The relationship between Anterior Cruciate Ligament (ACL) Injury and 7 types of Sports among Athletes in Hong Kong Baptist University (HKBU)

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_____________________________

DR. Chan Suet Ying Ada

Chief Advisor
DECLARATION

I hereby declare that this honours project “THE RELATIONSHIP BETWEEN ANTERIOR CRUCIATE LIGAMENT (ACL) INJURY AND 7 TYPES OF SPORTS AMONG ATHLETES IN HONG KONG BAPTIST UNIVERSITY (HKBU)” represents my own work and had not been previously submitted to this or other institution for a degree, diploma or other qualification. Citations from other authors were listed in the references.

_________________________
Man Miu Shan

25th April, 2016
ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my supervisor, Dr. Chan Suet Ying Ada for guiding and supporting me throughout the entire study. I would also like to thank the participants and coaches. My project would have not been conducted smoothly without their participations and supports.

__________________________
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Dtae: 25th April, 2016
ABSTRACT

AIMS: In Hong Kong, the number of people participate in sport has increased; and it was found that the anterior cruciate ligament (ACL) injury rate is also increasing. There is insufficient study about ACL injury among athletes in Hong Kong; therefore, it is needed to conduct a study to investigate the relationship between ACL injury and sports. This study would examine the relationship between ACL injury and gender, type of sports, injury setting (competition VS training), injury pattern (contact VS non-contact).

METHODS: Athletes (N=183) from 7 types of sports including: basketball team, badminton team, handball team, rugby team, soccer team, table tennis team and volleyball team in Hong Kong Baptist University (HKBU) had regularly participated in university training (>80%) were targeted to be the subjects in this study. Anterior Cruciate Ligament Injury Questionnaire (ACLIQ) would be used to collect data, it was expected that the ACL injury rate was higher in female athletes at competition without body contact.

RESULTS: There were 25 participants suffered from ACL injury, basketball team had the highest ACL injury rate and the second was rugby team. There was significant difference between badminton (p=0.03), basketball (p=0.02), rugby (p=0.04) and ACL injury but no significant difference between different ACL injury
and gender (p=0.60). However, the overall ACL injury rate in females was higher than in males. The overall ACL injury rate in competition were higher than in training but there was no significant difference between sports and injury setting (p=0.71). The total rate of contact injury was higher than in non-contact injury and there was significant difference between rugby and injury pattern (p=0.01).

**CONCLUSION:** All athletes should be careful and keep themselves away from injury, as ACL injury is a common sport injury and it affects athletes’ performance level and sport life, protection and prevention are needed to reduce the injury risk.

**Keywords:** ACL injury, sports, University athletes, knee injury
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CHAPTER 1

INTRODUCTION

In these years, many people do exercises for leisure and interests because the health awareness among Hong Kong people was increased. The number of sport participation was increased. According to the Consultancy Study on Sport for All - Participation Patterns of Hong Kong People in Physical Activities Summary Report (2009), after the Healthy Exercise for All Campaign was promoted to the public, also the effect of the 2008 Beijing Olympic Games, the overall sport physical activity participation was increased.

Nowadays, Hong Kong Marathon becomes one of the famous major sport events in Hong Kong, people are active and energetic in participation. A piece of news from Wen Wei Po reported that the number of Hong Kong Marathon 2015 application was broken through to 7.3 million (Pao, 2015). It is good news that number of sport participation is increasing; however, the injury rate during the Marathon was also increased.

In Hong Kong Pain Society Annual Scientific Meeting 2010, it indicated that people should pay attention to the sports in injury (Yung, 2010). Yung (2010) found that knee injury was the most common sport injury in recent years. Public hospitals perform around 1,000 Anterior Cruciate Ligament (ACL) reconstruction surgeries
every year (Yung, 2009). Within ten years, the ACL injury rate had increased about 20%, it became a serious issue.

What is ACL? There are three bones form the knee joint, they are thighbone, shinbone, and kneecap. Kneecap places in front of the joint to provide protection for our knee. These bones connect to each other by four ligaments. They act like strong ropes to hold the bones together and stabilize the knee. ACL is one of the ligament places vertically in the middle of the knee. It prevents the tibia from sliding out in front of the femur, and provides rotational stability to the knee (American Academy of Orthopaedic Surgeons, 2014). What contributes to ACL injury? According to Ireland (1999), factors can be divided into intrinsic (hyperextension, size of ACL, inherited skills and coordination, etc.) or extrinsic (strength, shoes, motivation, etc), and injury is likely to happen during the uncontrolled landing and stop phrase (Ireland, 1999).

Vauhnik et al. (2011) pointed out that ACL injury risk is greater in game than in training, it may due to different conditions between game and training. In the game, players will pay more effort and the pace, emotion or fatigue may increase the risk of knee injury (Vauhnik et al.).

How does athlete know if his ACL get tear? Spindler and Wright (2008) stated that:

Key points of the history suggesting ACL tear include a noncontact
mechanism of injury, the identification of an audible popping sound, the early occurrence of swelling as a result of bleeding (hemarthrosis) from the rupture of the vascular ACL, and an inability to continue to participate in the game or practice after the injury (P.2136).

Besides, there are some other warnings including knee pain, knee swelling and range of motion of the knee is significant decreased (Yung, 2015).

ACL injury is a serious problem, although there is reconstruction surgery for ACL, we cannot restore an ACL-injured knee back to normal conditions with a reconstruction surgery. Power and range of motion of the knee will decrease and it also leads to some side-effects. Vaishya and Hasija (2013) found that people had ACL injury were likely to suffer from joint hypermobility. “Chronic ACL insufficiency can cause damage to the articular cartilage and thus early degenerative arthritis, meniscal tears, and stretching of secondary stabilisers such as collateral ligaments.” (P.182).

To keep ourselves physically active and maintain our daily life and well being, it is very important to take care of our ACL and knee. This study would investigate the relationship between ACL injury and 7 types of sports among athletes in Hong Kong Baptist University, to provide more information for coaches and players as references, thereby, to reduce the risk of ACL injury.
Study Aims and Objectives

This study was aimed to examine the ACL injury rate in 7 sports among athletes in Hong Kong Baptist University (HKBU). Gender, type of sports, injury setting (competition VS training) and injury pattern (contact VS non-contact) will be focused. Specially, the objectives of this study will be:

(1) To investigate the overall ACL injury rate in 7 sports among athletes in HKBU;
(2) To compare difference of ACL injury by gender;
(3) To compare difference of ACL injury by type of sports;
(4) To compare difference of ACL injury by injury setting (competition VS training)
(5) To compare difference of ACL injury by injury pattern (contact VS non-contact)

Significance of the Study

The key words “Anterior Cruciate Ligament injury”, “ACL injury rate in Hong Kong”, “ACL injury number”, “ACL researches in Hong Kong”, “sport related ACL injury” had been searched from Google, Hong Kong Baptist University OneSearch search engine and Databases of SPORTDiscus on 1st – 20th September, 2015. There was insufficient study of ACL injury in Hong Kong, most of the statistics and information about ACL injury were only presented by newspaper. As there was insufficient ACL injury study in Hong Kong; therefore, it was needed to conduct a
study to investigate the relationship between ACL injury and 7 types of sports, in order to provide useful information for coaches and athletes about ACL injury among 7 types of sports. Also, it could help to design better preventive programme to reduce risk of ACL injury and reduce the amount of governmental medical expense.

Hypotheses

The hypotheses of this study would be:

Hypotheses 1: There would be no relationship between anterior cruciate ligament (ACL) injury and gender among athletes in Hong Kong Baptist University (HKBU);

Hypotheses 2: There would be no relationship between ACL injury and types of sports among athletes in HKBU;

Hypotheses 3: There would be no relationship between ACL injury and injury setting among athletes in HKBU;

Hypotheses 4: There would be no relationship between ACL injury and injury pattern among athletes in HKBU.
CHAPTER 2

REVIEW OF LITERATURE

Some literatures about Anterior Cruciate Ligament (ACL) injuries in different types of sports were reviewed in this chapter. The review of literature can be divided into six parts: (1) ACL Injury in United States, (2) ACL Injury in Hong Kong, (3) Gender Difference in ACL Injury, (4) Injury Setting in ACL Injury, (5) Injury Pattern in ACL Injury, (6) ACL Injury Associated Injuries (7) Summary and (8) Measuring Instrument.

Why ACL injury was focused in this study? Although medial collateral ligament (MCL) was known to be the most commonly injured ligament in 1991 (Ireland, 1991), ACL was the most common injured ligament in the body and the ACL was found to be the most frequently injured single ligament associated with limited range of motion (Spindler & Wright, 2008; Serpell, Scarvell, Ball, & Smith, 2012), therefore, ACL injury was targeted in this research.

(1) ACL Injury in United States

According to Yu and Garrett (2007), ACL injury was the most common sport injury in US. Every year, there are around 175,000 ACL primary ACL reconstruction surgeries were performed in US and the cost is over US $2 billion. In another study,
Bukoskey, Graves, and Humphreys (2010) found that there are 250,000 ACL injuries occurred every year and the cost of ACL reconstruction surgeries also over US $2 billion. From these two studies, it showed that the ACL injuries rate was increasing (Yu & Garrett, 2007; Bukoskey et al., 2010).

Vauhnik et al. (2011) had conducted a study about the ACL injury rate in three sports – basketball, handball and volleyball, and it found that basketball has the highest ACL injury rate. However, not many studies show which sport has a higher ACL injury rate. Joseph et al. (2013) explained that, as the cost of a multi-sport study was expensive, it was difficult to compare the ACL injury among several sports. Most of the studies were focused on one specific sport; therefore, it was difficult to prioritize which sport had a higher ACL injury rate.

(2) ACL Injury in Hong Kong

In Hong Kong, there was insufficient study on ACL injury. After searching the keywords: “Anterior Cruciate Ligament injury”, “ACL injury number”, “ACL researches in Hong Kong”, “sport related ACL injury”, “ACL injury rate in Hong Kong”, “ACL researches” from Hong Kong Baptist University OneSearch search engine and Databases of SPORTDiscus on 1st – 20th September, 2015; there was no study could be found, it showed that the study on ACL injury in Hong Kong was not
enough.

Some Chinese newspapers and government website had provided some information about ACL injury in Hong Kong. A piece of news (Yung, 2009) showed that there were about 24,000 ACL injuries found in Prince of Wales Hospital every year. Knee injury is most commonly seen in sport injury. There are 1,000 ACL reconstruction surgeries performed in Hong Kong hospital.

Another news from Apple Daily (Yung, 2013) showed that there are 2,000 ACL reconstruction surgeries performed in Hong Kong hospital every year. ACL injury was most likely to occur in basketball, football, volleyball, handball and rugby. It showed that the ACL injury rate was significantly increased.

Although information showed that ACL injury rate was increasing, there was no study showed the injury rate in different type of sports. There was a need to conduct a study to investigate the relationship between ACL injury and different sports in Hong Kong in order to provide useful information for coaches and athletes about ACL injury as to design better preventive programme to reduce risk of ACL injury. It also helps to reduce the governmental medical expense.

(3) Gender Difference in ACL Injury

People may think that the ACL injury rate in males were higher than in females,
it might due to the speed of males’ games were faster than females’ games and body
contact between players in males’ games seem to be more serious than that in females’
games, so people might misunderstand that ACL injury was more common in males
than in females. In fact, ACL injury rate was higher in women than men (Lewis, 2000);
besides, according to Ireland (1991), female athletes had a significant increase in the
risk of noncontact ACL injury than male athletes in basketball at that year.

Current literatures also showed that female athletes had a greater injury rate in
ACL injury than in male athletes (Vauhnik et al., 2011; Xie, Urabe, Ochiai, Kobayashi,
& Maeda, 2013; Spindler & Wright, 2008). Although each literature has different rate
of ACL injury between males and females, all findings showed that there was
significantly higher ACL injury rate in female athletes than in male athletes.

Why do female have a higher risk in ACL tearing than males? Xie et al. (2013)
explained that:

the ratio of hamstring to quadriceps muscle activation (H/Qratio) was
significantly lower in female athletes even though the knee flexion angle was
increased compared to that in the early phase of landing. Anterior tibial
translation and ACL strain are increased among female athletes with a low
H/Q ratio (P.85).

Xie et al. (2013) showed that low H/Q ratio was one of the reasons that women
have a greater risk in non-contact ACL injury rate during jump landing. As it was mentioned before, non physical contact injury rate was higher than contact injury in ACL injury, it indicated that females had a greater ACL injury rate than males. In addition, Spindler and Wright (2008) found that:

The increased risk of an ACL tear in female athletes remains incompletely understood but has been attributed to several factors, including sex differences in leg alignment, with an increased rate of valgus deformity (knock-knee) among women; in notch width, with possibly less space for the ACL in women; in hormonal factors, including an increased risk during the preovulatory stage of the menstrual cycle; and in neuromuscular control (p.2135).

(4) Injury Setting in ACL Injury

Many researches showed that the ACL injury rate was greater during competition than in training (Ireland, 1999; Vauhnik et al., 2011). Joseph et al. (2013) also found that an ACL injury rate in competition was higher than in practice. In that study (Joseph et al.), the injury rate in competition was 17.6% and injury rate in practice was 2.4% per 100,000 athlete exposures. However, these studies did not show the reason of that, and it was worth to find out the reason in present study.
(5) Injury Pattern in ACL Injury

ACL injury can be divided into contact injury or non-contact injury. Ireland (1991); Bukoskey et al. (2010) suggested that non-contact ACL injury rate was higher than that in contact injury rate. There were 71-78% of ACL injury occurred in non-contact situation (Bukoskey et al., 2010). It rejected the thought among people that the more body contact, the higher risk of ACL injury. Spindler and Wright (2008) indicated that “The majority of ACL tears (67% in men and almost 90% in women) occurred without physical contact” (P.2135). It proved that noncontact injury was more common to occur in ACL injury. Yu and Garrett (2007) found that non-contact ACL injury rate in female athletes was higher than in male athletes. Xie et al. (2013) pointed out that most common noncontact ACL injury was happened during sidestepping, landing and stop phrase of a player, it was because these movements involve the sudden change of knee movement and it was easy to lose knee control.

(6) ACL Injury Associated Injuries

Although ACL tearing could be cured by the ACL reconstruction surgery, it was not 100% successful in the treatment. Spindler and Wright (2008) explained that ACL surgery was not the repairing of the ACL but a reconstruction by tendon to improve the knee instability problem (Spindler & Wright, 2008). Spindler and Wright (2008)
said that there were both advantages and disadvantages in ACL reconstruction surgery, though the surgery could help patient to regain the normal capabilities of the knee, but there was a probability on reconstruction surgery failure, which might due to infection, deep nervenous thrombosis, and nerve injury.

Besides, ACL injury would contribute to other injury such as mensiscal tearing. (Ichinohe et al., 2010). Ichinohe et al. also investigated that ACL reconstruction helped to prevent changes of mensical tearing and secondary osteoarthritis. On the other hand, Vaishya and Hasija (2013) suggested that people with ACL injury are more likely to suffer from joint hypermobility in their studies, they provided details information on disadvantages of ACL injury:

Chronic anterior cruciate ligament (ACL) insufficiency can cause damage to the articular cartilage and thus early degenerative arthritis, meniscal tears, and stretching of secondary stabilisers such as collateral ligaments (p.2137).

And in joint hypermobility, women also had greater risk of suffering than in men (Vaishya & Hasija, 2013).

(7) Summary

In fact, basketball, football, rugby and volleyball are the popular sports which have a higher potential risk in ACL injury. To prevent the ACL injury rate, there is a
need to investigate the relationship of ACL injury and types of sports. From the above literatures, most of the studies showed that females with higher ACL injury rate than males (Vauhnik et al., 2011; Xie et al., 2013; Spindler & Wright, 2008). Some studies found that ACL injury was more likely to happen in competition rather than in training (Ireland, 1999; Vauhnik et al.). Also, the studies from United States showed that noncontact injury rate was higher than contact injury (Bukoskey et al., 2010; Yu & Garrett, 2007). Since there was a lack of study about ACL injury in sport in Hong Kong, and the condition from United States maybe different from Hong Kong; therefore, there was needed to find out the relationship of ACL injury rate between gender, type of sports, injury setting and injury pattern in Hong Kong. Although ACL injury could be treated by surgery, it might also risk in leading different associated injuries. In fact, ACL injury could end an athlete’s future or even bring him to poor qualities of daily life; therefore, it is essential to prevent ACL injury in sports.

(8) Measuring Instrument

After searching the keywords: “anterior cruciate ligament questionnaires”, “anterior cruciate ligament”, “ACL injury rate in Hong Kong”, “ACL injury number”, “ACL researches”, from Hong Kong Baptist University OneSearch search engine and Databases of SPORTDiscus on 1st – 10th November, 2015. There was no suitable
questionnaire for the present study. All the ACL injury related questionnaires were asked about how the injury affects the participants. Li (2012) had conducted a study which was similar to the present study and he also could not find any relevant questionnaire for his study. Li (2012) had designed a questionnaire and piloted the questionnaire, and some of the questions from Li (2012) were useful in present study, they were: Part A Question 5 “Hours per week that you participate in sports” and Question 9 “How long do you spent for warm up exercise?’, and Part B Question 4 “The reason(s) you think is/are contributed to that incident”, Question 6 “Did you have an ACL reconstruction?” and Question 8 “Are you still playing that sport?”. On the other hand, there was an ACL injury related questionnaire from Bottoni (2001), “Method of injury” and “If a sport/activity was involved, what was it?”. Theses relevant questions from these two questionnaires (Li, 2012; Bottoni (2001) were adopted in my present study.

“Anterior Cruciate Ligament Injury Questionnaire” (ACLIQ) was used to collect data in the present study. ACLIQ consisted of part A and B. In part A, there were 6 questions: Q1 sex of participant; Q2 age of participant; Q3 height and weight of participant Q4 type of sports participant played; Q5 the amount of time participant spent in sports per week ; Q6 the amount of time participant spent in warm up exercise. Question 5 and 6 were from “Knee Injury Questionnaire” (Li, 2012). In part B, there
were 7 questions: Q1 ACL injury history of participant; Q2 Injury pattern of participant; Q3 the sport or activity involved during injury; Q4 injury setting of participant; Q5 cause of injury; Q6 History of ACL reconstruction surgery; Q7 if participant re-engage the training. Question 2 & 3 were from “Tripler Knee Evaluation Form” (Bottoni, 2001) and Question 5, 6 and 7 were from “Knee Injury Questionnaire” (Li, 2012)
CHAPTER 3

METHODS

This study was a cross-sectional study and was aim to examine the Anterior Cruciate Ligament (ACL) injury rate among university athletes in Hong Kong. The study would examine the relationship between ACL injury and gender; type of sports; injury setting (competition VS training); injury pattern (contact VS non-contact).

The method of this study was presented in the following sections: (1) Subjects and Sampling, (2) Measurements, (3) Data Collection Procedures, (4) Data Analysis, (5) Pilot the Test and (6) Timeline of the project

(1) Subjects and Sampling

7 types of sports team members including badminton team, basketball team, handball team, rugby team, soccer team, table tennis and volleyball team in Hong Kong Baptist University (HKBU) were targeted to be the participants in this study. According to the statistics published from Education Bureau (2012) in Hong Kong, there were 8 institutions funded by the public through the University Grants Committee in Hong Kong. HKBU was selected because this school was the most familiarized, it was more convenient to distribute the questionnaires and collect data. Also, with limited time in investigated the large number of participants, only one
university would be selected in this study. Athletes from badminton team, basketball team, handball team, rugby team, soccer team, table tennis and volleyball team who attended the university team training for 80% or above would be selected.

For the sample size, convenience cluster sampling method was used to recruit participants. It was estimated that there would be around 140 participants (suppose there were >20 athletes in HKBU sport team including male and female athletes * 7 sport teams = >140). Both male and female athletes would be selected to attend the study.

In case of drop out rate or small number of athletes in selected sport teams, all athletes who attended the university team training for 80% or above would be selected to ensure the number of participants is enough for the study.

After collected all the questionnaires, there were 183 participants (82 males and 101 females) in this study. In badminton team, there were 25 participants (11 males and 14 females); in basketball team, there were 34 participants (17 males and 17 females); in handball team, there were 24 participants (7 males and 17 females); in rugby team, there were 32 participants (16 males and 16 females); in soccer team, there were 24 participants (8 males and 16 females); in table tennis team, there were 17 participants (8 males and 9 females); and in volleyball team, there were 27 participants (15 males and 12 females). All participants had regularly participation in
university training (>80%).

(2) Measurements

“Anterior Cruciate Ligament Injury Questionnaire” (ACLIQ) was used in present study, the ACLIQ consisted of part A and B. In part A, there were 6 questions and it was about the demographic information of the participants:

1. Sex
2. Age
3. Height and weight
4. Which sports team do you belong to
5. Hours per week that you participate in sports
6. How long do you spend for warm up exercise

Question 5 and 6 were from “Knee Injury Questionnaire” (Li, 2012). Participants should answer all questions in this part. In part B, there were 7 questions and it was about ACL injury:

1. Have you ever suffered from Anterior Cruciate Ligament Injury?
2. Injury pattern
3. If a sport/activity was involved, what was it?
4. Injury setting
5. The reason(s) you think is/are contributed to that incident

6. Did you have an ACL reconstruction

7. Are you still playing that sport

In Question 1, have participant ever suffered from ACL Injury, if the answer of participant was “no”, then it would be the end of the questionnaire; if the answer was “yes”, participant should continue to answer the following questions like: injury pattern, the sport or activity which lead to ACL injury, injury setting, reasons that contributed to the injury, and see if the participant continue play sport after ACL reconstruction. Question 2 and 3 were from “Tripler Knee Evaluation Form” (Bottoni, 2001) and Question 5, 6 and 7 were from “Knee Injury Questionnaire” (Li, 2012). Lastly, there were some spaces for the participants to leave their contact (Appendix A).

(3) Data Collection Procedures

In early January 2016, questionnaires and informed consents were distributed to the targeted university sport team athletes. Before investigator collected the questionnaires, participants were asked to complete and return the informed consent to control the internal validity. Participants were required to finish the questionnaires on-site with present investigator, it was because if participants got any difficulties or problems, investigator could answer them immediately. Also, investigator could
ensure the quality and collect all the questionnaires. Detail of the content would be explained to the participants before they started to fill in the questionnaires. In the questionnaire, participants were required to fill in their present contact, and all information would be kept confidentially. The questionnaires, collected data and contacts would only be used in this study and all information would be destroyed after the end of the study. Participants had all rights to answer all the questions or not (Appendix B).

(4) Data Analysis

Statistical Package For Social Science 20 (SPSS 20) would be used to analyze the data collected. An alpha level of p<0.05 indicated statistical significance. In this study, the independent variables were gender, type of sport, injury setting (competition VS training) and injury pattern (contact VS non-contact); and the dependent variable was ACL injury. Frequencies, descriptives and chi square were mainly used to analyze the collected data.

Categorical variables such as gender, do participants had ACL injury before or not, injury pattern, injury setting, type of sport which participants had ACL injury before, were participants still playing sport and did the participants have an ACL reconstruction would be presented by percentage. Continuous variables such as age, height and weight would be presented by mean and standard deviation. To find out the
mean differences in the ACL injury rate between gender, type of sports, injury setting and injury pattern, chi-square would be used.

The online chi-square calculator by Stangroom (2016) would also be used to find out the mean differences between ACL injury and a single independent variable which could not be showed in SPSS 20, like injury setting versus males, injury setting versus females, etc.

(5) Pilot the Test

Before distributing the questionnaires to the selected participants, 10 males and 10 females of university sport team players who were not included in my future participants would be invited to complete the questionnaire in order to check the understanding of the questions.

If all selected players could understand and answer all the questions, questionnaires would be distributed and started to collect data. If selected players found any difficulties in filling the questionnaires, the questionnaires would be revised and redo the pilot of the questionnaire again.

After conducted pilot test, all questions were clear and understood, the questionnaire would be used in this study.
(6) Timeline of the project

The project would be conducted in the following timeline (Table 1):

Table 1

<table>
<thead>
<tr>
<th>Time</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid December</td>
<td>Design Inform consent and questionnaire</td>
</tr>
<tr>
<td>Late December</td>
<td>Contact university sports team</td>
</tr>
<tr>
<td>Early January</td>
<td>Prepare the inform consent and questionnaire</td>
</tr>
<tr>
<td>Mid January</td>
<td>Pilot test</td>
</tr>
<tr>
<td>Early February</td>
<td>Distribute and collect inform consent and questionnaire</td>
</tr>
</tbody>
</table>

Delimitations

The followings were the delimitations of this study:

1. Participants were delimited to male and female members from badminton team, basketball team, handball team, rugby team, soccer team, table tennis and volleyball team in Hong Kong Baptist University.

2. Participants were delimited to athletes who attended the university team training for 80% or above.

3. The period of data collection was delimited to February 2016.
Limitations

The following limitations were included in this study:

1. Study findings might be applicable only to the participants included in this study.

2. The sample size of this study was small (N=183) that might not enough to represent a large sport injury cases.

3. It was assumed that all participants were honest and reliable.

4. The questionnaire might not be detail enough as only consist of 2 Questionnaires (Li, 2012; Bottoni, 2001)

5. Study was limited to one university only (HKBU).
Chapter 4

RESULTS

The purpose of this study was to examine the Anterior Cruciate Ligament (ACL) injury rate in 7 sports (badminton, basketball, handball, rugby, soccer, table tennis and volleyball) among athletes in Hong Kong Baptist University (HKBU). Gender, injury setting (competition VS training) and injury pattern (contact VS non-contact) would also be focused.

Frequencies, descriptives and chi square were mainly use to analyze the collected data. The data was presented in the following aspect:

1. ACL injury rate in gender
2. ACL injury rate in 7 types of sports
3. Injury setting of participants
4. Injury pattern of participants
5. The amount of time participants spent in sports per week
6. The amount of time participants spent in warm up exercise
7. Cause of ACL injury
8. Reaction on ACL injury of participant
1. ACL injury rate in genders

In this study, there were 183 participants from 7 sports teams (badminton, basketball, handball, rugby, soccer, table tennis and volleyball) in HKBU. The data consists of 82 males (44.8%) and 101 females (55.2%), 25 participants (13.7%) from badminton team, 11 males (6%) and 14 females (7.7%) respectively; 34 participants (18.6%) from basketball team, 17 males (9.3%) and 17 females (9.3%) respectively; 24 participants (13.1%) from handball team, 7 males (3.8%) and 17 females (9.3%) respectively; 32 participants (17.4%) from rugby team, 16 males (8.7%) and 16 females (8.7%) respectively; 24 participants (13.1%) from soccer team, 8 males (4.4%) and 16 females (8.7%) respectively; 17 participants (9.3%) from table tennis team, 8 males (4.4%) and 9 females (4.9%) respectively; 27 participants (14.8%) from volleyball team, 15 males (8.2%) and 12 females (6.6%) respectively. (Table 3)

Among the 183 participants, the youngest age was 18 and the oldest age was 29 was (M=21.23, SD=2.10). For height, the shortest was 150cm and the tallest was 190cm (M=165.2cm, SD=8.67). For weight, the lightest was 44kg and the heaviest was 88kg (M=62.1kg, SD= 10.57). (Table 3)
Table 2

Distribution of sport teams and gender of the Participants (N=183)

<table>
<thead>
<tr>
<th>Sport</th>
<th>Gender</th>
<th>Number of players</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Badminton</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Basketball</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Handball</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>Rugby</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Soccer</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Table tennis</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Volleyball</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>82</td>
<td>101</td>
</tr>
</tbody>
</table>

Table 3

Demographic Information of the Participants (N=183)

<table>
<thead>
<tr>
<th></th>
<th>Min.</th>
<th>Max.</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>18</td>
<td>29</td>
<td>21.23</td>
<td>2.10</td>
</tr>
<tr>
<td>Height</td>
<td>150cm</td>
<td>190cm</td>
<td>165.2</td>
<td>8.67</td>
</tr>
<tr>
<td>Weight</td>
<td>44kg</td>
<td>88kg</td>
<td>62.1</td>
<td>10.57</td>
</tr>
</tbody>
</table>

Table 4 showed the relationship between different genders of the same sport with ACL injury. From the data, there was no significant difference (p>0.05) between
different genders of the basketball team (p=0.70), handball team (p=0.24), rugby team (p=1), soccer team (p=1), table tennis team (p=0.33) and volleyball team (0.26) with ACL injury. Also, there was no significant difference (p>0.05) between different genders and ACL injury (p=0.60). However, the overall ACL injury rate in female (8.2%) was higher than male (5.5%). Details please refer to Table 4.

Table 4

*Chi Square Test of relationship of different genders and the Rate of ACL Injury*

<table>
<thead>
<tr>
<th>Sport</th>
<th>Yes</th>
<th>No</th>
<th>Chi Square</th>
<th>P (a=0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Badminton</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>(0%)</td>
<td>(0%)</td>
<td>(6%)</td>
<td>(7.7%)</td>
</tr>
<tr>
<td>Basketball</td>
<td>5</td>
<td>4</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>(2.7%)</td>
<td>(2.2%)</td>
<td>(6.6%)</td>
<td>(7.1%)</td>
</tr>
<tr>
<td>Handball</td>
<td>0</td>
<td>3</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>(0%)</td>
<td>(1.6%)</td>
<td>(3.8%)</td>
<td>(7.7%)</td>
</tr>
<tr>
<td>Rugby</td>
<td>4</td>
<td>4</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>(2.2%)</td>
<td>(2.2%)</td>
<td>(6.6%)</td>
<td>(6.6%)</td>
</tr>
<tr>
<td>Soccer</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>(0.5%)</td>
<td>(1.1%)</td>
<td>(3.8%)</td>
<td>(7.7%)</td>
</tr>
<tr>
<td>Table tennis</td>
<td>0</td>
<td>1</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>(0%)</td>
<td>(0.5%)</td>
<td>(4.4%)</td>
<td>(4.4%)</td>
</tr>
<tr>
<td>Volleyball</td>
<td>0</td>
<td>1</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>(0%)</td>
<td>(0.5%)</td>
<td>(8.2%)</td>
<td>(6%)</td>
</tr>
<tr>
<td>Total (N=183)</td>
<td>10</td>
<td>15</td>
<td>72</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>(5.5%)</td>
<td>(8.2%)</td>
<td>(39.3%)</td>
<td>(47%)</td>
</tr>
</tbody>
</table>

*p<0.05 with significant
2. **ACL injury rate in 7 types of sports**

Among 183 participants, there were 25 participants (13.7%) suffered from ACL injury. There were 25 participants in badminton team and none of them had ACL injury. There were 34 participants in basketball team and 9 (26.5%) of them had ACL injury; 24 participants in handball team and 3 (12.5%) of them had ACL injury; 32 participants in rugby team and 8 (25%) of them had ACL injury; 24 participants in soccer team and 3 (12.5%) of them had ACL injury; 17 participants in table tennis team and only 1 (5.9%) of them had ACL injury; and 27 participants in volleyball team and only 1 (3.7%) of them had ACL injury. Basketball team had the highest ACL injury rate and the second highest was rugby team. (Table 5)

According to the data shown in table 5, handball team (p=0.86), soccer team (p=0.86), table tennis team (p=0.33) and volleyball team (p=0.10) have no significant difference (p>0.05) with ACL injury. Moreover, there were significant difference between badminton team (p=0.03), basketball team (p=0.02), rugby team (p=0.04) and ACL injury. Details please see Table 5.
### Table 5

*Chi Square Test of relationship of 7 sports and the Rate of ACL Injury (N=25)*

<table>
<thead>
<tr>
<th>Sport</th>
<th>ACL injury</th>
<th>Chi Square</th>
<th>P (a=0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Badminton</td>
<td>0 (0%)</td>
<td>25 (100.0%)</td>
<td>4.58 *0.03</td>
</tr>
<tr>
<td>Basketball</td>
<td>9 (26.5%)</td>
<td>25 (73.5%)</td>
<td>5.81 *0.02</td>
</tr>
<tr>
<td>Handball</td>
<td>3 (12.5%)</td>
<td>21 (87.5%)</td>
<td>0.03 0.86</td>
</tr>
<tr>
<td>Rugby</td>
<td>8 (25%)</td>
<td>24 (75%)</td>
<td>4.23 *0.04</td>
</tr>
<tr>
<td>Soccer</td>
<td>3 (12.5%)</td>
<td>21 (87.5%)</td>
<td>0.03 0.86</td>
</tr>
<tr>
<td>Table tennis</td>
<td>1 (5.9%)</td>
<td>16 (94.1%)</td>
<td>0.96 0.33</td>
</tr>
<tr>
<td>Volleyball</td>
<td>1 (3.7%)</td>
<td>26 (96.3%)</td>
<td>2.66 0.10</td>
</tr>
</tbody>
</table>

Total (N=183) 25 (13.7%) 158 (86.3%)

*Significance at 0.05 level

3. **Injury setting of participants**

In basketball team, there were 4 (16%) ACL injury cases happened in training and 5 (20%) in competition; in handball team, there were 1 (4%) ACL injury case happened in training and 2 (8%) in competition; in rugby team, there were 3 (12%) ACL injury cases happened in training and 5 (20%) in competition; in soccer team, there were 2 (8%) ACL injury cases happened in training and 1 (4%) in competition; in table tennis team, there were 1 (4%) ACL injury cases happened in competition; and in volleyball team, there were 1 (4%) ACL injury cases happened in training. The
overall ACL injury rate in competition (56%) was higher than training (44%).

There were no significant differences (P>0.05) between basketball (p=0.97), handball (p=0.69), rugby (p=0.65), soccer (p=0.40), table tennis (p=0.37), volleyball (p=0.25) and injury setting. Overall, there was no significant differences (P>0.05) between sports (p=0.71) and injury setting. Details please refer to Table 6.

According to Table 10, there was significant difference (p<0.05) between gender and injury setting (p=0.05). Males suffered from ACL injury in competition (32%) more than training (8%) and females suffered from ACL injury in training (36%) more than in competition (24%). However, the overall ACL injury rate happened in competition (56%) was higher than in training (44%). (Table 7)
Table 6

*Chi Square Test of relationship of 7 sports and ACL Injury Setting (N=25)*

<table>
<thead>
<tr>
<th>Sport</th>
<th>Injury setting</th>
<th></th>
<th></th>
<th></th>
<th>Chi</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Training</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Square (a=0.05)</td>
</tr>
<tr>
<td>Badminton</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>/</td>
</tr>
<tr>
<td></td>
<td>(0%)</td>
<td>(0%)</td>
<td>(0%)</td>
<td>(0%)</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Basketball</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(8%)</td>
<td>(8%)</td>
<td>(12%)</td>
<td>(8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handball</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td></td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>(0%)</td>
<td>(4%)</td>
<td>(0%)</td>
<td>(8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rugby</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td></td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>(0%)</td>
<td>(12%)</td>
<td>(16%)</td>
<td>(4%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soccer</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td></td>
<td>0.71</td>
</tr>
<tr>
<td></td>
<td>(0%)</td>
<td>(8%)</td>
<td>(4%)</td>
<td>(0%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Table tennis</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
<td>0.82</td>
</tr>
<tr>
<td></td>
<td>(0%)</td>
<td>(0%)</td>
<td>(0%)</td>
<td>(4%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volleyball</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
<td>1.33</td>
</tr>
<tr>
<td></td>
<td>(0%)</td>
<td>(4%)</td>
<td>(0%)</td>
<td>(0%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (N=25)</td>
<td>2</td>
<td>9</td>
<td>8</td>
<td>6</td>
<td></td>
<td>2.96</td>
</tr>
<tr>
<td></td>
<td>(8%)</td>
<td>(36%)</td>
<td>(32%)</td>
<td>(24%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significance at 0.05 level

Table 7

*Chi Square Test of relationship of different genders and ACL Injury Setting (N=25)*

<table>
<thead>
<tr>
<th>Gender</th>
<th>Injury setting</th>
<th></th>
<th></th>
<th>Chi</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Training</td>
<td>Male</td>
<td>Female</td>
<td>Square (a=0.05)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>2 (8%)</td>
<td>8 (32%)</td>
<td>3.896</td>
<td>*0.048</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>9 (36%)</td>
<td>6 (24%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11 (44%)</td>
<td>14 (56%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significance at 0.05 level
4. **Injury pattern of participants**

In basketball team, there were 4 participants (16%) suffered from contact ACL injury and 5 participants (20%) suffered from non-contact ACL injury. In handball team, there were 2 participants (8%) suffered from contact ACL injury and 1 participant (4%) suffered from non-contact ACL injury. In rugby team, there were 8 participants (32%) suffered from contact ACL injury. In soccer team, there were 2 participants (8%) suffered from contact ACL injury and 1 participant (4%) suffered from non-contact ACL injury. In table tennis and volleyball team, there were 1 participant (4%) suffered from non-contact ACL injury. The total rate of contact injury (64%) was higher than non-contact injury (36%).

In this study, there was significant difference (p<0.05) between rugby (p=0.01) and injury pattern. On the other hand, basketball (p=0.13), handball (p=0.92), soccer (p=0.92), table tennis and volleyball (p=0.17) have no significant difference (p>0.05) with injury pattern. Overall, there was no significant difference (p>0.05) between these 6 sports and injury pattern (p=0.88) except rugby team. Details please refer to Table 8.

There were 8 males (32%) suffered from contact ACL injury and 2 males (8%) suffered from non-contact ACL injury; and there were 8 females (32%) suffered from contact ACL injury and 7 females (28%) suffered from non-contact ACL injury. From
the data, there was no significant difference (p>0.05) between gender and injury pattern (p=0.174). However, non-contact ACL injury rate in female (28%) was higher than in male (8%). Details please refer to Table 9.

**Table 8**

*Chi Square Test of relationship of 7 sports and ACL Injury Pattern (N=25)*

<table>
<thead>
<tr>
<th>Sport</th>
<th>Injury pattern</th>
<th>Male</th>
<th>Female</th>
<th>Male</th>
<th>Female</th>
<th>Chi Square</th>
<th>P (a=0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Contact injury</td>
<td></td>
<td>Non-Contact injury</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Badminton</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0%)</td>
<td>(0%)</td>
<td>(0%)</td>
<td>(0%)</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Basketball</td>
<td></td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2.33</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(12%)</td>
<td>(4%)</td>
<td>(8%)</td>
<td>(12%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handball</td>
<td></td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0.01</td>
<td>0.92</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0%)</td>
<td>(8%)</td>
<td>(0%)</td>
<td>(4%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rugby</td>
<td></td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>6.62</td>
<td>*0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(16%)</td>
<td>(16%)</td>
<td>(0%)</td>
<td>(0%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soccer</td>
<td></td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0.01</td>
<td>0.92</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4%)</td>
<td>(4%)</td>
<td>(0%)</td>
<td>(4%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Table tennis</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1.85</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0%)</td>
<td>(0%)</td>
<td>(0%)</td>
<td>(4%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volleyball</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1.85</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0%)</td>
<td>(0%)</td>
<td>(0%)</td>
<td>(4%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (N=25)</td>
<td></td>
<td>8</td>
<td>8</td>
<td>2</td>
<td>7</td>
<td>9.57</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(32%)</td>
<td>(32%)</td>
<td>(8%)</td>
<td>(28%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>16</td>
<td>9</td>
<td>9</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(64%)</td>
<td>(36%)</td>
<td>(36%)</td>
<td>(4%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significance at 0.05 level*
Table 9

*Chi Square Test of relationship of different genders and ACL Injury Pattern (N=25)*

<table>
<thead>
<tr>
<th>Gender</th>
<th>Injury pattern</th>
<th>Chi Square</th>
<th>P (a=0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contact injury</td>
<td>Non-Contact injury</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>8 (32%)</td>
<td>2 (8%)</td>
<td>1.85</td>
</tr>
<tr>
<td>Female</td>
<td>8 (32%)</td>
<td>7 (28%)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>16 (64%)</td>
<td>9 (36%)</td>
<td></td>
</tr>
</tbody>
</table>

*Significance at 0.05 level

5. *The amount of time participants spent in sports per week*

Table 10

*The amount of time participants spent in sports per week (N=183)*

<table>
<thead>
<tr>
<th>Hours</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5 hours</td>
<td>29</td>
<td>15.8</td>
</tr>
<tr>
<td>6-10 hours</td>
<td>96</td>
<td>52.5</td>
</tr>
<tr>
<td>11-15 hours</td>
<td>40</td>
<td>21.9</td>
</tr>
<tr>
<td>16 hours or above</td>
<td>18</td>
<td>9.8</td>
</tr>
<tr>
<td>Total</td>
<td>183</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 10 showed that all participants had participated in sports regularly. 96 participants (52.5%) spent 6-10 hours in sports per week, 40 participants (21.9%) spent 11-15 hours, 29 participants (15.8%) spent 1-5 hours and 18 participants (9.8%) spent more than 15 hours per week. (Table 10)
6. **The amount of time participants spent in warm up exercise**

Table 11 showed the average amount of time for participants spent in the warm up exercise. Most of the participants had warm up exercise before participating in sport; 84 participants (45.9%) spent 11-20 minutes, 53 participants (29%) spent less than 11 minutes, 39 participants (21.3%) spent 21-30 minutes and 4 participants (2.2%) spent more than 30 minutes. Only 3 participants (1.6%) did not have warm up exercise before exercise. (Table 11)

### Table 11

*The amount of time participants spent in warm up exercise (N=183)*

<table>
<thead>
<tr>
<th>Minutes</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10 minutes</td>
<td>53</td>
<td>29</td>
</tr>
<tr>
<td>11-20 minutes</td>
<td>84</td>
<td>45.9</td>
</tr>
<tr>
<td>21-30 minutes</td>
<td>39</td>
<td>21.3</td>
</tr>
<tr>
<td>31 minutes or more</td>
<td>4</td>
<td>2.2</td>
</tr>
<tr>
<td>None</td>
<td>3</td>
<td>1.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>183</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
7. *Cause of ACL injury*

According to Figure 1, most of the participants (48%) presume the reason of ACL injury was body contact, 24% participants thought that it was due to their poor fitness, 12% thought it was caused by over-training and 8% thought the reason was inadequate warm up exercise. There were also 8% participants thought that was caused by emotion and lack of knowledge of safety and protection.

**Figure 1**

_The presumption on the reason of ACL injury by participants_
8. Reaction on ACL injury of participants

Table 12

Numbers of participants require an ACL reconstruction surgery (N=25)

<table>
<thead>
<tr>
<th>ACL reconstruction</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>13</td>
<td>52%</td>
</tr>
<tr>
<td>NO</td>
<td>12</td>
<td>48%</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>100%</td>
</tr>
</tbody>
</table>

In this study, there were 25 participants had ACL injury, not all of them require a surgery; only 13 participants (52%) needed to have an ACL reconstruction.

Table 13

Sport life of the participants after injury (N=25)

<table>
<thead>
<tr>
<th>Still play that sport</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>24</td>
<td>96%</td>
</tr>
<tr>
<td>NO</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>100%</td>
</tr>
</tbody>
</table>

After ACL injury, most of the participants continue their sports, only 1 participant quit from that sport.
Chapter 5

DISCUSSION AND CONCLUSION

This chapter would discuss about Anterior Cruciate Ligament (ACL) injury on gender, 7 types of sports (badminton, basketball, handball, soccer, rugby, table tennis and volleyball), injury pattern and injury setting among Hong Kong Baptist University (HKBU) athletes.

Summary of the Result

1. Among 183 participants, there were 82 males and 101 females; 11 males and 14 females from badminton team; 17 males and 17 females from basketball team; 7 males and 17 females from handball team; 16 males and 16 females from rugby team;, 8 males and 16 females from soccer team, 8 males and 9 females from table tennis team; and 15 males and 12 females from volleyball team. All participants have regularly participated in university training (>80%).

2. 96 participants spent 6-10 hours in sports per week, 40 participants spent 11-15 hours, 29 participants spent 1-5 hours and 18 participants spent more than 15 hours per week.

3. 180 participants did warm up exercise before training or competition. Only 3 participants did not have warm up exercise before exercise.

4. Among 183 participants, there were 25 participants suffered from ACL injury.
There was no injury happened in badminton team. Basketball team had the highest ACL injury rate and the second was rugby team.

5. Handball (p=0.86), soccer (p=0.86), table tennis (p=0.33) and volleyball (p=0.10) have no significant difference with ACL injury. However, there was significant difference between badminton (p=0.03), basketball (p=0.02), rugby (p=0.04) and ACL injury.

6. There was no significant difference between ACL injury and different gender (p=0.60). However, the overall ACL injury rate in female was higher than in male.

7. The overall ACL injury rate in competition was higher than in training. There was no significant differences between sports and injury setting (p=0.71). Also, there was significant difference between gender and injury setting (p=0.05). Males suffered from ACL injury in competition more than in training and females suffered from ACL injury in training more than in competition. However, the overall ACL injury rate happened in competition was higher than in training.

8. The total rate of contact injury was higher than in non-contact injury. There was significant difference between rugby (p=0.01) and injury pattern. However, basketball (p=0.13), handball (p=0.92), soccer (p=0.92), table tennis and volleyball (p=0.17) had no significant difference with injury pattern. Although, there was no significant difference between gender and injury pattern (p=0.17),
non-contact ACL injury rate in female was higher than in male.

9. There were 25 participants had ACL injury and only 13 participants needed an ACL reconstruction surgery. After ACL injury, only 1 participant leave that sport.

Discussion

The findings would be divided into several parts: (1) ACL injury rate in gender, (2) ACL injury rate in 7 types of sports, (3) Injury setting of participants, (4) Injury pattern of participants, (5) The amount of time participants spent in sports per week, (6) The amount of time participants spent in warm up exercise, (7) Cause of ACL injury and (8) Reaction of ACL injury

(1) ACL injury rate in gender

Both studies from old time (Traina & Bromerg, 1997) or recent years (Bukoskey et al., 2010) suggested that there was relationship between ACL injury and gender. Although the ACL injury rate between males and females were differed from different studies, it was consistent that females had higher injury risk than males. In this study, although the result showed that the injury rate of females (8.2%) is higher than males (5.5%), there was no significant difference between 7 types of sports and gender (p=0.60). It might due to the methods and procedure of data collection and the
ways the data being compared were different, small sample size may also affect the result (Renstrom et al., 2008).

Renstrom et al. (2008) indicated that the injury risk in women was higher than in males no matter in which age groups. Despite the risk decreased when the female athletes became mature and the level of play was increased, they still had a bit higher risk in ACL injury compared to male athletes. The reason was the anatomical, biomechanical and hormonal differences in males and females supported by Bien (2011). For example, when compared to males, the ratio of quadriceps to hamstrings strength is higher in female. Females perform landing sequence with their knee joint extend while male tend to be flexed (McDaniel, Rasche, Gaudet, & Jackson, 2010). It makes women more potential to have ACL injury.

(2) ACL injury rate in 7 types of sports

From the data shown in Chapter 4, there was significant difference between badminton (p=0.03), basketball (p=0.02), rugby (p=0.04) and ACL injury. It seemed to have higher ACL injury risk in these three sports out of 7 sports. Rosa et al. (2014) had done a study about ACL injury and they found that handball and volleyball got the highest ACL injury rate among 13 sports; however, the finding was different with the present study. The participants from handball team and volleyball team had the
low ACL injury rate. It might due to the physical difference between foreigners and Asians, or the participants had done well safety protection during exercise.

Vauhnik, et al. (2011) found that basketball has the highest injury risk compared to volleyball and handball. It matched with the finding of the present study. As basketball is an antagonistic sport, players always have body contacts with each other. Also, this sport requires high risk movement, such as sudden change of motion, jumping, landing, and cutting; it increases the risk of ACL injury.

For rugby, a study from Peck, Johnston, Owens, and Cameron (2013), rugby had the high sport injury risk; however, ACL injury rate in rugby was relatively low in present study. It was difficult to find a study of rugby which was focused on ACL injury, as ACL injury was not a big problem to the athletes. However, rugby team got the second highest ACL injury rate in this study. It might due to the difference of fitness level between the foreigners and Asian. As the participants were not strong enough, the related muscle groups could not protect the ACL. While players had body contact with each other, it was potential to ACL contact injury.

As it was mentioned before, there was no study provided comprehensive comparison among multi-sports as it was difficult to implement and the costs was expensive. Therefore, it was not surprised that each study has different results. In fact, those sports had highest injury rate was having similar characteristic, they required
sudden change of motion, sudden stop, landing and side stepping. These performances were potential risk for ACL injury (Xie et al., 2013).

(3) Injury setting of participants

Many studies (Renstrom et al., 2008; Spindler & Wright, 2008; Ireland, 1999) agreed that ACL injury risk was higher in competition than in training. In this study, the data showed that there was no significant difference between 7 sports and ACL injury setting; however, overall injury rate in competition was higher than in training. It matched with the findings of above studies (Renstrom et al.; Spindler & Wright, 2008; Ireland, 1999). Renstrom et al. pointed that ACL injury risk in all sports in their study was higher in competition than in training. The reasons could be explained by the level of competition and the way which the athletes competed. From the data in this study, most of the sports had higher ACL injury rate during competition than training, excluding soccer and volleyball. It may due to the small sample size, only few participants in those sports have suffered from ACL injury in this study were difficult to show the significant different (Button et al., 2013). More participants should be recruited to find out the result.
(4) Injury pattern of participants

In this study, it was found that rugby had significant difference with ACL injury pattern (p=0.01) while other 6 sports and gender have no relationship with ACL injury. McDaniel et al. (2010) suggested that 70% of ACL injury cases were non-contact injury. The anatomical, biomechanical and hormonal differences of males and females cause the increase of non-contact ACL injury in females (Renstrom et al, 2008).

From the data, rugby seemed to have more contact injury than non-contact injury (P=0.01); however, the non-contact injury rate in this study was lower than the contact injury. It might due to small sample size, and it could not represent the large population on ACL injury in Hong Kong, it only reflected that contact injury was more common in HKBU sports teams (Button et al., 2013). Besides, there was another study found that the contact injury was the highest injury pattern in ACL injury and its injury rate (42.8%) was higher than non-contact injury rate (37.9%) (Joseph et al., 2013).

(5) The amount of time participants spent in sports per week

As the participants were the members of university sports team, they needed to have high intensity training to prepare for the competitions. Also, most of them were also represented other local or Hong Kong team, they might have tight training and competition schedule. There were 31.7% participants spent more than 10 hours in
training per week. Over training or competition could be one of the risk factors that contribute to ACL injury. According to Myklebust, Skjølberg, and Bahr’s (2013) study, although their intervention program helped to reduce ACL injury risk and strengthen the related muscle groups, the increased training loads and intensity of the game may contribute to the increase of injury risk (Myklebust et al., 2013). ACL injury is more common to appear during season rather than postgame (James, Kelly, & Beckman, 2014); therefore, it must ensure that there is adequate rest and recovery time for athletes.

(6) The amount of time participants spent in warm up exercise

From Table 11, most of the participants would have warm up exercise before training or competition. Only 1.6% of the participants did not do any warm up exercise before exercise. Myklebust et al. (2013) suggested that 20 minutes structured warm up exercise could provide improvement in running, cutting and landing. Also, the risk of lower extremity injuries decreases as well as the severe knee ligament injuries. Balance mats, wobble boards were used to design some strength, neuromuscular control and balance related programmes like jumping and landing exercise for the athletes. It was suggested to have at least once exercise during both the preseason and season (Myklebust et al., 2013).

There were many types of ACL intervention programmes, through these
programmes, the modifiable ACL injury risk could be reduced. Bien (2011) suggested that put the intervention programme in warm up exercise as to reduce excessive training time and avoid fatigue. Hip, hamstring, neuromuscular training, balance, agility and core stabilization were focused in the program. Evidence showed it could help to reduce the risk of noncontact ACL injury, especially in female athletes (Bien, 2011).

Therefore, a well organized, structured warm up exercise before exercise was essential to prevent the ACL injury.

(7) Cause of ACL injury

In this study, body contact was the most common cause of ACL injury (48%). It was not surprised to have this result because the contact ACL injury rate (64%) was higher than non-contact ACL injury (36%) in this present study. The second most common cause was poor fitness (24%). ACL injury is like to happen during sudden change of motion, landing and jumping (Xie et al., 2013). If muscles of quadriceps and hamstring were weak, it would increase the ACL injury risk (James et al., 2014). On the other hand, poor fitness would lead to athlete fatigue rapidly. Fatigue is a potential risk to non-contact ACL injury (James et al., 2014). Therefore, athletes needed to train and strengthen the muscles of quadriceps and hamstring. The third
common cause of injury was over-competition (12%). Over-training also leads to fatigue. As it was mention that fatigue contributed to ACL injury (James et al., 2014), it should be ensured that athletes could have enough rest and recovery time.

(8) Reaction of ACL injury

There was 25 out of 183 participants have suffered from ACL injury. As it was mentioned in Chapter 2, not all ACL injury cases required for a reconstruction surgery. In this study, 13 (52%) out of 25 sufferers needed an ACL reconstruction. Although ACL injury could be fixed by a surgery, once the ACL is tore, it is impossible to reattach the ligament. Also, the outcome of reconstruction surgery was poor in females than in males (McDaniel et al., 2010). ACL injury costs huge amount of money for treatment, time for recovery and affect performance, so it was a need to have study to investigate the effective way of ACL injury prevention.

As ACL injury affects athletes' performance, some of them may need to give up certain competitions or even to quit their sport. In this study, 96% of participants continued their sport life, only 1 sufferer no longer continued that sport.

Most of the people might think that ACL injury was not a big deal, if they devoted more effort, keep working hard in the treatment and training after the surgery,
the performance and fitness level could be recovered. However, there were many side-effects. Fok and Yau (2015) claimed that people with ACL tearing are potential to have meniscal tear and chondral lesions, it is because the tissues and muscles around the ACL become weak after injury.

Conclusion

Although the result showed in this study were a bit different from other studies (Renstrom et al., 2008; Spindler & Wright, 2008; Ireland, 1999; McDaniel et al., 2010), data showed that most of the athletes from HKBU had healthy ACL, only basketball and rugby team have higher injury risk; however, all athletes should be careful and keep themselves away from injury, as ACL injury is common and it affects athletes’ performance level and sport life, protection and prevention are needed to reduce the injury risk.
Recommendation for further studies

1. With the limited number of participants, the results could not show the significant differences between sports and Aterior Cruciate Ligament (ACL) injury. More participants should be recruited such as include the other universities in Hong Kong so that the result can be more reliable.

2. The questionnaires could be more specific and in-depth, so as to provide more detailed information.

3. More schools should be included as one school could not represent the all athletes in Hong Kong.

4. This study only focus on athletes in university, another study should be conducted for athlete at different level, such as in Secondary or Primary schools.
REFERENCES


Li K.H. (2012). A Comparison of knee injuries among University basketball and soccer players in Hong Kong. Hong Kong Baptist University, 2-89.


APPENDIX A

Anterior Cruciate Ligament Injury Questionnaire (ACLIQ)

Contact
Name: __________________  Phone: __________________

Part A
1. Sex:  □ M  □ F

2. Age: _______

3. Height: _______cm ; Weight: ________kg

4. Member of
□ Badminton  □ Basketball  □ Handball  □ Rugby
□ Soccer  □ Table tennis  □ Volleyball

5. Hours per week that you participate in sports
□ 1-5 Hours  □ 6-10 Hours  □ 11-15 Hours  □ 16 Hours or above

6. How long do you spend for warm up exercise?
□ <10minutes  □ 11-20minutes  □ 21-30minutes  □ >31 minutes
□ None
Part B

1. Have you ever suffered Anterior Cruciate Ligament Injury?
   □ Yes (Answer B2) □ No (Finished)

2. Injury pattern
   □ Contact injury □ Non-Contact injury

3. If a sport/activity was involved, what was it?
   E.g. Volleyball – landing, Basketball – sudden change of direction

4. Injury setting
   □ Training □ Competition

5. The reason(s) you think is/are contributed to that incident
   □ Inadequate warm-up exercise □ Poor fitness □ Over-training
   □ Body Contact □ Facility problem □ Inappropriate equipment
   □ Other (explain) ________________________________

6. Did you have an ACL reconstruction?
   □ Yes □ No

7. Are you still playing that sport?
   □ Yes □ No

-END-
APPENDIX B
《研究知情同意書》

親愛的先生/女士：

我是香港浸會大學社會科學學院運動及康樂領導學系的四年級學生，現正進行前十字韌帶受傷的研究。特此邀請閣下參加是項研究。本研究旨在通過了解本地大專運動員前十字韌帶受傷的情況，為制定減低運動相關的前十字韌帶受傷的相應政策提供科學依據。問卷內容包括：閣下過去前十字韌帶受傷的記錄，以及一般個人資料等。

本研究所收集的所有資料絕對保密，並只用作研究之用。本研究完全遵照自願參加的原則，閣下有權決定是否參加本研究，並隨時可以退出。一經要求，我們會向閣下提供本研究的主要結果，以供參考。

閣下的幫助和支持是本次研究得以順利進行和達到預期目標的根本和前提，希望閣下同意參加本次研究，並請閣下填妥以下問卷（填寫本問卷大概需要 5-10 分鐘），填妥之後請連同《研究知情同意書》一起交回。

多謝合作，非常感謝！

如有疑問，可查詢：

香港浸會大學運動及康樂領導學系學生文淼柵，電話：95836863，電郵：miu720@gmail.com

《研究知情同意書》

請在下方□打勾：

□ 我已經仔細閱讀過上面的說明，明白本次研究的目的和內容，並同意參加本次研究。

□ 我已經仔細閱讀過上面的說明，明白本次研究的目的和內容，但不同意參加本次研究。

姓名：_______________ 聯絡電話：_______________

簽名：_______________ 日 期：_______________