ACUTE EFFECTS OF STATIC AND DYNAMIC
STRETCHING ON VERTICAL JUMP PERFORMANCE
IN FEMALE VOLLEYBALL PLAYERS

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25th April 2016
ACUTE EFFECTS OF STATIC AND DYNAMIC STRETCHING ON VERTICAL JUMP PERFORMANCE IN FEMALE VOLLEYBALL PLAYERS

BY

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Programme: Bachelor of Social Sciences in Sport and Recreation Leadership

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Signature of Author: ______________________  Date: 25th April, 2016
We hereby recommend that the Honours Project by Miss Mo Hoi Yan entitled

“ACUTE EFFECTS OF STATIC AND DYNAMIC STRETCHING ON VERTICAL JUMP PERFORMANCE IN FEMALE VOLLEYBALL PLAYERS” be accepted in partial fulfillment of the requirements for the Bachelor of Social Sciences in Sports and Recreation Leadership.

Mr. Wu Shing
Supervisor
DECLARATION

I hereby declare that this honours project “ACUTE EFFECTS OF STATIC AND DYNAMIC STRETCHING ON VERTICAL JUMP PERFORMANCE IN FEMALE VOLLEYBALL PLAYERS” represents my own work and had not been previously submitted to this or other institution for a degree, diploma or other qualification. Citations from the other authors were listed in the references.

Mo Hoi Yan

25th April, 2016
ACKNOWLEDGEMENTS

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Also, I would like to express my appreciation to the students from TIACC Woo Hon Fai Secondary School and Our Lady of the Rosary College for their participation in this study.

______________________________
Mo Hoi Yan

Department of Physical Education

Hong Kong Baptist University

Date: 25th April, 2016
ABSTRACT

Stretching was commonly involved in the pre-exercises or pre-competitions and it used for warming up the body. Static and dynamic stretching were one of the hot topic discussed for decades. In the field of volleyball, static stretching was traditionally used in pre-exercises, and dynamic stretching were popped up in the warm-up session recently. The present study was to compare the effects of two stretching warm-up protocols towards the performance of vertical jump (VJ), the three stretching protocols were (1) no stretching (NS), (2) static stretching (SS) and (3) dynamic stretching (DS). Twenty six female school volleyball team players (age 13.5 ± 1.3 years old; height 158.9 ± 7.3 cm; weight 52.3 ± 5.6 kg) were recruited in the study. Subjects were required to perform three stretching methods (NS; SS; DS) with random sequences of in 3 consecutive weeks. Each protocol involved standardized warm-up included 5-minutes jog and 1-minute walk followed by a VJ pre-test. Then, perform one of the three stretching protocols. After the completion of each protocol, three times of VJ post-test were recorded. The result of the present study indicate there were significant differences between NS, SS and DS protocols towards VJ performance (p < 0.05). It is found that volleyball positions and performance levels did not influenced by three stretching protocols in VJ performance. In conclusion, dynamic stretching was recommended for female volleyball players on enhancing the
jumping height. So, dynamic stretching was recommended to involve in the warm-up session for female volleyball players.

**Keywords:** static stretching; dynamic stretching; performance; volleyball; warm up
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Chapter 1

INTRODUCTION

Traditionally, warm-up is used for pre-exercises or pre-competitions as it aimed to “increase the temperature of the muscles, thus preparing the body for the demands of the endurance conditioning phase, or main focus, of the workout.” (ACSM, 2010)(p.101). Warm-up is also a key factor of avoiding injuries and improving in performances in trainings and competitions (Fattahi, Sadeghi, Rezaei, & Einanloo, 2015). There are more and more new warm-up protocols come up and claim that they have various benefits for exercises, for example static stretching can improve flexibility (Bandy, Irion, & Briggler, 1997) and dynamic stretching can improve agility (McMillian, Moore, Hatler, & Taylor, 2006). The comparison of the effectiveness of static and dynamic stretching is one of the hot topics that discuss in worldwide sports area from 1990s to nowadays. To investigate the effects of static and dynamic stretching methods, many researchers conducted different tests to compare the effects of static and dynamic stretching. However, the study figures were still contradicting. Some of them suggesting dynamic stretching are more effective, while others found that there are no significant differences between static and dynamic stretching.

A study found out that dynamic stretching have a significant improvement in
agility and 5-steps jump comparing with static stretching in a group of army cadets (McMillian et al. 2006). Also, another research suggests dynamic stretching has more applicability of enhancing performance on power (Curry, Chengkalath, Crouch, Romance, & Manns, 2009). In contrary, a study state that “There were no significant differences between the static stretching, dynamic stretching and no stretching conditions for any of the jump.” (Dalrymple, Davis, Dwyer, & Moir, 2010). Samson, Button, Chaouachi, and Behm (2012) found that static stretching involved within activity warm-up could lead to an enhancement of sprint performance. Hough, Ross, and Howatson (2009) conducted a study and pointed out that there are negative effects to vertical jump when performing static stretching, whereas dynamic stretching has a positive effect. Those studies show that there are still controversial on the effectiveness among static and dynamic stretching.

Volleyball has widely spread to the world over this century. Over 200 million participants played volleyball in the world (Tillman, Hass, Brunt, & Bennett, 2004). Jumping is a common technique and essential movement involved in volleyball trainings and competitions. A study recorded that “each of the player averaged nearly 22 jumpings per game” (Tillman et al., 2004). Jumping ability is also one of the keys to be success for volleyball players. While attacking, a greater height will result in a higher opportunity to hit over the block. While defending, a greater height will result
in a higher blocking position (Sheppard J.M. et al., 2011). As the volleyball player always require lots of jumping in practices, there is a need to find out a better stretching protocol that would enhance the improvement of vertical jump in volleyball player.

However, only few studies investigated different stretching protocols effects on female volleyball players. A study stated that the sport-specific physical demands, training hours and criteria involvement, the body shapes and body composition of different female team ball players varied among different sports (Bayios, Bergeles, Apostolidis, Noutsos, & Koskolou, 2006). It explained the existing researches about different stretching protocols on other sports might not be applicable to volleyball players.

To sum up, warm-up stretching is one of the key factors affecting the performance before exercises or competitions. However, there is a knowledge gap about the choice of warm-up stretching and the performance of vertical jump in female volleyball players. To understand the impacts of different types of warm-up stretching is essentially important, which is also a prerequisite to conduct an effective training on volleyball players.

Study Aims and Objectives

This study aims to determine the better warm-up stretching between static and
dynamic stretching on vertical jump performance. The objectives of the study would be:

(1) To compare the acute effects of no stretch warm-up, static stretching and dynamic stretching on the improvement of vertical jump performance in female volleyball players;
(2) To compare the acute effects of no stretch warm-up, static stretching and dynamic stretching among three volleyball positions on the improvement of vertical jump performance in female volleyball players; and
(3) To compare the acute effects of no stretch warm-up, static stretching and dynamic stretching among two performance levels on the improvement of vertical jump performance in female volleyball players.

Significance of the study

The current practices in competitions and physical education lessons of female volleyball players in Hong Kong usually involved static stretching in the warm-up sessions. And there were a sign of dynamic stretching popping up in some high competition level female volleyball teams. This study would like to clarify which stretching method would be more effective for female volleyball players.

Also, due to the contradictory results of static and dynamic stretching, this study would clarify the contradiction of static and dynamic stretching. There are just few
studies specifically studying on different stretching effects on female volleyball
players, a specific comparison on the acute effect of static and dynamic stretching on
female volleyball players would be provided in the study. At the meanwhile, the most
effective stretching method would be find out and give a recommendation to the
female volleyball players on enhancing the height of jumping. In addition, the study
would compare the differences among three volleyball positions on two stretching
methods and performance levels, the best stretching method would be find out
specifically for different volleyball positions and performance levels.

Hypotheses

The hypotheses of this study would be:

**Hypotheses 1:** There would be significant difference in vertical jump performance
after NS, SS and DS protocols;

**Hypotheses 2:** There would be no significant differences among different positions of
volleyball players in vertical jump performance after NS, SS and DS protocols; and

**Hypotheses 3:** There would be no significant differences among different performance
levels of volleyball players in vertical jump performance after NS, SS and DS
protocols.
Chapter 2

LITERATURE REVIEW

The study was to compare the acute effects of static stretching and dynamic stretching on vertical jump in female volleyball players. This chapter was aimed to review the literature which is related to this study. It mainly divided into six sections: (a) warm-up stretching; (b) vertical jump in volleyball; (c) effects of static stretching; (d) effects of dynamic stretching; (e) summary of literature review; and (f) definition of terms.

Warm-up Stretching

The American College of Sports Medicine (ACSM) demonstrates the importance of warm-up in exercise training session and it is a transitional phase for the body to prepare the changing of biomechanical, bioenergetics and physiological demands during the sports phase of the exercise session (ACSM, 2010). In addition, National Strength and Conditioning Association (NSCA) guidelines stated that pre-competition stretching improved performance and functional abilities (Unick, Kieffer, Cheesman, & Feeney, 2005). The study of Witvrouw, Mahieu, Danneels, and McNair (2004) reported that stretching exercise was traditionally involved in warm-up section and aimed to increase flexibility of joints, improve performance and decrease the occurrence rate of injuries. It was also a recommended method to prime the muscular,
cardiovascular and neural system (Curry et al., 2009). According to Fradkin, Zazryn and Smoliga (2010), warm-up was shown to improve performance in 79% of the criterions examined in thirty-two studies in their systematic review. In other words, after a completion of an adequate warm-up activities could lead to an improvement of performance. It also pointed out there should be more evidence and studies to determine the role of warm-up in relation to performance improvement. Stretching exercise was also proposed to be effective of increase the range of motion about a joint and reduce the risk of injury (Dalrymple et al., 2010). In this study, static warm-up stretching and dynamic warm-up stretching would be investigated in order to determine which method should be recommended for volleyball players.

**Vertical Jump in Volleyball**

Soundara and Pushparajan (2010) mentioned volleyball players have to be good at vertical jumping, also known as explosive power. Jumps in volleyball playing take up 50-60% high speed movements and change of direction. The action of blocking and spiking required the corresponding explosive strength. The players’ ability of vertical jump is the key of winning points. The result of Tillman et al. (2004) also indicated that vertical jump appeared in volleyball practices and competitions frequently, 45 jumps were recorded in two games in the study. The successfulness of blocking and spiking dependent upon the height of vertical jump (Sheppard et al.,
Effects of Static Stretching

Bandy, Irion, and Briggler (1997) and Curry et al. (2009) indicated that static stretching resulted in increasing range of motion when it held for 9 seconds. After static stretching as part of the warm-up section, the risk of muscle injuries during sports activities could also be reduced (Robbins & Scheuermann, 2008; & Fattahi et al., 2015). However, there are several studies shown that static stretching may decrease the performance of explosive activities. Yamaguchi, Ishii, Yamanaka, and Yasuda (2006) reported that static stretching may decrease explosive performance in their study. Similar findings in Hough, Ross, and Howatson (2009) shown that static stretching may have a negative influence in activities requiring power outputs. Cornwell, Nelson, and Sidaway (2002) indicated pre-exercise static stretching may impaired the height of jumping. Although those studies demonstrate static stretching may have negative effects in explosive performance, they still failure on reporting significant reduction of static stretching. For example, Unick’s study resulted in no significant differences in vertical jump between static and dynamic stretching (Unick et al., 2005). Also, Egan, Cramer, Massey, and Marek (2006) fail to demonstrate the negative effects of static stretching in performing explosive power. Indeed, there were numbers of studies proposed static stretching have no difference to other stretching
methods or no effects on jumping. Dalrymple et al. (2010) reported that there were no significant differences between no stretching, static stretching and dynamic stretching in vertical jump. Other researchers found that there were no significant impairments in jumping with a shorter time (15 seconds to 2 minutes with 90% intensity, 2 to 4 sets) of static stretching (Robbins & Scheuermann, 2008; & Young, Elias, & Power 2006). Obviously, there were still knowledge gap of the impairment effects on jumping in static stretching.

Effects of Dynamic Stretching

According to McMillian et al. (2006) and Samson et al. (2012), dynamic stretching enhances the performance of activities required power and agility. Numerous researches indicated dynamic stretching has positive effects on performance. The results of Yamaguchi and Ishii's research shown that dynamic stretching had a positive enhancement on leg extension power and dynamic stretching would be preferred when performing power-related activities (Yamaguchi & Ishii, 2005). McMillian et al. (2006) also demonstrated a better performance of medicine ball throw and T-drill when the subjects using dynamic stretching comparing with static stretching. In other words, dynamic stretching was more preferable than static stretching when performing power and agility-related activities. Nevertheless, other studies shown that pre-exercise dynamic stretching had no changes in maximal
voluntary contraction force (Herda, Cramer, & Stout, 2008) and drop jumping height (Unick et al. 2005). As mentioned above, there are still doubtful results on claiming dynamic stretching has absolute positive effects on power and agility performance.

Summary of Literature Review

According to ACSM (2010), warm-up before activities offered a transitional phase for the body to prepare physically demands during sports phase. Warm-up stretching could reduce risk of injuries, increase range of motion of joints and improve sports performance (Witvrouw et al., 2004; Dalrymple et al., 2010; & Fradkin et al., 2010). Volleyball requires numbers of jumping. The successfulness of spiking and blocking during volleyball games is dependent upon the skills of vertical jump (Sheppard et al., 2011; & Dalrymple et al., 2010). Pre-exercise static stretching is an indicator of increasing range of motion and reducing risk of injuries during sports activities (Robbins & Scheuermann, 2008; & Fattahi et al., 2015). At the same time, static stretching may decreases the performance of power and agility (Yamaguchi, Ishii, Yamanaka, & Yasuda 2006; Hough et al., 2009; & Cornwell, Nelson, & Sidaway 2002). However, there were also studies claimed that static stretching have no changes on power and agility performance (Dalrymple et al., 2010; Robbins & Scheuermann, 2008; & Young et al., 2006). On the other hand, Yamaguchi and Ishii, (2005) reported that dynamic stretching could enhance performance of power and agility. Better
performance of medicine ball throw and T-drill were resulted in McMillian et al. 
(2006) study comparing with static stretching. But there were studies found that pre-
exercise dynamic stretching do not have any effects in maximal voluntary contraction 
force (Herda et al., 2008) and drop jumping height (Unick et al., 2005). Apparently, 
there are still questions and knowledge gap of determining which stretching method is 
better. This study would able to fill up the knowledge gap by comparing the acute 
effects of different stretching methods and proposed the recommended method to 
clarify which method would be the most suitable for female volleyball players.

Definition of Terms

*Acute Effect*

The immediate effects caused by performing a movement on a human or animal 
body (Unick et al., 2005).

*Static Stretching (SS)*

Static stretching is a performance of placing muscles to the greatest possible 
length and holding that position for a period of time (Bandy et al., 1997).

*Dynamic stretching (DS)*

Dynamic stretching is cooperating whole body movements which including 
actively and rhythmically contracting the muscle group through part of its functional 
range of motion (Curry et al., 2009).
**Vertical Jump Performance**

Vertical jump performance was the jumping height that the subject begin with a standing position then perform the crouching action followed immediately by a jump of maximal height (Fattahi et al., 2015).

**Different positions in volleyball players**

Positions of volleyball players mainly separated into three positions, which are setter, middle blocker and outside hitter. Different positions were responsible for different purposes in the volleyball competition. (Sheppard et al., 2011)
Chapter 3

METHOD

The purpose of this study is (1) to compare the effectiveness of static stretching, dynamic stretching on vertical jump performance in female volleyball players; (2) the effectiveness of static stretching, dynamic stretching on vertical jump performance among three different volleyball positions; and (3) the effectiveness of static stretching, dynamic stretching on vertical jump performance among two performance levels. This chapter mainly divided into following sections: (a) subjects and sampling; (b) procedures; (c) delimitations; and (d) data analysis.

Subjects and sampling

Twenty six female school volleyball team players, who were studied in TIACC Woo Hon Fai Secondary School and Our Lady of the Rosary College were invited to participate in the test of vertical jump of two different warm up stretching methods. Subjects were aged between 12 to 16 years old. Before the study, The Physical Activity Readiness Questionnaire for Everyone (Par-Q+) (Canadian Society for Exercise Physiology, 2011) were collected to ensure the body condition of the subjects is appropriate to perform the test. Consent forms were also collected from the subjects and their guardians’ to ensure they understand the testing purpose, procedure, potential benefits, risks and their agreement to participate in the study.
Procedures

In the study, completed Par-Q+ and consent form were collected and checked to ensure the availability and readiness for the tests. At the meanwhile, a brief rundown were explained and demonstration of the test were shown to the subjects, it ended with a questioning section. Several background information: age, body height, body weight and team position that they regularly played were recorded for further data analysis in this study.

**Figure 1. Schematic representation of testing procedure. DS = dynamic stretching protocol; SS = static stretching protocol; NS = no stretching protocol.**
The test design was shown in Figure 1. Subjects were asked to perform a pre-test of vertical jump test (VJ test) and followed with one stretching protocol (No Stretching (NS); Static Stretching (SS); Dynamic Stretching (DS)). Three times of VJ post-test were conducted after the stretching conditions. Subject was invited to perform the tests in random sequences of three stretching methods (NS ; SS; DS) on three separate days. The test were conducted in the school covered playground.

No stretching (NS)

No stretching protocol was a control trail in this study. Subjects were advised not to have meal three hours before the test. (Fletcher et al., 2001). Subjects were invited to perform standardized warm-up exercises, including jogging for 5 minutes in the covered playground and 1 minute walking. After the standardized warm-up exercises, the subjects were required to take 10 minutes of rest, then perform a post-test of vertical jump.

Static Stretching (SS)

A pre-test of VJ test were conducted before static stretching. After that, the subjects were invited to perform the standardized warm-up exercises, then followed by static stretching. The stretching protocol were focus on the lower limb, as vertical jump mainly involved the muscles in lower limb. According to the study of Dalrymple et al. (2010), Fattahi et al. (2015), and McMillian et al. (2006), a static stretch protocol
was designed for power and agility performance, it included: sitting toe-touch, calf stretch, quadriceps stretch, posterior hip stretch and trunk flexion. Subjects need to perform 2 repetitions of each stretch on both left and right side, each stretch should hold for 15 seconds. Also, there were a 20 seconds rest interval between repetitions (Dalrymple et al., 2010; Fattahi et al., 2015; & McMillian et al., 2006).

**Dynamic Stretching (DS)**

A pre-test of VJ test were conducted before dynamic stretching. Start with a standardized warm-up exercises, then perform dynamic stretching over the volleyball court (18 meters), it included: high-knee walk, slow butt-kicks, high-knee run, leg swing to opposite hand, turn and reach, lunge walk (Dalrymple et al., 2010; Fattahi et al., 2015; & McMillian et al., 2006). Subjects performed each stretch for 2 repetitions with slow to moderate cadence include all the movements with 20 seconds rest interval between repetitions. (Dalrymple et al., 2010; Fattahi et al., 2015; & McMillian et al., 2006)

**Vertical Jump Test**

Subjects were required to perform vertical jump test as pre-test before the warm-up exercise of NS, SS and DS. Subjects were also be required to perform post-test of vertical jump test after each of the protocol was completed. Subjects were first stand and reach the highest height with both feet flat on the floor, then the subjects
were advised to reach the highest point by performing vertical jump with maximum effort. Then, subject were required to perform 3 trials in each vertical jump test with 30 seconds of rest interval between trials. The difference between standing and jumping height were recorded as the test result, and the best trial of performance were recorded for data analysis.

Delimitations

Several delimitations were conducted during the tests:

1. Subjects were delimited to the female students of school volleyball team in TIACC Woo Hon Fai Secondary School and Our Lady of the Rosary College and aged between 12-16 years old.

2. Total of 24 subjects were involved in the study.

3. The standardized warm up exercises, stretching protocols and tests were executed in the covered playground in TIACC Woo Hon Fai Secondary School and Our Lady of the Rosary College.

4. The three stretching protocols were conducted on three Wednesdays and Fridays in three consecutive weeks.

5. The three stretching protocols were timed and performed in 10 ±1 minutes.

6. Physical Activity Readiness Questionnaire for Everyone (Par-Q+) (Canadian Society for Exercise Physiology, 2011) were used to ensure the health status of
the subjects.

Data Analysis

Hypotheses

The following hypotheses was examined:

Hypotheses 1: There would be significant difference in vertical jump performance after NS, SS and DS protocols;

Hypotheses 2: There would be no significant differences among different positions of volleyball players in vertical jump performance after NS, SS and DS protocols; and

Hypotheses 3: There would be no significant differences among different performance levels of volleyball players in vertical jump performance after NS, SS and DS protocols.

Statistical Analysis

In this study, all the collected data were calculated by the computer software Statistic Package of Social Science (SPSS) for windows version 21. The difference between pre-test and post-test would be the test result. All variable would be reported as the means, standard deviations, minimum and maximum values. One-way and two-way analysis of variance (ANOVA) were used to examine if there were any significant differences among NS, SS, and DS, volleyball positions and performance levels (categorical variable) towards pre-test and post-test results of vertical jump
performance (independent variable). The significant level of 0.05 ($p<0.05$) would be used in the analysis. If the result of ANOVA exist any significant differences, LSD Post Hoc test were used to examine if there were any significant differences specifically between one stretching protocol to another.
Chapter 4

RESULTS

Twenty six school volleyball team female players from TIACC Woo Hon Fai Secondary School and Our Lady of the Rosary College were invited to participate in this study. The purpose of this study is to compare the effectiveness of static stretching, dynamic stretching on vertical jump performance in female volleyball players. All subjects participated in two stretching protocols (NS; SS; DS). Table 1 and 2 shown the physical characteristics and volleyball positions distribution of subjects.

Table 1

*The physical characteristics of subjects (N = 26)*

<table>
<thead>
<tr>
<th></th>
<th>Range</th>
<th>Mean</th>
<th>±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>12 - 16</td>
<td>13.5</td>
<td>1.3</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>144 - 172</td>
<td>158.9</td>
<td>7.3</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>42.3 - 66.9</td>
<td>52.3</td>
<td>5.6</td>
</tr>
<tr>
<td>BMI</td>
<td>18.2 – 24.7</td>
<td>20.7</td>
<td>1.4</td>
</tr>
<tr>
<td>Experience</td>
<td>1 - 5</td>
<td>2.7</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Table 2

*The volleyball positions distribution of subjects (N = 26)*

<table>
<thead>
<tr>
<th>Positions</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setter</td>
<td>8</td>
</tr>
<tr>
<td>Middle Blocker</td>
<td>11</td>
</tr>
<tr>
<td>Outside Hitter</td>
<td>7</td>
</tr>
</tbody>
</table>
The descriptive statistics of the vertical jump performances pre-test and post-test in three stretching protocols were shown in figure 2:

Figure 2

*Mean in vertical jump performance (cm) pre-test and post-test of 3 stretching protocols. (N = 26)*

The differences between pretest and posttest of each stretching protocol had been calculated for data analysis. The descriptive statistics of the vertical jump performance in no stretching protocol, static stretching protocol and dynamic stretching protocol were shown in table 3:
Table 3

Descriptive statistics of the VJ performance in three stretching protocols (NS; SS; and DS) (N = 26)

<table>
<thead>
<tr>
<th></th>
<th>Range</th>
<th>Mean</th>
<th>±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>No stretching (cm)</td>
<td>-1 - 2</td>
<td>0.3</td>
<td>0.7</td>
</tr>
<tr>
<td>Static stretching (cm)</td>
<td>-2 - 6</td>
<td>1.5</td>
<td>1.7</td>
</tr>
<tr>
<td>Dynamic stretching (cm)</td>
<td>0 - 8</td>
<td>3.8</td>
<td>2.2</td>
</tr>
</tbody>
</table>

In the present study, a one-way between subjects ANOVA was conducted to compare the effects of stretching protocols on vertical jump in NS, SS, and DS (Table 4). There was significant differences of stretching protocols on vertical jump at the p < 0.05 level between three stretching protocols (NS; SS; and DS) [F (2, 75) = 30.897, p < 0.05].

Table 4

One-way between subjects ANOVA test between three stretching protocols (N = 26)

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>F</th>
<th>Sig.</th>
</tr>
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<tbody>
<tr>
<td>Between groups</td>
<td>2</td>
<td>30.897</td>
<td>0.000*</td>
</tr>
<tr>
<td>Within groups</td>
<td>75</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 level.

A LSD Post Hoc Test (Table 5) was conducted to clarify the differences of post-test between three stretching protocols. The comparison of Post Hoc using Least Significant Difference test indicated that the effect of NS protocol was significantly different with SS protocol (p = 0.009) and DS protocol (p = 0.000). The effect of SS protocol was significantly different with NS protocol (p = 0.009) and DS protocol (p
The effect of DS protocol was significantly different with NS protocol (\( p = 0.000 \)) and SS protocol (\( p = 0.000 \)). As a result, the above statistic suggested that using DS protocol to enhance the performance of vertical jump was more effective than SS protocol.

Table 5

*LSD Post Hoc Test of Pre-test and Post-test between three stretching protocols (\( N = 26 \))*

<table>
<thead>
<tr>
<th></th>
<th>Mean Difference</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Stretching</td>
<td>Static Stretching</td>
<td>-1.231</td>
</tr>
<tr>
<td></td>
<td>Dynamic Stretching</td>
<td>-3.538</td>
</tr>
<tr>
<td>Static Stretching</td>
<td>No Stretching</td>
<td>1.231</td>
</tr>
<tr>
<td></td>
<td>Dynamic Stretching</td>
<td>-2.308</td>
</tr>
<tr>
<td>Dynamic Stretching</td>
<td>No Stretching</td>
<td>3.538</td>
</tr>
<tr>
<td></td>
<td>Static Stretching</td>
<td>2.308</td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 level.

In the present study, two-way repeated measure analysis of variance (ANOVA) was conducted to compare the effects of three stretching protocols, three volleyball positions and two performance levels on VJ performance in pre-test and post-test (Table 6). The three stretching protocols consist NS, SS and DS, each of the protocol consist six tests (pre-test and post-test). The three volleyball positions include Setter, Middle blocker and Outside hitter, and the six performance levels include Grade B and Grade C. Table 4 shown the multivariate tests of the six tests. The effect for six tests show the F ratio of F (1, 20) = 40.997, \( p = 0.000 \), indicating significant
differences between the pre-test (34.92 ± 15.47) and post-test (33.73 ± 4.73). The effect for the six tests and three positions of volleyball show the F ratio of F(2, 20) = 1.023, p = 0.378, indicating the interaction of the pre-test and post-test was not significant difference among three positions of volleyball. The effect for six tests and two performance levels show the F ratio of F(1, 20) = 0.652, p = 0.429, indicating the interaction of the pre-test and post-test was not significant difference between two performance levels. The effect for six tests, two performance levels and the three positions of volleyball show the F ratio of F(2, 20) = 1.158, p = 0.334, indicating the interaction of the pre-test and post-test was not significant difference among two performance levels and the three positions of volleyball.

Table 6

Between-Subjects effect tests of Pre-test and Post-test between three volleyball positions and two performance levels. (N = 26)

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test</td>
<td>1</td>
<td>40.997</td>
<td>0.000*</td>
</tr>
<tr>
<td>Test * Performance Levels</td>
<td>1</td>
<td>0.652</td>
<td>0.429</td>
</tr>
<tr>
<td>Test * Positions</td>
<td>2</td>
<td>1.023</td>
<td>0.378</td>
</tr>
<tr>
<td>Test * Performance Levels * Positions</td>
<td>2</td>
<td>1.158</td>
<td>0.334</td>
</tr>
<tr>
<td>Error (Test)</td>
<td>20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 level.
Figure 3

The estimated VJ performance means of pre-test and post-test in three stretching protocols according to three positions of volleyball players (N = 26)

Figure 4

The estimated VJ performance means of pre-test and post-test in three stretching protocols according to two performance levels (N = 26)
The above results do not indicate any significant differences except the six tests. The null hypotheses “There would be no significant differences between different positions of volleyball player and the effects of NS, SS, and DS protocols in vertical jump performance.” And “There would be no significant differences of vertical jump performance in different performance levels among three stretching protocols.” were accepted.

As a result, there were significant differences between (1) NS protocol and SS protocol, (2) NS protocol and DS protocol and (3) SS protocol and DS protocol. We accepted the hypothesis “There would be significant difference in VJ performance among no stretch warm-up, static stretching and dynamic stretching” and “Dynamic stretching would be more effective on enhancing vertical jump performance comparing static stretching”. As there were significant differences between three protocols, dynamic stretching was recommended for female volleyball players to gain enhancement in vertical jump performance.
Chapter 5

DISCUSSION AND CONCLUSION

In the present study, the purpose was to compare the effectiveness of static stretching, dynamic stretching on vertical jump performance in female volleyball players. In the discussion part, five parts would be divided: (1) differences between SS and DS stretching protocols on vertical jump performance, (2) Mechanism of SS and DS warm-up protocols on VJ performance, (3) environmental factor affected the VJ performance of the three stretching protocols, (4) gender differences affected the VJ performance of SS and DS protocols, (5) Performance levels and volleyball positions in SS and DS protocols.

Differences between SS and DS stretching protocols on VJ performance.

Static stretching has been a traditional stretching in practices, which was a part of the warm up session before physical activity (ACSM, 2010). In addition, static stretching had been involved in schools’ physical education lessons and sports team training sessions. However, there were more and more researches had demonstrated dynamic stretching were better for athletes to warm up their body before practices. Hough et. al (2009) pointed out that SS warm-up protocol was impairing the muscle power, whereas DS warm-up protocol was strengthening the muscle power while performing vertical jump. Fattahi et. al (2015) concluded that DS movement were
more effective on strengthening high power and explosive skills comparing SS movement. Another similar result also indicated the effects on pre-event DS was more beneficial than pre-event SS in performing power activities (Faigenbaum et. al, 2006). For the reason of DS warm-up protocol can benefits the power related activities, Fletcher & Jones (2004) explained the SS warm-up protocol was increasing the musculotendinous unit compliance which will lead to a decrease of the ability of storing elastic energy in the musculotendinuous unit when the athletes were performing the eccentric phase of the jump.

In the present study, a similar result was concluded, there were significant differences of three stretching protocols in VJ performance among female volleyball players. The results indicated the DS protocol was significant differences comparing with SS protocol \([F (2, 75) = 30.897, p = 0.000]\). In other words, DS protocol was more effective on enhancing VJ performance than SS protocol. DS protocol was suggested to apply in the warm-up phase for female volleyball players to enhance jumping height.

Mechanism of SS and DS warm-up protocols on VJ performance

The only difference in setting between three tests were the stretching protocols, as the standardized warm up exercise and pre-test and post-test of VJ were both included in three conditions. The SS and DS stretching protocols focused on the
muscle group of the lower body, the factor of warming up different muscle group has been minimized.

The review of Behm and Chaouachi, (2011) explained that static warm-up stretching was commonly used before activities in decades. It was a movement includes a limb going to the end of its range of motion, and hold the position for 10-60 seconds. This stretching was aimed to increase the range of motion of the joint and as a preparation of the activities following. The increased range of motion could affect the length and stiffness of the musculotendinous unit. In addition, the increased range of motion could benefits in injury prevention and decreased muscle soreness.

The review also concluded there were researches (20%) reporting a significant improvement, whereas more than twice of researches (57%) were reporting the static warm-up having significant impairment on jump height performance. At the meanwhile, there were still 23% of the researches in the review do not indicate significant change in static warm-up on jumping height (Behm & Chaouachi, 2011).

The present result indicated the significant impairment on VJ performance in static stretching, which could collaborate with the majority researches (57%) of Behm and Chaouachi (2011) review, proving that static stretching was impairing the jumping height. At the meanwhile, static stretching was not suggested to perform before performing exercises include jumping.
The stretching intensity was also an important factor which could lead to the change of results of the present study. Point of discomfort was commonly interpret as a high intensity to a stretch (Avela, Kyröläinen, & Komi, 1999). Power, Behm, Cahill, Carroll, & Young (2004) reported that a high intensity of stretching would cause deficit effects on neuromuscular activation. In the other words, a point of discomfort static stretch would cause a decrease of agility in jumping. That might be a concern of having an appropriate intensity of SS in the future development of SS protocol. In the present study, the subjects were instructed to having the point of discomfort during SS protocol. It ensured the intensity of SS were same for all subjects.

Another stretching protocol involves in this study was DS protocol. DS warm-up includes active and controlled movements throughout the range of motion of a joint. This stretching aimed to facilitate the muscle power, sprint and jump performances (Hough et al., 2009; Yamaguchi et al., 2006; & Fletcher & Jones, 2004).

Behm & Chaouachi, (2011) pointed out that the duration of DS warm-up affects the performances of force, torque and power, the study demonstrated the longer stretching duration, the more positively changes on force, torque and power. It also demonstrated a significant improvement on force and power performance with over 90 seconds of DS compare with DS less than 90 seconds. Curry et al., (2009); Gelen, (2010); and Hough et al., (2009) also implement research with DS over 90 seconds.
and resulted in a significant enhancement \( (p < 0.01) \) on jumping height. While Herda et al., (2008) implement research less than 90 seconds also resulted in significant enhancement \( (p < 0.05) \), but less effective. Similar result showed in the present study, there were significant differences between SS and DS protocols \( [F(2, 75) = 30.897, p = 0.000] \), and the DS protocol was over 90 seconds.

In the recent decade, a combination of SS and DS was popped up in numerous studies, Power et al., (2004) and Fletcher & Anness, (2007) combined SS and DS as a prior aerobic warm-up. The results showed that there were still negative effects in SS upon force and power performance, but lack of significant evidences to prove the impairment of combined SS and DS warm-up. The combination of SS and DS was out of concern in the present study, further study may need to investigate on this new combination of SS and DS comparing with traditional stretching methods.

*Environmental factors affected the VJ performance of SS and DS stretching protocols*

For environmental factors, the temperature of the testing area was another main difference that affected the performance of the test. The difference of the temperature in three consecutive weeks were fluctuated and affect the motivation of the subjects. According to Cui, Cao, Park, Ouyang, & Zhu (2013), it indicated the physical activity motivation was stimulated by temperature, an appropriate temperature of 22°C to 26°C could motivate athletes to perform physical activity. Sargeant (1987) also
demonstrate there was a significant reduction of maximal peak power when the temperature at 12°C to 18°C.

The testing dates in the present study were having a fluctuated temperature. The range of temperature in three days was 11 - 20°C. It was not an appropriate temperature for motivating the subjects to perform their best and it may also reduce the jumping height of the subjects. Further study was recommended to perform the test in an indoor venue in order to maintain a stable temperature in different days of the test.

Gender differences affected the VJ performance of SS and DS stretching protocols

Different gender were resulted in different physiological and physical attributes, also with the differences of body mass aerobic profile, muscle strength, muscle endurance, speed and agility between genders (Lidor & Ziv, 2010; & Sattler, Hadzic, Dervisevic, & Markovic, 2015). The present study was a gender-specified study to examine the VJ performance of three stretching protocols.

However, there were only few researches found the SS protocol demonstrated a significant reduction on jumping performance in women (Hough et al., 2009; & Unick et. al , 2005). In contrary, there were relatively much more researches demonstrated a significant reduction on jumping performance in men after a series of SS (Cornwell, Nelson, & Sidaway, 2002; & Young, Elias, & Power, 2006). The study of Kubo,
Kanehisa and Fukunaga (2003) pointed out that the stiffness of medial gastrocnemius muscle significantly decreased in women comparing with men in the study of sex differences in the viscoelastic properties of tendon structure. In the study, only female volleyball players were recruited to be subjects. The results showed that there were less significant differences on SS protocols (p = 0.009) comparing with DS (p = 0.000) and NS protocols. The reason of the results may conclude as a hypothesis of women were less affected by SS protocol as their musculotendinous unit was already reduced stiffness in the standardized warm up exercise. Further study was also recommended to separate the gender when comparing the stiffness of medial gastrocnemius muscle in order to conclude with a reliable result.

*Performance levels and volleyball positions in SS and DS protocols*

A study of Sheppard, Gabbett and Stanganelli, (2009) demonstrated that there were significant differences between three volleyball positions (setter; outside spiker; & middle blocker) in vertical jump and spike jump. This explained that there should be different outcome when three volleyball positions receiving same treatment.

Another study claimed that they were the first study of their knowledge to evaluate the VJ performance differences in competition levels and different volleyball positions (Sattler et al., 2015). However, the results demonstrated there were no significant differences between three volleyball positions in female volleyball players.
In the present study, it share the same result with Sattler et al., (2015) when comparing the SS and DS protocols. The reason of this result could be the experience of volleyball positions were not well-developed, most of the subjects practices with their position less than a year.

Sattler et al. (2015) also indicated a significant differences between competition levels in VJ performance. In contrary, the performance levels in the present study do not demonstrated any significant differences between performance levels in SS and DS protocols. The reasons were the experiences of subjects were not enough, also with a narrow range of age of the subjects.

The future study on VJ performance among different performance levels and different volleyball positions in SS and DS protocols were recommended to recruit subjects with experienced practices in their positions and a wider range of age would be an advanced to interpret more reliable results.

**Summary of Results**

This study was designed to compare the effectiveness of static stretching, dynamic stretching on vertical jump performance in female volleyball players; the effectiveness of static stretching, dynamic stretching on vertical jump performance among three volleyball positions; and the effectiveness of static stretching, dynamic stretching on vertical jump performance among two performance levels.
Twenty six female school volleyball team players in TIACC Woo Hon Fai Secondary School and Our Lady of the Rosary College were participated in the study. They performed a standardized warm-up exercise followed by a VJ pre-test. After that, NS, SS and DS protocols performed, then end with a VJ post-test. Tests were took place in the covered playground in both schools in three separate days. The highest pre-test and post-test VJ performance of each protocols were recorded, and the data were analyzed by the computer software Statistic Package of Social Science (SPSS) for windows version 21. The significant level of 0.05 (p<0.05) was used in the analysis.

The results of the present study were summarized as follows:

1. There were significant difference in pre-test and post-test among NS, SS and DS in enhancing VJ performance \[F ( 2, 75 ) = 30.897, p = 0.000\].

2. DS were more effective on enhancing VJ performance comparing SS \[F ( 2, 75 ) = 30.897, p = 0.000\].

3. There were no significant differences between different positions of volleyball player and the effects of NS, SS, and DS protocols in VJ performance \[F ( 2, 20 ) = 1.023, p = 0.378\].

4. There were no significant differences of VJ performance in different performance levels among three stretching protocols \[F ( 1, 20 ) = 0.652, p = 0.429\].
Conclusion

To conclude, the present study found that there were significant differences among three stretching protocols. Hence, it was concluded that DS protocol was effective on enhancing VJ performance in female volleyball players comparing with SS protocol.

Limitations

The following limitations were included in this study:

1. The vertical jump skills of the subjects were fluctuated, especially the existence of the swinging arm, which would affect the results of the study.

2. The outdoor temperature is uncontrollable, as the temperature may affect the stiffness of the muscle and joints, which would affect the performance of the subjects.

3. The outdoor humidity is uncontrollable, the different humidity of three different days may affect the performance of subjects.

Recommendation of Further Study

1. The duration and intensity of stretching should be considered to accomplish the largest effects of the stretching methods.

2. A combination of SS and DS protocol should also be concern in comparing the traditional stretching methods.
3. The test should take place in an indoor venue to maintain a stable temperature for the subjects to minimize the environmental factors affecting the results of the study.

4. The age group and performance levels should be extended, as there might have differences in VJ performance.

5. The experience of volleyball practicing should be considered, since unexperienced subject might have movement differentiation each time in performing VJ.
REFERENCES


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Questionnaire for Everyone (Par-Q+), 4–7.


static stretching on peak torque and mean power output in National Collegiate Athletic Association Division I women’s basketball players. *Journal of Strength and Conditioning Research / National Strength & Conditioning Association*, 20(4), 778–82. doi: 10.1519/R-18575.1


Yamaguchi, T., & Ishii, K. (2005). Effects of static stretching for 30 seconds and


### APPENDIX A

**Data Collection Form**

<table>
<thead>
<tr>
<th>Name:</th>
<th>Subject No.:</th>
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</thead>
<tbody>
<tr>
<td>Age:</td>
<td>Gender:</td>
</tr>
<tr>
<td>Height: cm</td>
<td>Weight: kg</td>
</tr>
<tr>
<td>Position:</td>
<td>Reached height (stand): cm</td>
</tr>
</tbody>
</table>

**No stretching condition**

<table>
<thead>
<tr>
<th>Pre-test: cm</th>
<th>Post-test: cm</th>
</tr>
</thead>
</table>

**Static stretching condition**

<table>
<thead>
<tr>
<th>Pre-test: cm</th>
<th>Post-test: cm</th>
</tr>
</thead>
</table>

**Dynamic stretching condition**

<table>
<thead>
<tr>
<th>Pre-test: cm</th>
<th>Post-test: cm</th>
</tr>
</thead>
</table>
APPENDIX B

立定跳高測試內容及家長同意書

本人是香港浸會大學社會科學學院－體育及康樂領袖學系四年級學生，現正就有關畢業論文進行一項有關立定跳高測試的研究。特此邀請 貴子弟參加是次立定跳高測試。

請 閣下詳閱下列細則：

1. 測試目的及內容

受試者將會進行三項測試，分別為無熱身狀況立定跳高；靜態熱身狀況立定跳高及動態熱身狀況立定跳高測試。是次測試目的是希望透過實驗，找出那種熱身狀況對於排球員的跳高能力有最大幫助。

2. 存在風險及不適感覺

是次測試需要受試者盡力跳至最高點。測試涉及受試者大腿群肌的肌力。所有不合理的動作將會立即被停止，把受傷風險盡量降至最低。

3. 參加者的責任

如參加者本身有任何肌肉受傷或其他不尋常的不適感覺，參加者有責任於測試前向測試工作人員報告有關資料。如有任何其他藥物背景，受試者亦需於測試前向工作人員報告。

4. 測試結果的運用

本研究所收集的所有資料絕對保密，僅用於是次研究作統計及科學分析用途。為了保護參加者個人私隱，如沒有受試者的書面同意，所有資料一概不會向任何人公開。

5. 參加者的意願

參加者參加是次測試，是出於自願性質的。如果參加者在測試前或測試期間感到不適，或不願意進行測試，可在任何時候選擇退出測試，並不會有任何後果。

參加者責任聲明及家長同意聲明：
本人____________________身體健康狀況良好，適宜參加上述的仰臥起坐測試。本人並未有任何疾病，適合參與是次測試，包括無熱身狀況立定跳高；靜態熱身狀況立定跳高及動態熱身狀況立定跳高測試。如有疑問，本人會向醫生尋求指示。
在測試期間，如發生意外而導致任何事故，本人願承擔全部責任，主辦或協機構並不需要負上任何法律責任。此外，本人亦明白必須遵守是次測試的一切規則及教練 / 指導員之安排。

確認日期：_________________ 參加者簽名：__________________

※ 註：未滿 18 歲的參加者，必須填妥以下部份：

家長/監護人姓名：_________________ 家長/監護人簽名：_______________

與參加者之關係：_________________ 日期：___________________