THE PENNSYLVANIA STATE UNIVERSITY
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DEPARTMENT OF KINESIOLOGY

Agility and Soccer Performance of Soccer Athletes Following Short-Term Balance Training with AMTI Force Platform

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Abstract

The purpose of this study was to determine whether the AMTI Force Platform combined with sway balance training could be an effective intervention to help soccer athletes improve their postural stability and athletic performance. Twenty collegiate soccer athletes (Age: 20.22 +/- 1.19; Years Playing Experience: 14.8 +/- 2.76) were randomly divided into two groups, the experimental group (n=10) and the control group (n=10). To determine if there was a relationship between balance and agility performance, both groups completed the 505 Agility Test and the Agility T-Test before initiating the experimental balance training intervention. The experimental group then underwent 3 weeks, consisting of 6 days of proprioceptive balance training on the AMTI Force Platform. Following the 3 weeks of training both groups completed the pre-intervention agility tests once more to locate differences in performance. The experimental group athletes who underwent balance training showed significant improvement in 505 Agility Test scores for a right-directional turn (R) as well as Agility T-Test scores beginning with a right-directional pivot (R) ($p<0.05$). Although improvements were noted in experimental group scores within 505 Agility Test for a left-directional turn (L) and Agility T-Test beginning with a left-directional pivot (L) in relation to the control group, these results were not deemed significant ($p>0.05$). It was also important to note that the average balance scores for the experimental group who underwent the balance training protocol improved for Templates (A-G) across the 6 days of training. Results from this study demonstrate the effectiveness of using the AMTI Force Platform as a balance and agility training modality in soccer athletes. More studies should investigate leg strength and dominant footedness and how this played a defining

role in the significance of the agility scores beginning with a turn or pivot in the right direction.

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Chapter 1

Introduction

Proprioceptive balance training is a developing field of study that has been proven to provide quantifiable improvements in an athlete's agility and on-field performance. Studies have shown that only second to gymnastics, the physical demands of soccer require athletes to have the highest postural control in sports (Bressel et al., 2007). If postural control and balance are such pivotal and defining characteristics of soccer performance, then why is that focus absent in training and pre-game settings? Interventions using unstable platforms to train soccer athletes are often employed in professional settings to reduce the risk of injury (Romero-Franco et al., 2014). However, in pre-professional sport settings, common training modalities such as footwork drills, weightlifting, and cardio training take precedent over balance interventions (Stølen et al., 2012). Implementing balance training earlier in an athlete's life begins by finding or developing proprioceptive balance training interventions that are more engaging and effective for pre-professional soccer athletes. Utilizing pre-created modern technology in the form of force platforms could be the next promising approach. The following study seeks to understand this relationship between balance and soccer performance through training athletes on a stable force platform and using verified agility modalities to test for improvements in performance. The findings within the study have the potential to open new doors, allowing for soccer athletes to make drastic improvements in performance and agility through short-term balance training on stable force platforms developed with interactive and engaging software.

Proprioceptive Balance Training Techniques

Proprioceptive balance training is a relatively new technique found to help improve the balance and agility of athletes. Proprioception is a concept related to an individual's cognitive awareness of their neuromuscular positioning in space. When proprioceptive activities are paired with balance training, a strong correlation between training duration and postural control has been documented (Martínez-Amat, 2013). In conjunction with increased postural control, the speed and center of balance within non-athletic individuals also improved with proprioceptive balance training (Martínez-Amat, 2013).

Understanding the well-documented relationship between postural control and agility performance, has led to new research delving into the relationship between proprioceptive balance training and athletics (Hrysomallis, 2012). Studies involving youth athletes recently tested the effect that proprioceptive balance training involving unstable platforms had on the balance, strength, agility, and dribbling of the juvenile athletes. Researchers have documented small to medium correlations between the experimental group and improvements in the selected parameters, specifically that of agility (Gidu et al., 2022).

Previous research in proprioceptive balance training commonly utilizes unstable platforms for their subjects to train on. The most common unstable platform used in research is referred to as a BOSU ("Both Sides Up") platform. This apparatus includes the upper third of a traditional yoga ball flanked by a flat plastic platform on the opposite side (Figure 1). Unstable platforms like this and Swiss Balls are used for proprioceptive training in both preventative and rehabilitation settings. Although BOSU is a valid research intervention, these platforms have been found to increase the risk of injury for athletes due to the ability to fall off (Wahl & Behm, 2008). Furthermore, for athletes in collegiate and professional settings, unstable platforms, such as BOSU, has led to muscular deactivation (Wahl & Behm, 2008). Muscular deactivation has been found to decrease the postural stability and negate the agility benefits for the athlete (Wahl & Behm, 2008). With most proprioceptive balance studies utilizing this BOSU method for balance training purposes of all athletes, more research is needed to explore novel methods that may be better suited to train advanced athletes.

Figure 1: BOSU Platform

Stable Platform Balance Training

Proprioceptive balance training techniques are not limited to unstable platforms such as BOSU. Recent advancements in technology have allowed for the construction of stable force platforms as pre- and post-intervention indicators for postural stability (Chen et al., 2021). Little research, however, is available to document the effectiveness of force plates as a balance training intervention to improve agility and athletic performance in athletes. One common stable force platform constructed by AMTI detects changes in a subject's center-of-pressure to understand and postural feedback software to enhance their postural stability. Previous research has demonstrated the potential effectiveness of the device as a training device for a non-athlete's overall postural stability (Milas, 2018). However, it is yet to be determined if short-term training on AMTI can lead to noteworthy improvements in an athlete's agility and in-game performance.

Agility T-Test Testing

Studies have concluded that soccer players perform 700 directional changes on average each game. Of the 700, an average of 600 directional changes occurs at angles ranging from 0 to 90 degrees (Nygaard Falch, Rædergård, & Tillaar, 2019). To better understand the influence of balance training on athletic performance it is important to identify a realistic testing parameter that could allow for an understanding into how balance training affects these directional changes in soccer athletes. Studies have concluded that the Agility T-Test as a valid test for an athlete's agility and future soccer performance based on time to completion of the exercise (Krolo et al., 2020; Raya). Further, time to complete the test has been found to have a strong relationship with the postural stability and balance ability of the athlete performing the test (Sekulic et al., 2013). The test requires a level surface for the athlete to accelerate, decelerate, shuffle, and backpedal to specific designated points on a playing surface, while 90-degree directional changes within the exercise mimic the movements that a soccer athlete would perform in a game and allow for an accurate assessment of agility and future in-game performance.

505 Agility Testing

Of the observed 700 directional changes a soccer athlete performs in a game, an average 100 of these occur at angles ranging from 90 degrees to 180 degrees (Nygaard Falch, Rædergård, & Tillaar, 2019). To account for this notable minority of directional changes, our study sought an additional agility test that could capture the 180-degree change of direction corresponding agility in athletes. The 505 Agility Test is a well-studied agility test that has been proven to account for changes in an athlete's athletic performance and agility (Kadlubowski et al., 2019). The test involves a single 180-degree change of direction, allowing the athlete to put maximum exertion into the single pivot. Maximum exertion is employed in half of all directional changes performed by soccer athletes within their respective matches (Nygaard Falch, Rædergård, & Tillaar, 2019). Studies have also demonstrated that unstable balance training has had noticeable improvements in male athlete performance in the 505 Agility Test, confirming its practicality as an accurate testing mechanism for measuring the effectiveness of AMTI force platform balance training in collegiate male soccer athletic performance (Sekulic et al., 2013).

Hypotheses

The goal of this study seeks to answer understand a question involving two parts. Does short term balance training on the AMTI stable force platform improve a soccer athlete's postural stability, and does this influence functional agility? Specifically, do athletes that undergo short-term balance training on the AMTI stable force platform show improvement in their postural stability (higher scores), and consequently, the 505 Agility Test and Agility T-Test (lower scores) compared to controls completing only stretching?

It is anticipated that the experimental group of soccer athletes would have an upward trajectory in their overall balance scores as balance training progresses. Further, since prior research has demonstrated that unstable balance training has led to noticeable improvements in 505 Agility Test and Agility T-Test scores, soccer athlete scores are also expected to significant improvement, compared to their peers who only complete a stretching program, as they will train and stimulate muscles associated with agility on the AMTI force platform (Sekulic, 2013).

Chapter 2

Methodology

Subject Recruitment and Responsibilities

Twenty Penn State Club Soccer players were enrolled in this study during the Fall 2022 semester. Inclusion criteria for this study were: Participants who were age 18 or older and participants in Penn State varsity, club, or intramural sport willing to participate in this study. Exclusion criteria for this study were athletes with current/recurring injury(s) to lower extremities that directly or indirectly impact balance performance. After enrollment and obtaining informed consent, players were randomly assigned to either the experimental (N=10) or control group (N=10). Participants in the experimental group were asked to perform a the 3-week proprioceptive balance training program using the AMTI Force platform. Participants in the control group were asked to perform 15-minute daily stretch routines.

Baseline data on speed and agility (seconds) was collected using the 505 Test and Agility T-Test at a Penn State facilities location. Once baseline agility scores were collected for all subjects, the experimental group underwent proprioceptive balance training on the AMTI force platform. A series of 3 X 7 - 30 second tests, measuring and stimulating a club soccer player's proprioception ability were performed through a series of 6 trials during a 3-week period. Final data on speed and agility was be calculated using the 505 Test and Agility T-Test following the third week of balance training. The corresponding timeline enabled the research team to determine how sway balance pad training affects soccer player performance.

Players were informed that their on-field movement (505 Agility and Agility T-Test), and balance training (AMTI) scores would be assessed, but that these variables would not influence coaching or medical decisions in any way, with data access limited to only the research team. The Pennsylvania State University Institutional Review Board approved this study and obtained written consent from participants prior to enrollment.

505 Agility Test

Baseline and post-balance-intervention agility test scores (seconds) were calculated using the 505 Agility Test and Agility T-Test via a stopwatch. The 505 Agility Test is a proven timed test that measures soccer agility. With three cones placed, 15 and 5 meters apart, subjects from the experimental group were asked to position their body adjacent to the three cones. Following a brief countdown, subjects sprinted from Cone 1 to the Cone 3, perform a 180-degree turn at Cone 3 and sprint through Cone 2 (5). Subjects performed 4 trials of the 505 Agility Test during each agility session. Subjects were asked to perform the 180-degree turn, turning to the right twice and to the left twice. The order of the directionality of the turn that the subject would perform was randomly assigned. Following each trial, subjects received 30 seconds of rest to eliminate the confounding variable of the subjects' varying endurance levels.

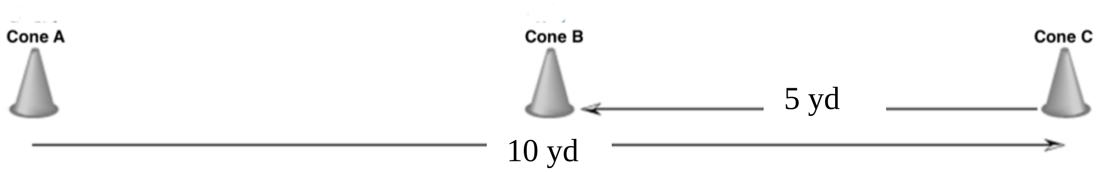


Figure 2: 505 Agility Test

Agility T Test

The Agility T-Test is a similar agility measure that tests a soccer player's combined lateral and longitudinal agility (Raya MA). Four cones are placed in a T-shaped array and are spaced out according to the diagram below. Subjects were asked to position their body adjacent to Cone A facing Cone B. Following a brief countdown, subjects sprint from Cone A to Cone B and touch Cone B with their hand. They are then asked to side shuffle from Cone B to either Cone C or Cone D. After touching one of these cones with their hand, they pivot and side shuffle to the far cone adjacent to Cone B. After touching this cone with their hand, subjects return to Cone B, touch it, and back pedal through cone A. The timer stops once the subject returns to Cone A. Subjects were asked to complete two trials of the Agility T Test pivoting in opposite directions after touching Cone B. A 30 second rest was given to subjects between the first and second trials to eliminate the effect that varying endurance has on agility scores.

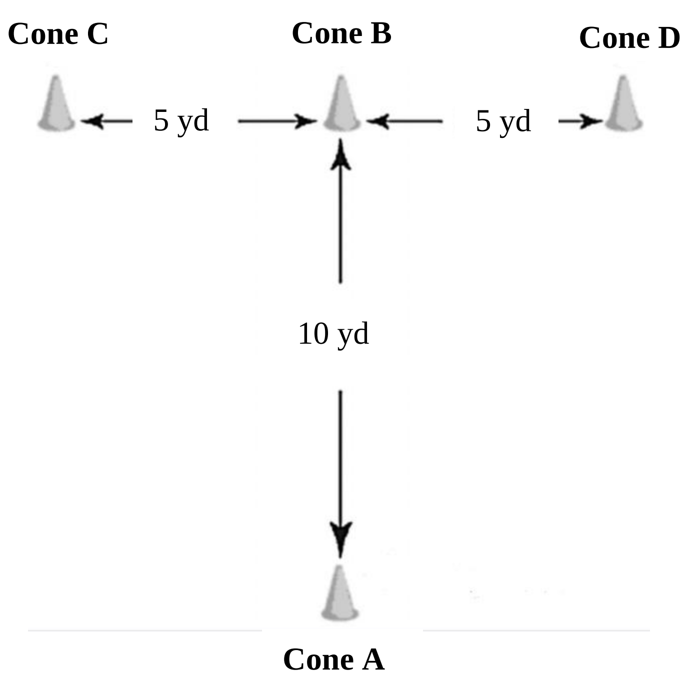


Figure 3: Agility T Test

AMTI Force Platform Protocol

During each balance intervention the AMTI software was retrieved through a desktop application on a computer and a series of checks were performed to ensure accuracy. The AMTI force platform was set in place on level ground with no objects residing near or on top of the platform. To confirm data accuracy, offsets within the platform were established to zero the force platform for data collection. If zero disturbances were collected, the software would present a series of green numbers on the monitor, signifying the platform is ready for use.

AMTI Pre-Intervention COP

Once experimental subjects completed the pre-intervention agility tests, they were asked to complete balance training using the AMTI force platform. To familiarize subjects with the training software, subjects underwent a one-minute preparation stage to test and understand the sensitivity of the force plate. Under the drop-down menu of the application this is referred to as the ‘Plot COP’ option, which is indented to track the center-of-pressure oscillations. At this point, subjects navigate a dot along an X and Y axis to understand how transitioning their center of balance will impact the puck during the actual proprioceptive training. During the preparation stage, the path in which the puck travels is traced and highlighted with a bright orange line, indicative of the subject’s deviation from the center-of-pressure within the force plate.

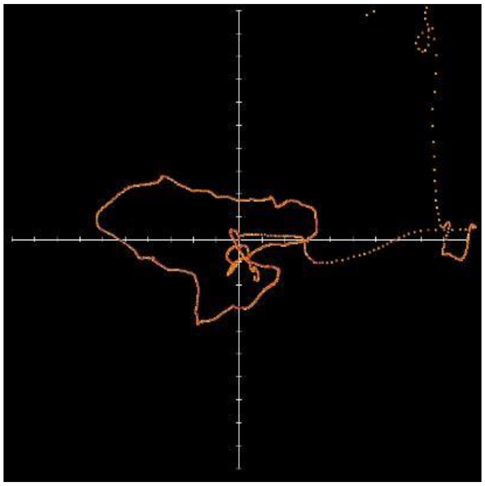


Figure 4: Plot COP

AMTI Force Platform Balance Training

The 2D interactive proprioceptive software was crafted by the Sport Concussion Research and Services Lab within the Department of Kinesiology at the Pennsylvania State University. The training system combines the designed computer software with an AMTI force platform to test and train a subject's proprioceptive responses and postural stability. In a series of seven templates, subjects were asked to transition their center of balance to navigate a white dot along a pathway through designated checkpoints. The software is programmed with color distinctions to inform subjects of their positioning and improve the accuracy of the balance assessment. The white dot, or puck, navigates along a green pathway lined with dark green circles. Subjects are informed if they are outside the boundaries with the white puck turning red in these regions.

Subjects began the training by positioning their feet on the AMTI force plate shoulder width apart, positioning their theoretical center-of-balance through the center of the force platform, and maintaining a comfortable athletic stance with knees partially bent. Beginning with Template A, subjects had 30 seconds to navigate the puck steadily along the light-green pathway to each dark-green dot checkpoint. At the end of the 30 seconds, subjects received a score from 0 to 100. This score indicated the percentage of time that the puck was within the green pathway boundary during the 30 second duration. Subjects navigated each of the 7 templates for a total of 3 trials, totaling 21 individual score values for each training session. After each trial their corresponding score was recorded.

Figure 5. Example Score

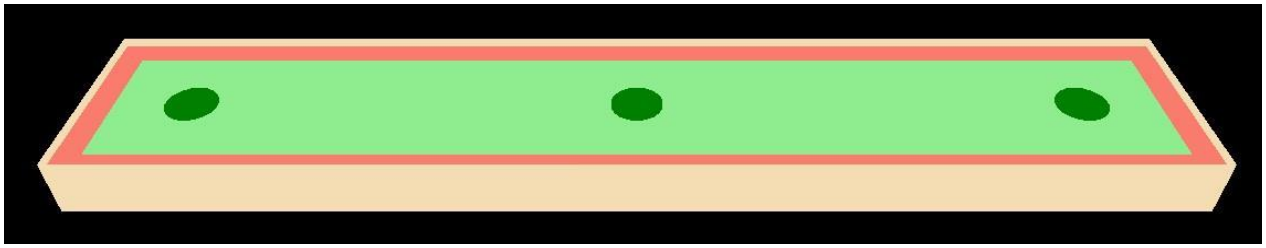


Figure 6. Balance Training Template A

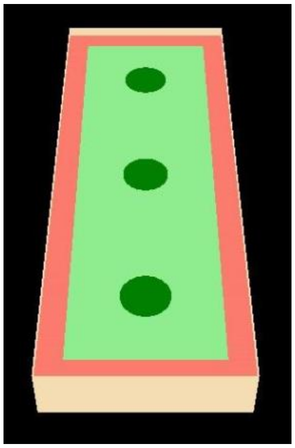


Figure 7. Balance Training Template B

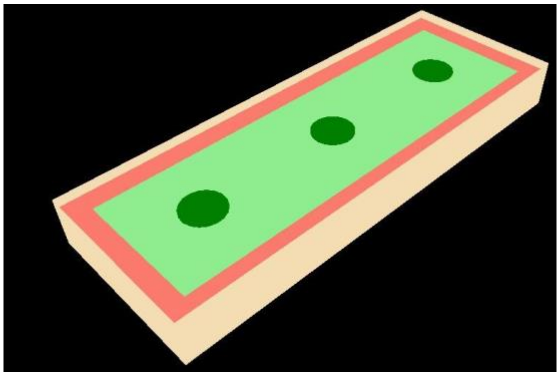


Figure 8. Balance Training Template C

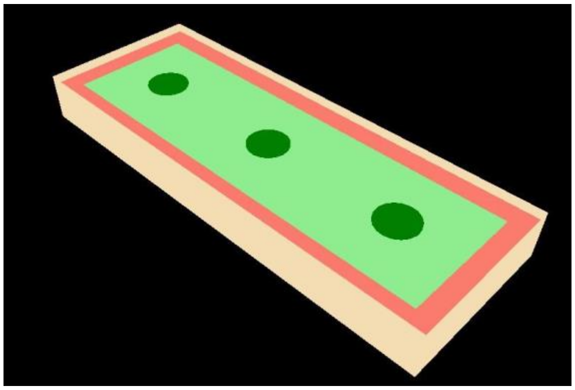


Figure 9. Balance Training Template D

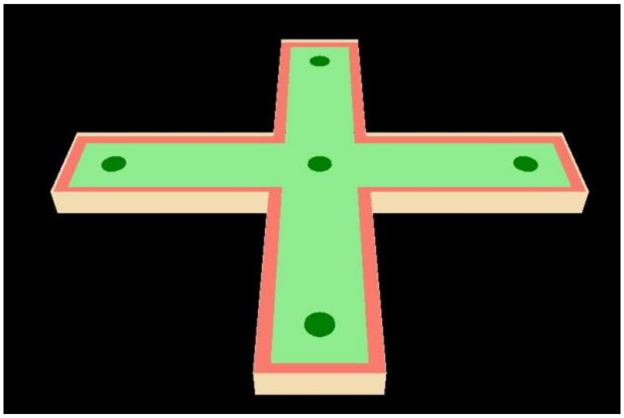


Figure 10. Balance Training Template E

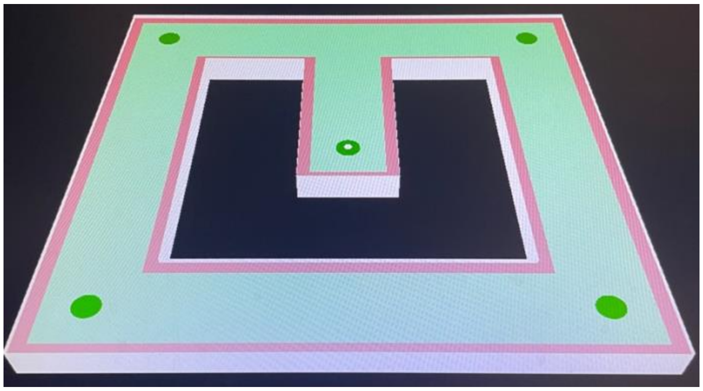


Figure 11. Balance Training Template F

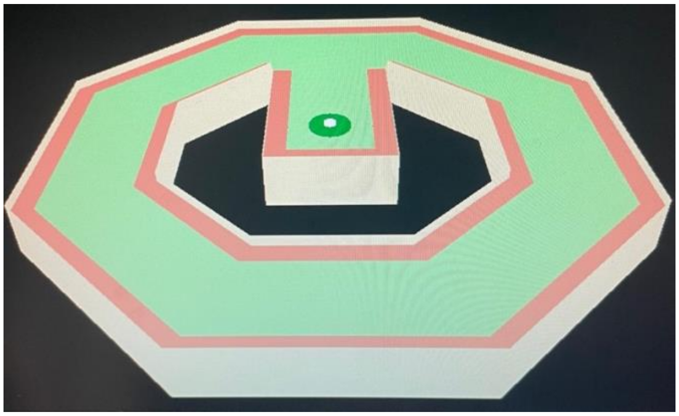


Figure 12. Balance Training Template G

Statistical Analysis

All statistical analyses were performed using SPSS V25 (IBM Corp. Somers, NY). All p-values were set *a priori* at $p = 0.05$. Data was assessed for normality using visual inspection of Q-Q plots, which determined all variables were normally distributed. Bivariate correlations of all relevant variables were run to determine potential relations between variables. A power analysis using G*Power determined a sample size of 20 would be required to achieve adequate power for a ANOVA.

Chapter 3

Results

Agility Testing Results

Preliminary data from the pre-screening questionnaire, including subject age, years of soccer played, concussion history, and position on the field were obtained and consolidated into Table 1. In addition to the questionnaire data, the pre and post agility test averages were obtained and added to Table 1 as these carried heavy importance in the findings of the study. Statistically significant agility data ($p < 0.05$) was indicated with an asterisk in the table.

Table 1. Demographics Information

Descriptive Variable	Sample Characteristic			
	Control		Experimental	
Total	N=10		N=10	
Age, *mean ± standard deviation (SD)*	20.49 ± 1.08		19.96 ± 1.29	
Years Played, *mean ± standard deviation (SD)*	14.6 ± 2.32		15.0 ± 3.27	
Previous Concussion, *N= (%)*				
Yes	N=3		N=3	
No	N=7		N=7	
Position, *N= (%)*				
Forward	N=2		N=2	
Defender	N=3		N=3	
Midfielder	N=3		N=4	
Goalkeeper	N=2		N=1	
505 Agility Test, *mean ± SD*	Preseason	Postseason	Preseason	Postseason
Right Direction	3.32 ± 0.13*	3.27 ± 0.11*	3.42 ± 0.14*	3.14 ± 0.11*
Left Direction	3.33 ± 0.10	3.30 ± 0.14	3.37 ± 0.15	3.22 ± 0.10
Agility T-Test, *mean ± SD*	Preseason	Postseason	Preseason	Postseason
Right Direction	10.47 ± 0.36*	10.42 ± 0.27*	10.62 ± 0.92*	10.11 ± 0.50*
Left Direction	10.76 ± 0.49	10.49 ± 0.34	10.62 ± 0.59	10.17 ± 0.73

*indicates statistical significance between control and experimental player groups

We used ANOVA to locate the delta mean and standard deviation for the 505 Agility Test and Agility T-Test scores of both the control and experimental groups. These values, along with significance values were obtained and recorded in Table 2. To further demonstrate the magnitude of improvement that experimental subjects trained on balance presented in Tables 3-6, contrasting them with the control group.

Table 2. ANOVA Statistical Data

	Control Delta Mean	Experimental Delta Mean	Standard Dev.Control	Standard Dev. Experimental	Significance
505 Agility R	-0.0545	-0.282	0.157	0.128	0.002
505 Agility L	-0.026	-0.156	0.194	0.132	0.096
T-Test R	-0.05	-0.508	0.28	0.612	0.045
T-Test L	-0.274	-0.45	0.49	0.416	0.398

Table 3. Difference 505 Agility Test R Improvements

	Improved	Total Particpants	Percent Improved
Control 505 Agility Test R	6	10	60%
Experimental 505 Agility R	10	10	100%

Table 4. Difference 505 Agility Test L Improvements

	Improved	Total Participants	Percent Improved
Control 505 Agility Test L	4	10	40%
Experimental 505 Agility L	8	10	80%

Table 5. Difference Agility T-Test R Improvements

	Improved	Total Participants	Percent Improved
Control T-Test R	5	10	50%
Experimental T-Test R	8	10	80%

Table 6. Difference Agility T-Test L Improvements

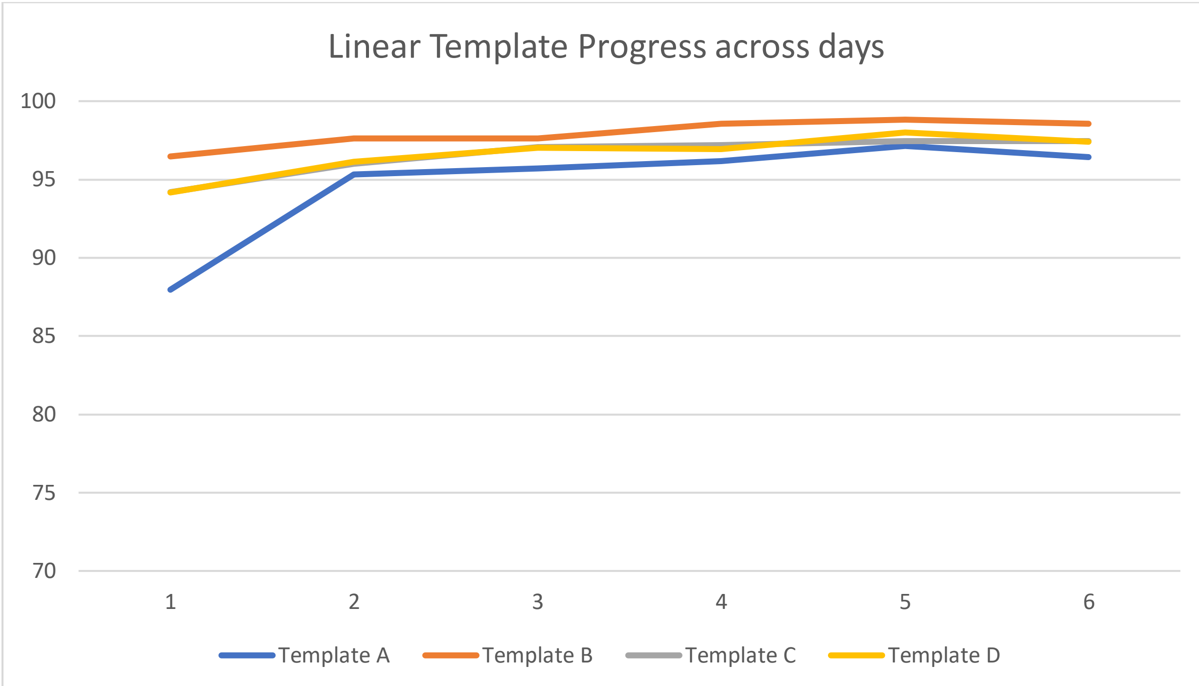
	Improved	Total Participants	Percent Improved
Control T-Test L	7	10	70%
Experimental T-Test L	9	10	90%

Results of ANOVA analysis revealed for 505 Agility Test R (Right-directional turn) that $p<0.05$, indicating significance in the data. Averages from the 505 Agility Test L (Left-directional turn) presented a significance value of $p>0.05$, indicating an insignificant data set. For the alternative Agility T-Test R (Beginning with right-directional pivot) exercise, data presented a significance value of $p<0.05$, which was also deemed significant to the dataset. Finally, Agility T-Test L (Beginning with a left-directional pivot) presented a significance value of $p>0.05$, indicating insignificant values for the dataset.

Balance Training Results

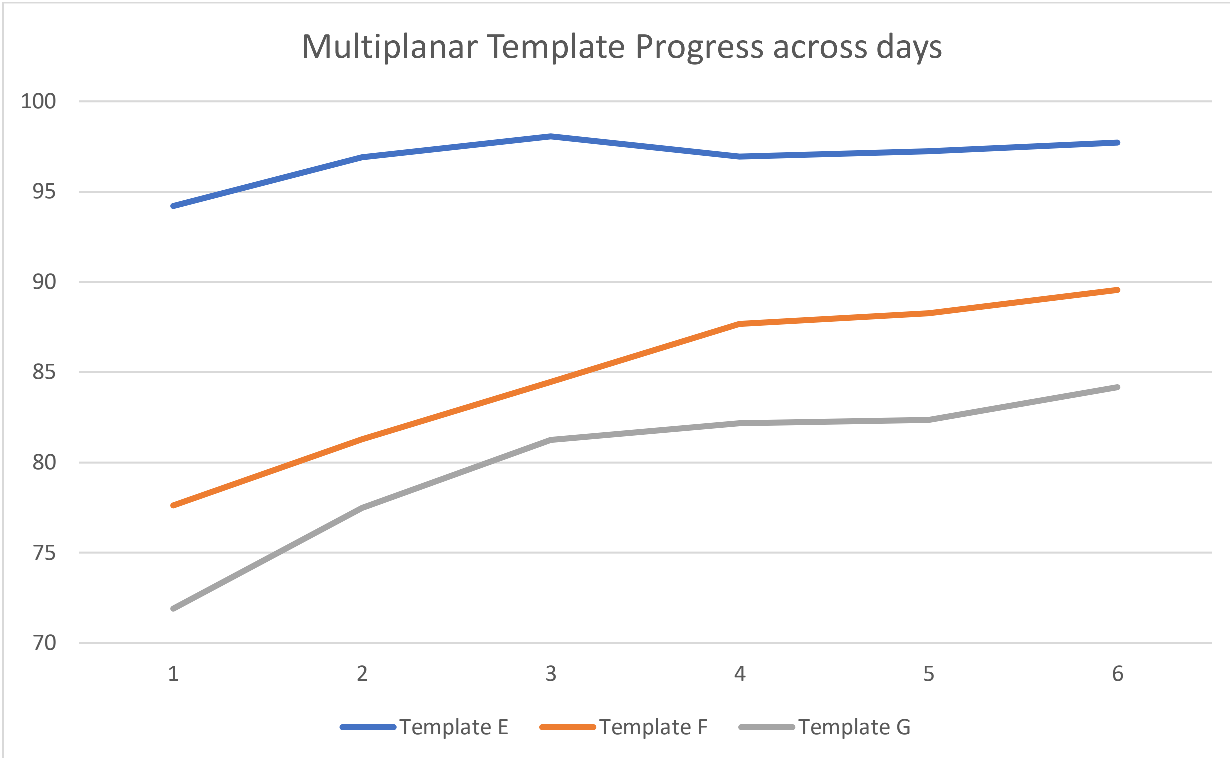
Balance scores as computed by the AMTI force platform software were averaged for the 7 templates (A-G) for all of subjects in the experimental group. The averages for each template were computed for each of the six days of balance trials. These average scores illustrated in Figures 9 and 10. The mean scores for the templates were presented in two separate figures to account for the planar and multiplanar directionality of the alterations of the athletes’ center of balance within each template.

Figure 13. Mean Linear Template Training Scores Across 6 Days



The corresponding figure depicts the collective averages of the experimental group's balance scores per balance session computed by software within the AMTI Force Platform. The three templates displayed above include the linear templates. These templates, which consist of Templates A-D, all involve the subjects swaying in a linear manner along a vertical plane. T-tests showed significant improvement in Template A from pre (M = 87.96, SE = 2.66) compared to post (M = 96.44, SE = 1.00) with a mean difference of 8.49, 95% CI [4.27, 12.7]; d=1.44, $p<0.001$. Template C showed improvement from pre (M = 94.19, SE = 1.33) compared to post (M = 97.45, SE = 0.90) with a mean difference of 3.26, 95% CI [0.93, 5.60]; d=1.00, $p<0.05$. Template D also showed improvement from pre (M = 94.17, SE = 1.21) compared to post (M = 97.42, SE = 0.82) with a mean difference of 3.26, 95% CI [1.12, 5.39]; d=1.09, $p<0.01$.

Figure 14. Mean Multiplanar Template Training Scores Across 6 Days.



The corresponding figure depicts the collective averages of the experimental group's balance scores per balance session computed by software within the AMTI Force Platform. The three templates displayed above include the multiplanar templates. These templates, which consist of Templates E-G, all involve the subjects swaying in a linear manner across vertical planes to complete each exercise. T-tests showed significant improvement in Templates F showed improvement from pre (M = 77.61, SE = 4.67) compared to post (M = 89.55, SE = 3.91) with a mean difference of 11.94, 95% CI [2.17, 21.71]; *d*=0.88, $p<0.05$, and G showed improvement from pre (M = 71.89, SE = 3.94) compared to post (M = 84.16, SE = 2.54) with a mean difference of 12.28, 95% CI [3.93, 20.63]; *d*=1.05, $p<0.01$.

Chapter 3

Discussion

Purpose

The purpose of the study was to determine if utilizing the AMTI Force Platform as a mode of training balance could improve the postural stability and/or agility of soccer athletes through the 505 Agility Test and Agility T-Tests. To account for the confounding variable of directionality, varying strength of legs, and dominant footedness, the athletes were asked to complete the agility tests multiple times by pivot or turning in opposite directions. These values were also quantified and referred to as 505 Agility R (Right-handed turn), 505 Agility L (Left-handed turn), T-Test R (Right-handed pivot), and T-Test L (Left-handed pivot). Averages in balance scores for Templates A-G were also documented to further illustrate the connection between balance and agility. It was hypothesized that the experimental athletes undergoing balance training would show an upward trajectory in balance scores as well as improvements agility scores from pre- to post-intervention.

Supporting Literature

Previous literature supported our findings, connecting the concepts of balance training improvements with significant improvements in the agility of athletes. These studies have found that training on unstable BOSU platforms have improved the strength and balance of athletes (Hrysomallis, 2012; Gidu et al., 2022). Studies have also found that these unstable platform training measures improve agility in youth and elderly populations (Gidu et al., 2022; Martínez-Amat, 2013). Previous literature fails to observe how training on these platforms impact the balance and agility of collegiate and pre-professional athletes, or in other words individuals with higher athletic capabilities. Further gaps in literature include addressing the concept of stable force platforms, safer alternatives to unstable platforms, and the role they play in enhancing an athletes' agility. Furthermore, a recent study has found that short term balance training on the AMTI Force Platform increases subjects' balance performance across multiple sessions, enhancing the credibility of the AMTI technology for our study (Milas, 2018).

Significant Results

Although the results of the study provided a variety of useful findings, the most significant findings were that of the agility scores when participants turned or pivoted in the right-handed direction for both agility tests. These findings are potentially useful for all athletes, but particularly collegiate soccer athletes, showing that a balance training regimen on a stable platform can increase postural stability that translates to functional agility. Participants in the balance training program showed significant improvements in 5 templates, which resultantly significantly improved their agility performance to the right. As improved performance in the agility tests was essentially faster times, this has direct translation to sport. Players with faster movements on these tests can likely get to the ball more quickly, move with more agility, and gain more advantageous positions over their opponent. If these results continue to be replicated with different populations and devices, it may be wise for all competitive soccer programs to adopt a balance training regimen.

Noteworthy Results

Although significance was not noted in 505 Agility Test L and Agility T-Test L, it is important to note that the experimental groups from both agility tests had more drastic improvements than the controls. To further illustrate this, Table 2 provides the delta mean for the pre- and post-intervention agility scores for the experimental and control groups. Furthermore, Tables 4 and 6 were included to depict number of athletes who improved in relation to subject size. Table 4 demonstrated percent improvement for 505 Agility Test L, with 80% of experimental subjects improving their scores and only 40% of control subjects improving. As previously mentioned, this trend was also observed in the Agility T-Test L in Table 6, with a striking 90% improvement rate within the experimental and only a 70% improvement rate of the control group. It is important to note that the percentage of experimental subject who underwent balance training and improved in their agility scores was higher than the percent improvement of the control group for all 4 agility tests.

Other notable findings are illustrated in Figures 9 and 10, which focus on the improvements in balance of the 10 experimental group athletes. Figure 9 depicts the daily averaged scores for participants completing AMTI balance templates A-D, which involve transitioning weight along a single planar axis. All templates depict gradual increases in balance scores across the 6 days of training, which was expected due to the positive effect that short-term training has on balance ability. Figure 10 depicted templates D-G, which involved subjects transitioning weight across multiple planes. These templates demonstrated much more drastic improvements in balance capacity from pre- to post-intervention than the single plane balance templates. Although scores improved across all balance templates, results for templates A, C, D, G, and F presented very large effect sizes, suggesting not only significant improvements in the 505 Agility R Tests and Agility T-Tests, but also the ability to improve on a functional balance test through stable platform training.

Limitations of Study

Although careful measures were taken to ensure the results within the study were conducted thoroughly and without error, the study has minor limitations that should be addressed. The failure of compliance by subjects within the control group limited our study from obtaining initial and final balance scores for templates A-G for the control group in conjunction with the experimental group. Obtaining these values would have enabled us to compare the balance scores of the control group without the 6 days of training. This would have allowed us to see if the balance training intervention within the experimental group caused the improvement, as observed in Figures 9 and 10. Additionally, it would have enabled us to compare the balance averages of both subject groups with the agility scores to confirm if there was a direct correlation between balance training and soccer agility.

Future Implications and Conclusions

Future studies could expand on the findings within this study through multiple avenues. It has been documented that both training on stable and unstable platforms can improve both balance and agility in soccer athletes. However, the variations and effectiveness between the two modes of training has not been documented. Such a study could be constructed where half of the athletes train on an unstable platform such as BOSU and the other half of athletes train on a stable platform such as the AMTI Force Platform. Using valid agility tests to test for the magnitude of improvements will enable researchers to determine which mode of balance training provides greater improvements in agility and could be more effective for athletic training purposes. Additionally, it is important that future studies focus on the significant improvements in 505 Agility Test R and Agility T-Test R scores. This drastic improvement more could be the result of multiple confounding variables. These could include parameters such as differences in leg strength or the variable of dominant footedness. Creating a study where these variables are accounted for and observing their direct relationship with athletes' agility could provide further clarity into defining the results of this current study and assist in finding new avenues to improve agility scores in the direction that is lacking.

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Academic Vita

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EDUCATION

The Pennsylvania State University, State College, PA
The Schreyer Honors College
Bachelor of Science in Biological Sciences and Health Professions
Anticipated Graduation Date: Spring of 2023

PROFESSIONAL EXPERIENCE

Hartman Oral & Maxillofacial Surgery **June 2021 - Current**
Mechanicsburg, Pennsylvania

Radiology & Surgical Care Assistant
- Took intraoral & extraoral dental X-Rays of patients
- Assisted during X-Nav guided implant surgery & wisdom teeth extraction
- Provided post-operative care for patients

Sterilization Technician
- Sterilized surgical and dental instruments
- Prepared operating room for procedures
- Assembled surgical trays for extractions/implants/bone grafting/etc.

Center for Sport Concussion Research and Service **September 2020 - Current**
State College, Pennsylvania

Undergraduate Research Intern
- Currently completing undergraduate honors thesis looking at the connection between balance training and soccer performance of 35 subjects
- Completed 2 literature and scoping reviews for post-doctoral scholar
- Performed virtual reality and balance subject screening for student athletes

LEADERSHIP EXPERIENCE

Pennsylvania State University Club Soccer **August 2019 - Current**
University Park, Pennsylvania

President (Winter 2022 – Spring 2023)
- Managed and prepared 30 team members during fall and spring seasons
- Organized fundraising & community events to generate $10,000 seasonal revenue
- Worked with local trainers to improve practice quality

Treasurer & Safety Officer (Spring 2021 – Winter 2022)
- Generated seasonal cost/deficit initiative to raise over $6,000 in revenue
- CPR/First Aid Certified to provide care for injured team members