficial component of exergames for balance training is hand-eye, or foot-eye coordination that is required to perform the task.[21,29,33] Visual acuity is conceptually an important component of balance, increasing the stimulus of hand-eye or foot-eye coordination can improve kinesthesia, the body's sense of joint in motion possibly causing an increase in balance. While other forms of balance training may elicit similar response, the combination of motivation, is thought to increase the benefits here.[21]

As previously stated, exergames balance training versus traditional balance training has not been heavily researched. Brumels et al[21] looked at traditional balance exercises using the SEBT, DynaDisc balance eyes open and closed, DynaDisc ball toss, and DynaDisc orbits compared to the exergames Dance Dance Revolution using one foot and the Nintendo Wii Balance System. Both of these groups were also compared to a control group for the study. The participants were college aged individuals that performed a four week, three times a week balance training program. Results of the study yielded no difference between

balance training groups, but with improvements in balance for both groups. However, differences were yielded in participant engagement and level of enjoyment with the traditional balance program having the lowest observed scores.[21]

Vernadakis et al[20] performed a similar study assessing differences between traditional balance exercises and the Nintendo Wii. The participants were college-aged physical education majors that performed the study for 8 weeks with 2 training sessions per week. The traditional balance exercises consisted of an exercise program with mini trampolines and inflatable discs (BOSU ball). The Nintendo Wii group played ten various games throughout the study, beginning with the easiest and progressing in difficulty. Specifically, this study was looking into the difference in static balance ability in the balance stability indexes, balance antero-posterior indexes, and balance medial-lateral indexes. Results showed no difference between the two groups; however both conditions improved balance ability over the 8 week training period. These results support Brumels' findings both in balance improvements in healthy college-aged adults, but no difference due to balance training condition over 12 to 16 training sessions.

Finally, Kleim et al[22] provided similar research as well with middle-aged adult subjects (M=46.7 yrs). The study lasted for 3 weeks with 3 training sessions per week. Looking into the Wii's influence on "flow", subjects took a pre test survey on mood state and self-efficacy followed by the post test survey of the same pre and post questions used in Brumels et al[21] study. Kleim's traditional balance exercises consisted of squats on unstable surface, ball-handling, rotary board, and ball-cycling. The Wii group played Ski Slalom, Table Tilt, and Tightrope Walk on the game system. The results of the study yielded traditional balance exercises had a higher, but not significant, improvement in balance over the Nintendo Wii in the SEBT, ball-handling test, and DBT, whereas the Wii group had a higher, but not significant improvement in the Wii balance testing. These results could be due to task specificity using the same instrumentation for both training and testing. In regards to results from "flow" analysis, there was no difference in enjoyment, engagement and difficulty.[22] These results are contrary to Brumels et al[21] study which found a significant difference in enjoyment, engagement and difficulty.

While research is indicating no difference between traditional and exergame balance training regimens, but balance

improvements due to both, further research needs to be done to solidify this statement in the collegiate athlete population. Therefore, the purpose of this study was to see if using the Nintendo Wii is a viable alternative to traditional balance training exercises in the college-aged athlete.

METHODS

Research Design

The study was a quasi-experimental training design. The independent variable was the type of balance training (Traditional/Nintendo Wii/no training). The dependent variables for balance testing were the limits of stability score (LOS) and time to complete test using the Biodex Stability System (BSS). Additional dependent variables, difficulty of the program, engagement and enjoyment of the training program were taken from the post test survey. Under this design, participants engaged in balance training of either the traditional or Nintendo Wii group for four weeks with three training sessions each week, or no training as a control while continuing any respective team or individual offseason conditioning programs. Participants were measured for balance prior to training as a baseline measurement, and at the conclusion of the study as post test. The test results are a generalization to Division II soccer athletes.

Subjects

Division II National Collegiate Athletic Association (NCAA) athletes (n=23) from California University of Pennsylvania participating in women's soccer or men's soccer were asked to be a part of this study during their spring offseason. The sample was obtained through oral presentation during a practice session with no coaches present. Athletes volunteered for the study through a sign-up sheet passed out after the presentation of the project at practice. No bias was present to pressure athletes to participate in the study. Subjects were fully participating in practice in order to participate in the study and were assumed to be healthy if no participation limitations existed. All subjects read and signed the informed consent form prior to participation in this study (Appendix C1). Confidentiality was kept by giving each participant a subject number that was used as their identity for the duration of the study. Subjects performed baseline LOS balance measurements using the BSS. Upon completion, subjects were divided into a randomized sample size using random.org for computerized randomization.

Preliminary Research

Preliminary research consisted of two trial runs using volunteer graduate assistant athletic trainers (GA ATC) as subjects for the testing procedures, and training of two senior athletic training students for the Nintendo Wii balance training protocol. The volunteer GA ATCs performed a LOS test using the BSS to ensure the researcher is familiarized with the equipment. All testing was done in the graduate athletic training research lab located in B6 Hamer Hall. No preliminary research was done on the balance training protocols due to their acceptance as standard and/or appropriate balance training exercises within the rehabilitation setting.

Two volunteer senior athletic training students(ATS), all certified Emergency Medical Technician (EMTs), were trained on the instruction of Nintendo Wii training program and verbal commands they were allowed to say to maintain consistency. The ATS helped provide assistance for the intensive training time that existed with the training program that lasted four weeks long with three training sessions per week. Each training session was 15 minutes long consisting only of the balance training the participant is assigned to. All training was done in the Hamer Hall B5. The researcher administered the

traditional balance training program and the ATS provided set up and monitoring of the Nintendo Wii balance training program by providing any necessary spotting and proper progression. Progression of training was added on a per-session basis when the participant was no longer being challenged during the exercise and all of the traditional balance training progression was completed. The progression was determined by the participant beating all the levels of the Wii game. The progression was made on a per subject decision, not a group progression to ensure an individualized training program. Verbal commands only consisted of instruction of how to perform the exercises and no encouraging terms or feedback on performance during and after the training session.

Instruments

Three testing instruments were used: A demographic sheet (Appendix C2), the Biodex Stability System (BSS), and a qualitative survey (Appendix C3). Two balance training programs were used: traditional balance training program (Appendix C4), and Nintendo Wii balance training program (Appendix C5).

Testing Instruments

The balance ability of each participant was assessed prior to and at the conclusion of the four week training program using the BSS. The BSS measured the participants LOS by controlling a cursor through the balance platform to touch eight flashing points on the screen. The participant was instructed to hold the cursor in the flashing point for .25 seconds. This test assessed how accurately and quickly the participant controlled their center of gravity. The following equation was used to calculate the LOS score and total time to complete the test.[28,30]

$$\text{LOS score \%} = \frac{\text{Straight line distance to target}}{\text{Actual distance traveled}} \times 100$$

$$\text{Overall LOS score} = (\text{LOS scores})/8$$

Participants with higher balance scores in a shorter time period, using time to complete the task, were indicated to have better control of COG within their LOS, and as a result, better balance. The reliability of the LOS test on the BBS was reported as being from .77 to .89.[31]

The survey was assessed using a 5-point Likert scale (Appendix C3). Difficulty of the program was statistically compared between the two training groups. Engagement and enjoyment was also compared in a separate statistically analysis between groups.

Training Instruments

Traditional balance protocol. Established and accepted traditional balance exercises completed in any training or clinical rehabilitation setting were used for the protocol. For balance improvements to be seen, training reportedly must be performed at least three training sessions per week for four weeks.[9,35] Eisen et al[9] showed that a rocker board or discs yield the same results in balance improvements. Vernadakis et al[20] found the use of a BOSU balance training program to be influential in balance ability. Based on the prior research done, the traditional balance training program was developed (Appendix C4). Progression of the exercises was based on patient ability to complete the traditional balance training progression checklist developed the researcher to increase inter trainer/rater reliability (Appendix C6).

Nintendo Wii balance protocol. Based on previous research, the Nintendo Wii balance training program was developed for selected Wii exergames thought to improve dynamic balance.[20-22] Three Wii balance games were selected from the available nine games, and were not played in any particular order. All games were played in that training session (Appendix C5). Progression of the exercises was based on the patient's ability to beat all the levels of the balance game. The progression was made by the

researcher and/or the athletic training student as outlined in the preliminary training for the study.

Procedures

The proposal was reviewed and approved by the California University of Pennsylvania Institutional Review Board (IRB) (Appendix C7). Participants were obtained as volunteers from the women's and men's soccer teams at California University of Pennsylvania before or after practice where the coaches were not present to prevent any coercion. The researcher explained the study fully to ensure the participants knew the time commitment and any risks that were involved as a subject in the study. Upon completion of the meeting, participants that wanted to volunteer for the study were given an informed consent form that was signed and left with the researcher. At that time, the participants signed up for a time to complete their demographic information and pre-testing. At pre-testing, the participants filled out their demographic information with the researcher performing measurements of their height and weight using a manual weighing and height scale, and the participant answering the offseason training participation questions. Participants then performed a baseline LOS test using the BSS. The

participant performed two practice trials to reduce the learning effect that has been noted previously using the BSS.[30,32-34] This involved balancing on the BSS platform that became unstable as the participant moved the cursor to eight flashing locations on the screen. The participant had a spotter the entire testing period to prevent any falls from occurring. The BSS calculated the LOS score based on how fast and accurately the participant was able to reach the flashing locations. In between each testing trial the participant rested for 60 s. The subject then completed two test trials with the third score being used for data analysis. Upon completion, subjects were randomly assigned to one of the three groups (Traditional/Nintendo Wii/control) using www.random.org for a computerization random sample. All subjects were allowed to participate in any team offseason programs or other regular activities.

Subjects were scheduled for their assigned individual training sessions, or no training for the next four weeks, three times a week. Training involved performing 15 minutes of balance activity described in Appendix C4 and C5.

Upon completion of the four week study, subjects participating in either type of balance training were asked to fill out a survey that was compiled by Brumels et al[21] (Appendix C3). Control subjects were not incorporated into the data analysis of

the post-training survey as they did not participate in any balance training activities. These results were recorded using a 5-point Likert scale and compared for difficulty, enjoyment and engagement of the programs.

Hypotheses

The following hypotheses were studied:

1. There will be no difference in balance improvements on the BSS LOS score and time to complete test between the Nintendo Wii and Traditional Balance Training groups, but significant improvement due to training compared to the control group.

2. The Nintendo Wii group will yield significantly higher engagement and enjoyment scores on the post test survey compared to traditional balance training.

3. The traditional balance training group will yield significantly higher level of difficulty based on the post test survey compared to the Nintendo Wii group.

Data Analysis

All hypotheses were tested using SPSS version 18.0 assuming a $P \leq .05$ level of significance.

Hypothesis 1: A repeated measures (pre/post) MANOVA (LOS score and time to complete test) was used for the LOS score and the time to complete test.

Hypothesis 2: A one-way ANOVA was used to determine significant differences between mean scores for engagement and enjoyment of the training program. An average value between engagement and enjoyment question scores was used for the analysis.

Hypothesis 3: A one-way ANOVA was used to determine significant differences between mean scores for level of difficulty for the training program.

RESULTS

The purpose of this study was to see if using the Nintendo Wii is a viable alternative to traditional balance training exercises in Division II soccer athletes as measured by the BSS. Subjects engaged in a four week balance training program that consisted of Nintendo Wii Balance games or traditional balance exercises. Balance ability was measured by the LOS overall score and the time to complete test on the BSS.

Demographic Data

The study consisted of 23 volunteer Division II soccer athletes at California University of Pennsylvania. Out of the 23 subjects, 22 completed the pre and posts testing with one participant being eliminated from the study due to an injury not related to the study. All traditional training sessions were supervised by a licensed athletic trainer with Nintendo Wii training sessions supervised by an athletic training student or licensed athletic trainer. All pre and post testing was conducted in the same way and by the same administrator to increase test validity. All demographic data was collected by

the test administrator through oral questioning (Table 1 and Table 2).

Table 1. Demographic Data (N = 22)

	Min	Max	Mean	SD
Age (yrs)	18	24	19.9	1.57
Height (in)	62	75	68.36	3.84
Weight (lb)	117	234	167.68	29.01

Table 2. Gender Distribution among Groups

Group	Traditional	Nintendo Wii	Control	Total
Male	5	4	3	12
Female	3	3	4	10
Total	8	7	7	22

Hypothesis Testing

Hypothesis testing was performed by using data from the 22 participants who completed the four week training study and the pre and post testing. The hypotheses were tested at an alpha level of $\leq .05$.

Hypothesis 1: There will be no difference in balance improvements on the BSS LOS score and time to complete test between the Nintendo Wii and Traditional Balance Training groups, but significant improvement due to training compared to the

control group. A repeated measures (pre/post) MANOVA (LOS score and time to complete test) was used for the LOS score and the time to complete test.

Conclusion: A one-way repeated-measures MANOVA was calculated comparing the LOS and TOC scores during the pre and post testing of the study. No significant effect was found for group ($F_{1,19} = 1.49$, $p \geq .05$). No significant difference exists among pre LOS score (31.5 ± 8.12), post LOS (30.88 ± 5.94), pre TOC test (48.88 ± 10.55), and post TOC test (45.37 ± 6.19) means. No significant difference was reported for TOC test group ($F_{2,19} = .516$, $p \geq .05$).

Table 3. Pre and Post LOS Means and Standard Deviations by Training Group

Measure	Group	Mean	sd
Pre LOS score	Traditional	31.50	8.12
	Nintendo Wii	27.43	7.91
	Control	27.57	5.59
	Total	28.95	7.26
Post LOS score	Traditional	30.88	5.94
	Nintendo Wii	32.00	7.12
	Control	28.43	4.50
	Total	30.45	5.85

Table 4. Pre and Post TOC Means and Standard Deviations by Training Group

Measure	Group	Mean	sd
Pre TOC test	Traditional	48.88	10.55
	Nintendo Wii	46.57	8.38
	Control	47.00	10.89
	Total	47.55	9.60
Post TOC test	Traditional	45.37	6.19
	Nintendo Wii	42.14	8.95
	Control	43.86	4.63
	Total	43.86	6.61

Hypothesis 2: The Nintendo Wii group will yield significantly higher engagement and enjoyment scores on the post test survey compared to traditional balance training. Two one-way ANOVAs were used to determine significant differences between mean scores for engagement and enjoyment of the training program.

Conclusion: A one-way ANOVA comparing the engagement scores of the subjects who participated in the balance training groups was computed. A significant difference was found among the training groups (F 1,13 = 4.11, p = .05). Those who participated in the traditional balance training group reported significantly higher scores (4.75 $\pm$ .463) than those in the Nintendo Wii group (4.14 $\pm$ .690). A second one-way ANOVA comparing the enjoyment scores who participated in the balance training groups was analyzed. No significant difference was found (F 1,13 = 2.43, $p \geq .05$). The two balance training groups did not differ significantly in enjoyment scores due to type of balance training as indicated on the post test balance training survey.

Hypothesis 3: The traditional balance training group will yield significantly higher level of difficulty based on the post test survey compared to the Nintendo Wii group. A one-way ANOVA was used to determine significant differences between mean scores for level of difficulty for the training program.

Conclusion: The difficulty score means of the participants in the balance training groups were compared using a one-way ANOVA. No significant difference was found (F 1,13 = 1.49, $p \geq .05$). The two balance training groups did not differ significantly on level of difficulty of the training program as indicated on the post test balance training survey.

Table 5. Descriptive Statistics of Post Training Survey

Group	Question	N	Min	Max	Mean	SD
Traditional	Difficult	8	2	5	3.38	.92
	Engaged	8	4	5	4.75	.46
	Enjoy	8	2	5	3.75	1.04
Nintendo Wii	Difficult	7	2	4	2.86	.69
	Engaged	7	3	5	4.14	.69
	Enjoy	7	4	5	4.43	.54

Additional Findings

Further testing was done to see if any differences and/or correlations existed in LOS and TOC scores among gender, height and weight among the three groups.

A repeated measures ANOVA test was used to analyze any differences in LOS and TOC scores due to gender. No significant difference was reported (F 1,20 = 1.51, p > .05). This shows that there is no gender difference in balance ability in LOS and TOC scores among control, traditional balance training and Nintendo Wii balance training groups.

A Pearson correlation coefficient was used to calculate the relationship among height, weight and post LOS score. A negative correlation was found ($r(20)$ = -.47, p > .05), indicating a low, negative relationship between weight and LOS score. In this way, and in supporting previous research, as weight goes up, balance ability goes down, but only around 50% of the expected time. Height and post LOS score did not show a significant correlation ($r(20)$ = -.31, p > .05). Height is not related to a higher post LOS score, and therefore, better balance (Table 3).

Table 6. Correlations between Post LOS scores to Height and Weight

		Post LOS Score	Height	Weight
Post LOS Score	Pearson Correlation	1	-.311	-.467*
	Sig. (2-tailed)		.159	.029
	N	22	22	22
Height	Pearson Correlation	-.311	1	.691**
	Sig. (2-tailed)	.159		.000
	N	22	22	22
Weight	Pearson Correlation	-.467*	.691**	1
	Sig. (2-tailed)	.029	.000	
	N	22	22	22

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

The significance of these findings show that while gender and height do not have an influence on LOS and TOC scores, however weight may influence LOS scores.

DISCUSSION

Discussion of Results

According to the review done by Hrysomallis,[11] balance training has been shown to significantly reduce injury rates in the ankle and knee.[11,14-18] Research is limited in the focus of balance training of different training devices in traditional exercises and exergames, particularly in the college-aged athletic population. Therefore, the purpose of the study was to determine if the Nintendo Wii was a viable option for balance training college-age athletes rather than traditional balance training exercises. Data was collected using the BSS in terms of the LOS and TOC scores in a pre and post testing manner in healthy athletes as opposed to injured or those engaged in rehabilitation.

A key finding was that there was no significant difference in improvements of pre and post LOS and TOC scores among the three groups. This is contrary to the literature in that balance training programs for four weeks have shown overall improvements in balance ability.[9,35]

Studies using the Nintendo Wii and traditional balance exercises found significant improvements in balance ability

overall, but not due to group. Brumels et al[21] found significant improvements in balance ability in their four week training study. This study measured the center of pressure using the AMTI AccuSway[Plus] Balance Platform which was performed on the participants' dominant leg. This was performed with the eyes open and eyes closed for 10 seconds with hands on hips and slightly flexed opposite knee and hip. Vernadakis et al[20] also found results to be significant in balance improvement in their eight week training study. Balance was measured using the BSS with participants performing a single leg static balance on the unstable BSS platform for 20 s. Overall total stability, anterior-posterior, and medial-lateral indexes were reported. Three test trials were administered with the lowest score (best performance) being used for data analysis.

Implementing proper testing devices is difficult in balance testing because there is no gold standard in measuring balance. The use of the AMTI AccuSway[Plus] Balance Platform measures ground reaction forces with center of pressure and displacement from base of support.[21,36] Brumels et al[21] used this testing method in a dynamic static testing environment with no movement or reaction component to the testing. Although Vernadakis et al[20] used the BSS, the testing was performed in a dynamic static testing environment with no reactive component used to measure balance

as well. Vernadakis et al[20] instructed participants to perform a single leg balance on the unstable platform of the BSS, that then calculated deviations from neutral. The BSS LOS was chosen for our study to compliment mimicked foot-eye coordination utilized in the Nintendo Wii group, as well as the basic nature of regaining balance in balance training overall. This relationship was thought to give a more valid representation of the balance ability of the participant as the LOS task requires dynamic components of balance as well as regaining balance to create equilibrium. Based on our results, individual motor learning patterns can be considered to have an effect on LOS balance performance on the BSS, while in previous research; the dynamic stability was considered more as opposed to LOS scores. We also used the best balance score, typically the last test trial, as in previous research.

While LOS scores were not significantly different due to group, the Nintendo Wii and control group means demonstrated improvement for pre to post in these scores, whereas the traditional group lowered their mean scores from pre to post. It might also be noted that improvements were higher for the Wii group. The TOC test for all groups showed a decrease in time, meaning an improvement in performance of the test. This may

present a learning curve was developed in performing the test and should be noted for future research.

Another key finding was there was no significant difference among the post testing training survey of participants' perceptions of difficulty of the program. Both groups saw the training to be somewhat difficult, although the traditional training group reported a higher mean in reported scores (3.38 $\pm$ .916) compared to the Nintendo Wii group (2.86 $\pm$ .69). This lines with results (p=.658) that were found by Kliem et al[22], which revealed almost identical means between the traditional (3.27 $\pm$ 1.56) and Nintendo Wii (3.45 $\pm$ 1.56) groups. This is contradictory to previous research as well done by Brumels et al[21]. Brumels et al[21] found that there was a significant difference (p = .016) in post testing survey scores of difficulty between groups. The current study used the same survey to limit the variability between studies, but different training methods were implemented for traditional and Nintendo Wii groups. The researcher chose different traditional balance exercises from those done in previous studies comparing traditional balance training and Nintendo Wii balance training.[20-22] The use of different exercises could potentially have an influence on differing results from the previous studies. The exercises that were chosen for this study may not have

presented to be as difficult as those of previous research. The Nintendo Wii balance training program was similar to Brumels et al[21] study in using the same three Wii games. The major difference in our study, was adding a BOSU ball as an additional balance progression to the Wii board while playing the game. All participants reached this progression for at least one of the Wii games by the conclusion of the 4 weeks of training. This could have had an effect on perceived difficulty of the program, as the Nintendo Wii game became more difficult to perform while on the BOSU ball as many of the participants noted this while performing the training. All of the participants played at least one game on the BOSU ball if they were a part of the Nintendo Wii balance training group.

Finally, the enjoyment scores did not present any significant differences between the training groups; however there was a significant difference in engagement scores between training groups. This contrary to the results produced by Brumels et al[21] in engagement scores in not being a significant difference between groups. Brumels' study did note, however, that the scores for engagement were higher in the Wii group, but were not significant. Brumels also reported significant differences ($p = .006$) in level of enjoyment between groups

which conflicts with our results. Kliem however, yielded similar results to ours in finding no significant difference in enjoyment scores (p=.972) among training groups. While it was expected that results may be different in healthy college-aged athletes, our results do support the literature. Athletes by nature may be more competitive than the healthy college-aged individual, as well as perceive exercise differently. All the balance training was done with a partner, and although they were instructed to have limited interactions participants did have a competitive nature when performing the training. This condition could have caused the participants to have higher engagement scores in both groups. Although the scores for enjoyment were not significantly different, the Nintendo Wii group did report a higher mean score than the traditional group. The presence of "flow" could have been the reasoning behind this increased mean score in the Nintendo Wii group. Each training session many participants came into the training set on beating their previous scores and wanting to reach the high score out of everyone in the group. They did not know who had the higher score, but could see what their score was after each game.

Conclusion

In contrast to previous research, balance training did not significantly improve balance ability in healthy college athletes. While supporting previous findings, the training program, Wii to traditional, did not significantly affect subjects' engagement, enjoyment or difficulty scores due to group, it is suggested that college-aged athletes may view exercise differently than the general population in that either program may be viewed as mutually challenging. The Nintendo Wii does present a viable option to be used as a balance training component in healthy college-aged athletes, but further research is needed to test program design.

Recommendations

Our findings suggest that using the BSS LOS and TOC with other balance instruments might track trends and potential difference that come about through balance training healthy college-aged athletes. Using multiple instruments might further help to distinguish differences in types of balance training to testing, and further support the specificity of tasks. Increasing the time allotted to do the balance training would

allow for more progressions to be added allowing for improved balance ability. The balance training programs should look at different methods that may produce improved balance ability. Further research is needed to be done to provide the Nintendo Wii to being a viable option of balance training in place of traditional balance training.

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APPENDICES

APPENDIX A

Review of Literature

REVIEW OF LITERATURE

Balance is defined as the ability to maintain equilibrium, through the combination of the three neural pathways, oculomotor, vesibular, and proprioceptive pathways. The two types of balance that are maintained to perform day-to-day activities are static and dynamic balance.[1-6] Static balance is the sense of an individual to maintain a still posture while maintaining balance on a stable surface; whereas, dynamic balance is an individual's ability to maintain balance in an unstable environment.[7] There has been an immense amount of research that has been done on different balance training regimens, specifically looking into "traditional" methods of using dynadiscs or foam pads as unstable surfaces.[8-13] However, research is lacking in the area comparing these traditional methods of balance training to the use of exergames (video games) as a substitute in college aged individuals.[20,21] Traditional Balance exercises can be considered boring and repetitive compared to exergames which provide a "flow" experience for the patient or athlete.[20-22,24,25,27,28]

The purpose of this literature review is to highlight current research on the validity of using the Nintendo Wii as a balance training apparatus compared to traditional balance

training, and the need to have further research to discover the best practice in balance training.

BALANCE

Balance is an important aspect of day-to-day activities. The communication loop between the central nervous and musculoskeletal systems gives an individual that ability to maintain balance. It is common knowledge that if an individual has good balance, they are less likely to have an injury. This is why balance is a key component of return-to-play considerations during the rehabilitation process.

Sensory Components of Balance

The internal factors within the human body that are crucial for balance performance are the vestibular, oculomotor, and proprioceptive systems. Through these systems, the body then provides motor activation of muscles to maintain equilibrium.[1,7-11,33,34]

The vestibular system within the inner ear acts as the liaison to send messages to the central nervous system (CNS) regarding static position and movement.[1] The ear contains a vestibular apparatus, composed of the utricle, saccule, and three semicircular canals. Vertical orientation and linear

movement is detected by the utricle and saccule components, whereas rotational movement is detected by the semicircular canals component of the ear.[2]

Visual perceptions of the body in space are provided by the oculomotor system. A component of this system is visual fixation, which aids an individual's balance by focusing in on one object and ignoring all other moving objects. Another important component that aids the oculomotor system is the vestibular-ocular reflex provided by the vestibular system, which helps the eyes be stable during motion to remain focused on an object to maintain balance.[1]

The somatosensory or proprioceptive system, provides for the body's sense of position in space. There are many receptors located within the skin, muscles, tendons, and joints that aid in the function of this system. These receptors send impulses through the CNS in a feedback loop that consists of a sensory or motor impulse that triggers a response. When injured, the body looses the most important component to balance in proprioception resulting in decreased balance and an increase in time to react.[1,34,35]

Measuring Balance

While balance can be measured through a variety of tests, unfortunately there is no "gold standard" method.[19,36] Research measures include center-of-pressure (COP) in participants; this measure has shown to reflect COP movements of both horizontal movement of center-of-gravity (COG) and ground reaction forces due to muscle activation of the lower leg that is transmitted through the foot. This movement that occurs is inherently related to the body's movement, and is otherwise known as body sway. These measurements are typically found using a force platform or other computer sensor platform systems.[19]

In this way, technological advancements has provided for further quantitative assessment of balance using objective numerical values. The force plate platform is an example of a computer-based static balance testing measurement that records the COP through sensors in a platform structure that are transmitted to a computer system that provide objective numerical values.[19]

Devices Using Technology. The Biodex Stability System provides a dynamic balance measurement through an unstable platform embedded with sensors that are relayed to a computer system.

This measures the degree of tilt about each axis of motion during dynamic conditions, providing greater measurements of ankle joint proprioception. These measurements are represented in reports that trace the total excursion area of the test and quantify them into numerical values.[19]

The Dynamic Postural Stability Index (DPSI) presented by Wikstrom[37] in 2005 provides a jump protocol using an integrated force plate that measures fluctuations of the center-of-mass (COM) around an equilibrium point during the time after the landing phase of the jump. The COP is calculated using a force plate to measure in 3 different directions, medio-lateral, antero-posterior, and vertical axis. DPSI provides an index for an individual's time-to-stabilization after performing a dynamic task.[19,37]

Devices Not Using Technology. The Star Excursion Balance Test (SEBT) is a commonly used method for dynamic balance testing using a reach method. This involves placing a testing grid consisting of 8 lines each 120 cm in length extending from a common point at 45° angle increments and should be performed on a textured tiled surface for more reliable results to be obtained; hence, the star shape. When reporting data, reach distances of

one leg are suggested to be normalized to leg length to prevent skewed results.[19,38]

The use of an unstable surface is used in the Balance Error Scoring System(BESS). Three stance positions (feet together, non-dominant single leg, and tandem stance)are performed for 20 s each on a stable and unstable surface. Points are awarded for violation of: (1) opening eyes, (2) lifting hands from hip, (3) touchdown of non-stance foot, (4) step, hop, or other movement of the stance foot or feet, (5) lifting forefoot or heel, (6) moving hip into more than 30° of flexion or abduction, and/or (7) remaining out of position for longer than 5 s.[19,39]

Factors Affecting Balance

Many factors have an influence on balance such as an age of the individual, the type of sport being played, and the level of competition of the individual. The importance of early balance training in youth athletes was reviewed by Ricotti.[19] The visual component of balance control was shown to have greater importance in higher level athletes, concluding that development of visual balance training may improve performance in youth athletes.[19,37] With improving balance at youth levels, there may result in a less chance for injury. [11,19,21] Continued research is

needed in this topic to ensure these correlation are in fact true.[11,19]

Another factor that is related to balance is the type of sport an athlete plays. A study done by Eisen et al[9] looked into multi-axial(Dynadiscs) versus uniaxial (Rocker board) balance training leading to differences in dynamic balance among Division I women's volleyball, men's soccer, and women's soccer teams. The participants performed baseline testing and were then separated by balance ranking into three groups. Equally ranked participants were then randomly assigned to one of three groups: a control group, rocker board training group, and dynadisc training group. The results showed no significant difference between the control and experimental groups. Limitations of this study however were the decrease in activity that occurred after their subjects seasons ended when the experiment began and the validity of the SEBT. The study argues if the improvements were based on the balance training or practice effect. The conclusion from this study is conventional training programs which focus on general fitness maybe sufficient enough for maintaining balance.[9]

Bressel et al[32] also looked into the variability among different sport athletes' static and dynamic balance scores. This study used the BESS and SEBT to measure balance among

female basketball, soccer, and gymnastic athletes to find that basketball players performed the worse in both dynamic and static balance tests and gymnasts were shown to have the highest scores.[32]

Men soccer and basketball athletes were assessed on their dynamic and static balance through the BESS and SEBT by Kachanathu et al.[33] No difference was yielded in the static balance, but soccer players held a high dynamic balance ability compared to basketball players. This proposes that basketball players would benefit more with balance training than soccer players.

Balance ability is also different across varying levels of competition/participation within particular sports. Hrysomallis[11] showed that professional athletes that are golfers, rifle shooters, ice hockey, luge and soccer players have increased balance compared to recreational or amateurs of their particular sport. Within each sport, balance levels may be a clue to increased performance.

Balance Training

Balance training is the process to improve balance ability. Programs should abide by the overload principle to ensure the

athlete progresses to be challenge in each balance training exercise.[1] Two forms of balance training are traditional balance training and exergame balance training. Traditional balance training involves using dynadiscs, Bosu balls, or other unstable surfaces to challenge balance ability. Exergame balance training involves using a video game based program, such as the Nintendo Wii, to challenge balance ability.

Balance Training - Traditional

The rehabilitation or prevention of injuries should always contain a balance section. According to the review done by Hrysomallis,[11] balance training has been shown to significantly reduce injury rates in the ankle and knee.[11,14-18] Balance training alone has also been shown to produce significant strength improvements compared to just strength training in lower leg musculature.[40] Keen et al[41] found an increase in rectus femoris activation during jump landing through balance training. Using the traditional balance training exercises that include the SEBT, Dynadiscs, wobble boards, and Indo Boards, rehabilitation specialist have been aiding individuals in improving postural control of both static and dynamic balance.[19]

Exergames as Balance Training

The technology age has presented many new training options for performance enhancement and injury prevention. Video exercise games were first developed back in the late 1950s with "Tennis for Two" on an oscilloscope,[42] and have developed into real-life-like game simulation that can be played at home. Nintendo, Microsoft (X-box), Sony, and Dance Dance Revolution are the major companies that are producing activity promoting game systems.[43] With the influx of these "exergames", a new option for rehabilitation was brought forth. Research has been mainly focused on preventing falls of elderly people through exergame balance training,[3,43-45,47,48] with little focus on the college-aged athletic population.[20-22]

A benefit of using exergame balance training is the increase psychological stimulation that is caused by the game interaction. In everyday life, when an individual is fully immersed in an activity characterized by energized focus, intense attention, full involvement, and perceived skill or success in the process of encountering challenges can be termed experiencing "flow".[25] With regards to exergames, "flow" is reached through "GameFlow" that is described by Sweetser et al,[26] and consists of clear goals, feedback, challenge, player skills,

concentration, control, immersion, and social interaction within and around the game. The Nintendo Wii Balance Board system possesses this experience through the avatar, patient look-a-like figure on the video game screen, called Mii.[24-27,43] With this added component of "GameFlow" to the rehabilitation process, athlete's maybe more compliant to the exercise plan.[20-22]

Another beneficial component of exergames for balance training is hand-eye, or foot-eye coordination that is required to perform the task.[21,29,33] With visual acuity as an important component of balance, increase the stimulus of hand-eye or foot-eye coordination can improve kinesthesia or the body's sense of joint in motion possibly causing an increase in balance.

Comparing Traditional to Exergame Balance Training

Comparison between traditional balance training and Nintendo Wii has not been researched heavily in the college age athletic population.[20,21] Brumels et al[21] performed a study that looked at traditional balance exercises using the SEBT, DynaDisc balance eyes open and closed, DynaDisc ball toss, and DynaDisc orbits compared to Dance Dance Revolution using one foot as well as to the Nintendo Wii Balance System. The study consisted of 25 college-age participants who were randomly assigned to a control

group, traditional balance training group, Dance Dance Revolution group, or Nintendo Wii group. The participants performed a four week, three times a week balance training program. Balance was measured using the SEBT described by Gribble et al[38] with eyes open and closed on force plate testing surface for ten seconds. The study also gave a survey to all participants after the study looking in to the difficulty of their program, level of engagement and if the participant enjoyed the program. Results of the study yielded no difference between balance training groups improvements of balance; however, differences were yielded in participant engagement and level of enjoyment with the traditional balance program having the lowest observed scores.[21]

Vernadakis et al[20] performed a similar study assessing differences between traditional balance exercises and the Nintendo Wii. Participants consisted of 32 college-aged individuals whose balance measurements were done through the Biodex Stability System at the beginning and end of the eight-week balance-training program. The participants were randomly divided into two training groups, a traditional balance training group and a Nintendo Wii balance training group. The traditional balance exercises consisted of an exercise program with mini

trampolines and inflatable discs (BOSU ball). The Nintendo Wii group played ten various games throughout the study, beginning with the easiest and progressing difficulty. Specifically the study was looking into the difference in static balance ability in the balance stability indexes, balance antero-posterior indexes, and balance medial-lateral indexes. These indexes provided a numerical value of deviations of the balance platform as a representation of limits of stability. Results showed no difference between the two groups, however both improved balance ability over the training period.

Kleim et al[22] provided similar research as well with middle-aged adult subjects (M=46.7 yrs). Twenty-two participants performed balance testing using the SEBT, ball-handling exercise, two Wii Balance games (Ski Slalom and Balance Bubble- taking the mean balance times of three trials for the test), and a dynamic balance test (DBT). The participants were then randomly assigned to either traditional balance training or the Nintendo Wii balance-training group. Looking into the Wii's influence on "flow", subjects took a pre test survey on mood state and self-efficacy followed by the post test survey of the same pre and post questions used in Brumels et al[21] study. Kleim's traditional balance exercises consisted of squats on unstable surface, ball-

handling, rotary board, and ball-cycling. The Wii group played Ski Slalom, Table Tilt, and Tightrope Walk on the game system. The results of the study yielded traditional balance exercises had a higher, but not significant, improvement in balance over the Nintendo Wii in the SEBT, ball-handling test, and DBT, whereas the Wii group had a higher, but not significant improvement in the Wii balance testing. This brought about a major limitation to this study to be the testing protocol was the same as the training protocol. This caused for a possible learning curve to the testing protocol to give an advantage to the balance group performing their activity. In regards to results from "flow" analysis, there was no difference in enjoyment, engagement and difficulty.[22]

Research is pointing in a direction where there could be no difference in the balance training regimens, but further research is to be done to solidify this statement.

SUMMARY

Everyday living involves a lot of balance to go about the day. Incorporating the three systems of somatosensory, visual, and vestibular ensure that an individual remains balanced. Without static and dynamic balance, activities of daily living

would be much more difficult to perform, and performing in athletics would be near impossible. Through mechanoreceptors, center of pressure and proprioception, dynamic and static balance can be maintained to perform activities.

Many tests exist to assess balance, but there is no gold standard to test balance. The BSS and DPSI provide quantitative numerical values through computer technology that supply objective data to be applied research and/or medical documentation. BSS and DPSI are calculating the COP that can be correlated with COM and body sway. The SEBT and BESS incorporate human error into the test resulting in possibility of invalid test results.

Many factors have an influence on balance such as an age of the individual, the type of sport being played, and the level of competition of the individual. Based on the information of the athlete in these three areas, the clinician can prescribe balance training. For example, a gymnast has higher balance ability than a basketball player, thus will not require additional balance training.[11]

Balance training has been shown to aid in injury prevention.[11,24,49,50] The current state of balance training is in

traditional approaches. Rehabilitation specialists use unstable surfaces to aid in the training, such as dynadisc, wobble boards, and Bosu balls.

Current research has presented a possible shift to using exergames as a viable option in balance training.[20,21,28] Brumels et al[21] and Vernadakis et al[20] showed that the use of the Nintendo Wii does have an effect on improving balance; however, none of them found a statistical difference between traditional balance training and Nintendo Wii balance training.

Another aspect that is positive in exergame balance training is the incorporation of GameFlow into the rehabilitation session. Brumels et al[21] found a statistically significant increase in level of engagement and enjoyment in the Nintendo Wii compared to traditional balance exercises. This can result in increase compliance to a rehabilitation program to speed up return-to-play of a patient.

Few research studies exist with the comparison of traditional and Nintendo Wii balance training; therefore, further research is to be done on the comparison of balance training between the Nintendo Wii and traditional balance exercises to see the most effective balance training program.

APPENDIX B

The Problem

STATEMENT OF PROBLEM

Balance can be considered an important component of rehabilitation and injury prevention plans, as a highly functioning proprioception system is required. Therefore, certified and licensed athletic trainers should seek effective training methods to aid in improving balance. One strategy used by clinicians is the introduction of video games such as the Nintendo Wii in balance training as opposed to more traditional balance exercises such as the Star Excursion Balance Test. Video games provide different challenges in balance training for the athlete which include ability to visually see balance dysfunction and provide elements of reaction during training sessions and a form of entertainment in "flow". If video games provide for similar or greater improvements in balance when compared to traditional programs, then athletes may potentially have better rehabilitation outcomes.

The purpose of this study was to see if using the Nintendo Wii is a more viable option for balance training rehabilitation exercises, rather than traditional balance training exercises.

Definition of Terms

The following definitions of terms were defined accordingly for this study:

1. Biodex Stability System: balance testing system in a closed-chained, multi-plane testing environment to assess static or dynamic balance, as well as limits of stability on either a single or double leg stance.[31]
2. Body Sway: patients movement during a balance exercises.[19]
3. Center of Pressure: body distribution of force to the ground that can be correlated to body sway.[19]
4. Dynamic Balance: ability to maintain equilibrium in a motion.[11]
5. Exergame: video game technologies that exhibit interactive environments requiring movements and gestures of the upper and/or lower extremities in order to simulate on-screen game play.[20]
6. Flow: an individual who has peak intrinsic motivation of happiness that is fully immersed in what they are performing.[20]
7. GameFlow: video game presents and individual with clear goals, feedback on performance, challenges the

individual, support player skill and development, require concentration, player should feel a sense of control of game, sense of immersion within the game, and support social interaction with others.[20]

8. Nintendo Wii: an interactive gaming device that involves an attachment balance board system to perform balance exergames.[20]
9. Proprioception: the body's awareness of joints through sensory input from various receptors including muscle receptors such as golgi tendon organs, ligaments, muscle spindles, joint capsules and cutaneous receptors.[35]
10. Static Balance: ability to maintain equilibrium over a stationary base of support.[11]
11. Star Excursion Balance Test: Single leg balance test measuring the reach distance of the free leg in eight directions.[38]
12. Traditional Balance Training: used for the purpose of this study includes exercises involving stable or unstable surfaces using a single or double leg stance with no technological feedback.

Basic Assumptions

The following were basic assumptions for this study:

1. All participants were considered to be healthy and able to participate in the study if participating in regular conditioning plans.
2. All balance testing instruments were reliable and valid.
3. Participants reported their flow honestly and appropriately.
4. The BSS was calibrated and working properly for this study.
5. The population was a fair representation of NCAA Division II athletes.
6. As participants were able to continue regular personal or team off season conditioning plans, any off-season regimens were considered to have no significant improvement on balance ability.

Limitations of Study

Results may be only generalized to similar school size and soccer athletes.

Significance of the Study

The use of the Nintendo Wii is a new concept being used in the athletic setting for rehabilitation and injury prevention. The Wii has been used for a variety of rehabilitation programs as an alternative to traditional exercises, in particular, for balance training. Little research exists to show which balance training regimens are the most beneficial to the athlete.

Balance is a basic, yet important skill for daily function. Many research studies exist showing the link between balance ability and sport injury risk. The better balance a person has the less likely to have an injury. Balance Training has been shown to have decreased rates of lower extremity injuries,[49] specifically rates of ankle sprains.[11,24,50] The problem with traditional balance programs is they can be boring and non-stimulating, leading to less than desired engagement and performance. The Nintendo Wii has been shown to be more engaging and enjoyable than traditional exercises in college-aged students.[21]

APPENDIX C

Additional Methods

APPENDIX C1

Informed Consent Form

Informed Consent Form

1. Peter Aune, a licensed and certified athletic trainer (LAT, ATC), is a Graduate Athletic Training Student at California University of Pennsylvania and has requested my participation in his thesis research study at California University of Pennsylvania. The title of the research is the "Comparison of Traditional Balance Training to Nintendo Wii Balance Training in Collegiate Athletes".

2. I am of 18 years old or older to be eligible to participate in this study.

3. I have been informed that the purpose of the research is to determine the usefulness of using a Nintendo Wii balance board training system compared to traditional balance training exercises, or no balance training.

4. I have been invited to participate in this research project. My participation is voluntary and I can choose to discontinue my participation at any time without penalty or loss of benefits of such training. My participation will involve balance testing twice (Prior to and after the 4 week training sessions) on the Balance Stability System in the graduate athletic training lab located in Hamer Hall B6, balance training 3 times a week for 15 minute sessions for 4 weeks in the Hamer Hall B6, or no training, providing demographic information such as age, height, weight, and gender, and a post training survey consisting of 3 questions if I am selected for one of the training groups. I will be allowed to continue any team or individual physical training programs and may be asked to identify them as well on the demographic form.

5. More specifically, again, my participation will involve, (1)completing written demographic information with the researcher, (2) pre testing for balance ability using the Balance Stability System (BSS). This will involve standing on the BSS platform which is an unstable surface and moving my body weight to checkpoints on a display screen while maintaining balance without holding onto the arm rails of the BSS. I understand that a spotter, whom is a licensed certified athletic trainer and the researcher, will be present and attentive to prevent injury during the entire process of testing in the case that I may fall or lose

balance during the testing process. I will then receive either 4 weeks of balance training, or no training (outlined in #6), followed by post testing on the BSS in the same manner as pre testing. Testing will be done on a separate day of training or no training and will last 15 minutes each. If I received balance training, I will be asked to complete a 3 question survey about the training which should take no more than 5 minutes to complete.

6. I understand that potential balance training could consist of 3 days of training for 15 minutes for 4 weeks. The researcher has explained the traditional and Nintendo Wii balance training programs fully during subject recruitment. I understand as the participant the programs will consist of balance exercises on the Nintendo Wii Balance system, BOSU balls, Dynadiscs, wobble boards or foam pads that will be supervised by a EMT or certified athletic trainer. I understand the Nintendo Wii Balance system consists of mimicking an avatar on a TV screen through weight shifting on the Nintendo Wii Balance board. This type of balance training does not exceed in exertion any other form of training that I do as a NCAA athlete. I may withdraw from the study at anytime during this time without any penalty or loss of benefit of such training. I understand there are foreseeable risks or discomforts to me if I agree to participate in the study. I understand that there is risk of soft tissue damage, muscle soreness, muscle cramping, loss of balance, falling and the possibility of experiencing fatigue during testing. With participation in a research program such as this there is always the potential for unforeseeable risks, such as a subject experiencing exaggerated fatigue due to sickness at the time of testing. I understand these risks will be minimized by a spotter being present at all times during testing, and training that is provided by either a licensed athletic trainer or a certified emergency medical technician (EMT), and that the balance training provided in this study does not exceed any physical training exertion that I might otherwise be engaged in as an NCAA athlete.

7. I understand that, in case of injury, I can expect to receive treatment or care in Hamer Hall's Athletic Training Facility. This treatment will be provided by the researcher, Peter Aune, LAT, ATC, or another licensed certified athletic trainer, either of whom can administer emergency

and rehabilitative care. Additional services needed for prolonged care will be referred to the attending staff at the Downey Garofola Health Services located on campus. I understand, in case of prolonged stress, there is on campus counseling services available in Carter Hall Room G-53.

8. I understand that there are no feasible alternative procedures available for this study.

9. I understand that the possible benefits of my participation in the research is a better understanding of the best balance training program for athletes in helping to prevent, reduce, and/or possibly rehabilitate injury.

10. I understand that the results of the research study may be published but my name or identity will not be revealed. Only aggregate data will be reported. In order to maintain confidentially of my records, Peter Aune will maintain all documents in a secure location on campus and password protect all electronic files so that only the student researcher and research advisor can access the data. Each subject will be given a specific subject number to represent his or her name so as to protect the anonymity of each subject.

11. I have been informed that I will not be compensated for my participation nor will there be any costs incurred on my behalf.

12. If I am to become pregnant during the study, I understand that the training programs presents no foreseeable risks besides potential of falling that could harm the fetus or embryo, and that may I may withdraw if desired with no penalty.

13. I have been informed that any questions I have concerning the research study or my participation in it, before or after my consent, will be answered by:

Peter Aune, LAT, ATC
STUDENT/PRIMARY RESEARCHER
Aun0607@calu.edu
(989)619-0591

Dr. Rebecca Hess, Ph.D.
RESEARCH ADVISOR
Hess_ra@calu.edu

14. I understand that written responses may be used in quotations for publication but my identity will remain anonymous.

15. I have read the above information and am electing to participate in this study. The nature, demands, risks, and benefits of the project have been explained to me. I knowingly assume the risks involved, and understand that I may withdraw my consent and discontinue participation at any time without penalty or loss of benefit to myself. I understand the Principal Researcher may terminate my participation at any time without warning. In signing this consent form, I am not waiving any legal claims, rights, or remedies. A copy of this consent form will be given to me upon request.

16. This study is waiting for approval by the California University of Pennsylvania Institutional Review Board.

17. The IRB approval dates for this project are from: NN/NN/NN to MM/MM/MM.

Subject's signature:_____
Date:_____

Witness signature:_____
Date:_____

APPPENDIX C2

Demographic Sheet

Demographic Sheet

Age:_____

Height:_____

Weight:_____

Gender:_____

Sport:_____

Are you participating in any organized balance, or strength and conditioning programs?

Yes, with the team.

Yes, as an individual.

No, I am not doing any balance, or strength and conditioning training specifically with the team or as an individual.

If yes,

Frequency (number of days per week):_____

Duration (in minutes per day):_____

Intensity (low, medium, high as perceived exertion):_____

Type of Training (Cardio fitness, strength, power, sport specific, balance, core, mixed):_____

APPENDIX C3

Post Balance Training Survey

Post-test Balance Training Survey[2]

Please reflect on the exercise activity you were asked to perform during the 4-week training session and answer the following questions. Please use the following numbers to explain your response placing that number in the ( ) provided:

1= Not Very, 2= Mildly, 3=Somewhat, 4=Moderately, 5=Very

1) How difficult was your program? ( )

2) How engaged were you during your program? ( )

3) How enjoyable was your program? ( )

APPENDIX C4

Traditional Balance Training Program

Traditional Balance Training Program

There is a 15 minute training program with a spotter provided; 5 exercises used as standard balance protocol in athletic training are described in the order in which they will be performed for balance training. Participants will rest for 60 s between exercises. Participants will progress at their own individual level based on the Traditional Balance Training Checklist (Appendix C7). All training was performed with shoes off.

1. Single Leg Balance

a. Description: The participant will then perform single leg balance on both legs on a solid floor which is a stable surface.

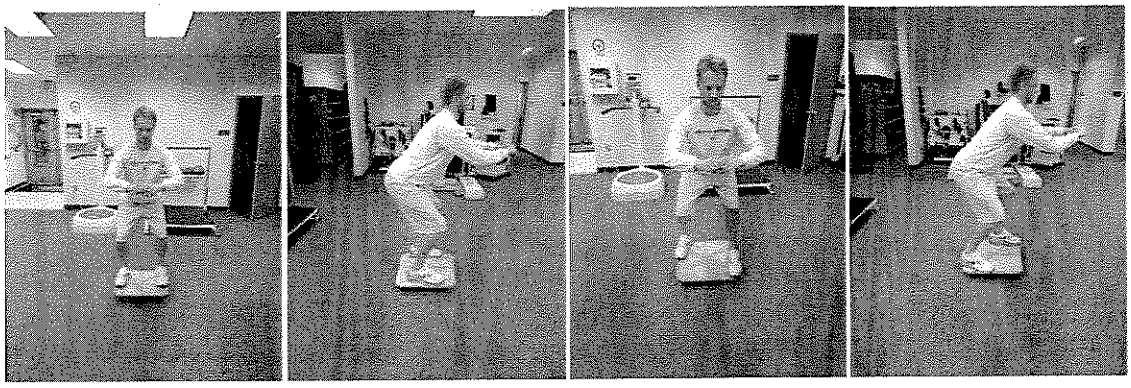
b. Parameters: Perform two sets at 45 s intervals with 60 s rest with eyes open.

2. Star Excursion

a. Description: With the participant standing on one leg, the athletic trainer instructs participate to balance with a 20-30 degree squat. They are then instructed to touch their uninvolved foot as far as they can reach towards the tips of a star diagram on the floor. The participant moves in a clock-wise movement returning to center prior to reaching for the tips of the star diagram.

b. Parameters: The participant will perform the exercise for 45 s for two sets with 60 s rest in between sets.

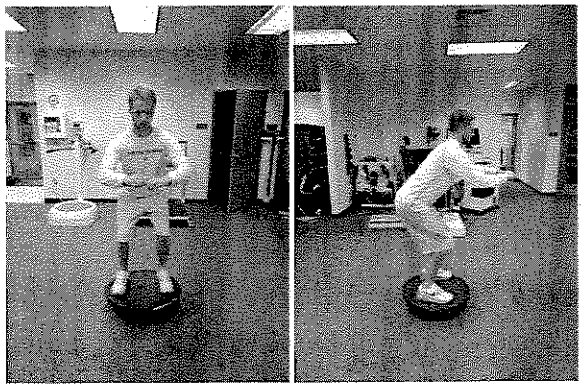
3. Rocker Board



a. Description: The participant stands with a both legs at the center of the rocker board so the motion is front to back.

b. Parameters: Perform the exercise for 45 s for two sets 60 s rest in between sets.

4. BOSU Balance exercises – Double Leg

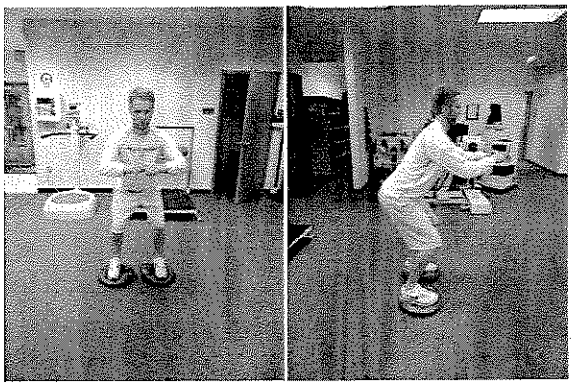


a. Description: The athlete stands shoulder width apart on the hard portion of the BOSU ball. The participant will then hold a 30 degree squat.

b. Progressions: The athlete can perform a squat when the balance component of the exercise becomes easy.

c. Parameters: The athlete performs the exercises for 45 s for two sets 60 s rest in between sets.

5. Dynadisc Balance exercises



a. Description: The athlete will stand with both feet on separate Dynadiscs and hold a 30 degree squat.

b. Parameters: Perform for 45 s for two sets 60 s rest in between sets.

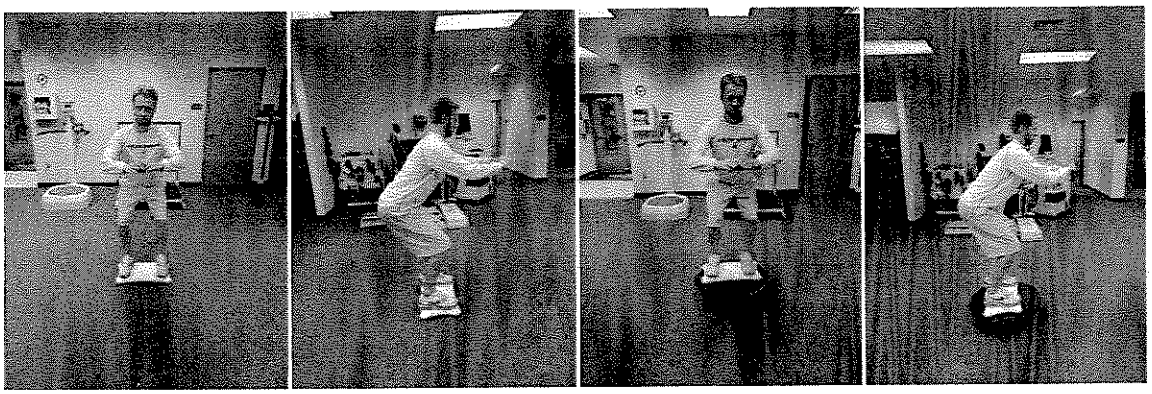
Appendix C5

Nintendo Wii Balance Training Program

Nintendo Wii Balance Training Description[25]				
Balance Bubble	Maneuver the bubble through the course without touching the walls	Tests your lower body balance & agility	Anterior & lateral weight shifting of the center of gravity over base of support	Two legged
Table Tilt	Tilt the board to roll the marbles into the holes	Tests your overall balance & coordination	Anterior-posterior & lateral weight shifting of the center of gravity over base of support	Two legged
Ski Slalom	Ski down the mountain while navigating between the flag gates	Tests your balance & agility	Anterior-posterior & lateral weight shifting of the center of gravity over base of support	Two legged

Participants will play three games lasting 4-5 minutes long each to ensure they stay within the 15 minute training limit which is comparable to the traditional training protocol. The participants will play the *Table Tilt*, *Ski Slalom*, and *Balance Bubble* games. These games have been selected out of the potential 9 balance games offered by the Nintendo to remain consistent with prior research.[23-25] The participant is to remain in a 30 degree squat for the duration of each game. The participant plays the game by performing weight shifting on the fixed balance board, at which the avatar, Mii, mimics the same movement scene on the screen. Participant will rest for 60 s between games. Progression of these exercises is done when the participant beats all the levels of the balance games. The first

progression is placing the Wii Balance Board system on to the flat portion of a BOSU ball. Participants will be told to keep both feet on the board and only use their postural sway to perform the task on the game. All training was performed with shoes off.



APPENDIX C6

Traditional Balance Training Progression Checklist

Traditional Balance Training Progression Checklist

1. Single Leg Balance

Has 3 or less toe touches?	Yes	No
Remains with hands on hips?	Yes	No
Hops or lifts heel?	Yes	No

The spotter must observe the answers above in the order of yes, yes, and no in one training session order to progress the participant to the next level. Progressions can be made by adding a firm foam surface to balance on which is an unstable surface. When the progression checklist is met again, the athlete may progress by performing the exercises eyes closed on the firm foam surface.

2. Star Excursion Balance Test

Remains with hands on hips?	Yes	No
Remains in 30 degree squat?	Yes	No

The spotter must observe the answers above in the order of yes and yes to progress the participant in one training session in order to progress the participant to the next level. The first progression consists of adding a firm foam surface to balance on. When the athlete again performs the exercises abiding by the

checklist, progression can be made to decrease the firmness of the foam pad.

3. Rocker Board

Remains in 30 degree squat?	Yes	No
Board touches ground 3 or less?	Yes	No

The spotter must observe the answers above in the order of yes and yes to progress the participant in one training session in order to progress the participant to the next level. The first progression is moving one foot back to the corner of the rocker board and the other foot to the top corner. Alternate the foot positioning for each set, doing one set with each foot back for only two total.

4. BOSU Ball Squat Balance

Remains in 30 degree squat?	Yes	No
Ball touches ground 3 or less?	Yes	No
Remains with shoulder flexion of 90°?	Yes	No
Knees remain over 2nd toe?	Yes	No

The spotter must observe the answers above in the order of yes, yes, yes and yes to progress the participant in one training session in order to progress the participant to the next level. The progression is to perform a 90 degree squat. When the

participant again completes the checklist, a weight vest will be added to the athlete to increase the work need to be done to maintain the squat.

5. DynaDisc Squat Balance

Remains in 30 degree squat?	Yes	No
Remains with shoulder flexion of 90°?	Yes	No
Knees remain over 2nd toe?	Yes	No

The spotter must observe the answers above in the order of yes, yes, and yes to progress the participant in one training session in order to progress the participant to the next level. Remove air from the Dynadiscs to cause the surface to be more unstable is the first progression. When the participant completes the progression checklist again, a weight vest will be added to the athlete to increase the work need to be done to maintain the squat.

APPENDIX C7

IRB Application

Institutional Review Board
California University of Pennsylvania
Morgan Hall, Room 310
250 University Avenue
California, PA 15419
instreviewboard@calu.edu
Robert Skwarecki, Ph.D., CCC-SLP, Chair

Dear Peter Aune:
Please consider this email as official notification that your proposal titled "Comparison of Traditional Balance Training to Nintendo Wii Balance Training in Collegiate Athletes" (Proposal #13-016) has been approved by the California University of Pennsylvania Institutional Review Board as amended.

The effective date of the approval is 3/3/2014 and the expiration date is 3/2/2015. These dates must appear on the consent form .

Please note that Federal Policy requires that you notify the IRB promptly regarding any of the following:
(1) Any additions or changes in procedures you might wish for your study (additions or changes must be approved by the IRB before they are implemented)
(2) Any events that affect the safety or well-being of subjects
(3) Any modifications of your study or other responses that are necessitated by any events reported in (2).
(4) To continue your research beyond the approval expiration date of 3/2/2015 you must file additional information to be considered for continuing review. Please contact instreviewboard@calu.edu

Please notify the Board when data collection is complete.

Regards,
Robert Skwarecki, Ph.D., CCC-SLP
Chair, Institutional Review Board

APPENDIX C8

Data Collection Sheet

Data Collection Sheet							
Subject #	Group	LOS Score	TOC Test	Difficulty	Engage	Enjoy	Final Progression

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ABSTRACT

TITLE: Comparison of Traditional Balance Training to Nintendo Wii Balance Training in Collegiate Athletes

RESEARCHER: Peter Aune, LAT, ATC, NASM-PES

ADVISOR: Rebecca Hess, PhD

RESEARCH TYPE: Master's Thesis

PURPOSE: The purpose of this study was to examine if using the Nintendo Wii as a balance training apparatus was a viable option for improving limits of stability compared to traditional balance training exercises.

Design: Quasi-experimental training design.

Participants: A total of 23 college-aged athletes volunteered with 22 participants completing the study. All participants were healthy and able to fully participate in practice and games. Volunteers were from the Men's and Women's soccer teams at California University of Pennsylvania. (Men=12, Women=10)

METHODS: The researcher gathered the volunteers for pre-testing and to fill out demographic information. Following this, participants were separated into three groups; control, Nintendo Wii, or Traditional. Participants then engaged in balance training for 4 weeks with 3 training sessions each week or no training as a control while continuing any respective team or individual offseason conditioning programs. At the conclusion of the 4 weeks, participants engaged in a post testing and those in the training groups filled out a post testing training survey.

FINDINGS: No significant difference was found between traditional balance training and Nintendo Wii balance training. No difference was found also

between difficulty, enjoyment and engagement scores among participants in the training groups.

CONCLUSION: Based on the findings of this study, the Nintendo Wii could be used as a viable option for balance training in college-aged athletes.