The Acute Effects of Different Warm-up Techniques of Power Output, Agility, and Flexibility in Athletes

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THE ACUTE EFFECTS OF DIFFERENT WARM-UP TECHNIQUES ON POWER OUTPUT, AGILITY, AND FLEXIBILITY IN ATHLETES

BY

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A THESIS PRESENTED TO THE GRADUATE FACULTY OF THE COLLEGE OF EDUCATION IN PARTIAL FULLFILLMENT OF MASTER OF SCIENCE IN EXERCISE SCIENCE IN THE FIELD OF HEALTH AND HUMAN PERFORMANCE

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DEDICATION AND ACKNOWLEDGMENT

This thesis is dedicated to the memory of my father, Manuel Nava Jr. I love you a lot and miss you even more as time goes by. Thank you for all the love and support you have given me. I can only hope to be as great a man, mentor, and father as you were to me.

I would also like to thank my mother, Marisela Nava, for the boundless love, guidance, and support to continue my education and to strive for the best. Words alone cannot describe how grateful I am to have you as my mother. I love you, momma; you're the greatest. As long as am living my momma you be. A huge thank you also goes out to my girlfriend, Esperanza Rios, whom I love and care for so much. Without your love, support, patience, helpfulness, and belief in me, none of this would be possible.

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Abstract

PURPOSE: The purpose of this study is: 1) To determine which warm-up technique (general warm-up (GW), dynamic warm-up (DW), weighted vest warm-up using body weight percentage [VW], and elastic exercise band training system warm-up [EEBTSW]) will provide the best and longest effect on athletes' performance regarding power output, agility, and flexibility. 2) To compare if there are any differences in power output, agility, and flexibility when using different resistance protocols (VW and EEBTSW) as warm-up techniques. 3) To determine which warm-up will benefit the athletes' performance. 4) To compare the hemodynamic responses to different warm-up techniques.

METHODS: Thirty-one male (age= 21.93 (2.71) n=15) and female (age= 21.25 (1.77), n=16) athletes performed four different type of warm-up on for separate occasions separate by at least 48 hours. Each of the sessions were randomized into the following conditions: GW (Control), DW, VW, and EEBTSW. During each warm-up, heart rate (HR), blood pressure (BP), and rate of perceived exertion (RPE) were recorded throughout the study. After the warm-up, flexibility, counter movement jump (CMJ), and T-test were performed. Flexibility and CMJ were tested every 2,6,10, 14, and 18 minutes, and T-test was tested every 2, 10, and 18 minutes.

RESULTS: There were significant condition*time interactions for HR, BP, and RPE ($p<0.01$) and significant condition and time main effects ($p<0.01$). No significant difference was found between conditions for flexibility, but there was a significant time difference ($p<0.01$). Both VW and EEBTSW were significantly better than GW at two and six minutes post warm-up for power. At ten minutes post warm-up, EEBTSW was

significantly better in power than DW. EEBTSW and VW was significantly better than GW for agility at two-minute mark ($p<0.01$).

CONCLUSION: The findings showed that the effects of both EEBTSW and VW on power lasted for six minutes compared to GW. In addition, both resistance warm-up techniques resulted in a better agility performance at two-minute mark following warm-up. This suggests that using resistance warm-ups would be ideal for those individuals, who perform activities requiring high levels of power and agility.

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CHAPTER I

INTRODUCTION

In sports, it is crucial that an athlete performs at his or her best. However, most coaches and trainers overlook one of the main components that can give the edge to their athletes: the warm-up. A warm-up is vital in order to increase body temperature and blood flow to the muscles before exercising (Baechle and Earle, 2008). Warming-up the body results in augmentations in metabolic reactions leading to increases in body temperature (Bishop, 2003). The more intensive the warm-up is, the greater metabolic reactions are (Bishop, 2003). By increasing body temperature, the body is able to decrease viscous resistance to muscle resulting in a decreasing in muscle stiffness and allows for better blood flow to the muscle (Bishop, 2003). This allows for better release of oxygen to the muscle resulting in a decrease of initial oxygen deficit (Bishop, 2003). A warm-up has also been shown to cause post activation potentiation, which increases the recruitment of muscle fibers, allowing for increases of force and speed of contraction (Bishop, 2003). An athlete may have to wait for a while after their warm-up. This can cause a loss of all attributes needed to perform. There have been reports showing that using a dynamic warm-up technique can improve lower body performance even after an 18-min post-warm-up period (Faigenbaum et al., 2010).

One of the most used warm-up techniques in sports is a dynamic warm-up. A dynamic warm-up consists of movements similar to the athlete’s sport, which serves as a walk through in the range of motion required for the sport (Baechle and Earle, 2008, p. 297). It has been proven that when a dynamic warm-up is compared to static stretching, dynamic warm-up has a higher performance output in lower body power (Gelen, 2012; Pagaduan, Pojskić, Užičanin, and Babajić, 2012).

Some athletes also warm up with resistance activities, using such equipment as weighted vest, ankle or wrist weights, or elastic exercise band training system (EEBTS). A resistance warm-up is similar to a dynamic warm-up, the main difference is the added weight on the athlete. This type of warm-up allows athletes to perform their action a lot quicker and provide more power. Studies have shown that using resistance to warm up can provide a significant increase in jumping ability (Faigenbaum, McFarland, Schwerdtman, Ratamess, Jie, and Hoffman, 2006; Burkett, Phillips, and Ziuraitis, 2005). Burkett et al. (2005) determined that using weight or resistance serves as an added stimulus increasing the amount of motor unit recruitment. Yet there are no studies showing how performance will be post-resistance warm-up.

There are many forms of warm-up exercises that can be used to prepare an athlete for performance. However, there is a lack of research identifying which warm-up is the most effective. More so, there is a lack of research determining how long the positive effects of warm-up on performance can last.

Study Purpose

The purpose of this study was: 1) To determine which warm-up technique (general warm-up, dynamic warm-up, weighted vest warm-up using body weight percentage [VW], and elastic exercise band training system warm-up [EEBTSW]) will provide the best and longest effect on athletes' performance regarding power output, agility, and flexibility. 2) To compare if there are any differences in power output, agility, and flexibility when using different resistance protocols (VW and EEBTSW) as warm-up techniques. 3) To determine which warm-up will benefit the athletes' performance. 4) To

compare the hemodynamic responses to different warm-up techniques.Research Questions

To accomplish the purpose of this study, the following research questions were addressed:

1. Will a general warm-up (GW), dynamic warm-up (DW), weighted vest warm-up using body weight percentage (VW), or an elastic exercise band training system warm-up (EEBTSW) have the best effect on power output, agility, and flexibility?
2. Which warm-up (GW, DW, VW, or EEBTSW) will have the longest lasting effect on power output, agility, and flexibility?
3. What changes in heart rate (HR), systolic and diastolic blood pressure (BP), and rate of perceived exertion (RPE) will be seen among the four different types of warm-up?

Hypothesis

The study was designed to address the following hypotheses:

1. EEBTSW will prove to have a better effect on power output, agility, and flexibility than GW, DW, and VW.
2. EEBTSW will prove to have the longest effect on power output, agility, and flexibility than a GW, DW, and VW.
3. HR, BP, and RPE will be at their highest when performing an EEBTSW. HR, BP, and RPE will be the same throughout a GW, DW, and VW.

Significance of the Study

Dynamic warm-up and resistance warm-up are techniques used by many athletes before an activity. Dynamic warm-up technique has been proven to benefit athlete's performance due to the sport related movement, which is a pre-readiness to the activity, when compared to other warm-up techniques for instance static stretching (Baechle and Earle, 2008; Gelen, 2011). However, there have been limited studies testing dynamic warm-up and resistance warm-up techniques. The studies that have compared dynamic warm-up and resistance warm-up have shown that resistance might be better (Thompsen et al. 2007; Burkett, Phillips, and Ziuraitis, 2005). However, there are few studies that show the effects of a post-resistance warm-up over a span of time. This study will allow coaches and trainers to see which warm-up is optimal for performance.

Delimitations

The study is delimited as follows:

1. Only male and females between the ages of 18-50 will participate in the study.
2. Individuals must have participated in High School UIL or Collegiate athletics within the past 3 months.

Limitations

The study is limited as follows:

1. The subjects recruited for this study was limited with the local community that may not be representative of all population.
2. The information of the health history and medical information questionnaires was limited to the subject's knowledge.

3. The subjects was not monitored before entering and after leaving the testing site, so the subject was asked to not change their current physical activity and not perform any vigorous physical activity for at 48 hours before testing sessions.

Assumptions

The following assumptions were made:

1. The participants were to perform each test to the best of their ability at maximal effort.

2. The participants were to complete the study.

3. The participants were to answer question about their health history and medical information honestly.

Operational Definitions

To aid the reader, the following terms are defined as used in the present study:

EEBTS: EEBTS (Elastic exercise band training system) is a training device used for improving an athlete's power, speed and agility. It is a platform that has an elastic exercise band that attaches to the belt that goes on a person's waist.

Power: "The ability to achieve high movement velocities requires skillful force application across a spectrum of power outputs and muscle actions (Baechle and Earle, 2008)."

Agility: The ability of an athlete's collective coordinative abilities which is comprised of: adaptive ability, balance, combinatory ability, differentiation, orientation, reactiveness, and rhythm. These skills are based on performed motor tasks that span the

power spectrum from dynamic, gross activities to fine motor control tasks. (Baechle and Earle, 2008)

Agility T-Test: is a common test that is used to measure agility.

Flexibility: is the measurement of a range of motion in a joint.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this study was: 1) To determine which warm-up technique (general warm-up, dynamic warm-up, weighted vest warm-up using body weight percentage [VW], and elastic exercise band training system warm-up [EEBTSW]) will provide the best and longest effect on athletes' performance regarding power output, agility, and flexibility. 2) To compare if there are any differences in power output, agility, and flexibility when using different resistance protocols (VW and EEBTSW) as warm-up techniques. 3) To determine which warm-up will benefit the athletes' performance. 4) To compare the hemodynamic responses to different warm-up techniques.

Warm-Up

A proper warm-up is vital for performance in any activity (Bishop, 2003). It has been stated that a warm-up allows for positive influence in performance (Baechle and Earle, 2008, p. 296; Bishop, 2003). Some of the ways in which a warm-up can improve performance is by: improvement in rate force development, reaction time, strength and power, oxygen delivery, blood flow, faster muscle contraction and relaxation, lower viscous resistance in the muscle, and enhancement in metabolic reaction (Baechle and Earle, p. 296, 2008; Bishop, 2003).These improvements in performance occur due to increased temperature and blood flow to the muscles (Baechle and Earle, 2008, p. 296).

One warm-up protocol that is highly used in sports is the dynamic warm-up. A dynamic warm-up, which serves as a walk through in the range of motion required for the sport, provides athletes with similar movement to the athlete's sport (Baechle and Earle, 2008, p. 297). Studies have claimed that it increases performance such as power, agility, and speed (Gelen, 2011; Pagaduan, Pojskić, Užičanin, and Babajić 2012; Herman, and

Smith, 2008). Faigenbaum et al. (2010) also demonstrates that dynamic warm-up can provide benefits over a range of time. However, the majority of the studies have compared dynamic warm-up against static stretching (Gelen, 2011; Pagaduan, Pojskić, Užičanin, and Babajić 2012; Faigenbaum et al., 2010). Another warm-up protocol that is used in athletes' pre-game is resistance warm-up. A resistance warm-up is very similar to a dynamic warm-up. The difference is that resistance warm-up has added weight while performing the dynamic exercises. Limited studies indicate that a resistance warm-up could allow athletes to perform better when compared with a dynamic warm-up (Thompsen et al. 2007; Burkett, Phillips, and Ziuraitis, 2005).Although a resistance warm-up may increase performance; it is still fairly a new idea. There is still lack of information on the proper amount of weight an athlete should use, which type of resistance equipment could be used, and what intensity a resistance warm-up should require.

Dynamic Warm-up

A dynamic warm-up has proven to increase performance. In one study, dynamic warm-up, static stretching, and aerobic exercise were compared to see which warm-up could improve vertical jump ability (Gelen, 2011). Gelen (2011) used 64 children around the age of 13, and the subjects performed three warm-ups consisting of five minutes of jogging then a static stretching, no stretching, or a dynamic warm-up. Gelen (2011) concludes that static stretching hinders vertical performance, but that a dynamic warm-up protocol would provide a better power production. Another study examined if dynamic warm-up protocol would show better results than static stretching and no warm-up (Pagaduan, Pojskić, Užičanin, and Babajić 2012). Pagaduan and colleagues (2012) used

29 male college football players for their study and had them test on counter movement jump. They had seven different variables that consisted of no warm-up, general warm-up (five minutes running at a preset pace), dynamic warm-up and static stretching. Each test was separated by 48 hours. They found that the best warm-up for low body power was dynamic warm-up with general warm-up (Pagaduan, Pojskić, Užičanin, and Babajić 2012). They concluded that this might have occurred due to improvement in muscle stiffness and nervous system activity (Pagaduan, Pojskić, Užičanin, and Babajić 2012).

When it comes to testing a warm-up, most studies only compare warm-up outcome right after the subject has completed the warm-up. However, one study set out to find the effects of different recovery time. A study done by Faigenbaum et al. (2010) compared dynamic warm-up and static stretching and tested how performance increased or decreased due to recovery time. Faigentbaum and colleagues (2010) had 19 male high school athletes perform a five minutes walking before pre-test. The test consisted of vertical jump and medicine ball throw. Then the subject performed either a dynamic warm or static stretch protocol. After the warm-up was completed, vertical jump and medicine ball throw were tested at 2, 6, 10, 14, 18, and 22 minutes during the recovery. During the rest time the subject was asked to sit or stand prior to assessment. Faigentbaum and colleagues' (2010) suggested there was a significant difference between vertical jumps from minute 2 all the way to minute 10. They speculated that physiological mechanism was responsible for this occurrence.

Even though there is great deal of data supporting that a dynamic warm-up is better, there are a few that argue that it is the best. It has been shown that a dynamic warm-up might have no effect on muscular performance or electrical activity

(Altamirano, Coburn, Brown, and Judelson, 2012). Altamirano and colleagues (2012) used 21 males that had experienced lifting to examine the effect of the warm-up on EMG and MMG signals, using a warm-up protocol that is more typical of those used by strength and conditioning practitioners. They compare their dynamic warm-up with no warm-up. They found that there was no difference between the warm-up and non-warm up used.

Dynamic warm-up has proven to improve performance in power. However, another study (cite the paper you are talking about) suggests that dynamic warm-up does not have an effect on athletes' performance. Further research is needed to see how dynamic warm-up is affected by the timing and using EMG during the dynamic warm-up to see if there is an effect.

Resistance Warm-Up

There are studies now showing that resistance added to a dynamic warm-up could provide athletes with better performance. There are several different resistance warm-up protocols that use a weighted vest for resistance (Thompsen et al. 2007;Faigenbaum, McFarland, Schwerdtman, Ratamess, Jie, and Hoffman, 2006). However, other studies show that free-weights can also be used for a resistance warm-up (Burkett, Phillips, and Ziuraitis, 2005; Sotiropoulos, Smilios, Christou, Barzouka, Spaias, Douda, and Tokmakidis, 2010).

In one study, 16 female college athletes participated in a study to examine whether using a weighted vest would improve lower body power (Thompsen et al. 2007). They used three different types of warm-up protocols, which were static stretching, dynamic warm-up and dynamic warm-up with weight vest (at 10% body mass). Thompsen and

colleagues (2007) stated that performing a warm-up with or without resistance would be better than static stretching in vertical jumping. It was also observed that a dynamic warm-up with weighted vest is better in long jump performance then the other warm-ups (Thompsen et al. 2007). The authors believe this occurred due to postactivation potentiation (PAP) (Thompsen et al. 2007). Another similar study tested 20 female high school athletes to find out which of the 4 warm-up protocols would improve anaerobic performance (Faigenbaum, McFarland, Schwerdtman, Ratamess, Jie, and Hoffman, 2006). The 4 protocol are static stretch, dynamic warm up, and dynamic warming while using 2% body mass and 6% percent body mass(Faigenbaum et al., 2006).The assessments used to test the warm-up were vertical jump test, long jump test, medicine ball toss, and 10 yard sprints (Faigenbaum et la., 2006). Faigenbaum et al. (2006) found that dynamic warm-up done with a vest at 2% body mass showed a significant increase in lower body power in female athletes (Faigenbaum et al., 2006). Faigenbaum et al. (2006) also suggested that PAP had a positive affected on jumping performance after using weight. However, they also noted using a vest at 6% of body mass might have caused fatigue in performance, resulting in a slight decrease in performance (Faigenbaum et al., 2006).

There have been other studies that have shown that resistance warm-up also works by using other types of resistance than a vest. One study used 29 male college football athletes and had them warm-up with 10% of their body mass in comparison to no warm-up, stretching, and submaximal warm-up (Burkett, Phillips, and Ziuraitis, 2005). The protocol used in the resistance warm up had the subject hold the dumbbell while performing warm-up. Burkett and colleagues (2005) found that performing resistance

warm-up produces the greatest benefit to performance on lower body power. Another study even looks at the muscle activation when using resistance in a warm-up (Sotiropoulos, Smilios, Christou, Barzouka, Spaias, Douda, and Tokmakidis, 2010). Sotiropoulos et al. (2010) had the subject do three sessions of warm-up that break down to dynamic warm-up, dynamic warm-up with half squat at a low intensity (25%-35% of their 1RM), and dynamic warm-up with moderate intensity (45%-65% of their 1RM). They claim that using low to moderate half squat as resistance improved performance better in the counter movement jump, which could be due to increases muscle activation that was proven by EMG.

Resistance warm-up has been proven to be better than dynamic warm-up in performance. Also weighted vest and free weights can be used as resistance warm-up. However, no one has tested other types of resistance equipment as a resistance warm-up. It is also not known how long the effect of a resistance warm-up will last for performance.

Conclusion

As it is seen in this review, there is a lack of proper protocol for a resistance warm-up. A resistance warm-up has proven to be just as good as or even better than a dynamic warm-up in specific areas in performance. A resistance warm-up is a fairly new idea, which has different type of protocols that are being used (Thompsen et al. 2007). In addition, research has to be performed to understand how long the effect of resistance warm-up will last, so it is necessary to know more about which warm-up protocol is the most effective in performance, in order to apply the most optimal warm-up to athletes.

CHAPTER III

METHODS

Subjects

31 subjects consisted of 15 males and 16 females between the ages of 18 and 24 years old. This was a within subject design. The procedure used in this study was approved by the University of Texas-Brownsville Institutional Review Board for Human Subjects and was followed. The length of the study was five, 60-min sessions, each separated by at least 48 hours between each session.

Inclusion Criteria

1. Subjects who were within 18-40 years of age.
2. Subjects who have participated in high school UIL or collegiate athletics within the past 3 months.

Exclusion Criteria

1. Subjects with a serious injury that required surgery within the last 3 months
2. Subjects with any lower extremities injuries within the 3 months.
3. Subjects with hypertension.
4. Subjects with cardiovascular problems.
5. Subjects taking medication for either hypertension or cardiovascular disease.

Recruitment

Participants were recruited from the University of Texas at Brownsville via fliers and word of mouth.

Experimental Protocol

On the first day, the participants were required to read and sign the informed consent form, completing the physical activity readiness questionnaire (PAR-Q) and

health status questionnaire before any testing. After all forms were signed, anthropometric measurement were taken including: height, weight, body fat%, and arm reach. The participant was then introduced to the study procedures and run through on the assessment: sit-and-reach test, countermovement jump, and agility t-test.

Each of the experimental sessions were be randomized into one of four different warm-up conditions:

1. General Warm-up (GW)
2. Dynamic Warm-up (DW)
3. Weight vest warm-up using body weight percentage (VW): Male subjects will be using weight at 10% of their body weight, and female subjects will be using 2% of their body weight.
4. Elastic exercise band training system warm-up (EEBTSW): Both gender will be using light band setting (5/16) at the first black mark for resistance.

On the following four visits, before warming–up the subject sat for five minutes. During this time, a warm up was selected for the subject at random. After the five minutes, resting heart rate and blood pressure were taken. As soon as heart rate and blood pressure was taken, the subject performed the warm-up. The general warm-up consisted of walking for ten minutes at self-selected pace. During the warm-up, HR was taken every minute, RPE (Borg’s Scale 6-20) was taken every five minutes of warm-up, and blood pressure was taken once the warm-up was completed.

The dynamic and resistance warm-ups consisted of five exercises and they were performed in the following order: high knees, back pedal, left side shuffle, right side

shuffle, and stationary squat jumps. Each warm-up exercise was done for one minute for two sets. The total time of warm-up was ten minutes. For DW and VW, the subject performed eight seconds of warm-up from starting line to finish line, and approximately seven seconds of walking back from end line to starting line. The distance covered for the warm-up was ten meters. For the EEBTSW, the subject performed high knees and back pedals as far as the subject could go and continued to perform exercise for eight seconds. They walked back to the starting line within the seven seconds. When performing left and right shuffle, the subjects went as far as they could and then shuffled back approximately ten feet and then shuffled back up as far as they could go until eight seconds were over. The subjects walked back to starting line within seven seconds. During the warm-up, heart rate was checked after every minute of exercise. RPE and blood pressure were also taken following each warm-up.

Flexibility Test (Sit-and-Reach)

Sit-and-reach test was tested post-exercise with the sit-and-reach box. The subject sat shoeless with heels press against the sit-and-reach box. The ruler of the sit-and-reach box was set at 26 cm mark . Each subject placed one hand on top of the other, and then reached slowly forward to the point of the greatest reach, while keeping both hands adjacent with each other and not leading with one hand, as far as possible and held the positon for at least two seconds on the sit-and-reach box ruler. The sit-and-reach test was performed at two-minute, 6-minute, 10-minute, 14-minute, and at the 18-minute mark. The sit-and-reach test was tested one time at each mark.

Explosive Power (Counter Movement Jump)

Counter movement jump (CMJ) was tested post- exercise using the Vertec. The Vertec is a commercial device used to measure vertical jump. The subject stood with dominant shoulder under the Vertec vanes, with both feet planted on the floor. The subject then performed a countermovement by rapidly flexing the knees and hips, moving the trunk forward and downward and swinging both arms back, without any stutter steps. When jumping, the subject was instructed to reach as high as possible with their dominant arm and hit the Vertec vanes marking how high the subject jumped. CMJ was tested at 2:50-minute, 6:50-minute, 10:50-minute, 14:50-minute, and at the 18:50-minute mark. The CMJ was tested one time at each mark.

Agility T-Test

Agility t-test was tested post-exercise using a SpeedTrap 1 (Brower Timing Systems, Inc., Draper, UT). The subject stepped on a touch pad, which will start the time as soon as the subject releases the touch pad. After hearing the auditory single, the subject sprinted straight forward 10 yards and touched the top of a cone with their right hand. Then, looking forward without crossing feet, the subject shuffled five yards to the left and touch the top of a cone with their left hand. Then the subject shuffled ten yards to the right and touched the top of a cone with their right hand. Then the subject shuffled five yards back to the middle cone and touch the top of the cone with the left hand and backpedaled back to the starting line. At this point the infrared lenses stopped the time once the subject crossed the finish line. This agility t-test was tested at 3:25-minute, 11:25-minute and 19:25-minute mark. The agility t-test will be tested one time at each mark. Heart rate will record after every set of assessment.

Statistical Analysis

A one-way analysis of variance (ANOVA) with repeated measures (Sessions [General warm-up, Dynamic, Weight Vest at Body Weight Percentages, and Elastic Exercise Band Training System]) was used to determine if significant differences existed in all dependent variables. An alpha of ≤ 0.05 was used to determine statistical significance and data was analyzed using SPSS 17.0 for Windows (SPSS Inc., Chicago, IL).

CHAPTER IV
RESULTS

The purpose of this study was: 1) To determine which warm-up technique (general warm-up, dynamic warm-up, weighted vest warm-up using body weight percentage [VW], and elastic exercise band training system warm-up [EEBTSW]) will provide the best and longest effect on athletes' performance regarding power output, agility, and flexibility. 2) To compare if there are any differences in power output, agility, and flexibility when using different resistance protocols (VW and EEBTSW) as warm-up techniques. 3) To determine which warm-up will benefit the athletes' performance. 4) To compare the hemodynamic responses to different warm-up techniques.

Subjects Characteristics

Thirty-one male (age= 21.93 (2.71), n=15) and female (age= 21.25 (1.77), n=16) college athletes participated in this study. The sports that the athletes participated in are volleyball, soccer, cross country and tennis. Table 1 shows mean anthropometric measurements of the participants. The participants were recruited voluntary from the University of Texas at Brownsville Athletics teams and the nearby community.

Table 1. Participants' Anthropometric Data

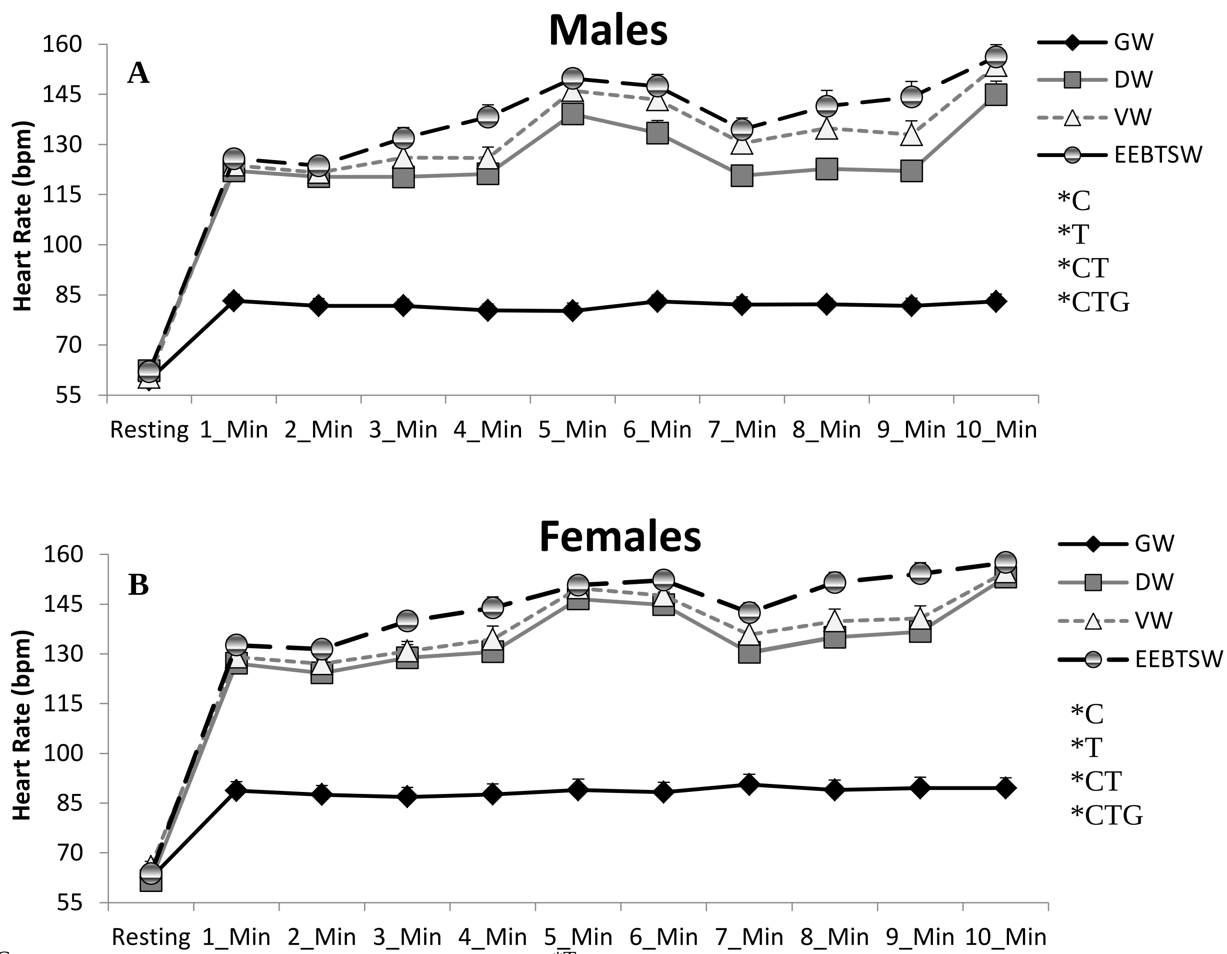
Variable	Male (n=15)	Female (n=16)
Age (yr.)	21.93 (2.71)	21.25 (1.77)
Height (cm)	175.71 (4.49)	167.46 (9.83)
Weight (Kg)	71.51 (6.50)	64.28 (9.99)
Body Fat (%)	9.37 (2.38)	22.33 (5.73)

Values are reported as means (SD)

Heart Rate

Figures 1A and 1B display heart rate for males and females from rest, through warm-up for all testing conditions. There were significant condition*time interactions ($p<0.01$), significant condition*time*gender interactions ($p<0.05$), and a trend for a time*gender interaction ($p=0.075$). There were also significant main effects for condition and time ($p<0.01$).

Figure 1A and 1B. Changes in Heart Rate in Male and Females during Warm-Up Exercise



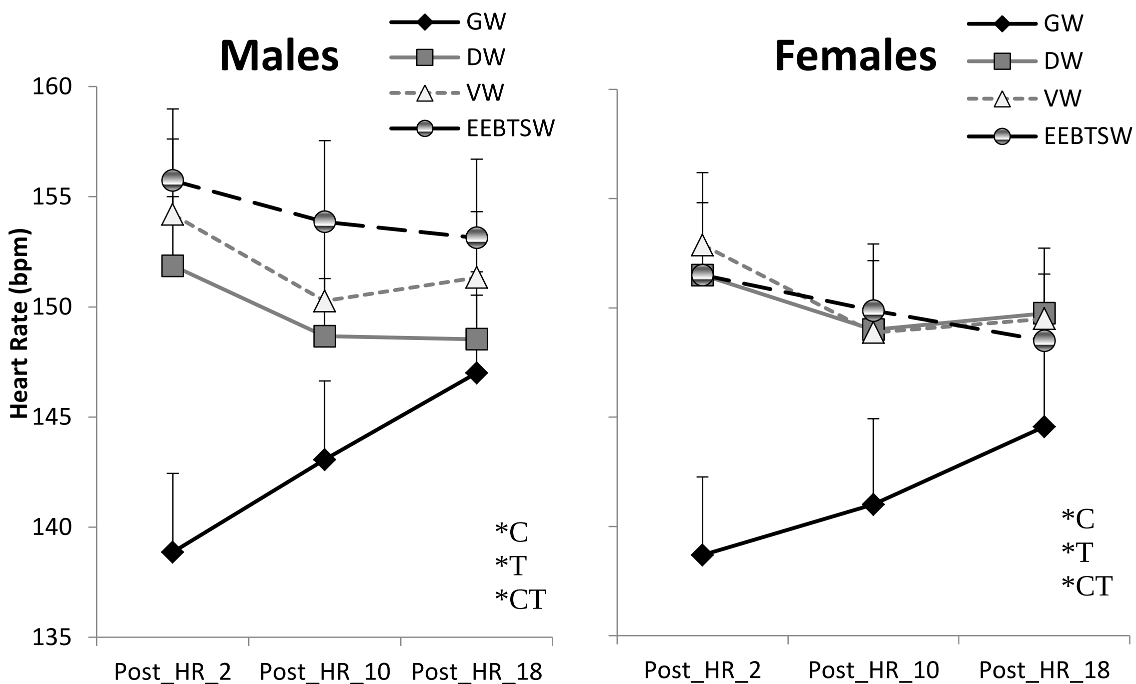
[C]Significant condition difference ($p<0.01$). [*T]Significant time difference ($p<0.01$). [*CT]Significant condition*time interaction ($p<0.01$). [*CTG]Significant condition*time*gender interaction ($p<0.05$). [#TG]Trend for time*gender interaction ($p=0.075$). Values reported as mean ± SE. (N=31)

Post Heart Rate

Post Heart Rate 2, 10, and 18 minutes

Figure 2A and 2B show the post heart rate response for males and females from two minutes post all three exercises through 18 minutes post all three exercises for all condition. There was a significant condition*time interaction ($p<0.01$). There were also a significant condition difference ($p<0.01$) and a significant time difference ($p<0.05$).

Figure 2A and 2B. Changes in Post Heart Rate after Agility T-Test 2, 10, and 18 minutes in Male and Females



*C Significant condition difference ($p<0.01$). *T Significant time difference ($p<0.05$).

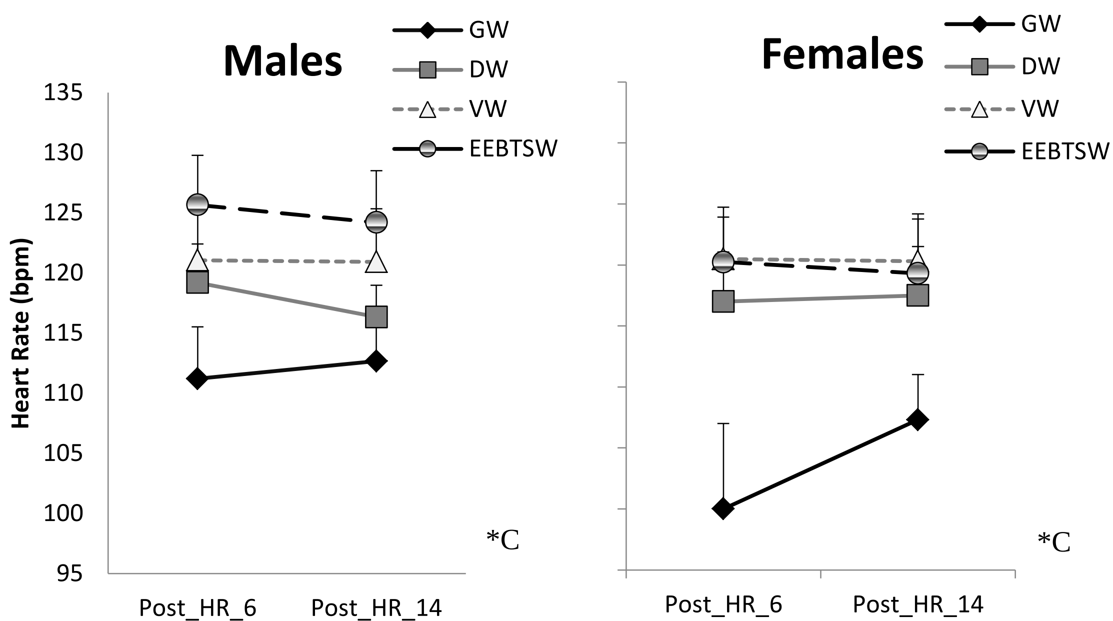
*CT Significant condition*time interaction ($p<0.01$). Values reported as mean ± SE.

(N=31)

Post Heart Rate 6 and 14 minutes

Figure 3A and 3B display the post heart rate response for males and females from six minutes post sit and reach and counter movement jump exercises to 14 minutes post sit and reach and counter movement jump exercises for all conditions. Repeated measures ANOVA showed a significant condition difference ($p<0.01$).

Figure 3A and 3B. Changes in Post Heart Rate after Counter Movement Jump 6 and 14 minutes in Male and Females



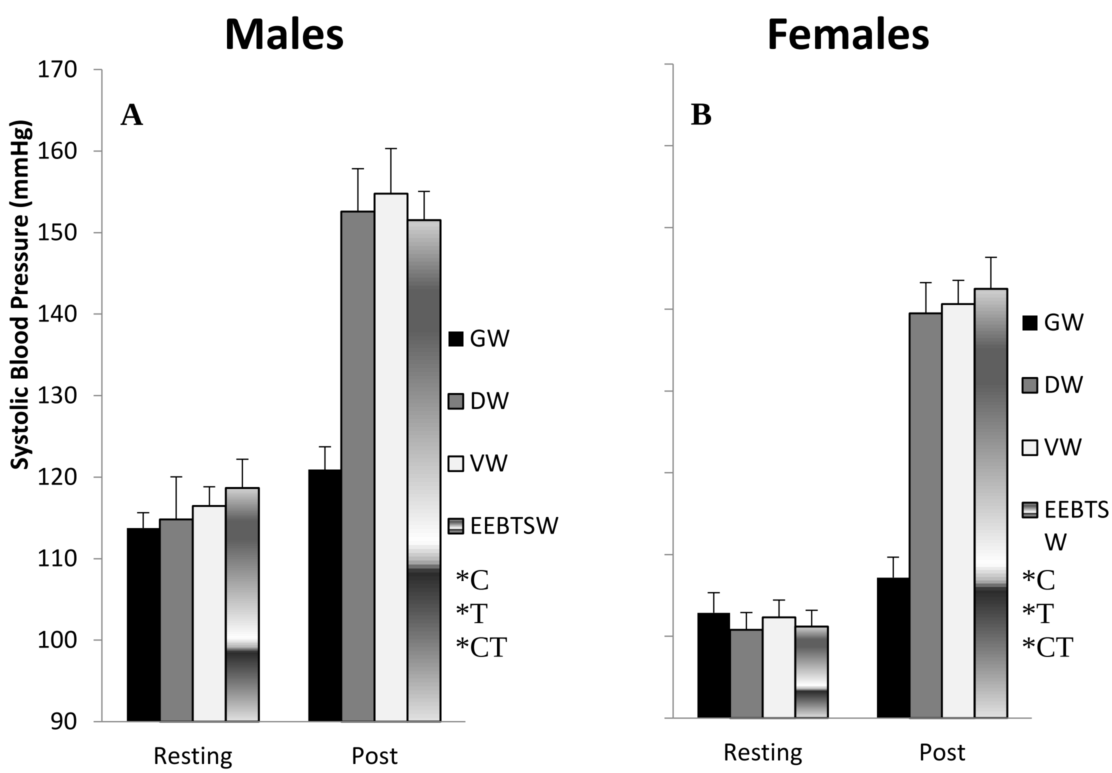
*CSignificant condition difference ($p<0.01$). Values reported as mean ± SE. (N=31)

Blood Pressure

Systolic Blood Pressure

Figures 4A and 4B display systolic blood pressure for males and females from rest to end of the warm-up for all testing conditions. There was a significant condition*time interaction ($p<0.01$). There were also significant condition and time main effects ($p<0.01$).

Figure 4A and 4B. Changes in Systolic Blood Pressure in Male and Females

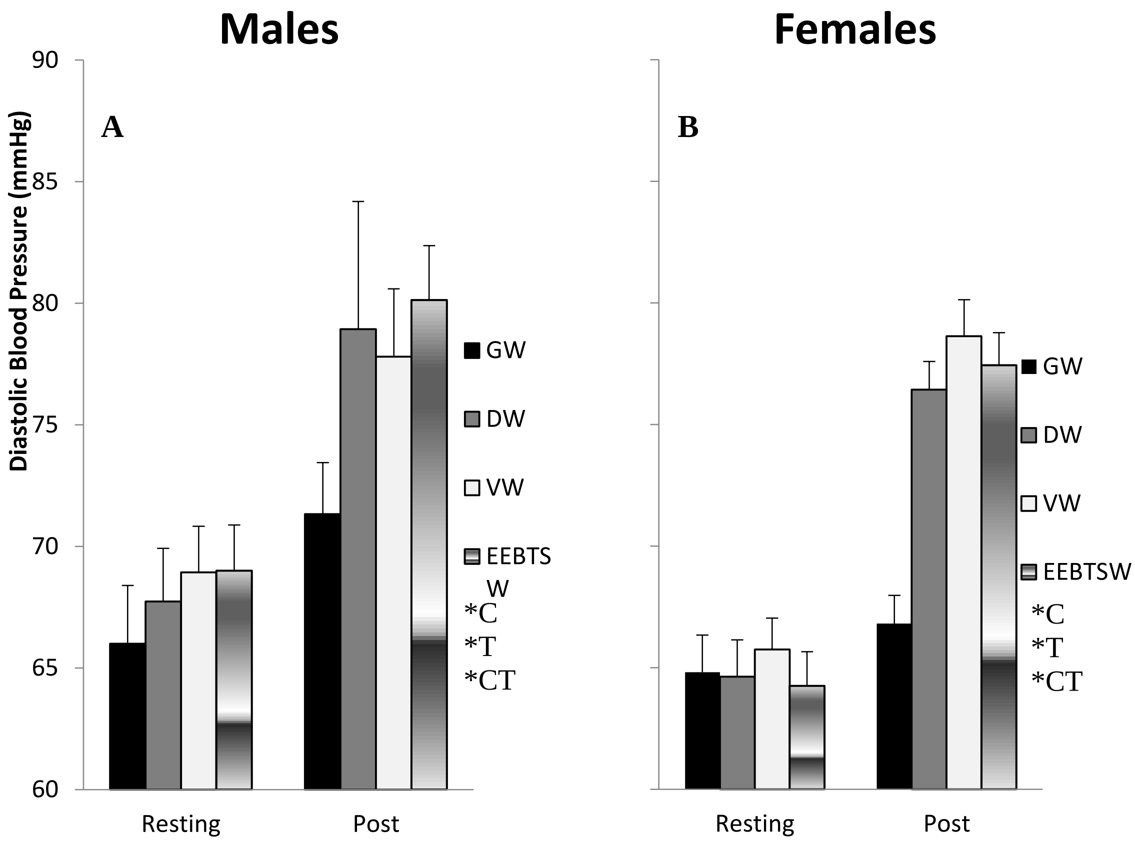


*C Significant condition difference (p<0.01). *T Significant time difference (p<0.01). *CT Significant condition*time interaction (p< 0.01). Values reported as mean ± SE. (N=31).

Diastolic Blood Pressure

Figures 5A and 5B display diastolic blood pressure for males and females from rest to end of the warm-up for all testing conditions. There was a significant condition*time interaction (p<0.01). Significant condition and time main effects were also detected (p<0.01).

Figure 5A and 5B. Changes in Diastolic Blood Pressure in Male and Females

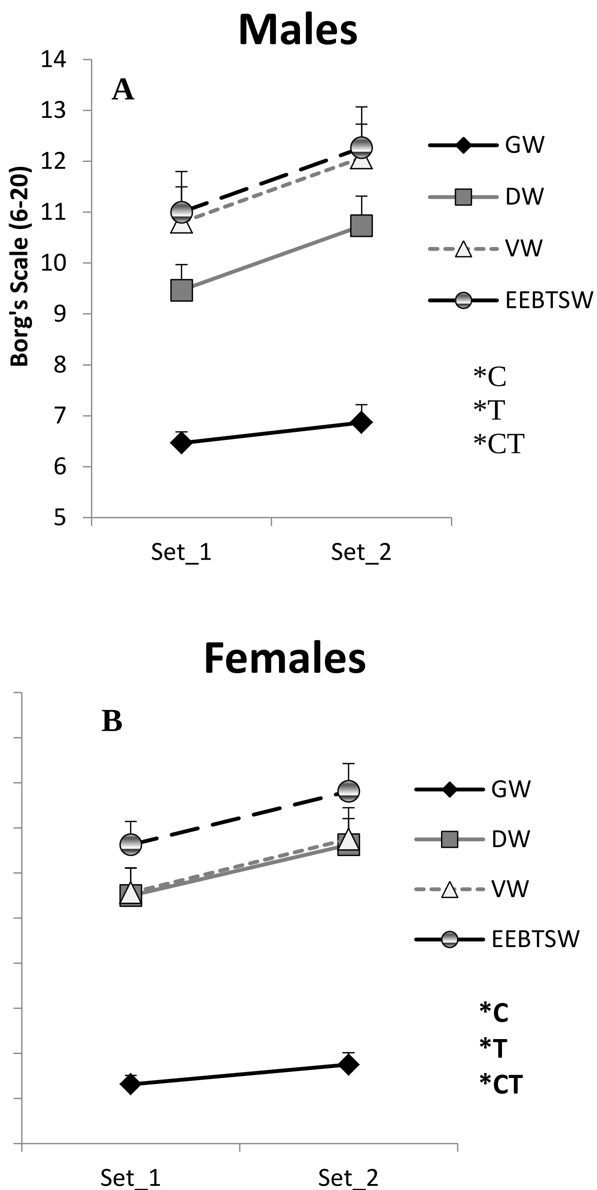


*C Significant condition difference (p<0.01). *T Significant time difference (p<0.01). *CT Significant condition*time interaction (p< 0.01). Values reported as mean ± SE. (N=31)

Rate of Perceived Exertion

Figure 6A and 6B show the rate of perceived exertion response for males and females from first set to the last set of the warm-up for all conditions. There was a significant condition*time interaction (p<0.01). There was also significant condition and time difference (p<0.01).

Figures 6A and 6B. Changes in Rate of Perceived Exertion in Male and Females

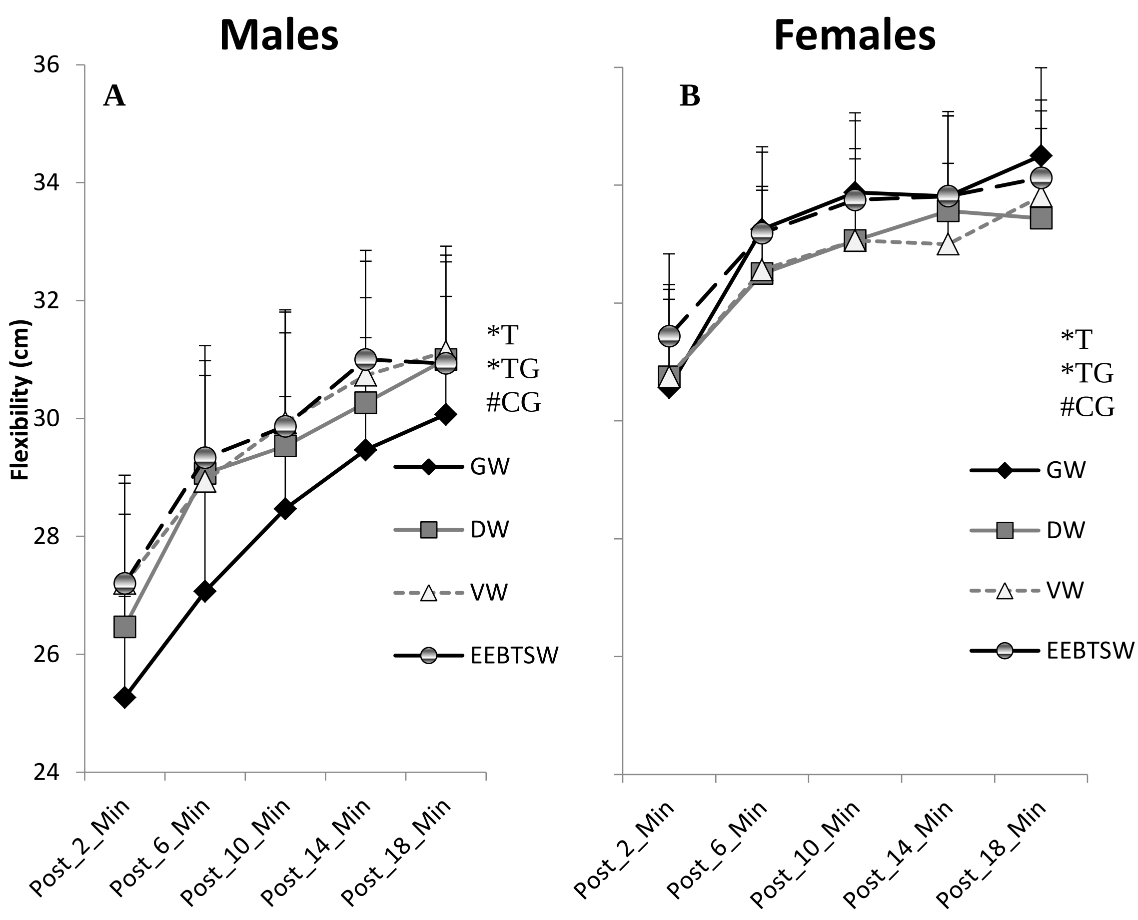


*C Significant condition difference (p<0.01). *T Significant time difference (p<0.01). *CT Significant condition*time interaction (p< 0.01). Values reported as mean ± SE. (N=31)

Flexibility

Figure 7A and 7B show the flexibility response for males and females from two minutes post warm-up through 18 minutes post warm-up for all condition. There were significant time*gender interaction (p=0.038) and a trend for a condition*gender interaction (p=0.077). There was also a significant time main effect (p<0.01).

Figures 7A and 7B. Changes in Flexibility in Male and Female

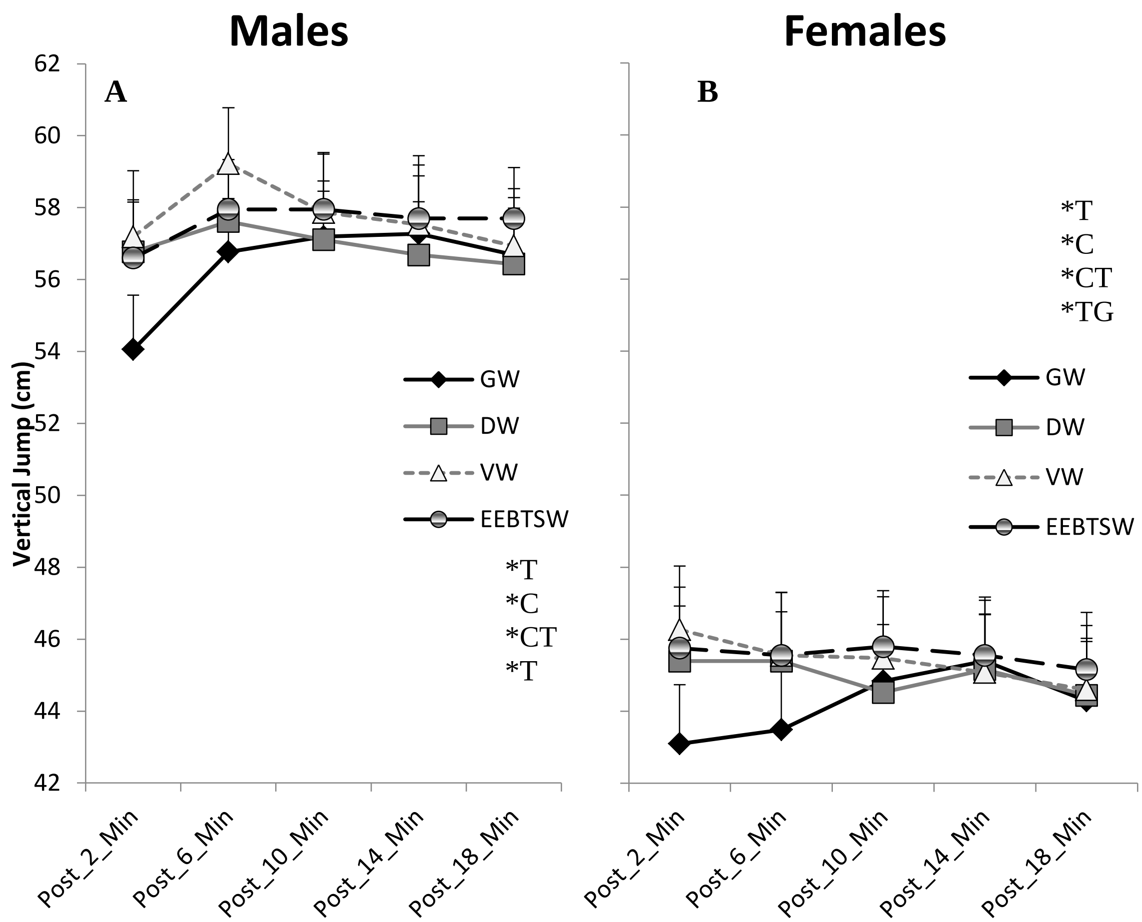


[*T]Significant time difference (p<0.01). [*TG]Significant time*gender interaction (p=0.038). [#CG]Trend for condition*gender interaction (p=0.077). Values reported as mean ± SE. (N=31)

Power

Figure 8A and 8B show the power response for males and females from two minutes post warm-up through 18 minutes post warm-up for all conditions. There were significant condition*time and time*gender interactions (p<0.01). There were also a significant time difference (p<0.01) and a significant condition difference (p<0.02).

Figures 8A and 8B. Changes in Power in Male and Females

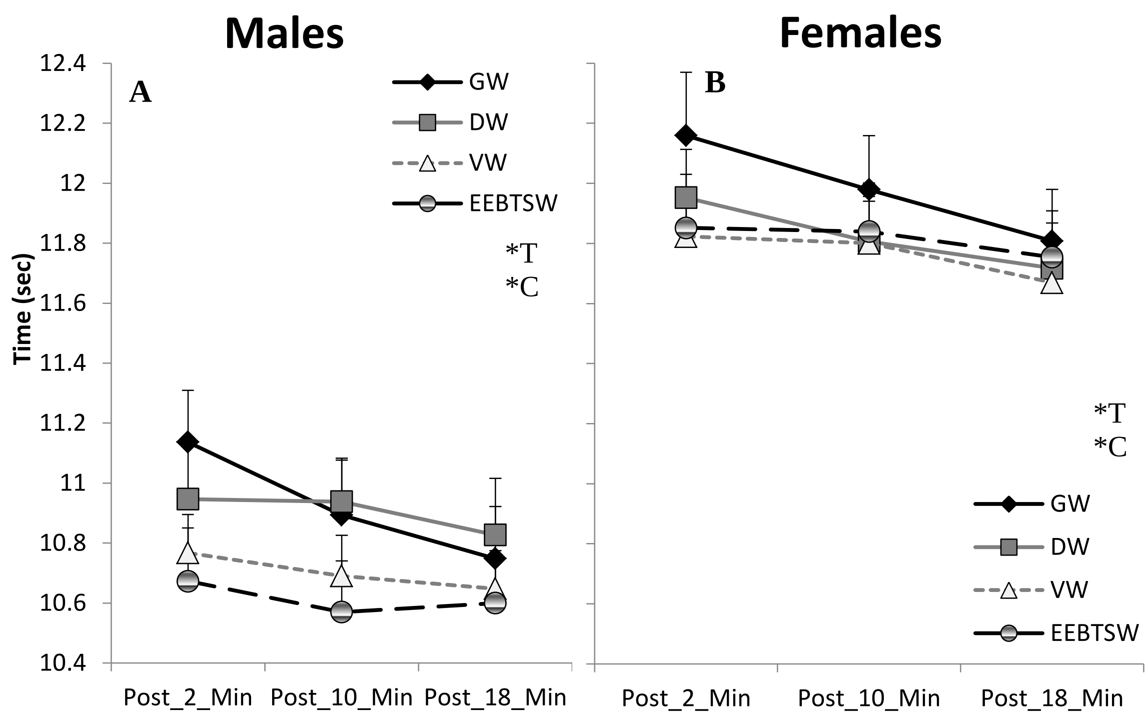


*TSignificant time difference (p<0.01). *CSignificant condition difference (p<0.01). *CTSignificant condition*time interaction (p<0.01). *TGSignificant time*gender interaction (p<0.01). Values reported as mean ± SE. (N=31)

Agility

Figure 9A and 9B show the Agility response for males and females from two minutes post warm-up through 18 minutes post warm-up for all conditions. Repeated measures ANOVA showed a significant time difference (p<0.01) and a significant condition difference (p<0.02).

Figure 9A and 9B. Changes in Agility in Male and Females



*T Significant time difference (p<0.01). *C Significant condition difference (p<0.02).

Values reported as mean ± SE. (N=31)

Chapter V

DISCUSSION

The purpose of this study was: 1) To determine which warm-up technique (general warm-up, dynamic warm-up, weighted vest warm-up using body weight percentage [VW], and elastic exercise band training system warm-up [EEBTSW]) will provide the best and longest effect on athletes' performance regarding power output, agility, and flexibility. 2) To compare if there are any differences in power output, agility, and flexibility when using different resistance protocols (VW and EEBTSW) as warm-up techniques. 3) To determine which warm-up will benefit the athletes' performance. 4) To compare the hemodynamic responses to different warm-up techniques.

The major finding in this study was that the use of a vest warm-up (VW) and elastic exercise band training system warm-up (EEBTSW) had the best improvement for power output for the first 2 - 6 minutes post warm-up when compared to the control. Findings also showed that the EEBTSW improved power output more than DW at the 10-minute mark. It was also discovered that EEBTSW improved agility significantly for the first minutes when compared to the control. This finding is important because it answers the problem that was presented in Chapter 1: that the use of a resistance warm-up can provide added benefit in performance and have a more lasting effect on athlete's performance than a dynamic warm-up.

Hemodynamic Responses

In this study, it was discovered that EEBTSW produced the highest heart rate response throughout the entire warm-up when compared to all of the other conditions. This finding was expected since the elastic exercise band increases resistance as distance

increases. As the athletes were going further from the platform, the elastic exercise bands were gradually increasing resistance causing the body to work harder and increase heart rate. As the level of work-performed increases, there is a greater amount of metabolic reaction occurs increasing muscle and core temperatures (Bishop, 2003, Baechle, and Earle 2008). Blood viscosity decreases with the increased body temperature allowing more blood to flow to muscles resulting in better performance (Bishop, 2003, Baechle, and Earle 2008). Although previous studies have not investigated the changes in heart rate while performing these warm-up protocols, it has been noted that a higher intensity warm-up produces better performance (Ingham et al., 2013; Burkett et al., 2005; Thompsen et al., 2007). However, using a higher intensity warm-up may not always be beneficial and may result in decreases in performance. Faigenbaum et al. (2006) investigated the difference between four different warm-up protocols (static stretching, dynamic exercise, dynamic exercise with a vest weighted to 2% body mass; and dynamic exercise with a vest weighted to 6% body mass) on four different performance tests in female college athletes. The results showed that subjects who performed the dynamic exercise with a vest weighted to 2% body mass had the best results on the four different tests. The authors concluded that dynamic exercise with a vest weighted to 6% body mass may have fatigued the subjects and hindered performance (Faigenbaum et al.2006). It is important to know the appropriate intensity of warm-up in order to improve performance and avoid fatigue. In other words, if the intensity of the warm-up is too high, athletes may experience fatigue and a decrease in performance.

“Systolic blood pressure estimates the pressure created against the arterial walls as blood is forcefully ejected during ventricular contraction” (Baechle and Earle, 2008, p 124). Diastolic blood pressure is used to estimate the pressure exerted against the arterial walls when no blood is being forcefully ejected through the vessels” (Baechle and Earle, 2008, p 124). In this study, there was no significant difference in diastolic blood pressure between the more active warm-ups. However, general warm-up (GW) had a significant lower systolic blood and diastolic blood increase pressure throughout the warm-up when compared to the other protocols. This finding was expected due the increase in cardiac output during DW, VW, and EEBTSW. Cardiac output is raised by an increase in heart rate and stoke volume (Powers and Howley, 2009). Increased cardiac output results in a greater amount of blood pumped through arteries applying more pressure to the arterial walls and therefore causing increases in blood pressure. Increases in exercise intensity causes augmentation in sympathetic nervous system activity and therefore increases in epinephrine level (Powers and Howley, 2009). When the level of epinephrine increases, heart rate and vasoconstriction increases resulting in higher systolic blood pressure.

Heart rate was assessed within a minute following every test performed and this study was the very first study to see the difference of heart rate after performance of test in every warm-up condition. All the warm-ups significantly had a higher heart rate compared to the control (GW). Also, there was a significant condition*time interaction with GW resulting in the greatest increases in heart rate from 2 minutes to 18 minutes post warm-up time after performing the agility T-Test. The results indicated that the control condition (GW) was not enough to prepare athletes to perform right after the warm-up. It can be speculated that the results in this study proved that a dynamic and

resistance warm-up could provide a better preparedness for better performances in power and agility.

Rate of Perceived Exertion

This is the first study to record a rate of perceived exertion (RPE) with different warm-up protocols. RPE serves as an indicator on how the subject feels about his or her level of exertion during exercise. RPE correlates with exercise heart rate and work rate of an individual (Thompson, Gordon, and Pescatello, 2010). The finding in this study for RPE showed that EEBTSW was significantly more intense when compared to GW and DW. However, there was no difference in RPE values between EEBTSW and VW and the RPE values ranged from light to somewhat hard.

Flexibility

This is the first study to see the effects of flexibility when using a resistance warm-up. Each warm-up improved flexibility when compared to the control, with EEBTSW having the best effect in flexibility. However none of these warm-ups were significantly different between conditions. The results found in this study are consistent with previous studies (Andrejić, 2012; Faigenbaum et al 2005), that there was no significant difference among warm-ups. Although both studies did not use a resistant warm-up as a condition, both studies used different intensities, which ranged from moderate to high intensity warm-up (Andrejić, 2012; Faigenbaum et al 2005). Andrejić (2012) examine 4 different protocols (no stretching, static stretching, dynamic exercises warm-up, and dynamic exercises warm-up followed by 5 drop jumps) on different parameters, including flexibility, in male youth basketball players. It was reported no significant difference between static stretching, dynamic exercises warm-up, and

dynamic exercises warm-up followed by 5 drop jumps when performed flexibility. In a similar study done by Faigenbaum et al. (2005), the researchers investigated the 3 difference warm-up conditions (5 minutes of jogging and static stretching, 10 minutes of 10 dynamic exercises warm-up from moderate to high intensity, and 10 minutes of 10 dynamic exercises warm-up followed by 3 drop jumps) on different variables (vertical jump, long jump, shuttle run, and flexibility) in both male and female youth athletes. It was found that there was no significant difference among the 3 conditions in flexibility. This is important because it indicates that using a resistance warm-up, such as EEBTSW (which produces a higher intensity), may not hinder flexibility.

In this study, it was also discovered that there were significant increases in flexibility over time among all the warm-ups. From 2 minutes through 14 minutes post warm-up, flexibility continued to increase overtime. After the 14 minutes, there was no significant difference in time. However, it can be speculated that the counter movement jump and t-test caused changes in the parameters such as muscle temperature and/or viscosity resulting in improvements in flexibility overtime.

Power

In this study all of the warm-ups improve power output when compared to the control. However, it was discovered that VW and EEBTSW provided the most improvement in power output by at least 2.5% for both warm-ups when compared to the control. This finding is consistent with previous studies (Burkett et al., 2005; Faigenbaum et al., 2006; Thompsen et al., 2007) when comparing resistance warm-up protocols to other warm-ups on vertical jump. In this present study the resistance used on VW was based on the previous studies (Burkett et al., 2005; Faigenbaum et al., 2006).

The study that was performed by Burkett et al. (2005) tested the difference between 4 warm-up protocols (no warm-up, static stretching, submaximal jump, and weighted jump warm-up at 10% body weight using a barbell) on vertical jump in college football athletes. They found that the vertical jump performance following weighted jump warm-up was significantly greater when compared to the performance following the other warm-ups. In a similar study done by Faigenbaum et al. (2006), the researchers examined 4 different warm-up protocols (static stretching, dynamic warm-up, dynamic vest warm-up at 2% body weight, and dynamic vest warm-up at 6%) on different performance variables, including vertical jump, in female high school athletes. Faigenbaum et al. (2006) found that subjects who performed a dynamic vest warm-up at 2% body weight significantly increased vertical jump performance by 13.5% when compared to the static stretching. This is due to the phenomenon known as postactivation potentiation (PAP). PAP is a muscular function that occurs when there is an increased amount of motor unit recruited before performance. In the present study, it can be speculated that the resistance used in the warm-up serves as a stimuli which increases the amount of motor units recruited.

However, not every study had the same findings (Maloney et al. 2014) when testing different warm-up protocols on power output. Maloney et al. (2014) tested 3 different resistance protocols (dynamic vest warm-up at 5% body weight, dynamic vest warm-up at 10% body weight, and dynamic warm-up as control) on vertical jump and agility with different post performance time in elite badminton athletes. They found no significant difference between the 3 warm-ups. They stated that the reason for not finding any differences between warm-ups may have been due to the fatigue of using too

much weight on the subjects. However in this present study, it was revealed that both resistance (VW and EEBTSW) warm-ups improved vertical jump when compared to the control. Yet, when the conditions are compared to subjects' sport, only EEBTSW showed a significant difference in jumping performance in volleyball subjects. It is logical to speculate that specific sports require specific muscles to be trained more and/or athletes perform certain movements more such as jumping in their practices and in games, therefore the muscles of volleyball players may have adapted to resistance being used, allowing more motor units to be activated without fatiguing. Another possible reason for why Maloney et al. (2014) did not find any significant differences between warm-ups might be due to the warm-ups used in the study. Maloney et al. (2014) used the dynamic warm-up as the control session. However, in this present study and other studies previously mentioned earlier (Burkett et al., 2005; Faigenbaum et al., 2006; Thompson et al., 2010), the dynamic movement exercise was compared to general walking, no warm-up, or static stretching.

As mentioned in previous studies (Faigenbaum et al., 2006; Thompson et al., 2010), there was a lack of information on how long the effect of PAP will last after a warm-up on vertical jump performance. In this present study, both VW and EEBTSW resulted in better performance in vertical jump power from 2 to 6 minutes post warm-up when compared to the control warm-up (GW). At 10 minutes post warm-up, the EEBTSW was significantly better than the dynamic warm-up (DW). After the 10 minutes post warm-up, there was no significant difference between warm-ups. Maloney et al. (2014) also tested the different post warm-up times (15 second, 2 minutes, 4 minutes, and 6 minutes post warm-up) and found no significant differences among

warm-up protocols for vertical jump. They stated that the warm-ups used in the study might not be the best warm-ups for improving jump performance due to fatigue. It can be speculated that the differences in results could be due to testing protocol used. The testing protocol in the present study had the subjects preform a sit and reach test, counter movement jump, 5 times with for 4 minutes of rest and an agility t-test for 3 times with at least 8 minutes of rest. The tests performed repetitively could have allowed subjects to maintain their core temperate thus allowing the subjects to maintain their performance after 10 minutes. There was also a significant time difference between 6 and 10 minutes post warm-up indicating that the best performance can be achieved if the power test is performed about 6 min after warm-up.

Agility

This study was the first study to test agility with EEBTSW and reported a significant difference for both VW and EEBTSW at two minutes and a trend for the EEBTSW to improve agility at 10-min mark compared to the GW. This is consistent with a previous study (Maloney et al. 2014) that tested countermovement jump and agility different post performance time using different warm-up protocols in badminton players. Maloney et al. (2014) investigated the effect of different warm-up protocols (dynamic vest warm-up at 5% body weight, dynamic vest warm-up at 10% body weight, and dynamic warm-up as control) on countermovement jump and agility. It was reported that using a dynamic vest warm-up at 10% body weight resulted in better performances in agility. The authors speculated that this could be due to PAP, which attributes to increases in recruitment of higher order motor units and an increase of phosphorylation of myosin regulatory light chains (Maloney et al. 2014; Horwath & Kravitz, 2008).

Maloney et al. (2014) also stated that while the subject performed the warm-up with added weight, they observed that acute increase in leg stiffness. Leg stiffness is created by the potential energy stored in muscle and tendons, which allows for better force contribution for powerful movement (Maloney et al. 2014; Barnes et al. 2014).

The findings regarding changes in agility from the present study are not consistent with the study by Sole et al. (2013). Sole et al. (2013) examined the differences between a dynamic and a heavy resistance warm-up (consisted of three sets of parallel back squats at 50%, 60%, 90% 1-RM) on agility in tennis and basketball players. It was found that heavy resistance warm-up did improve agility, but the changes were not significant. They speculated that there were no significant improvements in agility following warm-up protocols, because agility is a multidimensional skill that needs the speed, strength and perceptual elements, which includes pattern and visual recognition. It is important to highlight that a significant difference was discovered for both VW and EEBTSW at the two minute mark and a trend for EEBTSW at the ten-minute mark that resulted in a significant improvement in agility when compared to the control. It can be speculated that VW and EEBTSW allows subjects to display a greater PAP effect (Rhea et al., 2008).

This present study is the first study investigating if agility changes over time (2 to 18 minutes) after different warm-up protocols. Agility was tested at 2-minute, 10-minute, and 18-minute after warm-up in order to avoid fatigue effect. In the study, it was discovered that agility decreased significantly from 10 minutes to 18 minutes post warm-up when compared to 2 minutes post warm-up. The findings of present study indicated

that the effects of EEBTSW could have longer lasting effect and could allow athletes to maintain agility performance for 10 minutes following warm-up.

Conclusion

The purpose for this study was: 1) To determine which warm-up technique (general warm-up, dynamic warm-up, weighted vest warm-up using body weight percentage [VW], and elastic exercise band training system warm-up [EEBTSW]) will provide the best and longest effect on athletes' performance regarding power output, agility, and flexibility. 2) To compare if there are any differences in power output, agility, and flexibility when using different resistance protocols (VW and EEBTSW) as warm-up techniques. 3) To determine which warm-up will benefit the athletes' performance. 4) To compare the hemodynamic responses to different warm-up techniques. This study questions were as follows: Will a general warm-up (GW), dynamic warm-up (DW), weighted vest warm-up using body weight percentage (VW), or an elastic exercise band training system warm-up (EEBTSW) have the best effect on power output, agility, and flexibility? Which warm-up (GW, DW, VW, or EEBTSW) will have the longest lasting effect on power output, agility, and flexibility? What changes in heart rate (HR), systolic and diastolic blood pressure (BP), and rate of perceived exertion (RPE) will be seen in the 4 different types of warm-up?

Research Hypothesis 1. EEBTSW will prove to have a better effect on power output, agility, and flexibility than GW, DW, and VW.

Although, EEBTSW did show improvement when performing the power output, agility, and flexibility tests, EEBTSW was not significantly different from VW for power output, agility or flexibility. The results of the present study showed that both VW

and EEBTSW had significant improvements in power output and agility when compared to the control (GW).

Research Hypothesis 2. EEBTSW will prove to have the longest effect on power output, agility, and flexibility than a GW, DW, and VW.

EEBTSW showed to have similar effect over time in flexibility and agility when compared to the other warm-ups. Both VW and EEBTSW prove to have a significant longer effect time on power output when compared to the control (GW) from 2 to 6 minutes post warm-up. However, only EEBTSW resulted in significantly higher power values compared to those following DW at 10 minutes post warm-up.

Research Hypothesis 3. HR, BP, and RPE will be at their highest when performing an EEBTSW. HR, BP, and RPE will be the same throughout a GW, DW, and VW.

EEBTSW did produce a significantly higher HR and RPE when compared to all the warm-ups, but BP values during the EEBTSW session were only significantly different from those during the GW session. Subjects, who performed the GW, had significantly lower HR, BP, and RPE than all the other warm-ups.

This study is novel in that it was first study to test different warm-up techniques on power output, agility, and flexibility and to see how long the effects of the warm-ups would last on college athletes. The most significant finding presented in this study is how both VW and EEBTSW improved power output and agility without hindering flexibility, and have the longer effect in time for power and agility when being compared to the control. These findings provide added evidence to the existent the PAP theory in the way that a resistance warm-up can provide greater recruitment of motor units and force without fatigue (Horwath & Kravitz, 2008).

Future studies should use EMG equipment in order to better understand PAP theory. Also, future research is needed to find out the proper rest recovery time is needed for a resistance warm-up by individualizing the post warm-up recovery times in the testing protocols. This will allow the researcher to see the proper rest time needed for an athlete to perform at their best when using a resistance warm-up. According to findings of this study, it can be recommended that an athlete that preforms explosive and agile movements in their sport should use a resistance warm-up. However, it should be highlighted that a trainer or coach should individualize the level of resistance for their athletes in order have optimal performance. Failure to do so may cause the athlete to feel fatigue and hinder performance outcome.

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APPENDICES

Appendix A. Informed Consent
Appendix B. Recruitment Flyer
Appendix C. PAR-Q
Appendix E. Health Status Questionnaire
Appendix F. RPE Borg’s Scale
Appendix G. Data Collection Sheets

Appendix A. Informed Consent

University of Texas at Brownsville
Institutional Review Board
Informed Consent to Participate in a Research Study

Project Title: The Acute Effects of Different Warm-Up Techniques on Power Output, Agility, and Flexibility in Athletes
Principal Investigator: Murat Karabulut, PhD and Kris Nava, Graduate Student.
Department: Health and Human Performance

You are being asked to volunteer for this research study. This study is being conducted at the research laboratory in the Department of Health and Human Performance. You were selected as a possible participant because of your inquiry into the study. Volunteers, who are at minimal risk will be eligible to participate in this study, you will be asked to complete PAR-Q and Health status questionnaire to be screened prior to your participation in the study.

Please read this form and ask any questions that you may have before agreeing to take part in this study.

Purpose of the Research Study

The purpose for this study is: 1) to determine which warm-up technique (dynamic warm-up and resistant warm-up [weighted vest warm-up using body weight percentage (VW1), weighted vest warm-up at a set weight (VW2), and elastic exercise band training system warm-up (EEBTSW)]) will provide the best and longest effect on athletes' performance regarding power output, agility, and flexibility. 2) To compare if there any differences in power output, agility, and flexibility when using different resistance protocols (VW1, VW2, and EEBTSW) as warm-up techniques. 3) To compare the hemodynamic responses to different warm-up techniques.

Number of Participants

20 males 20 females will take part in this study.

Procedures

If you agree to be in this study, you will be asked to do the following:

A) You will be required to visit the Garza Gym Annex on 5 separate days for a total time commitment of approximately 5 hours.

B) On the first visit (about 1 hour), you will be required to read and sign an informed consent before any testing takes place. Then you will complete a PAR-Q and health-screening questionnaire. You will have to take your anthropometric measurements (height, weight and

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body fat %). You will be introduced to the study procedures and will practice the assessment: countermovement jump, t-test and sit-and-reach test.

C) The next 4 visits (**each visit separated by at least 48 hours**) resting heart rate and blood pressure will be taken following at least 5 min rest and pre-test will happen after resting level are done. At that point, you will perform a randomly selected warm-up technique during that visit. During the warm-up, heart rate will be checked every minute, RPE will be taken after each set of warm-up and blood pressure after warm up is completed. Then the post test will take place, which will be a series of 5 tests that will last about 18 minutes.

Length of Participation

You will be required to visit the Garza Gym Annex on 5 separate days for a total time commitment of approximately 300 minutes.

This study has the following risks:

You understand there are minimal risks that may occur to a heathy individual when performing any of the requirements of this project. However, even though these standard protocols have been approved at numerous other institutions and will be performed by qualified and trained personnel, you should be aware of the following:

A) You may feel some slight, brief discomfort from harness of the VertiMax.

B) There is possibiltiy for slight fatigue once done with the project.

Benefits of being in the study are:

There is no direct benefit for participation, however the data will help researchers understand which warm-up will be the most efficient for specific activities.

Injury

In case of injury or illness resulting from this study, emergency medical services will be contacted. However, you or your insurance company may be expected to pay the usual charge from this treatment. The University of Texas at Brownsville has set no funds to compensate you in the event of injury.

Confidentiality

In published reports, there will be no information included that will make it possible to identify you without your permission. Research records will be stored securely for 3 years after completion of the study and only approved researchers will have access to the records.

There are organizations that may inspect and/or copy your research records for quality assurance and data analysis. These organizations include Murat Karabulut and the UTB Institutional Review Board.

Costs
There is no cost for participation.

Compensation
You will not be reimbursed for you time and participation in this study.

Rights
Refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You can discontinue participation at any time without penalty or loss of benefits to which you are otherwise entitled.

Voluntary Nature of the Study
Participation in this study is voluntary. If you decline to participate, you will not be penalized or lose benefits or services unrelated to the study. If you decide to participate, you may decline to answer any question and may choose to withdraw at any time.

Waivers of Elements of Confidentiality
Your name will not be linked with your responses unless you specifically agree to be identified. Please select one of the following options

_____ I consent to being quoted directly.

_____ I do not consent to being quoted directly.

Contacts and Questions
If you have concerns or complaints about the research, the researcher(s) conducting this study can be contacted at the Department of Health and Human Performance: Dr. Murat Karabulut, Ph.D., University of Texas at Brownsville, (956)882-7236, murat.karabulut@utb.edu or Kristopher Manuel Nava, (956)639-8274,kris_31@live.com. You are encouraged to contact the researcher(s)if you have any questions. If you have concerns or complaints about the research, please contact the student's advisor Dr. Murat Karabulut, Ph.D., University of Texas at Brownsville, (956) 882-7236, murat.karabulut@utb.edu. If you have any questions about the right of research subjects, contact the Chair of the UTB IRB-Human Subjects at (956) 882-8888 (Dr. Matthew Johnson) or the Research Integrity and Compliance Office at (956) 882-7731 (Lynne Depeault).

You are voluntarily making a decision whether or not to participate. Your signature indicates that, having read and understood the information provided above, you have decided to participate. You will be given a copy of this information to keep for your records. If you are not given a copy of this consent form, please request one.

Statement of Consent

I have read the above information. I have asked questions and have received satisfactory answers. I consent to participate in the study.

Signature Date

Appendix B. Recruitment Flyer

UT BROWNSVILLE

ATTENTION

Participants Needed

MALES AND FEMALES BETWEEN 18 AND 40 YEARS OLD

The Health and Human Performance Department would like to invite you to participate in a research study at the University of Texas at Brownsville to assess the acute effects of warm-ups in response to using elastic exercise band training system, vest, and dynamic warm-up. Males and females that have participate in athletics within the past year, between the ages of 18 and 40 years old are asked to call Dr. Murat Karabulut at 882-7236 or e-mail murat.karabulut@utb.edu, or Kristopher Nava at 639-8274 or email kris_31@live.com. Total time required for participation in this study will amount to 5 separate days with each visit lasting an hour.

PLEASE CONTACT:

Kristopher Nava	Dr. Murat Karabulut
kris_31@live.com	Murat.Karabulut@utb.edu
956-639-8274	**956-882-7236**

Appendix C. PAR-Q

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO		
☐	☐	1.	**Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☐	2.	**Do you feel pain in your chest when you do physical activity?**
☐	☐	3.	**In the past month, have you had chest pain when you were not doing physical activity?**
☐	☐	4.	**Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☐	5.	**Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	6.	**Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	7.	**Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME ______________________________

SIGNATURE ______________________________ DATE ______________________________

SIGNATURE OF PARENT ______________________________ WITNESS ______________________________
or GUARDIAN (for participants under the age of majority)

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

continued on other side...

Appendix E. Health Status Questionnaire

University of Texas at Brownsville/TSC

Health Status Questionnaire

Instructions. Complete each questions accurately. All information provided is confidential.

Part 1. Information About The Individual

1. Date__________________

2. Legal Name____________________________ Nickname____________________________

3. Mailing Address____

____

Home Phone _________________________Business Phone__________________________

4. Personal Physician Phone _____________________

5. Person to Contact in Emergency Phone _____________________

6. Gender (Circle One): Female Male

7. Date Of Birth: ____/_____/_______ Month/Day/Year

8. Number of hours worked per week: Less than 20 20 - 40 41 - 60 Over 60

9. More than 25% of time on job is spent (Circle all that apply):

Sitting at desk Lifting or carrying loads Standing Walking Driving

Part 2. Medical Information

10. Circle any who died of heart attack before age 50:

Father Mother Brother Sister Grandparent

11. Date of last medical physical exam: _______________(Year)

Last physical fitness test: ____________________(Year)

12. Circle operations you have had:

Back Heart Kidney Eyes Joint Neck

Ears Hernia Lung Other__________________________________

13. Please circle any of the following for which you have been diagnosed or treated by a physician or health professional:

Alcoholism	Cirrhosis, Liver	Hearing Loss	Neck Strain
Anemia, Sickle Cell	Concussion	Heart Problem	Obesity
Anemia, Other	Congenital Defect	High Blood Pressure	Phlebitis
Asthma	Diabetes	Hypoglycemia	Rheumatoid Arthritis
Back Strain	Emphysema	Hyperlipidemia	Stroke
Bleeding Trait	Epilepsy	Infectious Mononucleosis	Thyroid Problem
Bronchitis, Chronic	Eye Problems	Kidney Problem	Ulcer
Cancer	Gout	Mental Illness	

Other____

14. Circle all medicine taken in last 6 months:

Blood Thinner	Diuretic	High Blood Pressure Medication
Diabetic Pill	Epilepsy Medication	Insulin
Digitalis	Heart-Rhythm Medication	Nitroglycerin

Other____

15. These health symptoms may require medical attention if they occur frequently. Circle the number indicating how often you have each of the following:

5 = Very Often 4 = Fairly Often 3 = Sometimes 2 = Infrequently 1 = Practically Never

a. Cough up blood	d. Leg pain	g. Swollen joints
1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
b. Abdominal pain	e. Arm or shoulder pain	h. Feel faint
1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
c. Low back pain	f. Chest pain	i. Dizziness
1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

j. Breathless with slight exertion

1 2 3 4 5

Part 3. Health-Related Behavior

16. Do you now smoke? (Circle one) Yes No

17. If you are a smoker, indicate number smoked per day:

Cigarettes: 40 or more 20 - 39 10 - 19 1 - 9

Cigars or pipes only: 5 or more or any inhaled Less than 5, non inhaled

18. Do you exercise regularly? (Circle one) Yes No

19. How many days per week do you normally spend at least 20 minutes in moderate to strenuous exercise?

0 1 2 3 4 5 6 7 days per week

20. Can you walk 4 miles briskly without fatigue? (Circle one) Yes No

21. Can you jog 3 miles continuously at a moderate pace without discomfort? (Circle one) Yes No

22. Weight now__________ lb. One year ago_____________ lb. Age 21_________ lb.

23. List everything not already included on this questionnaire that might cause you problems in a fitness test or fitness program:

____

____

____

Appendix F. RPE Borg's Scale

Borg Rating of Perceived Exertion

6	No exertion at all
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

Appendix G. Data Collection Sheets

The Acute Effects of Different Warm-Up Techniques on Power Output, Agility, and Flexibility in Athletes

Data Collection Sheet

Name: ______________________________________Age: _____________ Male / Female

Phone Number: ___________________Email: ______________________________________

Sport: __________________________

Height: __________ Weight: _________ Body Weight Percentage: ____________

Weight of Vest for Male at 10%: __________ Weight of Vest for Female at 2%: __________

Arm Reach: ________ Height of Vertec: ________ Length of Start: ________ Right / Left

Condition: GW DW VW EEBTSW **Date:** ________________

Resting HR _________, Resting BP ___________

Warm-up

1 Min: HR ________

2 Min: HR ________

3 Min: HR ________

4 Min: HR ________

5 Min: HR ________ RPE _______

6 Min: HR ________

7 Min: HR ________

8 Min: HR ________

9 Min: HR ________

10 Min: HR ________ RPE _______ BP _________ Lap Count: ________

Post-Test

2 Min 2:50 3:25
Sit-and-reach: ___________ CMJ: _________ T-test: __________ HR: ___________

6 Min 6:50
Sit-and-reach: ___________ CMJ: _________ HR: __________

10 Min 10:50 11:25
Sit-and-reach: ___________ CMJ: _________ T-test: __________ HR: ___________

14 Min 11:50
Sit-and-reach: ___________ CMJ: _________ HR: __________

18 Min 18:50 19:25
Sit-and-reach: ___________ CMJ: _________ T-test: __________ HR: ___________