Chapter 1

INTRODUCTION

Success in sports performance of today's athletes is a complex blend of many factors, such as, genetic endowment, training and nutritional status (MacDougall and Wenger, 1991). Although sport scientists have limited power in altering what has been determined by heredity, they can plan optimal training strategies to enhance athletes' performance. Consequently, performance enhancement has been a key topic that attracts many researchers.

One of the main factors in all the studies and researches above is the assessment of athletic performance. Athletic performance is assessed through physical performance test. There are two types of physical performance tests, namely laboratory test and field test. Laboratory test refers to the measurement that is conducted in a controlled environment (laboratory) that uses protocols and equipment that simulate sport or activity. Field test, on the other hand is the measurement that is conducted while the athletes are performing in a simulated competitive situation (MacDougall and Wenger, 1991). Generally, the results obtained from laboratory tests are more reliable than the results obtained from field tests but results obtained from field tests are often more valid due to greater specificity.

In sport settings, physical performance tests are used to indicate strengths and weaknesses in relation to athletes' performance. The information gained can then be used to provide baseline data for prescription of individual training program. Besides, physical performance tests are also able to provide information on the health status of the athletes. In addition, physical performance tests can be used to assess the effectiveness of intervening training program, especially at the end of each phase of training cycle. Furthermore, they help in educating the athletes to better understand their body and the demands of the particular sport. Last but not least, physical performance test plays a significant role in inspiring the athletes to train harder.

Basically, an effective physical performance test should be both valid and reliable. Validity refers to the ability of a physical performance test to measure what it is supposed to measure. In addition, a valid physical performance test should be able to differentiate between different levels of athletic performance. Reliability, on the other hand refers to the ability of a physical performance test to produce the same result whenever it is repeated. Protocol used in any physical performance test has to be as relevant and specific to the particular sport. Administration of the test has to be strictly controlled and the athletes' human rights have to be respected.

One of the most assessed performance components in sports is the vertical jumping ability. Many studies have been carried out to explore the many types of jump, such as squat jump, countermovement jump, one, two or few steps jump, one or two legged jump, and drop, depth or reactive jump (Bobbert et al., 1996; Dowling and Vamos, 1993; Holcomb et al., 1996; Young, Wilson and Byrne, 1999a; Young, Wilson and Byrne, 1999b; Young, Pryor and Wilson, 1995).

Review of these researches revealed that most of them addressed questions concerning maximal vertical jump height that can be attained in jumping, or jumping for distance (height). For instance, they focused more in answering questions like determining factors to jump for distance; training methods to enhance one's ability to jump for distance and training methods to improve athletes' reactive jumping ability to reach a higher distance. However, in sports scene nowadays, jumping for distance is no more a guarantee to success in sports. Athletes often do not need to jump to their maximal height; instead they have to jump fast to reach a certain level of height. Richardson, Schmotzer, Brandenburg and Kraemer (1983) claimed that the basic rebounding theory in the University of Wyoming is that the tallest player or the highest jumper does not have a guarantee of a rebounding success. The rebound often goes to the player that is quickest to the ball.

If we observe closely games like basketball and volleyball, we will notice that the rim in the game of basketball and the net in volleyball are only at a certain height, which is normally at sub-maximal level of the vertical jump height that can be reached by an athlete. Thus, despite the ability to jump high, success in these sports is often determined by the ability of these athletes to jump as fast as possible to their sub-maximal vertical jump height, and often, this movement has to be performed repeatedly. For example, success in under-basket battle in the game of basketball such as rebounding and tip-in are often determined by the ability of an athlete to jump rapidly two, three or more times in a row as opposing athletes battle for the ball coming off the rim (Dolcetti, 2001). The same goes to battle in front of net in the game of volleyball such as those during blocking and fast spiking. The need of being able to jump fast repetitively is especially obvious to short players

playing in games where height has an advantage, such as basketball. The repetitive speed jumping ability can compensate the lack in height for shorter players.

Therefore, it is the aim of this study to focus on the investigation of the athletes' ability to jump repetitively as fast as possible to reach a sub-maximal vertical jump height and to explore the characteristics of this type of stretch-shortening cycle activity.

1.1 Speed Jump Test

The Speed Jump Test used in this study actually originated from North America where it is called the 5 Jump Test and has been used to assess an athlete's ability to jump fast repetitively (Dolcetti, 2001). This test is performed by first measuring the subject's vertical jump height before setting a pre-determined reaching height at 80% of a subject's maximal vertical jump height. The subject then has to jump repeatedly to reach the pre-determined jump height for five times. The test is started by the first movement of the subject and is stopped when he touches the pre-determined height for the fifth time. Total time taken is measured and used as the reflective measure of repetitive speed jumping ability.

The pre-determined height is set at 80% because it was reported that this range of sub-maximal height is the highest that most athletes are able to reach for five times consecutively. Besides, jumping to this height can better characterize the repetitive speed jumping ability by demanding a higher speed component in jumping (Dolcetti, 2001).

However, a pilot study carried out prior to this test revealed that the validity of this measurement procedure is questionable because the total jumping time in this test is affected by a subject's vertical jump height since total time taken to complete the test is used as the reflective measure of repetitive speed jumping ability. For instance, a higher jumper will have a higher 80% value (pre-determined height) and thus has to travel for a longer distance during jumping. As a result, the score in the speed jump test will be affected since longer distance will require longer flight time and this will definitely affect the ability of this test to differentiate between different levels of athletic performances.

Two tests that were developed in the 1970s and 1980s have been identified in the literature to be able to measure rebound or reactive jumping ability. These two tests are the Reactive Jumping Test and Continuous Vertical Jump Test (Bouchard et al., 1991; Bosco, Luhtanen and Komi, 1983; Newtest, 2000). The Reactive Jumping Test basically requires the subject to perform six continuous fast and reactive jumps on a contact mat capable of measuring contact time and flight time to calculate the height of rise of center of gravity. Subject's hands are free and he or she is required to jump straight upward and lands on the balls of the feet and rebound immediately as high as possible. During the contact phase, the subject keeps the knees as straight as possible. Mechanical power can then be computed using the formula below:

$$P = 2hg/t \quad \text{- equation 1.1}$$

Where:

P = mechanical power per body mass (W/kg)

h = height of rise of center of gravity (m)

g = acceleration of gravity ($9.81 ms^{-2}$)

t = contact time (ms)

2 = constant

Continuous Vertical Jump Test is performed by having the subject to start in a semi-squatting position with knee angle at 90 degrees and hands on the hips. From this position, the subject perform continuous vertical jump with maximal effort on a contact mat for the selected period of time (15, 30 or 60 seconds). The measured variables in this test are the number of jumps, total flight time and the total time of the test performance. Knee angle has to be controlled carefully and should be measured using an electrogoniometer attached to the lateral side of the knee joint. In addition, it is important to control the position of the subject during take-off and landing since the displacement of center of gravity is calculated from the flight time and the assumption is that subject will take-off and land in the same position. A deviation from this will certainly increase the flight time and the displacement of center of gravity and therefore the calculated mechanical power. Mechanical power during jumping can then be calculated using the formula as follow:

$$P = g^2 \bullet Ft \bullet Tt / 4n (Tt - Ft) \quad - \quad \textit{equation 1.2}$$

Where:

P = mechanical power per body mass (W/kg)

g = acceleration of gravity ($9.81 ms^{-2}$)

Ft = sum of flight times (s)

Tt = total time of test (s)

n = number of jumps performed during test

Tt – Ft = sum of total contact times (s)

4 = constant

Both the Reactive Jumping Test and Continuous Vertical Jump Test have been proven to be valid and reliable. However, in the context of this study, they do not meet our needs because:

a) both of these tests are only capable of measuring the mechanical power. It is unlikely to reflect whether it is the force or the velocity component of power that has contributed to the performance.

b) both of these tests focus on measuring the reactive ability to reach a maximal height, whereas in this study we would like to measure the reactive ability to jump to a sub-maximal height.

c) the knee angle is controlled in these two tests but we are more interested to study individual preferred knee angle to jump as fast as possible to the pre-determined sub-maximal vertical jump height.

1.2 Statement of the Problem

The development of a measurement procedure that may provide a precise and reflective measure of the ability to jump repeatedly as fast as possible to a sub-maximal level of height, which also closely resemble the activity required for participation in specific sports, where the above mentioned ability is of major concern. This requires a thorough understanding of the nature and characteristics of the stretch-shortening cycle type of movement and the determinants of the ability to and the recovery period needed in between each trial. In addition, this research study

also attempted to study the characteristics of this different type of stretch-shortening cycle activity where repetitive jumping speed is of major interest.

1.3 Significance of the Study

None of the currently available field tests are capable of giving a reflective measure of human repetitive speed jumping ability. Considering the frequency where this type of movement is being performed, the significance and impact it has on the overall performance in particular sports, there is a need to develop a new test that closely mimics the requirements of sports specific situations where the athletes need to jump repeatedly as fast as possible to reach a sub-maximal level of height.

In addition, the fact that this type of stretch-shortening cycle activity where speed is of major concern has never been explored has brought about the demand to study the characteristics of this type of SSC movement to better understand different types of SSC performance and their underlying mechanisms.

1.4 Research Questions

Several research questions were identified in developing this measurement procedure to provide guidance in both the literature review and experiment design.

1. Is the proposed Speed Jump Test able to provide stable measurement on different testing sessions over different days?
2. What is the correlation between speed jump index and vertical jump (leg power) score?
3. What is the correlation between speed jump index and 40-yard dash (leg speed) score?

4. What is the correlation between speed jump index and both the countermovement and bounce drop jump tests scores?
5. Can the Repetitive Speed Jump Test differentiate between different levels of performance? (Subjects that had been training for more than 2 years prior to the test versus subjects that had been training for less than 2 years)
6. Is the proposed Speed Jump Test able to provide valid and reflective measure of the ability to jump repeatedly as fast as possible to a sub-maximal (80%) level of height?
7. What is the most suitable repetition that best reflects the ability to jump repetitively to a sub-maximal (80%) level of height?

1.5 Limitations

The subjects in this study were adolescent basketball players from a training center at the Chong Hwa High School, Kuala Lumpur. A random selection sampling technique was not used in this study. Therefore, generalizability may be limited.

The number of subjects was limited by the fact that basketball was not quite a popular game in Malaysia. This was especially true for the subjects' age group in this study where basketball was race dominated by certain ethnic group. Furthermore, there were not many organized training centres that can be approached, probably due to lack of funding and interest. Thus, the analysis and interpretation of the results has to be done carefully.

We were unable to control the gear worn by the subjects, which include shirts, pants and shoes. The instructions given to them were to wear their basketball

jersey and shorts without any compression garments and only proper basketball shoes were allowed. Compression garments, although do not improve single vertical jump power, have been proven to have a significant effect on repetitive vertical jumps by helping to maintain higher mean jumping power (Kraemer et al., 1996). However, the effects that different types of basketball jerseys and shoes have on performance are beyond our control.

The first testing session was organized in the way where the 40-meter dash test was carried out before the Speed Jump Test. This was meant to optimize the subjects' performance by providing resemblance to mimic the activity they are used to during training where sprinting bouts were incorporated in their normal warm-up routine. Therefore, during the second testing session, 3-4 sprints were incorporated into the warm-up procedure to standardize the pre-jumping activity.

This study was conducted after an agreement was mutually achieved between the coach and the author as the coach was actually seeking for help to test his players while the author was looking for subjects. Since the subjects are very young, the rules and regulations were explained to both the coach and the players and the consent form was signed by the coach after making sure that all the subjects understood their rights to participate and withdraw from the study.

The subject information sheet was not prepared in this study because the subjects were having problem in understanding the language used (English). However, we did make sure that all the subjects understood what to be done by verbally instructing them in the language they preferred, Mandarin. Besides, demonstrations and practices were conducted for each test to ensure that each

subject understood the instructions and were able to perform in a proper manner. The subjects were also encouraged to ask questions should there be any doubt and all the doubts were cleared before the first test started.

All the tests are limited by the motivational and environmental conditions. Since it is almost impossible to control these factors, subjects were always motivated by their teammates and the tester.

1.6 Delimitations

This study was delimited to 21 male basketball players, between 13 and 15 years of age. All subjects had a minimum of one year of basketball training experience. Reason being the testing procedure in this study demanded a substantial level of jumping skill. Basketball players were used in this study because of the nature of the basketball game where jumping skill and dynamic balance is importance.

There have been many researches that reported injury cases associated with drop or depth jumping. Due to the high tendency to cause injury, both our counter-movement and bounce drop jump tests were delimited to 11 subjects consisted of those who had at least two years of training experience. This somehow has caused limitation in this study and the result has to be interpreted carefully.