A 4-WEEK INTERNAL TRAINING LOAD MONITORING AND FATIGUE RESPONSES OF MALAYSIAN UNDER-18 RUGBY PLAYERS DURING COMPETITIVE SEASON

By

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EMPAT MINGGU PEMANTAUAN BEBANAN DALAMAN LATIHAN DAN TINDAK BALAS KEPENATAN PEMAIN RAGBI MALAYSIA BAWAH 18 TAHUN SEMASA MUSIM PERLAWANAN

Abstrak

Pengenalan: Pemantauan bebanan dalaman latihan dengan menggunakan RPE telah digunakan secara meluas untuk melihat kepenatan dan meningkatkan prestasi sukan dalam kalangan atlet namun tiada kajian terhadap atlet Malaysia. Pemantauan yang tepat terhadap bebanan dalaman latihan boleh membantu jurulatih untuk penambahbaikan latihan, mod, intensiti dan durasi semasa perlawanan.

Objektif: Kajian ini dilakukan untuk memantau dan mengukur bebanan dalaman (bebanan latihan, monotoni dan ketegangan) dan kepenatan bagi mengenalpasti hubungan antara bebanan dalaman terhadap tindak balas kepenatan pemain ragbi Malaysia bawah 18 tahun semasa musim perlawanan.

Kaedah: Tiga puluh lapan peserta dalam kajian, berumur 16-18 tahun, telah dipilih dalam kalangan pelajar dari Kolej Voksional Pengkalan Chepa (N=38). Hasil kajian ini diperolehi selama 4 minggu semasa musim perlawanan. Selepas 90 minit setiap sesi, peserta diminta untuk mencatat kadar sesi latihan menggunakan skala RPE. Kemudian, *Multidimensional Fatigue Symptom Inventory (MFSI)* diberikan kepada peserta sekali seminggu. Peserta dilatih selama 5 hari setiap minggu berpandukan program latihan daripada jurulatih, maka jumlah hari pengumpulan data adalah 20 hari. Jenis-jenis latihan

termasuklah kardiovaskular, kekuatan, power dan taktikal. Data direkod dalam *Microsoft Excel 2013.* Analisis statistik dilakukan menggunakan IBM SPSS versi 24.0. Semua data diterjemah sebagai min ± sisihan piawai dalam statistic deskriptif. Analisis statistik yang digunakan dalam kajian adalah ukuran berulang ANOVA. Statistik signifikan telah ditetapkan pada $p < 0.05$. Korelasi pearson telah digunakan untuk menganalisa hubungan antara bebanan dalaman latihan dan MFSI.

Keputusan: Keputusan menunjukkan bebanan latihan pada minggu 4 (2594.00 ± 2.30) lebih tinggi secara signifikan berbanding minggu 1 (2388.55 ± 343.87), minggu 2 (2284.34 ± 411.41) dan minggu 3 (2218.42 ± 521.63). Monotoni meningkat lebih tinggi pada minggu ke 4 (1.70 ± 3.13) berbanding minggu ke 3 (1.43 ± 0.44). Ketegangan meningkat pada minggu kedua lebih tinggi (3728.44 ± 1228.51) berbanding minggu 1 (3605.57 ± 653.51). Pada minggu ke-3, min ketegangan menurun (3354.59 ± 1810.58) dan meningkat pada minggu ke-4 (4145.66 ± 306.38). Dalam kolerasi antara bebanan laihan, monotoni, ketegangan dan kepenatan (TSF), keputusan menunjukkan bebanan latihan meningkat dengan kolerasi sederhana (r=0.342; r=0.402; r=0.469). Monotoni (r=354; r=0.371; r=0.421) dan ketegangan (r=0.343; r=0.383; r=0.446) juga menunjukkan kolerasi sederhana dengan TSF.

Kesimpulan: Hasil yang diperoleh dalam kajian ini akan membantu jurulatih untuk membangunkan program latihan yang cekap bagi memaksimumkan prestasi atlet mereka, mengurangkan kepenatan dan seterusnya mengelakkan kecederaan.

A 4-WEEK INTERNAL TRAINING LOAD MONITORING AND FATIGUE RESPONSES OF MALAYSIAN UNDER-18 RUGBY PLAYERS DURING COMPETITIVE SEASON

Abstract

Introduction: Monitoring internal training loads using session ratings of perceived exertion (RPE) has been used extensively to manage fatigue and to optimise sports performance in athletes but none was reported in Malaysian athletes. Accurate monitoring of internal training loads could assist coaches in the adjustment of training, mode, intensity and duration during the competitive season.

Objective: This study was to quantify the internal training loads (training load, monotony and strain) and fatigue and to identify the correlation of internal loads on fatigue responses of Malaysian under-18 rugby players for 4-weeks during competitive season.

Methods: Thirty eight male participants of the study, aged from 16-18 years old, were recruited among the students from the Kolej Vokasional Pengkalan Chepa (N=38). The research variables of this study were collected in four weeks prior to their competition. After 90 minutes of every training session, they were asked to rate their training session using the RPE scale. Then, the Multidimensional Fatigue Symptom Inventory (MFSI)-Short form were administered once per week at the end of their training session for 4 weeks. The participants were trained five days per week as per coach's training

programme, hence the total number of days of data collection were 20 days. The types of training consisted of cardiovascular, strength, power and tactical. All data was entered into Microsoft Excel 2013. Statistical analyses was performed using IBM SPSS version 24.0. All data are presented as mean ± standard deviation (SD) in descriptive statistics. The statistical analysis used in this study was repeated measure ANOVA. The statistical significance was set at $p < 0.05$. Pearson correlation was used to analyse the relationship between internal training load variables and MFSI.

Result: Results showed that the training load in week 4 (2594.00 ± 2.30) was significantly higher compared to week 1 (2388.55 ± 343.87), week 2 (2284.34 ± 411.41) and week 3 (2218.42 ± 521.63). Monotony in week 4 was higher (1.70 ± 3.13) compared to week 3 (1.43 ± 0.44). The mean of monotony in week 2 was higher (1.60 ± 0.35) than week 1 (1.49 ± 0.09). Strain increased in week 2 was higher (3728.44 ± 1228.51) compared to week 1 (3605.57 ± 653.51). In week 3, the mean strain decreased (3354.59 ± 1810.58) and increased in week 4 (4145.66 ± 306.38). In training load, monotony, strain and the total score of fatigue (TSF) correlation, the result showed that training load increased with moderate correlations to TSF (r=0.342; r=0.402; r=0.469). In monotony (r=354; r=0.371; r=0.421) and strain (r=0.343; r=0.383; r=0.446), there were also moderate correlation to TSF.

Conclusion: The results obtained in this study will help the coaches and trainers to develop an effective training programme in order to maximise their athlete's performance, reduce fatigue and subsequently prevent injuries.

CHAPTER 1

1.1 Introduction

The Malaysian Rugby Union (MRU) or known as the *Kesatuan Ragbi Malaysia* in the Malay language is the representative of Malaysian rugby sport established in 1921 (Malaysia Rugby Union, 2017). Although rugby is one of the oldest competition in the world, it received fewer viewership and participation than football in Malaysia (Liew, 2015). The Malaysian rugby team has been facing some setbacks as its funding has not been very generous compared to football, badminton or even cycling (Fauzi, 2017). However, in recent years, additional funding was sought by MRU president for improving training of the team (Fauzi, 2017; Liew, 2015).

Rugby is a contact team sport that delivers significant social and health benefits similar to others sport activities (Ross *et al.*, 2014). The physiological demands of rugby include the upper and lower strength, explosive power, endurance, speed and agility (Gabbett, 2001). Rugby player should not only be physically well prepared but also has the positive mental and emotional wellbeing to play safely (Mellalieu *et al.*, 2008). Hence, the coaches have to ensure that all players will be able to reach their fullest potential, through training methods and or using equipment to enhance performance.

Nations from New Zealand, Fiji, Wales, Samoa, and Tonga, have adopted rugby as their primary game (Cunnigham *et al.*, 2013). Among these nations, New Zealand has been known to be superior in skill and fitness, thus remained the best team in the world to beat (Fuller *et al.*, 2013). Their team named as the "All Blacks" have been consistently performing very well in every game they participated. The

New Zealand "All Blacks" is also famously known to perform the "Haka", a traditional war cry and dance by the Maori people to challenge the enemy, before every match. The "Haka" involves aggressive stamping of feet, slapping of hands on the body and several facial contortions using the tongue and eyes to poetically express the description of Maori ancestors and events from the history of the Maori tribe (Cunnigham *et al.*, 2013).

The game of rugby involves running with an oval ball in hand and to get the most score to win the game. The players have to touchdown at the try line or kick the ball over the goal post to score points. The duration of a rugby match is 40 minutes for each half with the total of 80 minutes to complete the game. There are two teams that go against each other in one field and each team consists of 15 players or known in short as 15s. The position of the player is divided into two main groups which are the forward and backlines. Uniquely, each position requires different physical and skill attributes. The forwards are usually the strongest, heaviest and tallest so as to be competitive inside rucks, mauls and line outs and for the backlines they require speed, acceleration and agility in open play as the part to beat the opposition, including skill and technique of playing (Duthie *et al.*, 2003).

In 1995, International Rugby Board (IRB) has made it official that rugby sport would become a professional game. As a result, the top-ranked players from Rugby Union have become full time professional athletes with high income. Therefore, training has been intensified and also impact between players has increased dramatically due to elevated power, size and speed of the athletes (Gabbett & Jenkins, 2011).

According to Bleakley *et al.*, (2011), in year 2014, there are approximately 3.5 million people including adults and teenagers who play rugby world-wide, with

117 Unions in the participation of the International Rugby Board (IRB), currently known as World Rugby. Bleakley *et al.,* (2011) stated the figure from World Rugby which shows that rugby is becoming progressively popular among youngsters, in which 22% to 39% of them are registered players in the main five rugby-playing nations.

Based on published studies on adolescent rugby injuries, the most common sites of injuries are mainly head and neck, upper limb, and lower limb (Bleakley *et al.*, 2011; Leung, *et al.*, 2015; Pringle *et al.*, 1998). The most common injury types are fracture, joint dislocation and ligaments sprains and body parts most at the peril of these injuries were the shoulder and knee (Bleakley *et al.*, 2011). Furthermore, thigh and calf strains are the most common injuries sustained during rugby league training, while overexertion is the most common cause of training injuries (Gabbett, 2004). Based on a report by Gabbett (2004), fatigue may influence the incidence of injury, with most amateur and semi-professional rugby league injuries occurring in the latter stages of training sessions. The report also mentioned that most training injuries occur in the early stages of the season prior to competition, suggesting that changes in training intensity may influence the incidence of injury in rugby.

Monitoring internal training loads using session rating of perceived exertion (session-RPE) have been used to manage athletes' training intensity and to prevent stress-related injury due to increased physical demands (Foster, 1998). According to the performance system model by Banister *et al.*, (1975), positive function is termed as fitness whereas negative function is termed as fatigue. They suggested that athlete's performance due to training is calculated from the difference between a positive and negative function. Ideally, a balance in the training load to increase

performance while reducing negative effect of training such as injury, fatigue and over-training should be accomplished.

1.2 Problem Statement and Study Rationale

To date, most of the research studies were only limited to injury incidences that occurred during heavy sports training in Malaysia, hence, there are no clear data available on the intensity of the training comparison of training loads, monotony, strain of the training method and fatigue responses. Particularly for rugby sports, being a non-core sports in Malaysia, there were very few reports on monitoring training intensities in the Malaysian Rugby under-18 players during the competitive season. The results obtained in this study will help the coaches and trainers to develop an effective training programme in order to maximise their athlete's performance, reduce fatigue and prevent injuries.

1.3 Research Question(s)

The result of the present study will add new scientific information on training load monitoring and fatigue responses of Malaysian under-18 rugby players in the field of sports science. This study was conducted to monitor the internal training load (training loads, monotony, strain) and fatigue responses on rugby players of Kolej Vokasional Pengkalan Chepa, Kelantan. This study evaluated the relationship of the internal load on fatigue as well as to identify the

relationships between internal training loads and fatigue. Hence, this study attempted to answer the following questions:

1. What are the training load, monotony, strain and fatigue responses of Malaysian under-18 rugby players during competitive season?
2. What are the relationships of internal load (training load, monotony and strain) on fatigue responses of Malaysian under-18 rugby players during competitive season?

1.4 Objectives

General Objective:

To monitor and quantify the internal loads (training load, monotony and strain) and fatigue and to identify the correlation of internal loads on fatigue responses of Malaysian under-18 rugby players.

Specific Objectives:

1. To determine the occurrence of variation of training intensity by quantifying the training load, monotony and strain of Malaysian under-18 rugby players for 4 weeks during competitive season.
2. To quantify the fatigue responses of Malaysian under-18 rugby players for 4 weeks during competitive season.
3. To identify the correlation of training loads, monotony and strain on the fatigue responses of Malaysian under-18 rugby players during competitive season.

1. 5 Hypotheses of the study

Null Hypothesis 1 (H_{o1}): There is no significant difference in weekly internal loads and fatigue responses of Malaysian under-18 rugby players during competitive season.

Alternative Hypothesis 1 (H_{A1}): There is a significant difference in weekly internal loads and fatigue responses of Malaysian under-18 rugby players of training prior to competition.

Null Hypothesis 2 (H_{o2}): There is no significant correlation between internal loads and fatigue responses of Malaysian under-18 rugby players during competitive season.

Alternative Hypothesis (H_{A2}): There is a significant correlation between internal loads and fatigue responses of Malaysian under-18 rugby players during competitive season.

1.6 Operational Definitions

Internal training load: Measurement of training load, monotony and strain among the Malaysian under-18 rugby players.

Fatigue response: Inability to maintain a specific level of normal physical activity or lack of endurance.

Training load: A measure of the total volume of training for the last 7 days. It is textual feedback on the strenuousness of a single training session. Training loads were calculated by multiplying the training session intensity by the duration of the training session

Monotony training: Measurement of the similarity of daily training.

Strain training: Type of physical exercise specializing in the use of resistance to induce muscular contraction which builds the strength, anaerobic endurance and size of skeletal muscles.

Multidimensional Fatigue Index – Short Form: 30-items short form of the MFSI that yield scores only for the empirically derived subscales. It has acceptable psychometric properties and may be used as a substitute for the MFSI when time constraints and scale length are of concern.

CHAPTER 2

2.0 Literature Review

2.1 Rate of Perceived Exertion in Sport

The use of the rate of perceived exertion or known as RPE scale is growing in popularity in team sports because the data collection is relatively simple to assess the internal load placed on an athlete during a training session (Foster, 1998). The RPE scale is a common tool used to assess training intensity in individual or team (Casamichana *et al.*, 2013; Kelly & Coutts, 2007). Basically, RPE values provide a reference point for an individual's internal load which can be compared with others during a similar session. A team's sport scientist and coaches use this data to plan sessions with specific intensities and manipulate the variables of training loads. When working on a budget in a team setting, there are benefits and challenges when using RPE scales (Troy, 2018).

In previous studies, Matthews *et al.,* (2017) claimed that RPE is a practical, noninvasive adjunction for monitoring physiological and psychological markers of fatigue during exercise or any physical activities. The utility of monitoring RPE during exercise has clear advantages from a practical standpoint as it eliminates the need for invasive blood draws or cumbersome testing equipment. In addition, perceptual measures also have the advantage of being related to multiple physiological variables such as heart rate, ventilation, oxygen uptake, blood lactate concentration and core

temperature (Coutts *et al.*, 2009; Ueda & Kurokawa, 1995). Thus, RPE can be used to monitor both the psychological and physiological state of the individual expeditiously and indirectly but accurately.

In another word, Crewe et al., (2008), adding that an individual's perception of effort is a consequence of a subconscious regulation of power output given that an individual can be measured by time of distance completely and duration of exercises done. Thus, an individual's initial perceptual response as well as power output should be a calculated response to computations made within the brain prior to beginning the exercise session (Crewe *et al.*, 2008; Hampson *et al*, 2001; Joseph *et al.*, 2008; Gibson *et al.*, 2006). According to Lupo, Tessitore, Gasperi, and Gomez (2017), the complexity and dynamism of youth in performing physical activities presents a need for a tool to monitor their intensity. They mentioned that the use of the session-RPE method to quantify the internal training load appears to be necessary for the grass root or junior level athletes to reduce the occurrence of injuries, monotony and strain in these age categories.

Session RPE training load monitoring along with recording minutes on the training pitch or in the gym can create a dual point measures using an external load with an internal load. The external load is defined as the speed, duration or distance travelled and the internal load is the heart rate (Scott *et al.*, 2013). The method of session-RPE is well researched and is a valid measure to quantify the training intensity (Foster et al., 2001; Lupo et al., 2017; Scott et al., 2013). Based on that statement, RPE can be measured

accurately when physiological demands such as training variables are listed after training and RPE obtained. All the variables were used to calculate each player's training load. From that data, coaches can predict or plan the next training load to maximise player's stamina and improve sports performance.

2.2 Training Load, Monotony and Strain

Psychological measures have been proven to be as effective as physical measures in diagnosing training stress. Consequently, several psychological questionnaires have been employed for monitoring training load, monotony and strain with the aim of detecting early signs of fatigue (Elloumi *et al.*, 2016). 'Workload' and 'load' are terms widely used in rugby and other sports. There has been a lack of consistency regarding the definition and use, in particular with respect to whether the term 'load' relates to the measurement of external stressors applied to an individual or to the monitoring of an individual's physiological and psychological responses to those stressors. Based on Gabbet and David (2011), they said that rugby league is one of the famous sport games that had been played by junior and senior levels.

Previous research done by Elloumi *et al.* (2016) shows that training loads, monotonies, strains and volumes were increased until reaching a maximum value for the 5th week during the 6-week intense training (IT) period. This increase was associated with simultaneous increased values of the total score of fatigue with the highest score recorded in the 5th week.

Most of the time, a typical rugby requires the player to finish up the games by comprising intense from sprinting and tackling but have to separating by the short bouts of lower intensity activity.

Everyone has their own ability to stands up towards to training load (TL). For a long term of training, coaches already know their player well and should give different TL to ensure all the players received the similarities of the metabolism. During games, player for rugby sevens' basic rules are substantially the same as for the 15-a-side rugby match (rugby union), some major exceptions such as reduced number of players, for example seven per team, and shorter match duration, or two seven-minute halves (with one minute of recovery in between) exist.

The major dissimilarity in match demands in conjunction with differences in the competition structure between the two codes suggests that rugby sevens generates potentially higher exercise loading. Usually, more than two games are held on the same day with only few hours of recovery in between and this led to the assumption that rugby 7's players may experience higher levels of psychological and physiological stresses and risky to injured and RPE result was higher compared to rugby union. In this context, rugby 7's training develops the physical requisites for competition and consists of a high volume of resistance training and anaerobic and aerobic conditioning leading to high levels of perceived fatigue. The objective in training competitive athletes is to provide training loads that are effective in improving performance. At some stages during the training process, athletes may experience an unexplainable decrease in performance

which might happen when prolonged excessive training takes place concurrent with other stressors and insufficient recovery.

Gabbett (2005) also adding a statement that high training loads at the early phases of the season to associate with higher injury rates to the player and vice versa. He also claimed that, the relationship between training load and injury, the evidence showing that the poor fitness and low training load contributing to injury risk and lead to fatigue in rugby league. The training load can be assessed via heart rate measures is well accepted in endurance sports, this method is questionable and presents several limitations especially during weight, interval, intermittent, and plyometric training.

Fortunately, the session rating of perceived exertion (RPE) method for quantifying training load and training strain has emerged as an alternative approach, and recent data have extended its application for monitoring training periodization in both team and individual sports. Psychological measures have been proven to be as effective as physical measures in diagnosing training stresses. Accordingly, several psychological questionnaires have been employed for monitoring changes in training stress, strain and recovery with the aim of detecting early signs of tiredness or overtraining.

2.3 Rugby Injuries in Relation To Fatigue

Rugby union becomes famous, with expanded number of youngster and youth playing consistently. In the 2008/2009 seasons, more than 1.2 million youngsters in England played rugby in school and clubs. While there have been a few past studies reporting the epidemiology and incidence of trauma in expert rugby union, there is restricted limited knowledge of injury profile in beginner and especially on adolescence rugby (Brooks *et al.*, 2005).

Based on a study by Johnston *et al.* (2014), players may have experienced fatigue and display pacing strategies that had to permit the completion of the games. Whilst low-speed activity was basically maintained over a game, but there was a reduction in high speed running. Possibility of suffering in the sport of rugby is significant, as the incidence of injury is one of the highest amongst all professional team sports. As the participation increase in the sport of rugby, the injury risk will increased. There were many injury surveillance programmes established to identify the injuries that occur in rugby union, either in senior or junior team. During Rugby World Cup 2011, the rates of injuries were 2.2/1000 player-training-hours (forwards: 2.7, backs: 1.7) and 89.1/1000 player-match-hours (forwards: 85.0, backs: 93.8) the mean severity of trauma during matches and during training were 23.6 days (forwards: 21.2, backs: 26.2) and 26.9 (forwards: 33.4, backs: 14.3) respectively (Fuller *et al.*, 2013).

During matches, the most common injuries were lower body region muscle/tendon (31.6%) and ligament (15.8%) and amid training, lower body

region muscle/tendon (51.4%) and trunk muscle/tendon (11.4%) injuries were also common. The most frequent element of injury during competition was the tackle (forwards: 43.6%, backs: 45.2%), whereas amid training, injury was caused by full and semi-contact skills activities (Fuller *et al.*, 2013).

A study had been conducted during the Women's Rugby World Cup (WRWC) 2006 to investigate the injuries among the athletes. Overall, the most common injuries reported were knee-ligament (15%), ankle-ligament (13%) and concussion (10%). Knee-ligament wounds brought about the most days lost (43%). The knee (38%) was the most typical injury area for backs and it was in charge of 68% of their total days lost. On the other hand, head/face (28%) was the most days lost (42%). During the tournament, around three anterior cruciate ligaments (ACL) tear which resulted in the loss of 836 days (Taylor *et al.*, 2011).

Based on previous injury surveillance study on adolescent players, the utmost percentage of concussion reported was 3.3/1000 playing hours (Bleakley *et al.*, 2011). Common sites of injury were head and neck, upper body region, and lower body region and it was noted that there was higher time loss due to upper body part fractures or dislocation and knee ligaments damages. Increase in age, the early part of the playing season and the tackle were most closely associated with injury (Bleakley *et al.*, 2011). Approximately 14% and 28% of all rugby injuries were upper body part injuries, from the shoulder to fingers and compared with other injuries, they

were more serious and associated with longest absence from tournament (Best *et al.*, 2005).

Until today, there has been little research which focused on upper body part injury occurrence frequency and related risk components in rugby union (Usman & Mcintosh, 2013). The upper body region injury occurrence rate (IIR) in rugby accounted for 1.50-7.90 injuries/1000 player participation (pph) in beginner, youth and expert players. In term of the type of upper body region injury, 55-71% was sprain/strain and 4-26% was dislocation and cracks (Bird et al., 1998). 80% of the severity upper body part injuries were due to hand/finger breaks and shoulder dislocations. Studies have shown that a significant part of all upper body part injuries (45-75%) are shoulder damages which consist of the acromioclavicular joint (ACJ), the sternoclavicular joint (SJC), glenohumeral joint (GHJ), clavicle, deltoids, biceps tendons and rotator cuff (Mcmanus & Cross, 1997).

2.4 Multi-Dimensional Symptom Fatigue Inventory – Short Form (MFI-SF)

MFSI – SF consists of 30 items that yield scores only for the empirically derived subscales. It is the short form of the full scale MFI (Stein *et al.*, 1998). Preliminary research suggests that it has acceptable psychometric properties and may be used as a substitute for the MFSI when time constraints and scale length are of concern. Additional information about the MFSI-SF can be found in. Additional evidence for the validity of the MFSI-SF was provided via correlations with other relevant instruments

(range −0.21 to 0.82) (Stein *et al.*, 2004).According to Foster (1998), increased training load may contribute to overtraining syndrome. If athletes train in over their limit they can devise strategies for controlling the strain of the training. Foster (1998) hypothesised that training monotony can cause negative adaptation as a result of heavy training. Hence, the increasing training volume may affect the training intensity and subsequently impairs performance due to overtraining syndrome.

In another study by Elloumi *et al.*, (2016), over the two training periods, several correlations have been found between the mean training load, strain and the mean questionnaire fatigue score. The mean fatigue score was significantly correlated with the mean training load and mean strain recorded during the 6-week internal load monitoring. In this situation, there were significant changes between the training load, strain and fatigue score throughout the 6-week monitoring. In the same article, the relationship between the mean training load, mean strain and the mean fatigue score during this period strengthens the reliability of the short questionnaire of fatigue as a sensitive and practical tool for monitoring training load and strain and changes in athletic performance.

Elloumi *et al.*, (2016) concluded that this study showed that the short questionnaire of fatigue was sensitive to changes in training load and physical performances throughout the whole training period. The findings had strengthened the interest of the questionnaire of fatigue to be a simple, costless and useful tool for monitoring perceived training load and strain in high level athletes. It is already proven that by using both session-RPE and

questionnaire method for monitoring training may consequently help coaches to control training stimuli and prevent eventual states of staleness or overtraining to athletes.

2.5 Source of Rugby Injuries and Fatigue during Matches and Training

The obvious goal of athletic training is to enhance or to maintain physical performances. It requires an optimal training program based on an adequate balance between training volume and intensity and rest periods. When training is prolonged, excessive stress is applied concurrently with possible inadequate recovery. In this case, many of the positive physiological adjustments associated with physical training are reversed, reaching states of overreaching or overtraining and leading to chronic maladaptation and performance decrements.

Studies have demonstrated that the tackle was the most reason for harms in rugby matches (Gabbett, 2001). Approximately 46% and 90% of all harms that happened in matches were tackle-related and all concussions recorded were because of tackle (Gabbett, 2005). For example, if every player was included in a normal of 41 physical impacts for each game, higher amounts of concussion might be predictable. Research into amateur rugby likewise shown that tackle was the most frequent reason for injuries, with injury rates as high as 538 for every 1000 playing hours. Damages were more predominant amongst ball carrier (405 for each 1000 playing hours) than the tackler (133 for each 1000 playing hours). Youth rugby had a lesser trauma frequency yet demonstrated comparable noticeable quality as in amateur rugby (Gabbett, 2008).

In contrast to amateur and expert rugby class, the tackler typically managed a larger number of harms than the ball carrier (27% to 44% versus 20% to 39%, respectively). This is the converse pattern found in novice and expert rugby class where the ball carrier managed more damages (46 for each 1000 playing hours) than the tackler (21 for each 1000 playing hours) (Stephenson *et al.*, 1996).

2.6 Fatigue Issue in Sport Activities

According to Lindsay *et al.* (2017), most athletic setting, exertional fatigue is a confounding variable in concussion diagnosis immediately when we finish any activities or movement. Moreover, baseline scores for concussion sideline assessments are taken at rest, but may be artificially changed when comparing scores in a fatigued state. Previous study on rugby wounds recognized that there were no contrast between damage percentage for forwards and backs during games. On the other hand, more recent investigation has recognized that forwards sustain a greater injury rate than backs, which could be due to the larger participation of forwards in body collisions (Meir *et al.*, 1997).

Contribution in different stages of rugby class in semi-professional or beginner actually has additionally indicated greater damage percentage in forwards than backs that caused by fatigue. In all opposition levels, forwards had greater percentage of head, neck, face and knee damages than backs, while backs had a greater damage percentage on the ankle and other site categories than forwards (Gabbett, 2004).Studies carried out among semi-professional players have shown that forwards (53 for each 1000 training

hours) had a greater percentage of practicing injuries compared with backs (38 for each 1000 training hours). Injury to the head and neck, shoulder, thigh and calf, ankle and foot were more common in forwards compared to backs (Gabbett, 2005).

Based on Adirim *et al.,* (2003), they claimed that performance basis that can give benefits from growth and improved the ability of training can be determine from the increasing of exposure to injury risk through greater frequencies and their intensity of training loads among a more vulnerable age of groups. To be more specific about this, tissues development, growth accelerates or behavioral changes patterns will be the main contributors to the injury risk. Gabbet *et al.* (2011) claimed that participation with intensive including to the early specialization and slow recovery it may increase the rate of player to sustain the injury that can lead to fatigue.

2.7 Fatigue in Rugby Sports

Nowadays, rugby has become popular nationwide and well perceived by others. Day by day, rugby games started to get a place in the hearts of the world society. In few countries, for example, New Zealand, Fiji, Wales, Samoa, and Tonga, they have considered rugby as their primary game. Rugby is a full contact sport which was first established in the early nineteenth century in England. Basically, the games involve running with an oval ball in hand and to get the most score to win the game, the players have to touchdown at the try line or kick the ball over the goal post. The duration of a rugby match is 40 minutes for each half with the total of 80 minutes for one

complete game. There are 2 groups that go against each other in one field and each team consists of 15 players (Duthie *et al.*, 2003).

The position of the player is divided into two groups which are the forward and backlines. also stated that forwards are usually the strongest, heaviest and tallest so as to be competitive inside rucks, mauls and line outs and for the backlines they require speed, acceleration and agility in open play as the part to beat the opposition and they also have to have playing skill and technique. In 1995, Rugby Union at the highest rank became a professional and International Rugby Board (IRB) then made it official that this game would become a professional game. As a consequence, the top players have become professional athletes with high income and most of them became fulltime sportsmen. Therefore, training has been intensified and also impact between players has increased dramatically due to elevated power, size and speed of the athletes.

Rugby is a contact team sport that delivers significant social and health benefits similar to others sport activities. The physiological demands in rugby are including the strength, explosive power and endurance. A rugby player should not only be physically well prepared but also has the positive mental and emotional wellbeing to play safely. Hence, the coach has to ensure that all players will be able to reach their fullest potential, through training methods and or using equipment to enhance performance.

The game of rugby involves running with an oval ball in hand and to get the most score to win the game. The players have to touchdown at the try line or kick the ball over the goal post to score points. The duration of a rugby

match is 40 minutes for each half with the total of 80 minutes to complete the game. There are two teams that go against each other in one field and each team consists of 15 players or known in short as 15s. The position of the player is divided into two main groups which are the forward and backlines. Uniquely, each position requires different physical and skill attributes. The forwards are usually the strongest, heaviest and tallest so as to be competitive inside rucks, mauls and line outs and for the backlines they require speed, acceleration and agility in open play as the part to beat the opposition, including skill and technique of playing (Duthie *et al.*, 2003).

Based on published studies around the world on adolescent rugby injuries, the most common sites of injuries are mainly head and neck, upper limb, and lower limb. According to Bleakley *et al.* (2011) the most common injury types were fracture, joint dislocation and ligaments sprains and body parts most at peril of these injuries were the shoulder and knee. Furthermore, thigh and calf strains are the most common injuries sustained during rugby league training, while overexertion is the most common cause of training injuries (Gabbett, 2004).

Based on a report by Gabbett (2004), fatigue may influence the incidence of injury, with most amateur and semi-professional rugby league injuries occurring in the latter stages of training sessions. The report also mentioned that most training injuries occur in the early stages of the season prior to competition, suggesting that changes in training intensity may influence the incidence of injury in rugby.

Monitoring training loads have been used to manage athletes' training intensity and to prevent stress-related injury due to increased physical demands (Gabbett, 2004). According to the performance system model by positive function is termed as fitness whereas negative function is termed as fatigue. They suggested that athlete's performance due to training is calculated from the difference between a positive and negative function. Ideally, a balance in the training load to increase performance while reducing negative effect of training such as injury, fatigue and over-training should be accomplished.

CHAPTER 3

3.1 Methodology

3.1.1 Sampling Method

The male participants of the study, aged from 16-18 years old, were recruited among the students from the Kolej Vokasional Pengkalan Chepa, Kelantan by approaching the rugby coach. A brief description of the study was given to the coach and students to explain the benefits of the study. All participants were informed about the nature and possible risks associated with the experimental procedure. Written informed consent were obtained from the participants (Appendix A) and their parents and/or guardians (Appendix B). A letter of permission was obtained from the head of the Kolej Vokasional Pengkalan Chepa and rugby coach prior to conduct this study (Appendix C).

3.1.2 Sample Size Calculation

Sample size used in this study was calculated by using G Power software based on the previous study by Lovell, Sirotic, Impellizzeri, and Coutts (2013). The session Ratings of Perceived Exertion (s-RPE) method using 10-point Borg scale has demonstrated strong correlation with internal training loads ($r = 0.83$, $p<0.05$). Hence, the power of the study set at 90% confidence interval, 80% power, alpha 0.05 and effect size of 0.9 with the total number of participants recruited will be 38 (Figure 1).

t tests - Linear multiple regression: Fixed model, single regression coefficient		
Analysis:	A priori: Compute required sample size	
Input:	Tail(s)	= Two
	Effect size f^2	= 0.3
	α err prob	= 0.05
	Power (1-β err prob)	= 0.90
	Number of predictors	= 3
Output:	Noncentrality parameter δ	= 3.3763886
	Critical t	= 2.0322445
	Df	= 34
	Total sample size	= 38
	Actual power	= 0.9065198

Figure 3.1 Sample size calculation for this study

3.1.3 Research Design

The proposed study was conducted from January until July 2018 using a prospective descriptive, correlational design (Figure 3.2). The study was approved by the Universiti Sains Malaysia Human Research Ethics Committee (USM/JePEM/17120705) and was conducted in accordance with the guidelines of the International Declaration of Helsinki. Training perceived effort were obtained from players after 30 min of completing their training session using the session RPE (s-RPE) method by Foster (1998) and the duration of the training was recorded to quantify training load, monotony and strain. A Multidimensional Fatigue Symptom Inventory-Short Form (MFSI) which consists of 30-item were administered according to the methods by Lim, *et at.* (2005).