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Effects of Dynamic and Static Stretching on the Subsequent Pitching Performance in Collegiate Baseball Players

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June, 2014

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Abstract

Stretching is an important component of all athletic warm-up routines. These activities are done before exercises as they are believed to prepare the body for vigorous physical activities and athletic events. The study poses that there is no significant difference between the effects of dynamic and static stretching to the pitching velocity of the players. This research aims to determine the effect of dynamic versus static stretching of throwing shoulder on throwing velocity of baseball players. The subjects of the study were 15 collegiate baseball players of Chinese Culture University. A repeated measure One-Way ANOVA was used to determine if there is any significant differences in velocity performance existed in baseball players. The statistic significance was set at $p < .05$. The result showed that stretching protocols has no significant effect on the pitching performance of the baseball players. It is concluded that no matter what type of stretching was performed there is no significant effect, either negative or positive, on the performance of throwing velocity among baseball players.

Keywords: stretching, velocity, throwing shoulder, flexibility

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CHAPTER I

INTRODUCTION

1.1 Background

Stretching is an important component of all athletic warm-up routines. These activities are done before exercises as they are believed to prepare the body for vigorous physical activities and athletic events. Purposed to increase flexibility and the ability of muscle units to produce force (Haag, Wright, Gillette, & Greany, 2010), stretching improves the joint range of motion, the end result of which are improved performance and reduced incidence of injury (Manoel, Harris-Love, Danoff, & Miller, 2008).

There are four types of stretching protocols widely utilized in sports. These are dynamic stretching, static stretching, ballistic stretching, and proprioceptive neuromuscular facilitative stretching. Researches, however, have commonly explored dynamic and static stretching protocols and their varying effects in the athletes' overall performance. McAtee and Charland (2007) mentioned that ballistic stretching is performed using rapid, bouncing movements to force the target muscle to elongate. Ballistic stretching is generally out of favour because it may elicit a strong myotatic stretch reflex and leave the muscle shorter than its pre-stretch length. McAtee and Charland (2007) cited that ballistic stretching creates more than twice the tension in the target muscle than a static does.

O'Sullivan, Murray, and Sainsbury (2009) identified that a static stretch is performed by placing muscles at their greatest possible length and holding that position for a certain period of time (O'Sullivan et al., 2009). On the other hand, dynamic stretching involves moving the limb from its neutral position to end point, where the muscles are at their greatest length and then moving the limb back to its original position.

Several researches have been conducted to investigate the effects of the static and dynamic stretching protocols in various athletic events and activities. The effects of both types of stretches have compared in vertical jump, long jump, seated ball toss, and sprint (Faigenbaum et al., 2006 and Dalrymple et al., 2010) in vertical jump and sprint (Taylor, Sheppard, Lee, & Plummer, 2009) and (Wallmann, Christensen, Perry, & Hoover, 2012) in tennis serve performance (Haag, Wright, Gillette, & Greany, 2010) and in wrestling activities like peak torque of the quadriceps and hamstrings, medicine ball underhand throw, 300-yd shuttle, pull-ups, push-ups, sit-ups, broad jump, 600-m run, sit-and-reach test, and trunk extension test (Herman & Smith, 2008). Knudson, Noffal, Bahamonde, Bauer, and Blackwell (2004) focused on the effects of stretching in overhand tennis serve performance, a skill similar to the overhand throw in baseball pitching.

Pitching is an overhead activity that has been thoroughly investigated. Although baseball pitching motion requires the entire body, the focus remains in the pitching shoulder Houglum (2010). Scher et al. (2010) had likewise explained that a pitching motion is very complex and involves an elaborate transfer of energy throughout the entire body. Haag et al. (2010), however, mentioned that several researchers focused on the upper body alone without considering the acute stretching on lower body muscular performance.

This study will focus on the effect of dynamic and static stretching in the pre-activity warm-up of the throwing shoulder on throwing velocity in pitching performance of baseball players. It poses importance in increasing the knowledge of the coaches and the players on benefits and disadvantages of such preparation activities. It can help them to decide whether or not an acute bout of static stretching on upper body in a warm-up before throwing, and therefore to evaluate its effect in the throwing shoulder on throwing velocity.

1.2 Research question

This research aims to determine the effect of dynamic versus static stretching of throwing shoulder on throwing velocity of baseball players.

Specifically, this study aims to answer the following question:

What are the effects of dynamic and static stretching of the throwing shoulder of players as measured in terms of Velocity of pitching.

1.3 Research Hypothesis

The study poses that there is no significant difference between the effects of dynamic and static stretching to the pitching velocity of the players.

1.4 Significance of the study

This research contribute to increase the knowledge of baseball coaches, trainers, and players in identifying beneficial as well as harmful pre-performance exercises specifically pertaining to pitching. Thus, it can help them decide whether or not an acute bout of static stretching is included in warm-up exercises before throwing. Consequently, this study can help trainers and coaches decide the best kind of stretching activities to be imposed on players during the warm-up exercises, ensuring positive effects in the throwing shoulder on pitching velocity.

1.5 Delimitations

1. Only the athletes who are familiar with the overhand throw were selected as subjects for the study.
2. Only healthy athletes who can safely perform the stretching protocols and execute the overhand throw with their full efforts were selected as subjects for this study.
3. All the stretching protocols, the resting period and the measurement of overhand throw were supervised by the researchers.
4. Subjects who fail to follow the instruction of stretching protocols were withdrawn from the study.

1.6 Limitation

1. Only 15 fastball pitches were recorded in each testing condition
2. The researcher assumed that during the stretching protocols, the subjects reach their true endpoints.
3. The researcher assumed that all subjects made their best effort to perform in the tests.

1.7 Definition of terms

The following definitions of terms are used in this study:

Stretching

Stretching is a preparation exercise believed to improve flexibility of the specific muscle group and thus improves overall physical performance (Faigenbaum et al., 2006)

Flexibility

Flexibility is a range of motion possible around a specific joint or a series of articulations and can be classified as either static or dynamic.

Static stretching

A static stretch is performed by placing the muscles at their greatest possible length and holding that position for an extended period of time (O'Sullivan et al., 2009). The duration of the holding is 30 sec.

Dynamic stretching

Dynamic stretching involves moving the limb from its neutral position to end range, where the muscles are at their greatest length and then moving the limb back to its original position. This dynamic action is carried out in a smooth, controlled manner and is repeated for a specified time period (O'Sullivan et al., 2009).

Overhand throw

Overhand throw is a complex motor skill that involves the entire body in a series of linked movements starting from the legs, progressing up through the pelvis and trunk, and culminating in a ballistic motion in the arm that propels a projectile forward. It is used almost exclusively in athletic events. The throwing motion can be broken down into three basic steps: cocking, accelerating, and releasing.

CHAPTER II

REVIEW OF LITERATURE

Warm up is an essential element of any sports activity. Whether in preparation for a competition or for recreation, athletes typically perform stretching exercises to warm their body systems up. These activities prior to any strenuous exercises are purposed to enhance physical performance and to reduce the likelihood of sports-related musculoskeletal injuries according to Shellock and Prentice (1985).

During warm-up, athletes normally include stretching the muscles to be used in the following sport or exercise. Stretching is believed to improve flexibility of the specific muscle group and thus improves overall physical performance(Faigenbaum, McFarland, et al. (2006). Shellock and Prentice (1985) defined flexibility as *the range of motion possible around a specific joint or a series of articulations* and can be classified as either static or dynamic. Static flexibility is the degree at which a joint can be passively moved to the end-points in its range of motion. Dynamic flexibility, on the other hand is the degree at which a joint can be moved as a result of cyclical muscular contraction.

In the main, stretching is classified as either static, dynamic, ballistic, or facilitative. Among these, static stretching is the most common stretching method. Nevertheless, each of these stretching conditions is anchored on the neurophysiological phenomenon involving the stretch reflex. However, because these different stretching techniques produce different responses from the stretch reflex, the relative effectiveness of these stretching methods also varies (Shellock & Prentice, 1985).

Studies have been conducted to characterize the effects of these four stretching exercises, and the results of which have been confusing and contradictory. The following studies present those involving static and dynamic stretching exercises.

2.1 Acute Effect of Static Stretching

A static stretch is performed by placing muscles at their greatest possible length and holding that position for a period of time, also static stretching was also reported to help reduce injury (O'Sullivan et al., 2009). Prolonged static stretching might have unintended adverse consequences on anaerobic performance in young athletes (Faigenbaum, McFarland, et al., 2006). One study found that acute static stretching did not have a significant effect on overhand tennis serve performance, a skill similar to overhand throw (Knudson et al., 2004). Some studies found no significant differences in tennis serve accuracy between tennis players of varying skill levels after an acute static stretching (Haag et al., 2010). In addition (E. G. Young W, Power J, 2006) proposed that experienced participants with well developed movement patterns would not be significantly affected by acute static stretching. Because pitchers have more experience throwing pitches from mound, their accuracy should be less affected by acute static stretching than position players. In most studies, static stretching resulted in either a significant decrease or no change in performance in accuracy.

Haag et al. (2010) cited that studies have shown that pre-event static stretching significantly decreased performance in activities such as sprinting and vertical jump Scher et al. (2010) explained that a pitching motion is very complex and involves an elaborate transfer of energy throughout the entire body. Thus, large forces are not restricted to the shoulder alone but rather are imparted across all the anatomical joints involved in the throwing motion it includes lower body motion. Conversely, several researchers focused on the upper body alone and did not consider looking into the acute static stretching on lower body muscular performance. Also, no research has been conducted to measure the impact of acute static stretching of the throwing shoulder on baseball pitching performance. No previous research has measured the effects of acute static stretching of the upper body in baseball pitching performance. If increased musculotendinous stiffness enables more efficient transmission of force, stretching just prior to activity might also decrease force output in skills such as jumping to attain maximum height and forceful throwing (Silveira, Sayers, & Waddington, 2011). Recent findings (Faigenbaum, McFarland, et al., 2006) indicated that pre-exercise static stretching may have similar consequences on muscle function in children and adolescents.

The result of the study by O'Sullivan et al. (2009) supports De Weijer, Gorniak, and Shamus (2003) in identifying that static stretching greatly affects hamstring flexibility by the muscle's lengthening ability. The authors aimed to identify the lasting effect of static stretching on hamstring length and to compare the efficacy of static stretching with or without warm-up exercise on hamstring length. Subjects in the study were assigned to 1 of 4 groups: (1) warm-up and static stretch, (2) static stretch only, (3) warm-up only, and (4) control. Hamstring length was measured before and after the assigned exercises using the active knee extension range of motion (AKE ROM) test. Among the four subject groups, significant increase in the hamstring length was observed in the warm-up-and-static-stretch group and the static-stretch-only group. Immediate post-stretch measurements are not found to be significant. Rather, subsequent decrease in muscle length was found significant 15 minutes post-stretch in both groups. The study concluded that increases in hamstring length can be sustained for up to 24 hours but decline in the length gains occur within 15 minutes post-stretch.

In another study, the effects of acute static stretching (SS) of the throwing shoulder on pitching velocity and accuracy of collegiate athletes were assessed by Haag et al. (2010). In the experimental group (SS), the subjects performed 6 static stretches following active warm-up exercises. Each stretch was performed once on the throwing shoulder for 30 seconds and 10 seconds rest between each stretch. After these, a 5-10 minute rest period was then given. Before data gathering, the participants were allowed 5 warm-up pitches from the pitching mound. The control group (NS), on the other hand, followed the same procedure excluding the performance of the static stretching exercises. Data analysis showed that both pitching velocity and accuracy were not significantly changed when static stretching was included in the players' warm-up exercises. This study reiterates that static stretching does not have significant impact on the throwing performance of baseball pitchers. The authors indicated that stretching the throwing shoulder may be performed as part of the warm-up exercises.

The result of the study by Knudson et al. (2004) coincides with the findings of Haag et al. (2010) and Wallmann et al. (2012) and point out that static stretching has no significant impact to muscular performance. Knudson et al. (2004) examined the serving percentage and radar measurements of ball speed and accuracy in tennis serve performance among 83 tennis players of different playing skills. In the study, Group T involved traditional warm-up exercises prior to data collection while Group S included traditional warm-up plus 5-minute stretching activities. Data analysis presented that stretching had no significant effect on both the service speed and accuracy regardless of skill level, age or gender of the participant.

Likewise it was found out that there was no short-term effect of stretching in the warm-up on the serving performance of adult players.

Likewise in the study by Taylor et al. (2009) evaluated whether the decline in performance normally associated by previous studies with static stretching remains when the static stretching is conducted prior to a sport specific warm-up. The study involved the subjects to undergo a series of static stretching and dynamic stretching prior to a netball specific skill warm-up. The height reached in the vertical jump and the time elapsed in the 20-meter sprint run were the data gathered to quantify the effects of both stretching exercises. Analysis of the gathered data revealed that static stretching resulted in significantly worse performance than dynamic exercises in both vertical jump and 20m sprint time. However, when the skill-based warm-up was preceded by the static and dynamic exercises, there was no significant difference in either performance variable. The authors then propose that dynamic warm-up routine is superior to static stretching when arranging for powerful performance. However, the differences in the effect of static and dynamic stretching can be unnoticed if followed by a moderate to high intensity sport specific skill warm-up prior to the on-field performance.

The study by Cramer et al. (2004) aimed to identify the acute effects of static stretching on peak torque (PT) and the joint angle at PT during maximal, voluntary eccentric isokinetic muscle activities of the leg extensors. The probable effects were identified for both the stretched and unstretched limbs of 13 participants. Statistical analyses revealed that there are no changes in the peak torque or the joint angle at PT in both the pre- and post-stretching. This suggests that static stretching has no significant effect on peak torque or the joint angle at peak torque of the leg extensors during maximal, voluntary, eccentric muscle actions in stretched and unstretched limbs in women. However, the authors had accounted that static stretching may affect torque production during concentric, but not eccentric muscle actions. Cramer et al. (2004) examined the effects of static stretching on concentric, isokinetic leg extension peak torque at velocities 60 and 240[degrees].s-1) in the stretched (dominant) and unstretched (non-dominant) limbs. Results show that PT decreased following the static stretching in both limbs and at both velocities. Thus it is indicated that static stretching impairs maximal force production during concentric, isokinetic leg extension at certain velocities.

In another study conducted by Evetovich, Nauman, Conley, and Todd (2003) had determined the effect of acute bout of static stretching of the biceps brachii on torque, electromyography (EMG), and mechanomyography (MMG) during concentric isokinetic muscle actions. Each stretch was held for 30 seconds and was repeated 4 times with 15 seconds between stretches. Prior to strength testing, the subjects were randomly assigned to stretching (STR) or non-stretching (NSTR) protocols. Statistical analysis revealed significantly greater torque for NSTR over STR; significantly greater MMG amplitude for STR compared with NSTR; and no significant difference in EMG amplitude as a result of stretching protocol. Accordingly, these researchers suggested that stretching hinders the full capabilities of the biceps brachii at both a slow and fast velocities.

Siatras, Mittas, Mameletzi, and Vamvakoudis (2008) conducted a study to assess the acute effect of different static stretching durations on quadriceps isometric and isokinetic peak torque production. The participants were randomly grouped and were asked to perform a stretching exercise of different duration (no stretch, 10-second stretch, 20-second stretch, 30-second stretch, and 60-second stretch). Before and after a static stretching exercise in the four experimental groups, knee flexion range of motion and the isometric and concentric isokinetic peak torques of the quadriceps were measured. The same parameters were examined in the control group (no stretch) without stretching. Statistical analysis proves no significant differences among groups before the experimentation regarding their physical characteristics and performance; thus suggesting homogeneity of the groups. Result reflected that significant knee joint flexibility increases and significant isometric and isokinetic peak torque have been shown to occur only after 30 and 60 seconds of quadriceps static stretching. On the other hand, isokinetic peak torque after 30 and 60 seconds of stretching was reduced accordingly. From this, it is suggested that torque decrements are related to changes of muscle neuromechanical properties. It is recommended that static stretching exercises of a muscle group for more than 30 seconds of duration be avoided before performances requiring maximal strength.

The effects of ballistic and static stretching protocols on lower limb strength were assessed in the study by Bacurau et al. (2009). Participants were subjected to different treatment protocols involving (a) control, (b) ballistic stretching, and (c) static stretching. It was found out that maximal strength decreased after static stretching but remained unchanged by ballistic stretching. Furthermore, static stretching exercises were seen to produce a greater acute improvement in flexibility (as assessed by sit-and-reach and hip joint ROM) compared with ballistic stretching. The effect of static stretching on the maximal muscular strength as assessed in this study suggests that it may not be recommended before athletic events or physical activities that require high levels of force. Conversely, ballistic stretching could be more appropriate because it seems less likely to decrease maximal strength.

In another study aimed to determine the effects of a practical duration of acute static and ballistic stretching on vertical jump (VJ), lower-extremity power, and quadriceps and hamstring torque, 24participants underwent a 5-minute warm-up followed by each of the following three conditions: static stretching, ballistic stretching, or no-stretch control condition. Statistics show that gender is not differently affected by any of the stretching conditions. The results of this study reveal that static and ballistic stretching did not affect VJ, or torque output for the quadriceps and hamstrings. Despite having no adverse effect on VJ, stretching did cause a decrease in lower-extremity power. It was then suggested that because of the varying results, strength coaches would be better served to use dynamic stretching before activity.

2.2 Acute Effect of Dynamic Stretching

Dynamic stretching involves moving the limb from its neutral position to end range, where the muscles are at their greatest length and then moving the limb back to its original position and has been recommended as an alternative to static stretching post-warm-up. As evidence suggested that dynamic stretching positively impacts on immediate physical performance (O'Sullivan et al., 2009). Warm-up dynamic exercise may create an optimal environment for power production by enhancing neuromuscular function, dynamic movements design to elevate core body temperature, enhance motor unit excitability, improve kinaesthetic awareness, maximize active ranges of motion and develop fundamental movement skills (Faigenbaum, McFarland, et al., 2006). Dynamic warm-up focuses more on the neuromuscular system of the muscle complex. These dynamic activities will aid in short term flexibility gains and the resting tone through stimulation of the Golgi tendon organs

(Haag et al., 2010). These organs are hidden deep in the muscle and measure muscle tension to protect it from injury. Dynamic warm-ups can have a dampening effect on this Golgi tendon complex, making them less reactive during normal activity levels, and without decreasing strength as noted in static stretching. Dynamic warm-ups can increase muscular flexibility for the short-term through the neuromuscular system and potentially reduce injury though decreasing reflexive muscle contractions (Ransom & Brinker, 2013). Dynamic warm-up can also enhance performance in such areas as sprinting, dribbling with cutting, kick power through increased hip range of motion, and kick velocity. While static stretching was found to be detrimental to the performance of these same activities (Ransom & Brinker, 2013).

Shoulder injuries in baseball players are common cited by Scher et al. (2010) that the upper extremity injuries were responsible for 75% of the total time lost because of injury in Collegiate baseball players, with the rotator cuff tendinitis cites as most frequent injury .That dynamic neuromuscular stabilization of the shoulder is imperative in the prevention of shoulder injury in the overhead-throwing athlete (Carter, Kaminski, Douex, Knight, & Richards, 2007). In baseball pitching, it involves optimal coordinating movements of the upper extremity, trunk and lower extremity to produce maximum ball velocity (Campbell, Stodden, & Nixon, 2010) . Other researchers mentioned that sport of baseball is dependent on the physical qualities of power, speed, strength and local muscular endurance, specifically the upper extremity (Carter et al., 2007). Previous researches have demonstrated significant stresses on the shoulder during the overhead throwing motion, and it is generally believed that these stresses combined with the innate repetition of the overhead arm motion in baseball, can lead to shoulder injuries. Forces of range of motion (ROM) restrictions at joints distance from shoulder (Scher et al., 2010).

Faigenbaum, McFarland, et al. (2006)Faigenbaum, McFarland, et al. (2006) studied the acute effects of 4 warm-up protocols with and without a weighted vest on anaerobic performance in female high school athletes. The study used the randomized counterbalanced, repeated-measures design. The warm-up protocols included in the study are as follows: Static stretching (SS), Dynamic exercises without weighted vest (DY), Dynamic exercises with a vest weighted with 2% of body mass (DY2), and the same Dynamic exercises performed with a vest weighted with 6% of body mass (DY6). The warm-up protocols aforementioned were assessed using 4 outcome measures namely, vertical jump, long jump, seated medicine ball toss, and 10-yard sprint. It was found that subjects' performance in vertical jump was significantly better after dynamic exercises (DY) and after dynamic exercises with vest weighted with 2% of body mass (DY2) compared with static stretches. Also, performance in long jump was significantly greater after DY2 compared with SS. However, there is no significant difference in subject's performance for the seated medicine ball toss and the 10-yard sprint. The study concluded that warm-up activities using dynamic exercises improve athletic performance greater than do static stretches. This supposition is consistent with previous studies which concluded that warm-up protocols including dynamic exercises resulted in superior athletic performance compared with warm-up using static stretching.

One study by Herda, Cramer, Ryan, McHugh, and Stout (2008) was designed to examine whether dynamic stretching elicits the same acute inhibitory influences on muscle force production as static stretching during isometric leg flexion muscle actions at four different joint angles. EMG and MMG amplitude were recorded from the biceps femoris muscle to test the hypothesis that stretching reduces muscle activation (EMG) and muscle stiffness (MMG). The results of the study indicate that the static stretching decreased isometric peak torque of the hamstrings muscles at knee joint angles of 101_ (15.94%) and 81_ (7.2%), but there were no changes in strength as a result of the dynamic stretching. These results are consistent with previous studies (Behm, Button, & Butt, 2001; Fowles, Sale, & MacDougall, 2000; Nelson, Allen, Cornwell, & Kokkonen, 2001) that have reported acute decreases in isometric muscle strength after a bout of static stretching, which has since been termed the stretching-induced force deficit. Based on the findings of the present study, dynamic stretching may not have an adverse affect on the isometric strength of the leg flexors. The study indicated decreases in isometric peak torque after the static stretching at the two shortest joint angle (101 and 81), whereas the dynamic stretching elicited no changes in isometric PT at any of the knee joint angles.

The effects of dynamic stretching on running energy cost and endurance performance in trained male runners was studied by Zourdos et al. (2012). Running energy cost was identified by measuring the total calories expended during a preload run and the distance covered in the time trial. Results had shown that average resting $\dot{V}O_2$ increased significantly after dynamic stretching but not during the quiet-sitting condition. Furthermore, caloric expenditure was significantly higher during the 30-minute preload run for the stretching compared with that during the quiet sitting. However, no difference was found in the distance covered after quiet sitting compared with hat for the stretching condition. Thus, it has been suggested that dynamic stretching does not affect running endurance performance in trained male runners.

Jaggers, Swank, Frost, and Lee (2008) conducted a study comparing the difference between two sets of ballistic stretching and two sets of a dynamic stretching routine on vertical jump performance. In the study, the subjects completed one of the treatments (no stretch, ballistic stretch, and dynamic stretch). Statistical analysis revealed no significant difference in jump height, force, or power when comparing no stretch with ballistic stretch. However, a significant difference was found on jump power when comparing no stretch with dynamic stretch. No significant difference was found for jump height or force. From the result, the authors reckon that neither dynamic stretching nor ballistic stretching resulted in increased vertical jump height or force. Dynamic stretching however proved gains in jump power after-stretch.

One study Herman and Smith (2008) aimed to determine whether a dynamic-stretching warm-up (DWU) performed everyday over a period of 4 weeks positively influences power, speed, agility, endurance, flexibility, and strength performance measures in collegiate wrestlers when compared to a static-stretching warm-up (SWU) intervention. Anthropometric and performance measures were conducted before and after the 4-week trial period. These measures include peak torque of the quadriceps and hamstrings, medicine ball underhand throw, 300-yd shuttle, pull-ups, push-ups, sit-ups, broad jump, 600-m run, sit-and-reach test, and trunk extension test. It was observed the wrestlers who completed the 4-week warm-up intervention had several performance improvements, namely increases in quadriceps peak torque (11%), broad jump (4%), underhand medicine ball throw (4%), sit-ups (11%), and push-ups (3%). Furthermore, a decrease in the average time to completion of the 300-yd shuttle (–2%) and the 600-m run (–2.4%) suggested an enhanced muscular strength, endurance, agility, and anaerobic capacity in the DWU group. In contrast, no improvement in the SWU group was observed for peak torque of the quadriceps, broad jump, 300-yd shuttle run, medicine ball underhand throw for distance, sit-ups, push-ups, or 600-m run, and decrements in some performance measures occurred. The study suggested that the incorporation of this specific 4-week DWU intervention into the daily routine training of wrestlers produces longer-term or sustained power, strength, muscular endurance, anaerobic capacity, and agility performance enhancements.

2.3 Effects of Static and Dynamic Stretching in Athletic Performance

In a study by Wallmann et al. (2012), the effects of static (SS), dynamic (DS), ballistic (BS) exercises as well as no stretching activity (NS) on sprint performance of recreational runners were assessed. A 40-yard sprint time was used to quantify the effect of the said stretching activities. The data yielded by the subjects after the 40-yard sprint were then compared with a baseline data gathered beforehand. This study found that there were no significant statistical differences in the 4 pre-condition times or the post-condition times. Likewise, there were no significant differences in the pre- and post-stretch sprint times in the static, ballistic, and dynamic stretching states. However, subjects improved significantly from pre- to post-sprint times in the no stretch condition. Thus, contrary to researches which recommend any of the known stretching activities, the authors concluded that sprint performance among recreational runners show greatest improvement with the use of walking generalized warm-up on a treadmill, that is, without any sort of stretching.

Dalrymple et al. (2010) examined the effect of static (SS) and dynamic (DS) stretching on peak jump height thru a series of vertical jumps performed by the participants.

The stretching exercises were performed immediately prior to a series of countermovement vertical jumps (CMJ). Statistical analysis of results indicate no significant differences in the peak jump height following static, dynamic and no stretching conditions. Nevertheless, it has been noted that 7 out of 12 subjects produced greater increases in peak jump height after the dynamic stretching protocol compared to only 1 subject producing a greater peak jump height after the Static stretching protocol. The remaining 4 out of 12 subjects exhibited no difference between the stretching conditions.

In a study by Torres et al. (2008) identifying the influence of upper body static stretching for 2 sets of 15 seconds each side and dynamic stretching on upper body muscular performance. In this research, the subjects were 11 healthy throwers (javelin, shot put, hammer, and discuss) NCAA Division I Track and Field team at the University of Connecticut. Each subject completed 6 laboratory visits: a) visit 1 – 1RM tests and stretching familiarization, b) visit 2 – Performance testing and Familiarization, c) visit 3 through 6 – Experimental protocol visits. Treatments were balanced and randomized across the experimental conditions to limit any order of treatment effects. Data were evaluated by using one-way repeated – measures analysis of variance. The level of significance was set at $P \leq 0.05$. Researchers found that there was no significant differences between stretch protocols for peak power (Pmax), peak force (Fmax), peak acceleration (Amax), peak velocity (Vmax) and peak displacement (Dmax) following each treatment in 30% of 1RM bench throw. No significant differences were found for Fmax in the isometric bench press among treatment. For the overhead medicine ball throw there is no significant differences among trials were found for Vmax or Dmax and lateral medicine ball throw there is no significant differences were found for Vmax, however, Dmax for the combined static and dynamic condition was significantly larger than Dmax for the static only condition.

One study by Chaouachi et al. (2010) purposed to determine the effect of static and dynamic stretching alone and in combination on subsequent agility, sprinting, and jump performance. Eight different stretching protocols ((a) static stretch (SS) to point of discomfort (POD); (b) SS less than POD (SS,POD); (c) dynamic stretching (DS); (d) SS POD combined with DS (SS POD + S); (v) SS,POD combined with DS (SS,POD + DS); (vi) DS combined with SS POD (DS + SS POD); (vii) DS combined with SS,POD (DS + SS,POD); and (viii) a control warm-up condition without stretching) were implemented following aerobic warm-up and dynamic activities. Results show that there were no significant statistical differences among the stretching protocols for the sprint or agility measures as well as for the jump measures. The authors mentioned that the study involved either trained or professional athletes who basically trained at disciplined schedules. Thus the lack of stretch-induced deviations is attributed to the trained state of the participants.

Another study by Torres et al. (2008) examined the influence of upper body static and dynamic stretching on upper-body muscular performance among National Collegiate Athletic Association Division I track and field athletes. The participants were divided into 4 stretch trial groups namely (a) no stretching, (b) static stretching, (c) dynamic stretching, and (d) combined static and dynamic stretching. Muscular performance was assessed by measuring peak power (Pmax), peak force (Fmax), peak acceleration (Amax), peak velocity (Vmax), and peak displacement (Dmax). In turn, these factors are measured through subjecting the athletes to (1) bench throw, (2) isometric bench press, (3) overhead medicine ball throw, and (4) lateral medicine ball throw. Accordingly, no significant differences were observed among the various stretch trials for Pmax, Fmax, Amax Vmax, or Dmax for the bench throw. For the overhead medicine ball throw, no differences were seen for Vmax or Dmax. No difference was found in Vmax for the lateral medicine ball throw. Nevertheless, Dmax was significantly larger for the static and dynamic stretching trial compared to the static-only condition. The researchers concluded that there was no short-term effect of stretching on upper-body muscular performance in young adult male athletes regardless of stretch mode.

A study conducted by O'Sullivan et al. (2009) examined the short-term effects of warm-up, static stretching and dynamic stretching on hamstring flexibility in individuals with previous hamstring injury and uninjured controls. Hamstring flexibility was measured using passive knee extension range of motion (PKE ROM). Four measurements of PKE ROM were derived from the following occasions: (1) at baseline; (2) after warm-up; (3) after stretch (static or dynamic) and (4) after a 15-minute rest. The recorded data were then analyzed using one-way repeated measures ANOVA. According to the study, hamstring flexibility is increased by mild aerobic warm-up activities. ROM after static stretching was significantly greater than after dynamic stretching. Further, ROM was found to be significantly increased from baseline and warm-up after static stretching, while ROM was observed to be decreased from warm-up although remained greater than at baseline. The 15-minute rest period was also seen to have negatively affected flexibility, although muscle flexibility remained significantly greater than at baseline. The study also concluded that although not statistically significant, the effect of warm-up and static stretching on flexibility was greater in those with reduced flexibility post-injury. The result of this study coincides with a study by De Weijer et al. (2003) noted that static stretching provides greatest muscle lengthening thus improving muscle flexibility greater than dynamic stretching. Dynamic exercises, however, are shown to increase muscle performance, a measure that is decreased with the use of static stretching. That is, flexibility improves most with static stretching, while immediate physical performance improves most with dynamic stretching.

The acute effects of static, dynamic, and proprioceptive neuromuscular facilitation (PNF) stretching on peak isokinetic power output of the knee extensors were assessed by Manoel et al. (2008). In the study, 12 recreationally active women were subjected to 3 different stretching protocols. Testing was performed before and after the subjects underwent such exercises. Statistical results indicated that none of the tested stretching protocols decreased knee extension power. However, among the three exercise protocols, dynamic stretching produced knee extension power greater than the increase in such in static and PNF stretching. The findings proposed that dynamic stretching is more effective in increasing muscular power output than either static or PNF stretching. Thus the authors suggested the inclusion of dynamic stretching as part of the warm-up exercises of players, as this may offer benefits in athletic performance.

The study by Perrier, Pavol, and Hoffman (2011) compared the effects of a warm-up with static and dynamic stretching on countermovement jump (CMJ) height, reaction time, and low-back and hamstring flexibility, and consequently to observe any performance deficits that may persist throughout a series of CMJs. The CMJ height and reaction time were determined from measured ground reaction forces. Analysis revealed that treatments, namely: no stretching (NS), static stretching (SS), and dynamic stretching (DS), has significant effects. CMJ height was greater for DS than for NS and SS and was not less for SS than for NS. Also, a significant main effect of jump on CMJ height was found, that is, jumping height decreased from early to the latter jumps. As to the analysis of reaction time, no significant effects of the treatments were noted. Treatment likewise had a main effect on flexibility. Flexibility was greater after both SS and DS compared to after NS, but with no difference between SS and DS. Perrier et al. (2011) concluded that athletes in sports requiring lower extremity power should use dynamic techniques in warm-up so as to enhance flexibility while improving performance.

Herda et al. (2008) conducted a study to examine the effects of static versus dynamic stretching on peak torque (PT) and electromyographic (EMG), and mechanomyographic (MMG) amplitude of the biceps femoris muscle (BF) during isometric maximal voluntary contractions of the leg flexors at four different knee joint angles. The participants performed two isometric leg flexion maximal voluntary contractions at 4 different knee joint angles below full leg extension. EMG and MMG signals were recorded from the BF muscle while PT values (Nm) were sampled from an isokinetic dynamometer. The right hamstrings, on the other hand, were stretched with either static or dynamic stretching exercises. Results showed that PT decreased after the static stretching at 81degrees and 101degrees below full leg extension but not at other angles. Also, PT did not change after the dynamic stretching. EMG amplitude remained unchanged after the static stretching but increased after the dynamic stretching at 101deg and 81deg. MMG amplitude increased in response to the static stretching at 101deg, whereas the dynamic stretching increased MMG amplitude at all joint angles. Overall, an acute bout of dynamic stretching may be less detrimental to muscle strength than static stretching for the hamstrings.

Mcmillan, Moore, Hatler, and Taylor (2006) conducted a study to compare the effect of a dynamic warm up (DWU) with a static-stretching warm up (SWU) on selected measures of power and agility. Statistical analysis revealed better performance scores after the DWU for all 3 performance tests (T-shuttle run, underhand medicine ball throw for distance, and 5-step jump) compared with the scores after SWU and NWU. Also, there were no significant differences between the SWU and NWU for the medicine ball throw and the T-shuttle run, but the SWU was associated with better scores on the 5-step jump. The results of this study indicated a relative performance enhancement with the DWU, thus suggesting the utility of warm up routines that use static stretching as a stand-alone activity.

One study by Van Gelder and Bartz (2011) determined the effect of SS and DS on performance time of a sport agility test. Participants were randomly assigned to one of three treatment groups: Static stretching (SS), dynamic stretching (DS), or no stretching (NS). According to statistical analysis, the DS group produced significantly faster times on the agility test in comparison to SS and NS. Differences between the SS and NS groups revealed no significance. Despite a significant difference in mean times for the type of athlete, interaction between the type of athlete and stretching group was not significant. These results indicate that in Comparison to SS or NS, DS significantly improves performance on closed agility skills involving a 180degree change of direction.

2.4. Summary

Stretching is a crucial part in sport training programs. Knowing the acute effect of different types of stretching is very important to strength and conditioning professionals. In general, static stretching might have negative acute effects on strength, power and sport-related performance. Different individuals may respond differently to stretching exercises. Static stretching may also result in different effects on different types of muscular performances.

Dynamic stretching results in more positive acute effects on the sport-related performance compared with other stretching (Yamaguchi et al., 2005). Well-designed dynamic stretching programs can help improve the strength, power or sprint performance. The positive effects remain the same across well trained athletes and recreational athletes.

Notwithstanding the conclusions of notable studies cited above, a number of studies have concluded that in notable areas, neither static nor dynamic stretching was found effective.

CHAPTER III

METHODS

3.1 Study Design

The independent variable is the type of stretching which included static stretching, dynamic stretching and control or no stretching. The dependent variable is the velocity of pitching of the players.

The aim of the study was to assess the effect of dynamic and static stretching of pitching shoulder on baseball players. The subjects of the study were Collegiate Baseball players of Chinese Culture University (CCU) Division I Baseball Team. In addition, the subjects were those who didn't experience shoulder injury four months prior to the test. The experiment was conducted in three non-consecutive days. All subjects were divided into three groups. The experimental protocols included static stretching, dynamic stretching and no stretching (control group).

Throwing requires strong flexible shoulders and upper arms including rotator cuff. Primary muscles on either side of the upper body are involved in the arm movements required in the baseball pitch: pectoralis major, posterior deltoid, teres major and latissimus dorsi. Pitching in particular makes use of variety of muscles belonging to four complexes: scapular, glenohumeral, elbow and forearm.

Before the stretching protocols, all the subjects performed walk and jog for 10 mins. After walk and jog, the subjects performed the stretches (static and dynamic) or non-stretching (control) protocol which they have been assigned for the day. The throwing performance was tested within 10 mins after the stretching exercises.

3.2 Subjects

The subjects of the study were 15 collegiate baseball players of Chinese Culture University Division I Baseball Team (age: 19.67 ± .724yr; height: 180.13 ± 3.833cm; weight: 76 ± 6.147 kg) who have been training and competing baseball for at least one year (years of training: 9.80 ± .561) and familiar with the technique requires to perform overhand pitching throw. The subjects also had basic knowledge about stretching exercises and were familiar with the practice of different stretching. Participants were informed of all the procedures, potential risks, and benefits associated with the study. Letter of consent was sent to the head coach and to the athletes that need to be approved by both parties before doing the procedure.

Table 1: Descriptive statistics of participants (mean ± SD)

Participants	Age (yr)	Height (cm)	Weight (kg)
All (n= 15)	19.67 ± .742	180.13 ± 3.83	76.27 ± 6.15

3.3 Stretching Protocol

In collecting data, participants did 2 separate warm-up protocols which are static stretching protocol and dynamic stretching protocol on the same muscle groups and one non stretching protocol. The subjects were divided into three groups. In 3 non-consecutive days, each protocol performed by each group on each day until all the groups went through all three protocols.

Six static stretching exercises were included in the Static Stretching condition (Figure 1). These stretches was completed three sets and holding for 30 seconds (Torres et al., 2008).

1. Straight arms behind the back
2. Cross arm in front of chest
3. Shoulder flexion
4. Head side to side
5. Overhead reach
6. Deltoid side press

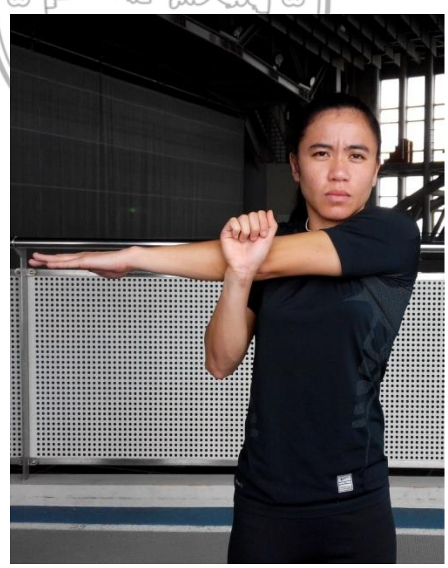
Likewise, 6 dynamic stretching exercises (Figure 2) performed in 3 sets of 15 repetitions on both sides was completed by the Dynamic Stretching group (Torres et al., 2008).

1. Arm Circle
2. Arm Swing
3. Horizontal abduction and abduction
4. Head side to side
5. Overhead reach
6. Crossover arm swing

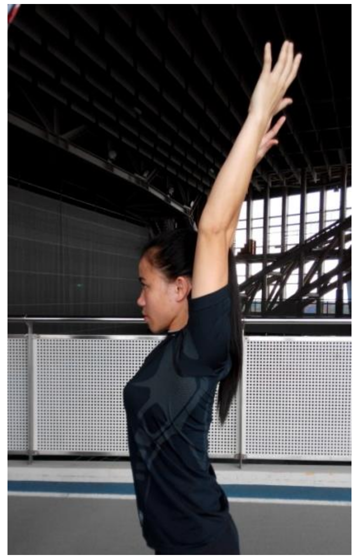
Figure 1. Static Stretchings

1. Straight arms behind the back

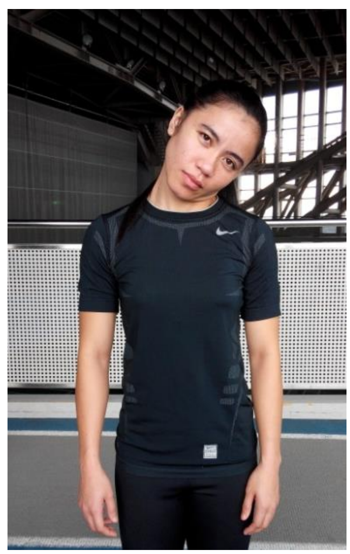
2. Cross arm in front of chest



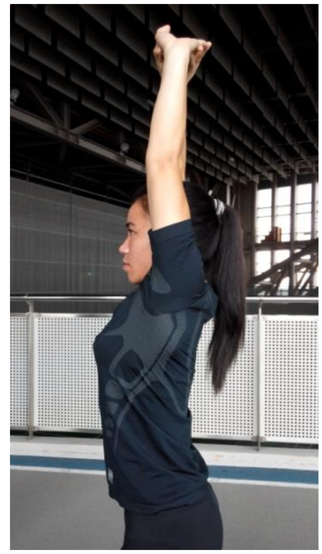
3. Shoulder flexion



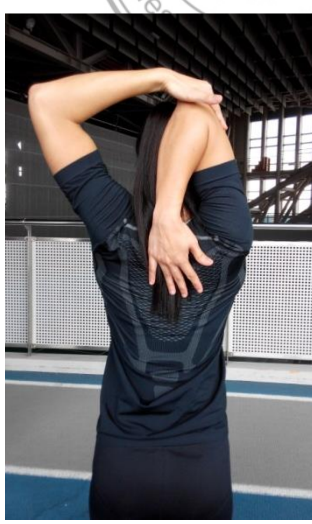
4. Head side to side



5. Overhead reach



6. Deltoid side press



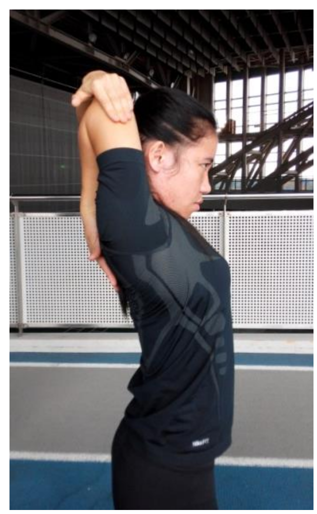


Figure 2. Dynamic Stretching

1. Arm Circle

1

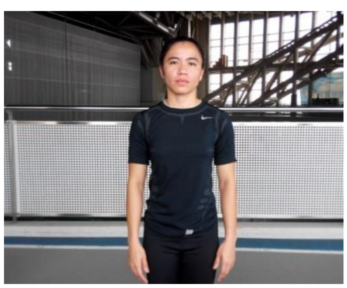
2

3

4

2. Arm Swing

1



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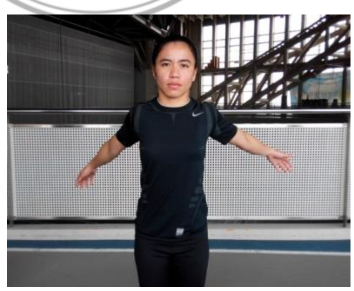

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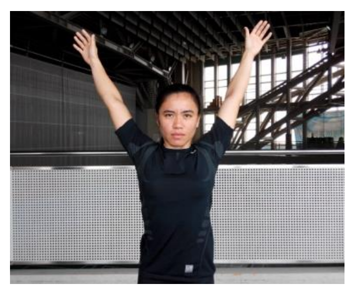

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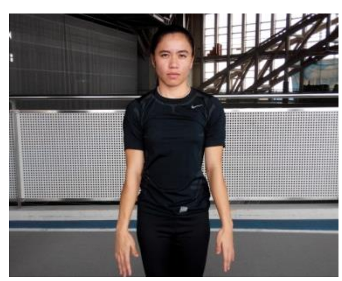

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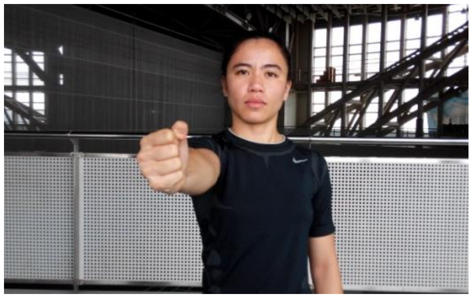
3. Horizontal abduction and abduction

1



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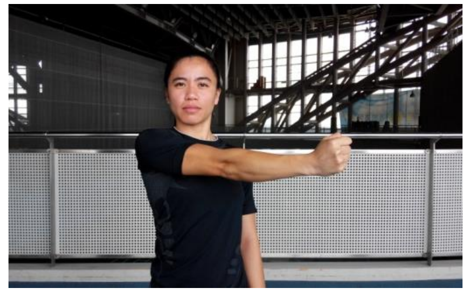

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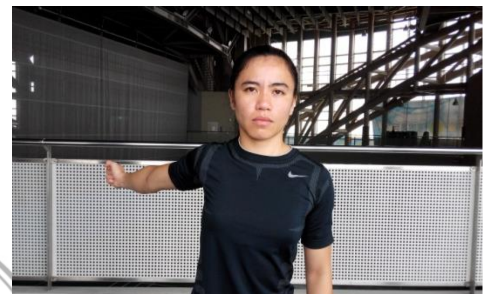
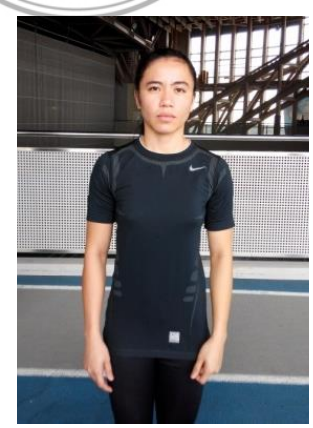


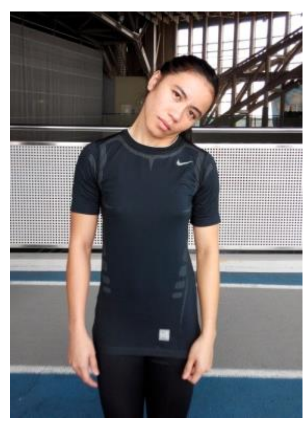
4

4. Head side to side

1

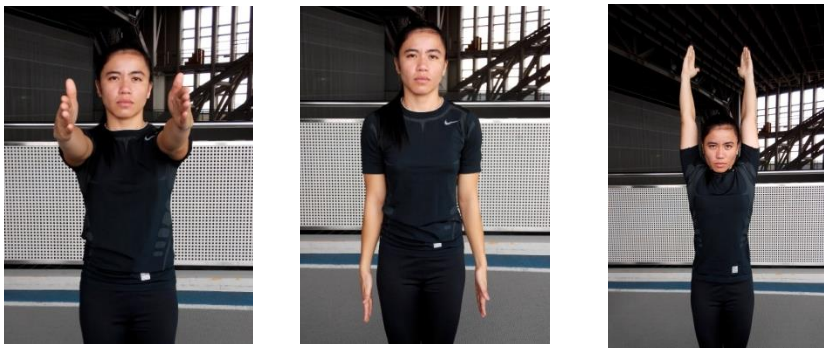


2



3

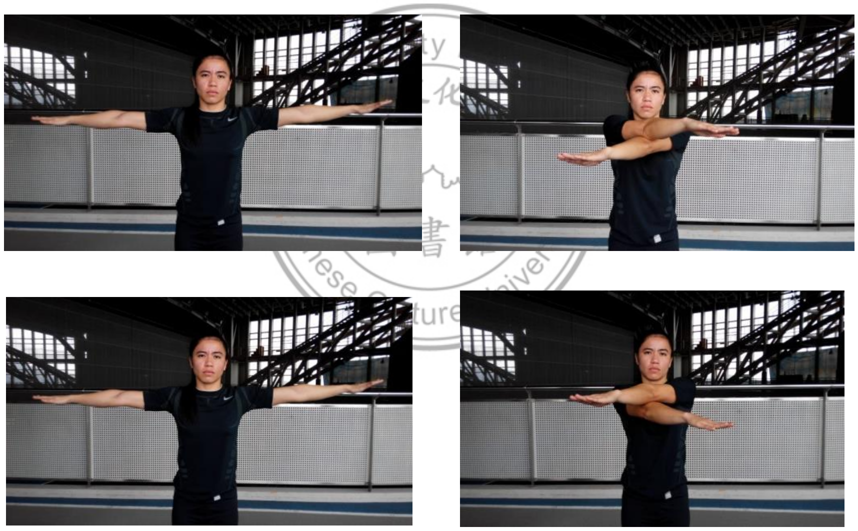
5. Overhead reach



1 2 3

6. Crossover arm swing

1 2



3 4

3.4 Test Instrument

The cordless radar gun was used to measure the throwing velocity by the personnel who were experienced in using the equipment. According to the manufacturer, the device is accurate up to ±0.5 mph. To compute average velocity, the mean of the 15 pitches was calculated.

3.5 Test Procedure

The test started with the participant positioned and ready to throw pitches. The radar gun was placed at the front of the subject with the distance of 18.45 meters. The subject then start pitching overhand throws for 15 pitches with the said distance. The throwing velocity was collected for the comparison of the effect of different stretching protocol.

3.6 Statistical Analysis

In analysing the data, a repeated measure One-Way ANOVA was used to determine if there is any significant difference of stretching protocols and non-stretching protocols in throwing performance existed in baseball players. The statistic significance was set at $p < .05$.

CHAPTER IV

RESULTS

The velocity of the throwing shoulder after dynamic stretching, static stretching and non-stretching protocols were 125.2978 ± 6.56483 Km/h, 124.3467 ± 6.00329 Km/h, and 124.1422 ± 7.26928 km/h, respectively. The descriptive statistics were summarized in Table 2.

Table 2: A descriptive results of the velocity of throwing shoulder in 3 different Protocols

	Mean	Std. Deviation	N
Dynamic	125.30	6.56	15
Static	124.35	6.00	15
Non	124.14	7.27	15

The velocity of the athletes throwing shoulder performance was highest in dynamic stretching followed by static stretching protocol. The throwing velocity was lowest in non-stretching protocol among all three protocols. No significant difference on ball velocity was found dynamic stretching static stretching and non-stretching protocols. The results of the repeated measure One-way ANOVA is shown in Table 3.

Table 3: The results of repeated measure One-way ANOVA in throwing velocity

Source		Df	Mean Square	F	Sig.
Stretching	Sphericity Assumed	2	5.704	.615	.548
	Greenhouse-Geisser	1.414	8.070	.615	.496
	Huynh-Feldt	1.526	7.477	.615	.508
	Lower-bound	1.000	11.409	.615	.446

CHAPTER V

DISCUSSION AND CONCLUSION

The purpose of this study was to determine the effect of dynamic stretching and static stretching in pre-activity warm-up of the throwing shoulder of the baseball players. Based on the results of the repeated measure one-way ANOVA, the velocity among dynamic stretching vs. static stretching and dynamic stretching vs. non-stretching protocols was small and not significantly different (Table 2). The results of this study demonstrated that the stretching protocols have no significant effect on pitching performance of the players.

The finding of the present study on throwing velocity is not significantly changed after dynamic stretching, static stretching and non-stretching protocols, which supports the original hypothesis of the study that there is no significant difference between the effect of dynamic stretching and static stretching to the pitching velocity of the players.

Pitching velocity measures were not significant in dynamic stretching and static stretching, in previous research, Knudson et al. (2004) examined the percentage and radar measurement of ball speed and accuracy in tennis serve performance. Data analysis revealed that stretching had no significant effect on both the service speed and accuracy regardless of skill level, age or gender of the participants. With regards to the effect of static and dynamic stretching on agility, sprinting, and jump performance, Chaouachi et al. (2010) found that there were no significant statistical differences among stretching protocols for the sprint or agility measures as well as for the jump measures. Likewise, Zourdos et al. (2012) suggested that dynamic stretching does not affect running performance in trained male runners.

Studies have been conducted to characterize the effect of dynamic stretching and static stretching, and the results of which have been confusing and contradictory. Faigenbaum, Kang, et al. (2006) studied the acute effects of different warm-up protocols including static stretching and dynamic stretching and found that dynamic stretches was significantly greater compared to static stretches. It was concluded that dynamic stretching improves athletic performance greater than static stretching. This supposition is consent with previous studies which concluded that warm-up protocols including dynamic stretches resulted in superior athletic performance compared with warm-up using static stretching.

Likewise, the study of Van Gelder and Bartz (2011), the subjects in the trial group who performed dynamic stretching produced significantly faster times on the agility test in comparison to those who did static stretching. Thus, dynamic stretching significantly improves performance on closed agility skills involving 180 degrees change of direction. It was presented that peak power output after dynamic stretching treatment was significantly increased compared to baseline. Thus, it was suggested that dynamic exercises specific to a muscle group and simulating the actual muscular motion pattern, in warm-up protocols enhances power performance.

Muscle power and stretching in women was particularly studied by Manoel et al. (2008). The findings of this study proposed that dynamic stretching is more effective in increasing muscular power output than any other stretching protocol. Thus the authors suggested the inclusion of dynamic stretching as part of the warm-up exercises of players, as this may offer benefits in athletic performance. Herda et al. (2008), stated that overall, an acute bout of dynamic stretching may be less detrimental to muscle strength than static stretching for the hamstrings. Considering power and agility, better performance scores were observed after dynamic exercise compared with scores after static stretching and non stretching exercises was found in the study conducted by Mcmillan et al. (2006).

The study by De Weijer et al. (2003) concluded a significant increase in the hamstring length when static stretching was included in the warm-up exercises of the participants. This is seconded by O'Sullivan et al. (2009) stating that hamstring flexibility, which was assessed using active knee extension ROM, was increased from baseline after static stretching. Siatras et al. (2008) have found that significant knee joint flexibility increases and significant isometric and isokinetic peak torque have been shown to occur only after 30 and 60 seconds of quadriceps static stretching. Consequently, isokinetic peak torque after 30 and 60 seconds of stretching was reduced accordingly. It was then recommended that static stretching exercises of a muscle group for more than 30 seconds of duration should be avoided before any performance requiring maximal muscle strength.

Many studies found that static stretching and non-stretching had no significant effect on the performance of the throwing velocity of the athlete compared with the dynamic stretching, which is consistent with our current study. In the study conducted by Evetovich et al. (2003) suggests that static stretching hinders the full capabilities of the biceps brachii at both slow and fast velocities. It was seconded by Cramer et al. (2004), the study resolved that static stretching has no significant effect on peak torque or the joint angle at peak torque of leg extensor during maximal, voluntary eccentric muscle activities. Haag et al. (2010) reiterated that static stretching does not have significant impact on the throwing performance of baseball pitchers. The results of the present study appear to support these positions.

Thus, it is concluded that dynamic stretching has a small and no significant on the throwing performance of the throwing shoulder of the athletes. However, it is also concluded that static stretching and non-stretching has no effect on the throwing performance of the throwing shoulder of the athletes. The results of the present study, which are supported by previous research, suggest that static stretching and dynamic stretching does not significantly affect pitching performance of baseball players.

To sum up, no matter what type of stretching, there is no significant acute effect, either negative or positive, on the performance of throwing velocity among baseball players. Different stretching techniques produce different responses from the stretch-reflex, relative effectiveness of these stretching methods also varies. It was also concluded that in notable areas, neither static nor dynamic stretching was found effective. Moreover, based on the results of the present study, athletes could choose any kind or a combination of stretching protocols without compromising throwing performance.

APPENDIX A

Participant Data

Project title: Effects of Dynamic and Static Stretching on the Subsequent Pitching Performance in Collegiate Baseball Players

Investigator: Theresa May B. Garin

Age _______

Height ________

Weight ________

Please answer the following questions:

1. How many years have you practiced baseball?

____

2. How many days per week do you practice baseball?

____

3. Do you practice pitching overhand throw on a regular base?

____

4. Does your training involve stretching exercises? If yes, please indicate what type of stretching exercise you practice (for example, static stretching, dynamic stretching, facilitated stretching, ballistic stretching)

____

5. Do you compete in baseball tournament? If yes, how many years have been competing?

____

APPENDIX B

INFORMED CONSENT FORM

CONSENT TO PARTICIPATE VOLUNTARILY IN A RESEARCH PROJECT
Master of Education Thesis
Graduate Institute of Sport Coaching Science
College of Education
Chinese Culture University

Theresa May Garin, MS

____

Investigator

Date

____

Project Title: Effects of Dynamic and Static Stretching on the Subsequent Pitching Performance in Collegiate Baseball Players

You are being asked to participate in a research project about the acute effects of different stretching exercises on the performance baseball. All research projects carried out within this department are governed by the regulations of Chinese Culture University Sports Coaching Department. Your agreement (consent) is required by the regulations before you participate in this research project.

The investigator will explain to you in detail about the purpose, the procedure, and the potential benefits and foreseeable risks of the project. You may ask the investigator any question about the project at any time during the project. The procedure of the project is described below. If you decide to participate in this project, please sign this form in the presence of the investigator and a witness.

The purpose of the research project is to investigate the acute effect of three different stretching protocols on the performance of baseball overhand throw. If you participate in this research project, you will undergo three stretching protocols plus one control protocol in three separated days. In each day, you will perform a standard warm-up drill, followed by a stretching protocol. After the stretching protocol, you will perform several overhand throw, and the investigator will film your pitching performance in order to analyze the pitching velocity and accuracy.

The risk in the research project will include muscle strain, joint sprain, and other possible injury. These risks are similar to any regular baseball practice.

The information you provide will be kept in confidence, although you still have the right to release it to other people. Your information will be used in this research project without identifying you, and you are entitled to see any result in this research project related to your information. You are free to withdraw from this research project at any time.

If an injury occurs, first aid will be provided, but no financial compensation will be given. The Graduate Office serves as the official contact office in the event of research related injury to you.

I CERTIFY THAT I HAVE READ THE INFORMATION ABOVE AND FULLY UNDERSTAND ABOUT THIS RESEARCH PROJECT. ALL MY QUESTIONS HAVE BEEN ANSWERED TO MY SATISFACTION AND I AM WILLING TO PARTICIPATE IN THIS RESEARCH PROJECT.

Signature of Participant

____

Date

____

I CERTIFY THAT I HAVE EXPLAINED FULLY TO THE ABOVE SUBJECT THE NATURE, THE PURPOSE, THE POTENTIAL BENEFITS AND FORESEEABLE RISK OF THE RESEARCH PROJECT. I HAVE ANSWER ALL QUESTION ASKED BY THE PARTICIPANT.

____

Signature of investigator

REFERENCE

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