MONITORING STRESS AND RECOVERY AMONG U/20 RUGBY UNION PLAYERS OVER A TRAINING SEASON

by
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Declaration

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SUMMARY

Stress and recovery plays an important role in the performance of semi-professional rugby players. Physiological and psychological markers have been established as reliable indicators of the recovery-stress state in athletes. Monitoring changes in the recovery-stress state enables the coaching staff to adapt training sessions to enhance performance.

The aim of this study was to monitor changes in stress and recovery states among U-20 rugby union players during a training year. Relationships regarding monitoring variables and differences in stress and recovery between playing positions were examined.

55 Players between the ages of 18 and 20 were monitored for 27 weeks, over a training year. The training year was divided into 5 training phases: Developing phase (week 1 – 7), Transitional phase (week 8 - 11), Early Competition phase (week 12 - 17), Performance phase (week 18 – 24), and High Performance phase (week 25 - 27). Ratings of Perceived Exertion (RPE) for sessions were reported on a daily basis. The Heart-rate Interval Monitoring System (HIMS) test was run every week. The Stellenbosch Mood Scale (STEMS) and Self-Report questionnaires were completed on a weekly basis, and the Recovery-Stress Questionnaire (RESTQ-76-Sport) was completed once a month.

Backline players physically recovered better and faster than the forwards throughout the training year, while the forwards exhibited better psychological coping methods. The backline players had significant higher scores for the Depression (p = 0.03), Anger (p = 0.009), and Confusion (p = 0.01) scales of the STEMS. The Total Mood Disturbance scores were also significantly higher (p = 0.03) for the backline players than the forwards during the Performance phase. The backline players experienced increased stress and decreased feelings of well-being during the competitive phases when compared to the forwards. The backline players had better physical recovery than the forwards after the high intensity and high volume Developing phase. Correlations were evident between the HIMS test and the RESTQ-76-Sport questionnaire. Additional correlations were found between training load, as well as training monotony and training strain, and scales of the RESTQ-76-Sport and STEMS questionnaires.

Lack of psychological skills-training might also have resulted in the players not knowing how to properly handle stressful situations and how to regulate their stress and recovery states. The lack of an educational system regarding recovery strategies, and the reinforcement thereof, especially during the Developing phases might play a role in the later increased fatigue and injury rates among the players.

Keywords: Monitoring, recovery, rugby union, mood states, heart-rate interval monitoring, RESTQ-76-Sport.

OPSOMMING

Stres en herstel speel ‘n groot rol in die prestasie van semi-professionele rugby spelers. Fisiologiese en sielkundige merkers is vasgestel as betroubare aanwysers ten opsigte van die stress-herstel toestand van atlete. Die monitoring van veranderinge in hierdie toestand kan die afrigtings-personeel help om die oefensessies aan te pas om optimale prestasie te verseker.

Die doel van hierdie navorsingstudie was om veranderinge in stres en herstel toestande in O/20 rugby unie spelers, oor ‘n oefenjaar, te moniteer. Verhoudinge in monitering veranderlikes en moontlike verskille in die stress en herstel toestand tussen die voorspelers en agterspelers is ondersoek.

55 Spelers tussen die ouderdomme van 18 en 20 is vir 27 weke, oor ‘n oefenjaar, gemonitor. Die oefenjaar was onderverdeel in vyf oefenfases nl. die Ontwikkelingsfase (week 1 – 7), die Oorskakelingsfase (week 8 – 11), die Vroeë Kompetisiefase (week 12 – 17), die Prestasiefase (week 18 – 25), en laastens die Hoë Prestasiefase (week 25 – 27). Spelers het daagliks hul “Rate of Perceived Exertion’s” aangedui vir elke oefensessie. Die “Heart-rate Interval System” toets (HIMS) was een keer ‘n week gehardloop. Die “Stellenbosch Mood States” (STEMS) en Selfrapporteringsvraelyste was op ‘n weeklikse basis ingevul en die “Recovery-Stress Questionnaire-Sport” (RESTQ-76-Sport) was een keer ‘n maand ingevul.

Agterspelers het deur die jaar fisies beter en vinniger as die voorspeler herstel, terwyl die voorspelers beter sielkundige beheer getoon het. Die agterlyn se tellings vir die Depressie ($p = 0.03$), Woede ($p = 0.009$), en Vervanging ($p = 0.01$) skale van die STEMS was betekenisvol hoër as die telling van die voorspelers. Die Totale Gemoedsversteuringstellings was ook betekenisvol hoër vir die agterlyn as die voorspelers tydens die Prestasiefase ($p = 0.03$). Die agterspelers het toenemende stres tydens die kompetitisie fases ervaar, sowel as ‘n afname in die gevoel van Welsyn. Die agterlyn het beter fisiese herstel na die hoë intensiteit en hoë volume Ontwikkelingsfase as die voorspelers getoon. Korrelasies is gevind tussen die HIMS en die RESTQ-76-Sport. Verdere korrelasies is ook tussen “training load”, sowel as “training monotony” en “training strain”, en sekere skale van die RESTQ-76-Sport en STEMS vraelyste gevind.

Die tekort aan sielkundige tegniek-ontwikkeling kon bydrae tot die spelers se verwardheid rondom die hantering van stresvolle situasies en hoe om hul stres en herstel toestande te reguleer. Die afwesigheid van ‘n opvoedkundige sisteem rondom herstel strategieë, en die toepassing daarvan, veral tydens die Ontwikkelingsfases, mag moontlik ‘n rol speel in latere toenames in vermoeienis en getal beserings onder die spelers.

Sleutelwoorde: Monitering, herstel, rugby-unie, emosionele toestande, hart-tempo interval monitoring, RESTQ-76-Sport

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CHAPTER ONE

INTRODUCTION

Increased media coverage of rugby union may be one of the factors leading to a rise in popularity and a higher interest in the sport among public viewers. More competitions, means more rugby for the viewing public, and more media coverage. This also means more practice and game time, and less time at home for the players. Increased game time results in an increase in training, which means greater training loads. Training loads and or the athlete's response to those loads may sometimes exceed the threshold of what the individual can adapt to. This can lead to underperformance and other fatigue-associated symptoms, which ultimately result in performance decline (Fry et al., 1991; Halson & Jeukendrup, 2004; Meeusen et al., 2006). Although large training loads can enhance performance, it can also lead to performance decline when there is insufficient recovery (Kentta & Hassmen, 1998).

A coach wants the athlete to perform to the best of his ability, and for optimal performance athletes need to recover after competition and between training sessions. Thus a balance between training stress and adequate recovery is essential for optimal performance (Kellmann, 2002). Coaches and athletes need to regularly evaluate the relationship between training load and performance. According to Tim Noakes 1600 minutes is the maximum game time a professional rugby player should play per year. Data analysis by Tim Noakes showed that 37%

of the original Springbok squad members for 2010 already played between 250-900 minutes more than the suggested 1600 minutes (Nell, 2010). This included competitions such as the Currie Cup-series and the Super14 tournament as well as European tours.

Underrecovery is not only the result of frequency of competitions and high training loads. Various researchers (Foster *et al*., 1998; Gastmann *et al*., 1998) suggested that underrecovery can also occur as a result of the following training mistakes: (1) monotonous training programs, (2) exceeding three hours of training per day, (3) more than a 30% increase in training load between weeks, (4) not alternating hard days with easy days, (5) no training periodization and regeneration microcycles after 2-3 weeks of training, or (6) no specific rest days. Increased athletic performance depends on the correct manipulation of training intensity and training volume, provided there is adequate rest and recovery between these training sessions (Hoffman *et al.*, 1999). Reducing training load is not always the best answer to avoid overtraining, and the answer may lie in the fact that training load may need to be individually determined in order to ensure maximum performance (Lehmann *et al.*, 1997), as well as incorporating recovery strategies.

Apart from training load, there are psychological stress factors that play a role in the development and the performance of an athlete. Many coaches do not believe that events outside the sporting environment are relevant to performance, but what happens in the athlete's private life can add to the stress the athlete experience (Kallus & Kellmann, 2000). Kallus and Kellmann285 (2000) stated that stress, the coping with it, and recovery determine the state of the athlete, which in turn determines the athlete's reaction to subsequent stressors and ultimately influence performance. Not only is the intensity of the stress an important factor, but the duration, distribution over time, and the nature of the stress play important roles. Kallus and Kellmann (2000) stated that increased stress demands and insufficient recovery leads to the athlete experiencing more stress. If recovery demands cannot be met, the athlete will be stressed beyond the point of failure, and may need to find other ways of coping with the stress.

Rugby is a collision sport with physical, physiological and psychological demands. Different playing positions have different skills, physical and physiological demands, and require position specific training (Bompa & Claro, 2009; Gabbett, 2004). Gabbet and Domrow (2007) have suggested that training load may reflect these differences between positions. During similar high intensity efforts, backline players players needs more recovery time than forwards (Bompa & Claro, 2009). Recovery should occur on different levels. Research examined different recovery modalities and the levels on which it plays a vital role e.g. physiological, biochemical, psychological and behavioural levels. Not only is it important to know what the different levels entail, it is important to know how stress and recovery influence these levels and how to monitor for changes in any of these levels. The challenge for the coach is to develop a training program with the correct balance between training load and other physiological and psychological stressors, and incorporate adequate recovery to allow the body to adapt accordingly.

CHAPTER TWO

THEORETICAL FRAMEWORK

2.1.1 INTRODUCTION TO RECOVERY

Recovery is an important part of training that is often neglected or passed over for more training. Recovery can be active or passive and includes various modalities. The following chapter will focus on defining recovery and discussing the various levels of recovery and processes involved in the management of the recovery-stress state in athletes.

2.1.2 DEFINING RECOVERY

Recovery can be defined as an "inter-individual and intra-individual multilevel (e.g., psychological, physiological, social) process in time for the re-establishment of performance abilities" (Kellmann & Kallus, 2001: 22). Recovery is an active process of regaining physiological resources and re-establishing psychological states to allow the athlete to use these resources as needed in training and competitions (Kellmann & Kallus, 1999, 2001). Kellmann (2002: 6) suggested that recovery can be defined as "the compensation to fatigue or to a decrease in performance and, to adhere to the homeostatic principle, a re-establishment of the initial state". Recovery is often characterised as a process of decreased intensities, or periods of rest, but in under-demanding situations, the re-establishment of a recovered state can occur by an increase in intensity or an increase in tension (Löhr & Preiser, 1974). The complexity of the recovery process lead researchers to propose recovery as a general psychopysiological concept (Kallus & Kellmann, 2000).

The total time needed to recover depends on the previous activity and the type and duration of stress e.g. high-volume training needs more recovery time during a taper phase (Hoffman *et al.*, 1999). Löhr and Preiser (1974) suggested that recovery does not always incorporate relaxation. By alternating physiological and psychological stressors, the one system can recover while the other one is active. This method of recovery is often used when there is limited time to incorporate periods of complete rest or non-training. Recovery can occur from a reduction or enhancement of an activity, a change of activity, or a complete rest where the athlete can take a break from stressful situations. Recovery is specific to each individual and it is an important factor to take into account when deciding on strategies and modalities to enhance recovery. One activity can be relaxing to the one athlete and a stressor to another. It is therefore very important that the selection of recovery activities be specific to the athletes' recovery strategies and needs. When the psychopysiological state is restored and homeostasis is reached, the recovery period is finished (Löhr & Preiser, 1974).

Recovery enables the body to go into a repair process after the breaking down process of training. Without adequate recovery the body will not adapt positively to training and negative training adaptations take place (Coutts *et al*., 2007c). Meeusen *et al.* (2006) mentioned that inadequate recovery can leave the athlete not being recuperated, and when put under more stress, the athlete is vulnerable to overtraining and performance declines. Excessive fatigue could lead to negative changes in haematological, immunological, biochemical, hormonal and psychological variables (Halson *et al.*, 2003; Urhausen & Kindermann, 2002).

Botteril and Wilson (2002) illustrates in the total fitness model (Figure 2.1) that any capacity and state of one domain can affect the capacity and state of another domain. Relationships between these domains are complex, and are important in the athlete's ability to perform, as well as to recover.

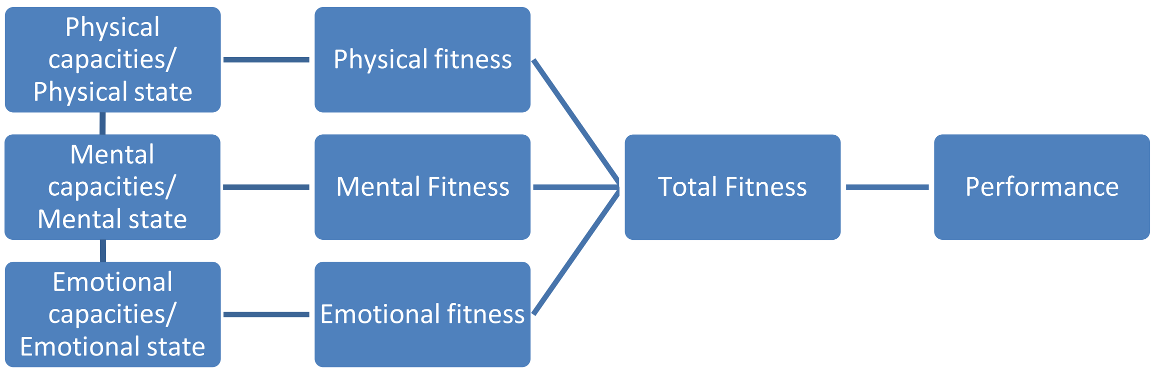

Figure 2.1. Total fitness model (Botteril & Wilson, 2002: 145)

In summary, three important aspects of recovery can be highlighted (Kellmann, 2002). Firstly, recovery is an opposition to fatigue or an overdemanding situation. If fatigue is due to high-intensity training or high volume training and the situation is psychologically overdemanding, recovery will take place by a reduction of activity or a reduction in the training intensity. Secondly, recovery can also be an opposition to an underdemanding situation. An underdemanding situation will be where the athlete is not sufficiently challenged either physically or emotionally. Recovery will take place through an increase in activity such as exercise. Recovery can also, thirdly, occur by changing the activity and varying the system being stressed. A change in activity is a way to stimulate the central nervous system in order to prevent monotony.

2.1.3 RELATIONSHIP BETWEEN STRESS AND RECOVERY

Stress is described by Hacker and Richter (1984) as a deviation from the norm in a biological/psychological system. Any deviations from the balance in such a system are because of demands either being too low or too high. This results in physical fatigue, psychological stress, or sleepiness (Hacker & Richter, 1984). Recently it came to an understanding that stress is the effect of a deviation in a biological/psychological system on the individual. The degree to which an individual will experience stress depends on the individual's perception of the stressor. Stress is not only a deviation from the biological/psychological balance, but is also accompanied by emotional symptoms such as anxiety and anger, hormonal responses, increased activation of the central and autonomous nervous system, changes in immune function, and changes in behaviour (Janke & Wolffgramm, 1995).

Stress, the coping with it, and recovery determine the state of the athlete, which in turn determines the athlete's reaction to subsequent stressors and ultimately influence performance (Kallus & Kellmann, 2000). Not only is the intensity of the stress an important factor, but the duration, distribution over time, and the nature of the stress are important. Increased stress demands and insufficient recovery leads to the athlete experiencing more stress. If recovery demands cannot be met, the athlete will be stressed beyond the point of failure, and may need to find other ways of coping with the stress. Imbalances between stress and recovery can lead to short-term and long-term reduction in the athletes' performance (Kellmann, 2002). Research by Kraemer *et al.* (2004) has shown that it is important for team-sport athletes to enter the season well-recovered. These researchers found that athletes who had inadequate recovery tested significantly lower on muscular strength, power, and sprinting performance than those who entered the season with adequate recovery (Kraemer *et al*., 2004).

Serious cases of inadequate recovery and increased stress states may result in the overtraining syndrome. The overtraining syndrome results from a combination of inadequate recovery, excessive amounts of high-intensity training, increases in training load, as well as non-training stressors (Fry *et al*., 1991; Meyers & Whelan, 1998). The concept of supercompensation is well known in the sport environment, and coaches have used functional overtraining (or short-term overtraining) (Meeusen *et al*., 2006) as part of their training programmes. However, for some athletes insufficient recovery is allowed during this period of intensified training. This can then lead to long-term overtraining, otherwise known as non-funtional overtraining (NFOR) or overtraining syndrome (OTS) (Budgett, 1990; Kuipers & Keizer, 1988; Meeusen *et al.*, 2006). Overtraining can result in increased susceptibility to injury and illness, increased negative mood states, and a decline in performance (Raglin & Morgan, 1994).

It is important that recovery sessions should be included in the training and competition schedule, but an interdisciplinary approach may be the key to a more effective diagnosis of the recovery-stress state of an individual. Kellmann's (2002) scissors model (Figure 2.2) describes the relationship between stress and recovery. As athletes are subjected to stressful life events psychological and physical stressors accumulates along the same pathway, and without adequate recovery it can lead to elevated stress levels (Davis *et al.*, 2007). With adequate recovery, however, the athlete can react accordingly and cope successfully with the stress, resulting in the re-establishment of an optimal level of performance. Any imbalances in the recovery-stress state that is not immediately taken care of can result in under-recovery, overtraining, and possible burnout.

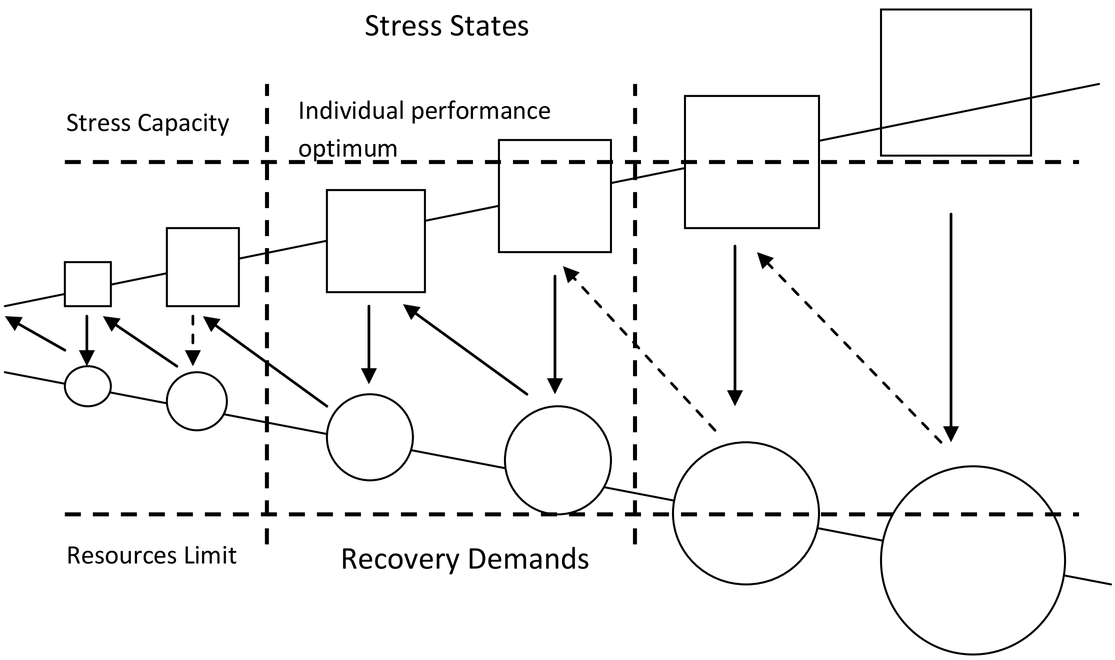

Figure 2.2. The "scissors model" of the interrelation of stress states and recovery demands (Kellmann, 2002: 11).

An athlete in an overreaching phase of training or intense competition would appear to be particularly vulnerable to injuries and psychological stress. As the potential to eliminate physical stressors is limited in sport, a potential avenue for decreasing injury rates is the controlling or elimination of unnecessary psychological stressors, thereby increasing reserves for responding in an emergency (Simjanovic *et al*., 2008). To eliminate unnecessary psychological stressors, the athlete and the coach should have a clear understanding of the stress and recovery factors, as well as the specifics of the recovery process as a multi-level process.

In a team sport setting, recovery can be an extremely complex process. Not only must the team recover from training and other physical stressors, but every individual athlete needs to recover from psychological stressors. As mentioned previously, psychological stress is very specific to the individual, especially when the athlete's coping abilities are taken into account. The coaching and conditioning team have the responsibility to not only balance the training loads, volumes and intensities, but also to balance the training stressors with adequate recovery. Monitoring the athletes is a process to help the coach with decision making in order to sustain the stress-recovery balance. The monitoring process, factors influencing it and suggestions on what factors are important to monitor will be discussed in the next chapter.

2.1.4 INDICATORS OF RECOVERY

According to Kellmann (2002) there are three different approaches to recovery; passive, active and proactive. Passive recovery includes modalities such as sleep and massages. Active recovery is used to eliminate the effect of fatigue through specific moderate physical exercises, e.g. stretching or low intensity exercises. Proactive recovery is a purposeful, self-initiated activity which could include physical exercise, recovery modalities and events e.g. watching television. Recovery is sometimes connected to circumstances, especially when the athlete is affected in his sleep due to environmental influences. The individual's perception of an activity is also an important factor to take into account. When the athlete's self-awareness and perception changes it can result in a recovery activity becoming a stressor (Kellmann, 2002). Kallus and Kellmann (2000) discussed different levels of recovery, e.g. physiological recovery, psychological recovery, behavioural recovery, social recovery, mood-related recovery, emotional recovery and environmental recovery. The physiological, physical, psychological, mood-related, behavioural, and social indicators of recovery will be discussed in further detail.

Biochemical and Immunological indicators

When physical demands placed on the athlete outweighs the ability to recover between training and competition, there is an increase in the risk of illness and/or the occurrence of injuries (Anderson *et al*., 2003). Current knowledge on upper respiratory infections (URTIs) and exercise suggests that heavy acute and/or chronic exercise can be associated with an increase in the risk of URTI (Putlur *et* *al*., 2004). Some studies have suggested that the occurrence of URTIs were related to activities above the individual's limits of training strain (Foster, 1998). Low-grade trauma and inflammatory responses have been reported as results of high-intensity training loads (Margonis *et al.*, 2007). Changes in C-reactive protein, creatine kinase, and increased neutrophil activity are some of the physiological reactions to exercise intensity and volume increases (Bury & Pirnay, 1995; Margeli *et al*., 2005; Peters *et al*., 2004; Urhausen & Kindermann, 2002).

Moderate exercise may stimulate the immune system and decrease the risk of contracting URTIs (Shepard & Shek, 1993). Too much exercise may have the opposite effect and increase the risk of contracting an URTI (Weidner & Schurr, 2003). Intense training has been shown to suppress immune parameters and this lowering of the immune system's resistance to infections may lead to upper-respiratory tract infections (URTIs) (Mackinnon, 1997). Positive correlations were also found between training load and URTIs (Gleeson & Pyne, 2000; Tomasi *et al*., 1982). Immune parameters examined by Mackinnon (1997) include the number of circulating leukocytes, plasma cytokine concentrations, neutrophil and macrophage phagocytic activity, and salivary immunoglobulin (S-IgA) secretion rate. Putlur *et al.* (2004) conducted a study to compare the influence of stress on S-IgA levels in female college students who were athletes, and those who were not involved in competitive athletics (control group). No significant differences were found in S-IgA concentrations in the soccer and the control group when related to URTI. They did, however, find that 82% of illnesses observed in their study were preceded by a decrease in S-IgA.

Filaire, *et al.* (2003) examined changes in haematological, metabolic, hormonal, and immunological levels in 20 professional soccer players relative to a high-intensity training programme. They also measured URTI and found that URTI occurred in only two of the players, and the immunological factors IgA, IgG, and IgM remained unchanged throughout the whole year. Putlur, *et al.* (2004) found a higher frequency of injury and illness in the higher trained group compared to the control group. Although previous research has been conducted on S-IgA and URTI, results are contradictory and specific immune parameters to indicate occurrences of URTI or injuries is yet to be established.

To find out whether or not cortisol secretion plays a role in the occurrence of URTI, Putlur, *et al.* (2004) conducted a study to compare the influence of physical stress on cortisol levels in female college students who were athletes, and those who were not involved in competitive athletics (control group). The major finding of this study was that there was no significant difference in cortisol concentrations in the soccer and the control group when related to URTI. Filaire, *et al.* (2003) found that a high-intensity training programme resulted in a significant decrease in cortisol concentrations. Despite the lack of formal investigations, cortisol as a cumulative physiological stress indicator has been shown to have a positive relationship with perceived stress and factors affecting the athlete negatively. This is well supported by recovery research in sport science (Davis *et al.*, 2002; Fogarty *et al.*, 1999; McEwan, 2003).

Some studies have shown that insufficient recovery between intense training sessions may limit the glutamine release from the muscles into the circulation, and this may lead to increase stress on the immune system (Gabriel *et al*., 1998; Petitbois, *et al*., 2002). Glutamine deficiency can have a negative effect on activity and proliferation of T- and B-lymphocytes, and may increase the risk of infections in athletes following a high-intensity training regime (Petitbois *et al*., 2002). Rowbottom *et al.* (1995) agrees with this concept and suggested that plasma glutamine levels in athletes represent a positive adaptation to a balanced training programme, while negative effects of excessive exercise and overtraining may be a result of lower glutamine concentrations.

Not all researchers agree with Rowbottom's findings and it is suggested that changes in glutamine concentrations might result from an adaptation mechanism to training (Krause *et al.*, 2002). Although many studies were done with long-distance runners and swimmers, little information is available in team sports (Filaire *et al*., 2003), and data about glutamine concentrations and the subsequent effects on performance are somewhat controversial. Filaire, *et al.* (2003) found that plasma glutamine concentrations differed significantly from the established normal range in the beginning of their study and was lower throughout the year. Their results suggest that, despite a long-term training program, immune suppression related to low glutamine concentrations was not obvious. This suggests that glutamine is not a useful marker of physiological stress in professional athletes. This is in contrast with Walsh, *et al.* (1998) who have shown glutamine to be a key substrate for cells of the immune system and to be very important in the immune response.

The use of biochemical and immunological variables or markers as indicators of recovery expressed in the immune system or on biochemical cell level are not yet determined as reliable. Too many findings is in contrast to each other, and therefore other possible physiological variables should be examined as possible indicators of recovery.

Physiological and Physical Indicators

Recovery from stress of training may vary within all the different organismic subsystems of the human body (Steinacker *et al.*, 2000; Viru & Viru, 1999). Physical training can increase the athlete's physiological capacity and increase performance when used in proper amounts. Excessive amounts of training can be harmful as physical training is also seen as a stressor (Arnheim, 1989; Bompa, 1985). Appropriate amounts of physical training are difficult to determine and is often related to the athlete's performance (Goss, 1994).

Swimmers, runners, cyclists, and rowers often use the principle of overload (imbalance between training and recovery) to improve performance (Kuipers & Keizer, 1988). Overload usually results in increased muscular endurance, power, aerobic capacity, and increased performance, but with inadequate recovery and adaptation time, fatigue will occur, leading to decreased performance (Goss, 1994; Morgan *et al*., 1987; Morgan & O'Connor, 1988). Silva (1990) suggests that overload can result in psychophysiological breakdown, and this can easily be observed in changes in mental states and changes in performance. Physiological indicators of overtraining or under-recovery include heart rate, immunological factors, biochemical and hormonal changes, and performance and fitness variables.

Delta sleep is described as recovery in relation to the metabolic activity and energy expenditure of an individual. Growth hormone and cell division are active during the delta sleep, while metabolic rate, respiration, and heart rate are very low during the delta sleep. If the sleep pattern, specifically the delta brain waves, is disturbed, it influences the recovery by affecting restoration and rejuvenation of the body (Savis, 1994).

It is widely reported that exercise leads to a decrease in resting heart rate but there is evidence that resting heart rate increases with overtraining (Dressendorfer *et al.*, 1985). Heart Rate Recovery (HRR) is one of the techniques to measure the autonomic nervous system's responsiveness to changes in work load (Buchheit *et al*., 2007; Lamberts *et al*., 2004, 2009) and measurements thereof has become increasingly popular to determine the relationship between training load and recovery. The advantage of measuring HRR is that it is non-invasive, easy to administer and sensitive to change (Hedelin *et al.*, 2000; Jeukendrup & Van Diemen, 1998; Kuipers & Keizer, 1988). Lamberts *et al.* (2010) had 14 well-trained cyclists participate in a high-intensity training programme, dividing them into two groups: a group that showed an increase in HRR, and a group that showed a decrease in HRR during the training programme. They found that the group with increased HRR improved with greater significant scores in peak power output as well as endurance performance, than the group with decreased HRR. The average power (resulting in faster time trial performance) also improved more in the group with increased HRR. They concluded that HRR decreased during a high-intensity training period and that the measurement of HRR is a good indicator of fatigue.

The training-performance relationship has shown that an increase in training intensity and volume result in increased performance (Foster *et al.*, 1996; Krebs *et al.*, 1986; Mujika *et al.*, 1995; Stewart & Hopkins, 2000). However, Foster (1998) found that there is a quantitative relationship between various types of training and the occurrence of negative training adaptations. These negative training adaptations are showed to be dose related, and that the highest frequency of illness and injury occurred when training loads are at their highest (Foster, 1998; Gabbett, 2004).

Increases in training volume may lead to fatigue (Endoh *et al*., 2005) or muscle damage (Mashiko *et al*., 2004b), which may result in reduced performance and in greater susceptibility to injury during training and subsequent matches (Brooks *et al*., 2008). Athletes often exhibit greater involvement and intensity during training and competition due to increased fitness and skill level, and this may contribute to increased risk of injury. This emphasises the importance of implementing recovery for the elite athlete.

Research hypothesised that higher training volume resulted in higher match injuries (Lee *et al*., 2001; Quarrie *et al*., 2001), but Brooks *et al.* (2008) assessed the influence of training volume on injuries in 502 professional rugby union players and their findings did not support the previous mentioned hypothesis. Brooks *et al.*

(2008) suggested that the coaches' focus was set on optimizing recovery strategies in response to higher training volumes. Brooks *et al.* (2008) found that more training injuries were reported when the training volumes surpassed 9.1hours per week, although insignificantly so.

Studies done in rugby league and rugby union showed that training injuries were dependent on training volume (Brooks *et al*., 2005a; Gabbett, 2004). In amateur rugby union increased training volume during pre-season as well as in weekly training were associated with a higher incidence of match injuries (Lee *et al*., 2001; Quarrie *et al*., 2001). Gabbet and Domrow (2007) found that predictable statistical models can be developed to successfully examine the relationships between training load, training injury, and physical fitness in collision sport athletes. While physical fitness improved in response to training, more frequent occurrences of injuries were seen with increases in training load. Training for collision sports should reflect a balance between the minimum training load required to improve fitness variables (e.g. strength, power, endurance, skill, and tactical preparedness) and the maximum training load tolerable before marked increases in injury occur. It is also important to incorporate adequate recovery to minimize the risk of injuries (Brooks *et al*., 2005b, 2005c; Gamble, 2004). Gabbet and Domrow's (2007) findings suggest that reductions in training load during the early-competition training phase lessen the frequency of injury without compromising agility performances in collision sport athletes.

Gabbett and Domrow (2007) found that increases in training load during the early-competition training phase may reduce agility performance. A possible explanation for the reduction in agility performance with higher training loads is that intensive aerobic conditioning is associated with higher perceived intensities than speed, impulse, and agility activities (Gabbett & Domrow, 2007). It was documented that aerobic conditioning has a negative effect on muscular strength and neural impulses (Hickson, 1980). This can have an influence on the different variables playing a role on how quickly an athlete can change direction (e.g. sprinting speed, sprinting technique, strength, power, and reactive strength) (Young *et al.*, 2002). Alternatively, increased focus on aerobic conditioning in the early-competition training phase may have limited the training time devoted to perceptual and decision making skills (e.g. visual scanning, anticipation, pattern recognition, and situation knowledge) (Young *et al.*, 2002), which could also have had a negative effect on agility performance.

Psychological Indicators

Silva (1990) suggested that overtraining can result in psychophysiological breakdown, and this can easily be observed in long-term changes in mental state and changes in performance. This is better known as the overtraining syndrome. Psychological factors related to overtraining have been found to increase total mood disturbances, especially during high intensity training. Mood disturbances have been shown to increase with training, but can stabilize again with a reduction in training (Morgan *et al*,. 1987; Morgan & O'Connor, 1988; Raglin *et al*., 1990). Disturbed sleep can be an indication of under-recovery. Under-recovery can lead to mood disturbances such as low positive effect, anxiety and fear (Davis *et al*., 2007). A state of under-recovery can lead to emotional/physical exhaustion, sport devaluation, and a reduced sense of accomplishment (Readeke & Smith, 2001).

Psychological recovery is dependent on the athlete's perception of a certain situation and whether or not the athlete experiences it as stressful. Athletes have been found to show different coping mechanisms with stress, and therefore the recovery processes are specific to the individual. Kobasa (1979) examined athletes' coping abilities and named the specific characteristic hardiness. Hardiness is a personality characteristic that enables the individual to cope with and react to stressful situations in such a way that the stressor becomes a method of improvement, rather than something threatening (Kobasa, 1979). Hardiness consists of three components: commitment, control, and challenge (Kobasa *et al*., 1985). Athletes that show signs of hardiness are always in control of situations, committed to any activity, and can change a stressor into a necessity for personal development (Kobasa *et al*., 1985). Hardiness enables an individual to cope better with stress, and such individuals usually report less psychological distress (Goss, 1994).

Goss (1994) examined the relationship between hardiness and mood disturbances in 253 competitive swimmers. They found a positive relation between hardiness and age, suggesting that older or more experienced individuals showed improved methods to cope with stress. They also found increased mood disturbances over the season specifically increases in the fatigue scale. Further results showed that swimmers exhibiting hardiness have significantly lower feelings of tension, depression, anger, fatigue, confusion, and higher feelings of vigour compared to those lacking characteristics of hardiness. This indicated that individuals with hardiness are more capable of coping with stressful situations.

Even though athletes are physically fatigued, some athletes exhibit the ability to cope with the stress and maintain their performance levels.

Research has determined the influence of increased or decreased training loads on mood states and performance. It has been shown that an increase in training load results in a progressive increase in mood disturbances. Mood disturbance, which is a psychological marker of distress, was associated with physiological measures of overtraining (Morgan *et al*., 1988). Increased training load is regarded as one of the leading factors of psychological and social stressors. In this regard, players have reported increased exhaustion due to greater training volumes, more games per season, and shorter off-season periods (Creswell & Eklund, 2005). The best solution for an increase in exhaustion is complete rest, but coaches and athletes usually see this as underperformance and react by increasing training load and training intensity (Marshall, 2005).

A brief overview of a few studies will be given to further emphasize the importance of psychological recovery or recovery periods.

Hoffmann *et al*. (1999) examined seven male professional basketball players during a competitive season to investigate the relationship between mood states and performance. They found that when vigour scores decreased the team's performance declined, and when vigour scores returned to the normal levels their winning percentages increased. Anger and depression increased during the time frame where there was a decrease in vigour score, but the researchers suggested that it was independent of team performance. They found that both depression and anger might have been influenced by other experiences such as finances or coaching factors. Hoffman *et al*. (1999) concluded that in this particular study it appears that the players' mood states affected their performance, but it is not necessarily true all the time.

Changes in psychological mood states of 20 professional soccer players were examined by Filaire *et al*. (2003). They found typical iceberg profiles in Profile of Mood State (POMS) scores which coincided with successful performance. They did, however, find increased scores in Depression, Tension, Fatigue, and Anger between the second and third testing times. This was in a period of the year where the team's winning percentage fell below 50% of the games played. According to this data it seems that there is a relationship between performance and mood state, specifically Depression, Vigour, and Tension scores. The authors did, however, suggest that although the relationship between performance and mood state is clear, their results could not sort out whether the poor performance affected the changes in mood state, or if the poor performance was due to the change in mood state.

Morgan *et al.* (1987) studied 400 athletes (swimmers) within a realistic setting as opposed to where the training load had been manipulated experimentally. Over a period of ten years it was observed that the greatest amount of mood disturbance occurs after an intense micro-cycle. Inspection of the individual Profile of Mood States (POMS) scores revealed that the significant changes in global mood were due to a significant increase in fatigue and a significant decrease in vigour. It can be hypothesized that increased training load results in increased physical fatigue which can lead to psychological fatigue. Morgan *et al.* (1987) studied the effect increased training loads have on the psychological state of an athlete.

The process of overtraining, staleness, tapering and recovery can be illustrated by a case study by Morgan *et al.* (1987). The athlete was a 22 year old competitive swimmer at the time of testing who was exposed to a training load of 4000 yards per day during the first micro-cycle. At this point in time his total POMS score was 106. With an increase in training load the POMS increased to 165, reaching a maximum of 183, following a training load of 15000 yards of swimming per day. After a four week tapering cycle ending at a training load of 2500 yards per day, his POMS score decreased to 100. This case indicates that tapering can be effective if there is sufficient time available. This study indicates that with increased training loads and sufficient recovery time, positive mood states can be maintained.

The significance of recovery was illustrated by a study done by King *et al*. (2010), who monitored 30 regional rugby league players for changes in stress and recovery as a result of competing in a rugby league competition. They found that RESTQ-76-Sport scales such as Fatigue, Lack of Energy, and Success were significantly lower in the late competition weeks than in the pre-competition and early-competition weeks. They suggested that pre-match activities should facilitate team recovery and aid in reducing stress stimuli.

Behavioural and Social Indicators

Behavioural and Social recovery supports the biological processes, and by changing activities from one stressor to another, it can result in enhancing the recovery process. Behavioural recovery can span from vigorous activity to engaging in leisure activities, such as watching television. Watching television can be used to describe a self-determined process of recovery, but only when the athlete is in control of what he is watching (Botteril & Wilson, 2002). Coaches' behaviour during recovery periods or sessions may also influence the athlete's experience and have great effects on the athlete's performance. A restless coach, wrong or lack of debriefing, or other annoyances and irritations, may change a recovery session into a disturbed recovery (Kellmann & Kallus, 2001).

Social recovery takes place as a result of contact with people during social events, such as going to the movies, family meals, or parties. Interpersonal relationships, those with a friend, partner, or family, are more private and intimate of nature (Kellmann & Kallus, 2001). In their study where they monitored 30 rugby league players using the RESTQ-76-Sport questionnaire, King *et al*. (2010) found that during a competitive season social recovery decreased as the season progressed. In this particular study social recovery was at its lowest after the team lost a game. This could be due to the fact that an athlete will not participate in celebratory activities after a loss.

2.2.1 INTRODUCTION TO MONITORING

Training for peak performance must maintain a balance between performance outcomes and positive overload. Coaches often react to poor performance with increased training loads. Excessive physical training (high training load), incomplete recovery and high general stress may manifest in short-term performance reduction and altered mood states (Coutts *et al*., 2007a; Kuipers & Keizer, 1988). Further increases in training load, without adequate recovery periods allow the athlete to recover from altered mood states and performance reductions, can lead to overtraining (Kenttä & Hassmén, 1998; Kuipers & Keizer 1988; Meeusen *et al*., 2006). In a team sport setting this is where individuality is important. An appropriate load for one athlete may cause overtraining in another (Main & Grove, 2009). Thus, it is very important to be able to determine the optimum training load for every player in the team.

Different models have been studied to define the relationship between training load and possible overtraining. Bannister *et al.* (1975) proposed a statistical model to describe an athlete's response to a given training stimulus. According to this model, the performance of an athlete as a response to training can be calculated from the difference between a negative function (e.g. fatigue) and a positive function (e.g. fitness). Studies have described the training-performance relationship as similar to the dose-response relationship reported in pharmacological studies. The training-performance relationship's primary goal is to provide a training stimulus that maximises performance potential and minimises the negative consequences of training (injury, illness, fatigue, overtraining) (Morton, 1997).

Overload might occur if the athletes are not monitored on an individual basis. Fry, *et al.* (1991) defined four major categories of symptoms associated with overload, namely, a) physiological symptoms, b) psychological symptoms, c) biochemical symptoms, d) immunological symptoms. Athletes can, therefore, be monitored on these four levels. Main and Grove (2009) mentioned that monitoring athletes on a biochemical level can be invasive, expensive, time-consuming and often not practical for coaches and sports teams. Biochemical and physiological symptoms have been proposed as potential indicators of overtraining, but only a few have been shown to be consistent across different athletic disciplines. Stronger and more consistent relationships have been observed with self-report measures (Main & Grove, 2009). These measures appear to be sensitive to the symptoms of both short-term and long-term training distress, and exhibit reliable relationships with training load responses (Main & Grove, 2009; Raglin & Morgan, 1994). Self-report measures have the added advantages of being efficient, inexpensive, and non-invasive.

Many studies have examined non-functional overtraining (NFOR) or overtraining syndrome (OTS) in endurance athletes (Halson & Jeukendrup, 2004) and strength athletes (Fry & Kraemer, 1997), but limited research has looked at the prevalence of NFOR/OTS in team sport athletes (Filaire *et al*., 2001; Naessens *et al*., 2000). Naessens, *et al.* (2000) found that 30-50% of elite soccer players reported symptoms of NFOR or OT during a competitive season. Other research has shown that 7-30% of all elite athletes may show these overtraining related symptoms at any given time in their athletic career. The implication for high performance team athletes are that excessive training fatigue without adequate recovery can have detrimental effects on performance. Team sport athletes need simple and reliable methods of monitoring the extent of team sport athletes' overreaching conditions (Coutts *et al*., 2007a). The general consensus among researchers is that NFOR/OTS are caused by factors related to inappropriate structure of training and exercise programs, large increases in training load, monotonous training, travel, and other social factors (Foster, 1998; Lehmann *et al*., 1997; Meeusen *et al*., 2006).

A study among soccer players have shown that a combination of psychological and hormonal changes during high-intensity training are of major importance when monitoring training stress to measure performance (Filaire *et al*., 2001). It has been hypothesized that in a team-based setting, where the team performance outweighs the individual performance, it may be more appropriate to rather monitor changes in mood states on an intragroup basis (Pierce, 1999) than on intraindividual comparisons (Hoffman *et al*., 1999). Investigators have examined the relationship between haematological, biochemical, hormonal, immunological, and psychological measures, but only a few have examined whether it can be a useful tool for regular monitoring in the practical environment (Halson *et al*., 2002; Rietjens *et al*., 2005).

Professional rugby league is played over a long season, on a regular week to week basis, and it can be difficult to balance appropriate training and adequate recovery strategies (Coutts *et al*., 2008). Monitoring fatigue is important, but limited research examined the most appropriate methods to do so in professional rugby league players (McLean *et al*., 2010). The only available research that has been done on monitoring fatigue has examined athletes who were deliberately overtrained (Coutts & Reaburn, 2008; Coutts *et al*., 2007a, 2007c). It has been suggested that non-fatiguing performance measurements and biochemical markers may be useful in the monitoring of team sport athletes (Cormack *et al*., 2008). These measures have been shown to be effective in deliberately overtrained athletes (Coutts *et al*., 2007a, 2007c). Relatively few studies examined the usefulness of sub-maximal performance measurements and biochemical markers during a team sport season when athletes were not deliberately overtrained, but may also be showing symptoms of early stages of overtraining (Cormack *et al*., 2008; Elloumi *et al*., 2003; Filaire *et al*., 2001, 2003). Early detection of subtle symptoms of overtraining may allow coaches to adapt training programs and recovery strategies in order to avoid the detrimental effects of maladaptive training (McLean *et al*., 2010).

2.2.2 BIOCHEMICAL AND IMMUNOLOGICAL MONITORING

Increased intensity or increased volume of exercise and overload symptoms has been found to relate to specific physiological and biochemical reactions. Cortisol and testosterone levels seem to give a good idea about the athlete's "overtrained" condition (Banfi *et al*., 1993; Smith *et al*., 1987; Passelergue & Lac, 1999). Other biochemical parameters include creatine kinase that is related to muscular strain, and a sensitive marker for inflammation (Margeli *et al*., 2005; Peters *et al*., 2004; Urhausen & Kindermann, 2002). The inflammatory response to muscle trauma includes increases of neutrophil activity and secretion of myeloper-oxidase (Bury & Pirnay, 1995). Reduced glutathione (GSH) and oxidized glutathione (GSSG) has also been shown to result from overtraining (Margonis *et al*., 2007). Many biochemical and physiological parameters have been associated with symptoms of overtraining and staleness, but not one of them seemed efficient to be used as a diagnosis, with staleness resulting from the athlete's inability to adapt to the training schedule and having both psychological and biological symptoms (Jidovtseff & Crielaard, 2001).

Bresciani, *et al.* (2010) monitored 14 male handball players during a 40-week season on biological markers of inflammation, as well as oxidative stress, mood states and recovery-stress states. They found a correlation between training load and GSH/GSSG, and training load and C-reactive protein expression. Total leukocyte activity increased during the competitive period and stayed at increased levels during the recovery period of decreased training load. C-reactive protein also increased as the training load increased, but unlike the leukocyte count, returned to low values following a recovery period. GSSG increased during the competition phase and decreased with recovery. These biological and oxidative stress markers significantly relate to training load, but the psychological stability indicated that players maintained a balanced state between stress and recovery throughout the season.

McLean, *et al.* (2010) examined changes in neuromuscular fatigue and salivary hormones in 12 professional rugby league players between the ages of 20 and 30 years. They tested the neuromuscular and endocrine responses at three different duration recovery periods; 5, 7 and 9 days in-between match periods. Baseline countermovement jumps (CMJ) and salivary analysis were examined. Testosterone-cortisol ratio did not appear to be influenced by changes in training load and/or competitions. Cortisol did, however, decrease for 24 to 48h after the match and then increased up until four days after the match. Cortisol levels were the lowest for the 5 days cycle. This can be due to decreased training load resulting in lower stress responses. The CMJ performance decreased post-match, but reached its highest in-season value four days after the match. There was lower training load in the five days cycle compared to the 7 and 9 day cycles. McLean, *et al.* (2010) suggested that this might have been due to the coaching staff focusing on decreasing the training load in order to optimize recovery when there were only a short period between matches. These results show that careful manipulation of training load is important for neuromuscular recovery from rugby league match play.

Coutts, *et al.* (2007a) investigated changes in biochemical, immunological, physiological and psychological markers for monitoring fatigue and recovery in team sport athletes. Eighteen male rugby league players completed a six week physical training program. Players were allocated to either intense training (IT) group or normally trained (NT) group. After the six week training programme they all underwent one similar in training taper week. The main findings of Coutts *et al.*'s (2007a) investigation were that the multi-stage fitness test (MSFT) performance and VO2max significantly decreased during the six weeks in the IT group compared to the NT group. The only biochemical measurement that was different was the Glutamine/Glutamate (Gln/Glu) ratio which was significantly lower in the IT group than in the NT group after the six weeks, and a significant difference in the Gln/Glu ratio between the post-six weeks test of the IT and NT measurements. The data of the MSFT and Gln/Glu ratio suggests that it may be useful to use these measurements to monitor for training tolerance in team sport athletes.

Coutts, *et al.* (2007b) conducted a similar study with well-trained male tri-athletes. The 16 athletes participated in a four-week progressive overload training period followed by a two-week taper phase. Training included swimming, cycling and running. VO2max and a 3km running time trial were done for physiological and performance measurements. Blood samples were taken for biochemical analysis. A significant decrease in performance of the intensified training group (IT), and an increase in performance in the group that underwent normal training (NT) were observed. No significant difference in VO2max was observed. Free testosterone to cortisol ratio significantly increased, while cortisol decreased in the IT group compared to the NT group during the two-week taper phase. Hb concentrations increased significantly more in the IT group than in the NT group during the taper phase, and a significantly lower neutrophil count was observed in the IT group compared to the NT group at the beginning of the training and at the end of the training phase and the taper phase. Although there were changes in the biochemical measurements, it did not relate to the onset of overreaching or recovery. The authors thus suggested that performance measurements, but not biochemical of physiological measurements, may be useful indicators of overreaching.

2.2.3 PHYSIOLOGICAL AND PHYSICAL MONITORING

Performance changes happen on a regular basis and it is expected that monitoring these changes should happen by frequent testing (Brink *et al*., 2007). Performance is also related to the different periods of training within a season, and the athlete's aerobic improvement is expected to be higher at the beginning of the season compared to later stages in the periodized season (Brink *et al*., 2010a). This stresses the need to have regular field performance tests. The relationship between physiological, biochemical, immunological parameters and training load and the associated effects on performance have been well researched. Research mostly examined these factors to establish markers to monitor fatigue.

McLean, *et al.* (2010) examined neuromuscular changes throughout a 26 week rugby league season in twelve professional rugby league players. Changes in countermovement jump (CMJ) performance were calculated by measuring flight time and relative power. The results indicated that CMJ performance decreased post-match, but returned to its highest in-season levels four days after a match. Flight time of the CMJ was significantly reduced 24 hours after a match. Relative power of the CMJ was found to decrease with inappropriately high training loads, suggesting that the neuromuscular status of an athlete may be affected by training dose (McLean *et al*., 2010).

Brink, *et al.* (2010a) monitored training load, recovery, and performance among 18 young elite soccer players. They used the Total Quality Recovery (TQR) questionnaire, RPE (training load duration, and training load as an expression of RPE), heart rate recordings, and a sub-maximal interval shuttle run test (ISRT). They tested two models which incorporates training load duration (match and training duration), and training load from RPE scores, together with TQR one week and two weeks before performance testing, to test if performance outcome could be predicted. The researchers found that training load expressed as training duration significantly predicted performance outcome, and adding it to the model one week before performance test improved the model significantly more than adding it two weeks before testing. The author concluded that in well-trained soccer players, the amount of training in the week prior to performance tests strongly relates to the outcome of the test. This is in contrast to the findings of McLean, *et al.* (2010). They found that the week prior to the performance tests did not influence the outcome of the test. They found the neuromuscular status of the athlete only to be influenced by the training dose within the training phase and in the week of testing.

A way of monitoring physiological symptoms is to monitor heart rate recovery after exercise. Heart rate recovery after exercise involves a coordinated interaction of parasympathetic re-activation and sympathetic withdrawal. The parasympathetic system dominates during rest and the sympathetic system dominates more as the exercise intensity increases. This is reflected in the heart rate which decreases after exercise stops. Heart rate recovery is defined as the rate at which heart rate decreases in the first minute after moderate exercise and is a consequence of parasympathetic re-activation and sympathetic withdrawal (Borresen & Lambert, 2008; Lamberts & Lambert, 2009).

Physiological adaptations to training have been investigated as possible markers with which to monitor fitness, fatigue, overtraining and recovery. Particular attention has been focused on heart rate variability, largely as a means with which to evaluate cardiac autonomic control (Borresen & Lambert, 2008). Increases in training load over two weeks can cause a slower heart rate recovery after sub-maximal exercise (Borresen & Lambert, 2008). Other findings of this study showed that heart rate recovery tended to increase when training load was decreased. The advantage of measuring heart rate recovery is that it is easy to administer, non-invasive, and sensitive to change. Lamberts *et al.* (2004) developed the HIMS (Heart rate Interval-Monitoring System) to monitor changes in training status and to monitor fatigue in athletes. The HIMS test started out in the 1990's when the designers of the test were approached by the conditioning coach of a professional rugby team. They designed the HIMS test in response to the requirements defined by the conditioning coach:

- Elicits an intensity of about 90% of maximal heart rate for about two minutes, thus non-aversive to players, and can be conducted frequently.
- Lasts 12 minutes
- Requires minimal equipment, to enable the test to be portable and used while the team travels. (Cones, 20m measuring tape, heart rate monitors and an audio pacing tape.)

- Measures recovery heart rate which is sensitive marker of training status, and can predict imminent player fatigue.

There can also be a negative side to using heart rate to monitor fatigue or under-recovery. Technical errors can occur resulting in incorrectly recorded data or sometimes a complete loss of data.

Research has examined subjective tests to find out whether there is a relationship with heart rate methods. Foster, *et al.* (2001) looked at the stability of information received from the session RPE method and Heart Rate methods for monitoring training, specifically during high-intensity and excessive training bouts. They divided their research into two parts where the first part was to evaluate 14 cyclists during maximal incremental exercise on a cycle ergometer (Lode), with subsequent eight randomly assigned exercise training bouts. The second part saw seven basketball players running an incremental treadmill test according to an Åstrand protocol. Each player was subsequently monitored during a basketball practice session and/or competitive matches. Heart rate was measured using radiotelemetry and a thirty minute wait period was assigned after exercise before the subjects had to rate the overall difficulty of the training/exercise bout. They found a statistical significant difference between the two methods for the cyclers and the basketball players, but regression analysis showed that the pattern of differences was consistent among the various exercise bouts. This indicated to the authors that even though the quality of information between the RPE and Heart rate method differed, the same critical information can be gathered from it.

2.2.4 PSYCHOLOGICAL MONITORING

Highly motivated athletes and coaches usually respond to a plateau or drop in performance with increases in the training load (Kenttä & Hassmén, 1998). High intensity training and high volume of training associated with inadequate recovery may induce fatigue and it is necessary to include regular performance tests as well as measurements of stress indicators as the training loads increased (Filaire *et al.,* 2003). Bompa en Claro (2009) asserted that the greatest training-related factor leading to overtraining is a failure to include enough recovery in the training programme. Consequences of overtraining include increased susceptibility to injury and illness, increased negative mood states, decreased performance, severe fatigue, muscle soreness, reduced appetite, disturbed sleep patterns and concentration difficulties (Fry *et al*., 1994; Main & Grove, 2009; Meeusen *et al*., 2006; Raglin & Morgan, 1994). Main and Grove (2009) suggested that self-report measures are efficient means to monitor for overtraining and recovery. Existing approaches to the monitoring of training state via self-report measures can be placed in three categories based on psychological parameters.

Mood States

One of the tools that can be used to assess mood disturbances is the Profile of Mood States (POMS) questionnaire (González-Boto *et al*., 2008). Main & Grove (2009) demonstrated that increases in training load were reliably associated with increases in mood disturbance scores, and decreases in training load were reliably associated with decreases in mood disturbance scores. Studies also found a dose-response between training volume and mood disturbance, and found that an Iceberg profile is mostly seen at the onset of training (Morgan *et al*., 1987; O'Connor *et al*., 1989; Raglin *et al*., 1990). The POMS provides a measure of total mood disturbances and six mood states, namely Tension, Depression, Anger, Vigour, Fatigue, and Confusion (McNair *et al*., 1992). Kellman and Kallus (2001) indicated that some of the advantages of the POMS include its usefulness in detecting mood fluctuations in exercise, the easy data assessment, the fact that it can be administered to individual athletes and teams, and the fact that it has been shown to be a reliable instrument.

Terry and Lane (2003) stated that the use of the original tables of normative values might be inappropriate for use in the sport and exercise environments. Studies indicated that athletes tend to score lower than the 'lower population' on scales such as anxiety, anger, tension, confusion, and fatigue, and have a higher score than the 'normal population' on vigour (Morgan & Johnson, 1978; Nagle *et al.*, 1975). This pattern is better known as the "Iceberg profile". Early POMS research indicated that it is not yet clear whether changes in mood states influence performance, and if it is performance that influences mood states (Heyman, 1982; Prapavessis & Grove, 1991).

Terry, *et al.* (2003) developed The Stellenbosch Mood Scale (STEMS), as a measure of mood descriptors in both Afrikaans and English for use in the South African context. Terry *et al.* (2003) indicated that the STEMS is based on the Profile of Mood States – Adolescents (POMS), developed by Terry, *et al.* (1999). The researchers concluded that the STEMS has shown acceptable psychometric properties and that it could be a suitable measure of mood states for use by Afrikaans and English speakers. Another advantage of the STEMS is that it is very brief, making it a useful instrument during limited time. The POMS is widely used to assess mood states in athletes, although it was not originally developed for athletes. The STEMS, developed for and with athletes, is a valuable instrument specifically within the South African context.

Goss (1994) examined the relationship between hardiness and mood disturbances in 253 competitive swimmers. A comparison between scales from the POMS test and the *Cognitive hardiness inventory* showed increased mood disturbances over the season specifically increase in the fatigue scale. Further results showed that swimmers who showed hardiness have significantly lower feelings of tension, depression, anger, fatigue, confusion, and higher feelings of vigour, when compared to those not showing characteristics of hardiness. This coincides with Kobasa's theory: Hardiness is a personality characteristic that enables the individual to cope with and react to stressful situations in such a way, that the stressor becomes a method of improvement rather than something threatening (Kobasa, 1979). This indicates how important it is for the coach and management team to monitor team-athletes on an individual basis and to know which athletes show characteristics of hardiness.

Morgan *et al.* (1987) attempted to demonstrate that monitoring of mood states during a given macro-cycle offers a potential method of quantifying distress and titrating training loads on an individual basis. The study demonstrates the efficacy of including psychological parameters in the effort to create monitoring models designed to prevent the onset of staleness.

Knowledge regarding psychological indicators of injury in elite sport is far from complete, and research has been somewhat contradictory. There is limited support for a direct positive relation existing between injury and variables of tension, anxiety, hostility, anger. Further examination of psychological predictors of injury may be beneficial for the sports community, especially for developing cost effective, injury preventative training programs (Lavallee & Flint, 1996; Thompson & Morris, 1994).

Perceived stress and recovery

Another approach to the monitoring of training distress via self-report measures focuses on perceived stress. It has been argued that training-specific stressors might combine with various sources of stress outside of sport to influence an athlete’s mental and physical readiness to perform (Coutts, 2007). Rushall (1990) suggested that it was particularly important to monitor perceived stress during periods of heavy training, because of the potential for perceived stress to increase fatigue levels and, in turn, decrease performance capabilities. Other data indicated that over-trained states were influenced by non-training stressors as well as the demands of physical training (Main & Grove, 2009).

Kellman and Kallus (2001) argued that the POMS might not be fully equipped to measure overtraining status as it does not include questions regarding recovery strategies. They thus developed the 76-item Recovery-Stress Questionnaire for Athletes (RESTQ-76-Sport) to systematically measure the recovery-stress states of athletes. This indicates the extent to which persons are physically and/or mentally stressed, whether they are capable of using individual recovery strategies, as well as recovery strategies used. By doing so it ultimately measures the balance between stress and recovery factors. The questionnaire is based on the hypothesis that an accumulation of stress in different areas of life, at least with insufficient recovery possibilities, leads to a changed psychophysical general state. As the initial state changes, the athlete’s capacity to act and perform also changes, along with their potential for adapting to further stressors (Kallus, 2000).

An advantage of the RESTQ-76-Sport can be that it has a systematic multi-level approach, and might be used as an instrument for recommendations towards specific intervention strategies. The RESTQ-76-Sport measures general parameters of training stress which can be used in the planning of recovery strategies. The stress scales and recovery scales will be explained in Table 2.1 and Table 2.2. respectively.

Table 2.1. Defining the stress scales of the RESTQ-76-Sport.

Scale	Explanation
General Stress	Nonspecific stress reactions that manifests in frequent indications of mental stress, depressed mood, and listlessness.
Emotional Stress	Deals with anxiety, inhibitions, and irritation
Social Stress	Measures the frequency of arguments, fights, irritation concerning others, and general upsets
Conflicts/Pressure	Assesses whether conflicts were unresolved, unpleasant things had to be done, goals could not be reached, or certain thoughts could not be dismissed
Fatigue	Deals with being constantly disturbed during important work
Lack of Energy	Indicates ineffective work behaviour, such as a lack of concentration, energy, and decision making
Physical Complaints	Relates to physical indisposition and complaints
Disturbed Breaks	Sensitive to deficiencies of recovery and interrupted recovery during periods of rest (e.g., halftimes, time-outs), both of which can impair subsequent performance
Emotional Exhaustion	Characterized by wanting to give up or lack of persistence. Relates to any disappointments in the context of sport that might lead to quitting the sport.
Injury	Any statements dealing with injuries, vulnerability to injuries, and an impairment of physical strength.

Table 2.2. Defining the recovery scales of the RESTQ-76-Sport

Scale	Explanation
Success	Relates to pleasure at work, having lots of ideas, and achievement.
Social Recovery	Assesses the frequency of pleasurable social contacts and change combined with relaxation and amusement.
Physical Recovery	Physiological relaxation and fitness
General Well-Being	Assesses frequency of good mood and high well-being, general relaxation and being content
Sleep Quality	Absence of trouble falling asleep and interrupted sleep
Being in Shape	Assesses subjective feelings about performance ability and competence, one's perceived fitness, and vitality
Personal Accomplishment	Appreciation and empathy within the team and the realization of personal goals in sport
Self-efficacy	measures the level of expectation and competence regarding an optimal performance preparation in practise
Self-regulation	Availability and use of psychological skills when preparing for performance (e.g., Goal setting, mental training, motivation)

Coutts *et al.* (2007b) did a study with 16 well-trained male triathletes. The athletes participated in a four-week progressive overload training period followed by a two-week taper phase. The RESTQ-76-Sport questionnaire was administered for psychological measurements. They found that during an overload phase, there was an increase in total stress and a decrease in total recovery. This was significantly more pronounced in the intensified training (IT) group than in the normally trained (NT) group. After the taper phase the IT group showed significant better homeostatic responses than the NT group, with a decrease in total stress and an increase in total recovery values. They also found that the recovery-stress state was significantly affected with changes in training load. This result is in agreement with the researchers' original hypothesis which suggested that psychological measurements would be useful indicators of overreaching.

Grobbelaar *et al*. (2010) compared 41 elite student rugby players' recovery-stress, burnout and mood states, based on position, experience level and starting status of the player. They made use of the Athlete Burnout Questionnaire (ABQ), RESTQ-76-Sport and STEMS questionnaires. They found statistical significant differences in positional data, experience level and starting status. The forwards showed more favourable scores than the backline players. These results differ from previous research done by Creswell & Eklund, (2006) where they reported the forwards to have significantly higher scores on the Sport Devaluation subscales than the backline players. Grobbelaar *et al.* (2010) also found higher scores for Emotional/Physical exhaustion among the forwards than in the backline players. More experienced players showed greater total mood disturbance scores and more negative mood state scores than the less experienced players. This coincide with Creswell and Eklund's (2006) findings that professional players with more national level experience showed higher Sport Devaluation and Emotional/Physical Exhaustion scores. Grobbelaar *et al.* (2010) concluded that the monitoring of rugby players should include factors such as playing position, experience level and starting status.

Bresciani *et al.* (2010) examined 14 male handball players during a 40-week season while monitoring mood states (POMS) and recovery-stress states (RESTQ-76-Sport). They found that training load correlated with some of the RESTQ-76-Sport subscales, such as Being in Shape, Physical Recovery, and Injury. Although there were significant relations in some of the subscales to training load, no significant changes were observed in total stress, total recovery or the recovery-stress state. There were no significant changes in total mood disturbance throughout the season. There were significant changes in the biological and physiological outcomes of this study, but the insignificant data from all the psychological questionnaires indicated that even though the handball players developed small elevations in inflammatory and oxidative states, the athletes maintained the stress-recovery balance across the entire season (Bresciani *et al.*, 2010).

Behavioural symptom checklists

An integrative and inexpensive, but effective method of monitoring is the use of monitoring charts. Calder (2000) stated that a training diary or logbook is one of the most important tools for every athlete. Apart from training details, recordings of morning resting heart rate, body weight variations, and incidences of infections and/or injuries can be made. Subjective ratings of fatigue, the quality and quantity of sleep, muscle soreness, levels of academic work, or financial stress, inability to respond to relaxation techniques, the quality of primary relationships (family and friends), and the quality of secondary relationships (coach and team-mates) can be indicated on a scale varying between very low or bad, and very high or good. A lifestyle profile can be incorporated, where athletes can identify areas within their lifestyle that could be compromising their regeneration and performance. It is suggested that the coach or trainer should look at the athlete's charts on a regular basis, adapt or modify the training programme if needed, and assess recovery strategies (Bompa, 2009; Jeffreys, 2005). The use of recovery logs can be enhanced by the regular use of questionnaires. These assessment tools should be used at training camps, as well as over an entire season as part of regular training routines. These tools can start an educational process for athletes and coaches, as well as fostering the interdisciplinary co-operation between all involved in the athletic environment (Kellmann, 2010).

A variety of such checklists have been used, based on observations of muscle soreness, general lethargy, insomnia, loss of appetite, and/or susceptibility to minor illness during periods of high-intensity training (Fry *et al*., 1994; Main & Grove, 2009). Hooper and Mackinnin (1995) concluded that self-reported ratings for quality of sleep, fatigue, stress, and muscle soreness could provide an effective means of monitoring both overtraining and recovery. A study with military personnel found that during periods of high-intensity overload training symptoms related to general fatigue, sleep difficulties, physical complaints, poor concentration, appetite changes, and increased emotional responses were more pronounced (Fry *et al*., 1994). Hooper and Mackinnin (1995) saw similar patterns and concluded that self-reported ratings for sleep, fatigue, stress and muscle soreness could be beneficial to the monitoring of both overtraining and recovery.

Main and Grove (2009) simultaneously assessed mood disturbance, perceived stress, and physical symptoms. Their study included 370 males and 122 females from 26 different types of sports. The Brunel Mood Scale (BRUMS) (Terry *et al.*, 2003), 10-item perceived stress scale (PSS) (Cohen *et al.*, 1983), and the 19-item training stress scale (TSS) (Grove & Sheperdson, 2005) were used to asses mood disturbance, perceived stress and physical symptoms. Their findings identified depressed mood, perceived stress, and reduced vigour as psychological indicators of training distress. They also found that sleep disturbances, physical symptoms, and general fatigue correlated with training distress. This study indicated how important it is to develop a multi-component measurement tool to monitor for training distress.

McLean *et al.* (2010) examined perceptual fatigue responses during a competitive season with three different durations of between-match recovery periods. The athletes completed a custom-made psychological questionnaire that was based on Hooper & McKinnon's (1995) recommendations. Overall well-being was calculated by adding up scores from the fatigue, sleep quality, stress levels, general muscle soreness, and mood scales. Post-match increases in fatigue, muscle soreness and poorer overall well-being were detected. These scores did however improve in the days after the match. The player's perception of overall well-being returned to normal baseline levels four days after the match in the 5, 7 and 9 day cycles. McLean *et al.* (2010) suggested that psychological questionnaires are useful tools in monitoring in-season fatigue in professional rugby league players.

Training Load

Monitoring training load has been found to be important in enhancing athletic performance and equip the coaching and management staff to incorporate varying periods of hard and easy training (Banister *et al.*, 1975; Brown, 2000; Busso *et al.*, 1997). Foster *et al.* (2001) noted that measurement of training load and training volume does not take into account the importance of high-intensity training bouts.

In ball team sports, training load is prescribed by the coach and is often referred to as external load. External load is the duration of the training session and expressed as low, medium or high intensity (Brink *et al*., 2010b). Internal load is the actual physiological stress that the athlete experience. The internal load is very individual specific, as it accounts for factors such as initial fitness level and psychosocial aspects (Impellizzeri *et al*., *2005*). The overall assumption is that training load and sufficient recovery can lead to enhanced performance. Therefore, a training program should not only focus on training load but also on incorporating sufficient recovery (Kenttä & Hassmén, 1998).

Brink *et al.* (2010b) monitored training load, and performance in eighteen young elite soccer players. They used the RPE (training load over time, and training load as an expression of RPE), and a submaximal interval shuttle run test (ISRT). Brink *et al.* (2010b) found that training load expressed as training duration significantly predicted performance outcome, and adding it to the model one week before performance test improved the model significantly more than adding it two weeks before testing.

Training load has been compared to measures of heart rate and Foster (2001) found that the same critical information can be gathered from the RPE and the Heart rate method. Foster *et al.* (2001) suggested that the simplicity of session RPE might be of greater practical monitoring value than the heart rate technique, due to technical difficulties that may be encountered using heart rate monitors (e.g. incorrect recording or lost data). Foster *et al.* (2001) also found that the session RPE method is easy to use, reliable, and consistent with objective physiological indices of intensity of training.

2.3.1 OVERVIEW OF RUGBY

Rugby is a physical contact sport that is played internationally. The levels of participation are junior, amateur, sub-elite and elite. The nature of rugby is for players to intermittently collide with the opponent to gain possession of the ball. This characteristic of the game requires the players to be strong, fast, and powerful. Players also need to be agile, flexible and have a good aerobic endurance (King *et al.*, 2010). In professional teams, the financial aspect of the game associated with success and failure increase the pressure on coaches and management staff to maximize the player's performance (Brooks *et al*., 2008).

2.3.2 RUGBY: A COLLISION SPORT

Collision sports (e.g. rugby, ice hockey, and lacrosse) are characterised by Gabbett (2004) as large numbers of physical collisions and tackles, short repeated sprints, rapid accelerations and decelerations, changes of direction, and an ability to produce rapid high muscular force. Collision sport athletes are required to have well developed speed, strength, muscular impulse, agility, and maximal aerobic power (VO2max). Previous studies of collision sport athletes have reported a relationship between training loads and the rate of training injuries (Gabbett, 2004), suggesting that the harder these athletes train the more injuries they will sustain. Reductions in training loads have been shown to reduce training injury rates and result in greater improvements in VO_2max (Gabbett, 2004). Collision sport athletes who perform less than 18 weeks of preseason training before sustaining an initial injury are at increased risk of sustaining a contact injury (Gabbett & Domrow, 2007). Training for collision sports reflects a balance between the minimum training load required to improve fitness and the maximum training load before sustaining noticeable increases in injury rates. While models of the training-performance relationship have been constructed for athletes from individual sports (Avalos *et al.*, 2003; Bannister & Calvert, 1980; Bannister *et al.*, 1975; Stewart & Hopkins, 2000), studies of the training-performance relationship of team sport athletes are limited (Filaire *et al.*, 2003).

Gabbett and Domrow (2007) wanted to develop statistical models that estimate the influence of training load on training injury and physical fitness in collision sport athletes. They studied 183 sub-elite rugby league players over two competitive seasons for incidence, site, nature, cause, and severity of training injuries. They observed a relationship between training load and likelihood of injury during the pre-season, early-competition and late-competition training phases, resulting in an increase in the likelihood of injury as training load increased. During the pre-season training phase, there was a significant relationship between team training load and the incidence of injury, but not significant relationship was found in the early- and late-competition phases.

Recent evidence has shown that most collision sport training injuries occur in the pre-season preparation period when training loads are greatest (Gabbett, 2004). However, it has also been shown that collision sport athletes that perform less than 18 weeks of pre-season training before sustaining an initial injury are at increased risk of sustaining a subsequent injury, while players with a low off-season VO2max are at increased risk of sustaining a contact injury (Gabbett & Domrow, 2007). The finding of increased injury risk with less than 18 weeks of pre-season training, together with the lack of a relationship between training load and injury frequency in the early-competition and late-competition training phases, suggest that an appropriate pre-season preparation is necessary to provide collision sport athletes with adequate physiological capacities to tolerate the demands of competition, and enhance muscoskeletal development to adapt positively to further increases in training load.

In a recent study by Theisen et al. (2012) it is suggested that team-sport players have a higher chance of being injured. This is not only because of the physical contact, but might be due to more weekly competitions. Players in a team-based setting can often not regulate their own tempo, and this emphasises the importance of monitoring individual players as well as incorporating sufficient recovery (Theisen *et al*., 2012).

2.3.3 DIFFERENCES IN PLAYING POSITION

Mashiko *et al.* (2004b) analysed pre- and post-match physical and mental fatigue in 37 university rugby players by comparing blood parameters, immune function, and Profile of Mood states (POMS) scores separately for forwards and backs. One of the objectives of the study was to explain the relationship between physical stress and mental fatigue caused by physical activity. Results show that a rugby match caused subjects in both the forwards and the backs to experience physical and mental fatigue. Mashiko *et al.* (2004b) observed greater protein catabolism in the forwards group than in the backs and suggested that it may be due to the different styles of play of the two groups, with the forwards group experiencing much more contact play than the backs. Backline players' mental fatigue can be attributed to the degree of energy metabolism. The backline players are likely to be influenced by protein catabolism and energy metabolism, whereas the forwards are likely to be influenced by protein catabolism, degeneration and injury to muscle tissue, energy metabolism, and anti-inflammatory response.

Mashiko *et al.* (2004b) suggested that as in addition to running, the forwards players sustain intense muscular impact at a high frequency. Playing a rugby football match causes players both physical and mental fatigue, and that the position related difference in activity is responsible for differences in physical and mental fatigue between the forwards and backline groups (Mashiko *et al*., 2004a, 2004b). Grobbelaar *et al.* (2010) examined the psychological stress and recovery levels of 41 male rugby union players. They found the backline players to have significantly higher scores for sport-specific stress (calculated by the RESTQ-Sport questionnaire), and significantly higher Emotional/Physical Exhaustion (calculated by the Athlete Burnout Questionnaire) than those reported by the forwards.

The differences in training load between playing positions most likely reflect the different physiological capabilities of players, the different skills and physical demands of different positions, and the specific training performed by these positions (Gabbett, 2004). Further research done by Gabbett and Domrow (2007) tried to develop statistical models that estimate the influence of training load on training injury and physical fitness in collision sport. They examined 183 sub-elite rugby league players over a period of nine months. Quantification of training load was estimated by the RPE scale, and injuries were assessed and recorded. They found that the forwards had higher overall training loads than the backs, with outside backs having the lowest training loads of all. Although a relationship was observed between the log of training load and likelihood of injury in all training phases, the only time there was a relationship between these two variables was during the pre-season training phase.

Forwards have been found to run more than the backs, but rarely reaching peak sprint speed, whereas the backs use higher velocities throughout the whole game (Bompa & Claro, 2009). Table 2.3 also shows the amount of tackles, rucks, and mauls with the forwards more involved in physical contact situations than the backs. This could have implications for the type of fatigue and different recovery requirements of different playing positions. Table 2.4 indicates the relationship between the forwards and backs regarding low intensity and high intensity activities during the game.

Table 2.3 Motion analysis of players in international game (adapted from IRB 2003).

	Fly Half	Center	Wing	Prop	Flanker
Sprinting	0:27	0:19	0:31	0:00	0:03
High Speed Running	2:36	1:25	1:44	0:27	1:08
Running	5:10	3:36	3:42	5:35	5:56
Jogging	14:34	14:45	12:40	16:06	13:36
Walking	47:20	54:45	57:00	56:38	51:10
Number of tackles	15	12	9	15	25
Number of rucks/mauls	22	22	16	40	46

Table 2.4 Players intensity effort (adapted from Brandon 2004).

	Front Row Forwards	Back Row Forwards	Inside Backs	Outside Backs
Average high intensity effort per game	128.5	113.5	51.5	41.6
Average duration of high intensity effort	5.0 sec	5.2 sec	4.2 sec	5.2 sec
Average duration of low intensity effort	35 sec	37 sec	88 sec	115 sec

Low intensity was categorized as standing, walking, jogging, side/backwards stepping. High intensity was categorized as running, sprinting, rucking/mauling, scrumaging and tackling (Bompa & Claro, 2009: 42). Rugby is a game where players alternate between high intensity work and low intensity activities. Each position on the field has a specific task in certain situations and therefore training for each position should be different in the context of the game.

Table 2.5 The analysis and work description of the different playing positions characterised as a “forward” player

Position	Function
Props	Ball winners. Essential to scrum and line-outs’ technique and strength. Provides work rate in rucks, mauls, and tackles, specifically clearing it.
Hooker	Ball carrier. More mobile than props, often defending with loose forwards and supporting backs. Major decision maker in the forwards.

Position	Function
Locks	Win balls in line-out. Must keep momentum in providing a quick ball for attack. Driving force behind props in the scrum.
Blind side Flanker	Supports the ball carrier, anticipating and making good tackles. Must always be in play and add speed and penetration power to the team. Decision maker.
Open side Flanker	Prominent at the breakdown to stick to the ball, often called a “fetcher”. Fast, powerful, technically sound, agile, tackling machines and be in a position to make decisions.
Eighth man	Coordinator at the back of the scrum, and acts as a link with the scrum-half and the backline players. Supports the open side flanker in attack and defence. Must be a powerful runner, with excellent ball skills as he is a strong ball carrier.

Table 2.5 explains the major functions of each playing position that falls into the forwards category. Each position has different responsibilities towards the team and the game, and this may result in different playing positions experiencing different stress and recovery levels. Table 2.6 explains the major functions of each playing position that falls into the backline players category.

Table 2.6 The analysis and work description of the different playing positions characterised as a “backline” player

Position	Function
Scrum-half	Symbol of decision making and tactical soundness. Skills include organization, vision, game understanding, support, linkage, technical skills, quickness, communication and leadership. Link between forwards and backs. Forwards conductor. Distributor of quick and quality balls.

Position	Function
Fly-half	Symbol of decision making and tactical soundness. Backs conductor. Must be able to read the game, communicate, direct and transfer play, adjust team's position. Running, passing, kicking, and tackling. Read the situation and take a good attacking option.
Centres	Carry attack moves and provide impenetrable defence in the midfield. Make excellent attacking options and get the ball into space. Kick chasers. Must be fast and strong and able to compete for the ball in the air. Decoy runners to allow strikers to hit the created space. Must be able to make decision according the opponents defence. Good passing and kicking.
Wings	Must be fast, powerful, agile, strikers by excellence, score tries, and win games. Usually conclude a great tactical movement. Must make maximum use of available or given space. Analyze the game and find space, keep the ball alive, and carry on continuity by creating space for support players.
Fullback	Space creator. Last line of defence on high kicks and chase. Be good with man on man defence situations. Must close space and gaps for opposition and create opportunities for teammates. Should support ball carrier for offload possibilities. Also an efficient decoy runner.

(Bompa & Claro, 2009: 55 – 68; Pool, 2009)

CHAPTER THREE

PROBLEM STATEMENT

3.1 SUMMARY OF LITERATURE

The athlete's ability to cope with stress together with the recovery state determines how the athlete will handle subsequent stressors and the influence it will have on performance (Kallus, 2000). Not only is the intensity of the stress an important factor, but the duration, distribution over time, and the nature of the stress also play important roles. If increased stress is not balanced out by sufficient recovery, the athlete will experience more stress. If recovery demands cannot be met, the athlete will be stressed beyond the point of failure, and may need to find other ways of coping with the stress. Overtraining often results from the inability of the athlete to cope with this unbalanced stress-recovery relationship.

Impaired performance due to insufficient recovery can be transitory, lasting for a couple of minutes or hours, or last for longer periods up to several days or even weeks (Barnett, 2006). Monitoring factors that influence the stress-recovery balance is critical to the maintain performance and prevent the athlete from sustaining long term injuries or health problems.

Kallus and Kellmann (2000) discussed different levels of recovery e.g., physiological recovery, psychological recovery, behavioural recovery, social recovery, mood-related recovery, emotional recovery, and environmental recovery. Athletes can be monitored on four levels e.g. physiological, biochemical, immunological, and psychological. Monitoring athletes on a biochemical level can be very invasive, expensive, time consuming and often not practical for a lot of coaches and sports teams. Biochemical, immunological, and physiological symptoms have been proposed as potential indicators of overtraining, but only a few have been shown to be consistent across different athletic disciplines. Stronger and more consistent relationships have been observed with self-report measures (Main & Grove, 2009). These measures appear to be sensitive to both long-term and short-term stress symptoms, and show reliable relationships with the training load response (Main & Grove, 2009; Raglin & Morgan, 1994).

Self-report measures have the added advantages of being efficient, inexpensive, and non-invasive. This is an important factor to take into account for designing monitoring models, especially where there are repeated measurements and insufficient funding. Psychological tests or self-report measures include RPE (rate of perceived exertion), POMS/STEMS, RESTQ-76-Sport, training diaries, behavioural symptoms checklists, and ABQ questionnaire. Coaches will need to develop coping skills for players to maintain focus during technical and tactical skill development even when they have high levels of fatigue (Bompa & Claro, 2009).

Team sport athletes need simple and reliable methods of monitoring the extent of team sport athlete's overreaching conditions (Coutts *et al*., 2007a). Many researchers have attempted in constructing models where training load correlates with mood states and occurrence of injuries in order to identify markers of overtraining or possible injury (Bannister *et al*., 1975; Gabbett & Domrow, 2007; Lavallee & Flint, 1996; Thompson & Morris, 1994).

It has been established that monitoring the stress-recovery state in athletes are important, and psychological variables are easy to administer, non-invasive and cost effective. Monitoring models have been constructed, but it was mostly to correlate training load with mood states and injuries, and the most efficient way of monitoring team sports athletes on an individual and team basis is yet to be determined.

3.2 LIMITATIONS IN THE LITERATURE

Professional rugby union is played over a long season, on a regular week-to-week basis, and it can be difficult to balance appropriate training and adequate recovery strategies (Coutts *et al*., 2008). Monitoring fatigue has been establish as being important, but limited research examined the most appropriate methods to do so in professional rugby union players (McLean *et al*., 2010). There is limited available research that has been done on monitoring fatigue and deliberate overreached athletes were mostly examined (Coutts & Reaburn, 2008; Coutts *et al*., 2007a, 2007c). While models of the training-performance relationship have been constructed for athletes from individual sports (Avalos *et al*., 2003; Bannister & Calvert, 1980; Bannister *et al*., 1975; Stewart & Hopkins, 2000), studies of the training-performance relationship of team sport athletes are limited (Filaire *et al*., 2003).

In individual sports researchers studied training distress, training variables, mood states, and performance variables and also monitored for these variables. This includes sports such as swimming, cycling, rowing, athletics, speed skating, triathlon, martial arts, gymnastics, cricket, golf, diving, and tennis (e.g. Chen *et al*., 2008; Davis *et al*., 2007; Foster, 1998; Galambos *et al*., 2005; Hooper *et al*., 1999; Kalda *et al*., 2004; Lamberts *et al*., 2009; Mäestu *et al*., 2007; Mendez-Villanueza *et al*., 2010; Morgan *et al*., 1987). Limited research is available on the above-mentioned effects on team sports athletes. Team sports include football, soccer, rugby union, rugby league, handball, and basketball (Coutts & Reaburn, 2008; Filaire *et al*., 2003; Gabbett & Domrow, 2007; Grobbelaar *et al*., 2010; Hoffman *et al*., 1999; McLean *et al*., 2010; Meister *et al*., 2011).

Lambert developed the HIMS test (Heart rate Interval-Monitoring test) to monitor changes in training status and to monitor fatigue in athletes. Research has looked at the relationship between heart rate and other fatigue or recovery variables (Borresen & Lambert, 2008, 2009; Coutts *et al*., 2007; Lamberts & Lambert, 2009). Lamberts *et al.* (2010) used heart rate recovery as a guide to monitor fatigue. The use of heart rate recovery to measure performance parameters are not well researched and the reason may be that heart rate monitors are not always reliable, and that there is a lot of factors that influence the relationship between work load and heart rate.

There is, however, a limitation in research with respect to the HIMS test being used as a measure of heart rate recovery. Another limitation in research is that heart rate recovery has been compared with training loads and performance parameters (Lamberts *et al*., 2010), but not with changes in mood states and other psychological variables.

AIM OF THE STUDY

The primary aim of this study was to monitor the stress and recovery states in U/20 semi-professional rugby union players over a training year.

Objectives:

1. To assess changes in heart rate recovery (measured by the HIMS) over the training year, and to determine differences between forwards and backline players.

2. To assess changes in mood states (measured by the Stellenbosch Mood Scale)(STEMS) over a training year, and to determine differences between forwards and backline players.

3. To assess changes in Self-Report measurements over the training year, and to determine differences between forwards and backline players.

4. To examine the Rating of Perceived Exertion (RPE) for each training session, and assess the changes in training load, training monotony, and training strain over a training year, and to determine differences between forwards and backline players.

5. To assess changes in the recovery-stress state (measured by the Recovery-Stress Questionnaire)(RESTQ-76-Sport) of the players, and to determine differences between forwards and backline players.

6. To determine the relationships between the heart rate recovery (HIMS data), mood states, training load, training monotony, training strain, self-report and the recovery-stress state among the total group of rugby players.

CHAPTER FOUR

METHODOLOGY

4.1 STUDY DESIGN

This study is descriptive and explorative of nature. Stress and recovery related questionnaires, mood state questionnaires and a heart-rate interval recovery test were used to monitor the stress and recovery levels of the U/20 rugby union players. A sampling by method of convenience was used to select participants.

4.2 PARTICIPANTS

55 male rugby union players, from a semi-professional club, between the ages of 18 and 20 volunteered to participate in this study. The players competed at club and also provincial level (the highest level of competition in the province for teams and players). Participants were assigned to either the “forwards” group or the “backline” group, depending on the position they played at the Western Province Rugby Institute (WPRI). The “forwards” group included the props, hooker, locks, flankers and the eighth man. The “backline” group included the scrumhalves, fly halves, centres, wings and fullbacks.

Inclusion and Exclusion Criteria:

Participants were male rugby players at the WPRI, between the ages of 18 and 20. Participants were pre-screened by a physiotherapist at the WPRI for competency to participate in this study. Participants were included in the study if they had no injuries that would require surgery or injuries that would result in the absence from training sessions during one or more of the training phases. Participants with above-mentioned injuries were however allowed to complete the questionnaires, but not participate in the heart rate recovery test (HIMS). Players were excluded if they failed to complete 85% or more of the tests during a specific training phase. Players with long-term injury/injuries were also excluded from the study. Three players were excluded from the study due to long-term injuries acquired in the first three weeks of the training year.

4.3 EXPERIMENTAL DESIGN

Place of Study

This study was conducted at the Department of Sport Science, Stellenbosch University, and the residence of the WPRI. Two indoor halls with artificial surfaces were used for the HIMS test, whereas one of the lecture rooms at the Department of Sport Science and the computer area in Huis Neethling were used for the completion of the questionnaires and the electronic forms.

Procedures

On arrival at the WPRI, the players underwent initial anthropometry evaluations (BMI, skinfolds, weight, height), as well as fitness tests (vertical jump test, repeated sprint test, 10m and 40m speed test) under supervision of the WPRI physiotherapist, as well as the biokineticist and conditioning specialist working with them. The whole squad were then introduced to the mechanisms of monitoring and the importance thereof for a rugby player. The protocol of each test was explained to the players; how, when and where it will be conducted. All participants received a verbal and visual explanation of the tests. After this they were given a consent form which they had to read and then sign. During the first week of the study, every test was explained and facilitators were given permission to help the participants with further explanation of the questionnaires to ensure that each participant knew what the question asked meant. For the rest of the testing period only protocol specific feedback was given, as to prevent the participants from deviating from the test's specific protocol.

Testing Schedule

The heart-rate recovery test (HIMS) and the mood state questionnaire (STEMS) were completed on a weekly basis: on a Monday morning before breakfast and after the morning training session respectively. The RPE-ratings, which had been electronically uploaded on a computer, were completed everyday of the week, 3 times a day, after each training session. On the days when no training or matches occurred, no ratings were recorded. Each player had his own password-protected file, which only he and the sole investigator had access to.

The stress and recovery questionnaire (RESTQ-76-Sport) was completed once a month during the developmental, transitional and early competition phases, and during the performance and high performance phases more than once a month. The participants also completed a training diary everyday of the week, on training and non-training days. The testing was conducted over the period of 27 weeks. Table 4.1 will show the exact outline of the testing schedule.

Table 4.1: The weekly outline of contact sessions with rugby players for the five phases.

Developing Phase						
Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
RPE	RPE	RPE	RPE	RPE	RPE	RPE
SELF-REPORT	SELF-REPORT	SELF-REPORT	SELF-REPORT	SELF-REPORT	SELF-REPORT	SELF-REPORT
HIMS	HIMS	HIMS	HIMS	HIMS	HIMS	HIMS
STEMS	STEMS	STEMS	STEMS	STEMS	STEMS	STEMS
		RESTQ			RESTQ	

Transitional Phase			
Week 8	Week 9	Week 10	Week 11
RPE	RPE	RPE	RPE
SELF-REPORT	SELF-REPORT	SELF-REPORT	SELF-REPORT
HIMS	HIMS	HIMS	HIMS
STEMS	STEMS	STEMS	STEMS
			RESTQ

Early Competition Phase					
Week 12	Week 13	Week 14	Week 15	Week 16	Week 17
RPE	RPE	RPE	RPE	RPE	RPE
SELF-REPORT	SELF-REPORT	SELF-REPORT	SELF-REPORT	SELF-REPORT	SELF-REPORT
HIMS	HIMS	HIMS	HIMS	HIMS	HIMS
STEMS	STEMS	STEMS	STEMS	STEMS	STEMS
			RESTQ		

Performance Phase						
Week 18	Week 19	Week 20	Week 21	Week 22	Week 23	Week 24
RPE	RPE	RPE	RPE	RPE	RPE	RPE
SELF-REPORT	SELF-REPORT	SELF-REPORT	SELF-REPORT	SELF-REPORT	SELF-REPORT	SELF-REPORT
HIMS	HIMS	HIMS	HIMS	HIMS	HIMS	HIMS
STEMS	STEMS	STEMS	STEMS	STEMS	STEMS	STEMS
				RESTQ		RESTQ

High Performance Phase		
Week 25	Week 26	Week 27
RPE	RPE	RPE
SELF-REPORT	SELF-REPORT	SELF-REPORT
HIMS	HIMS	HIMS
STEMS	STEMS	STEMS
	RESTQ	RESTQ

Table 4.2. Duration and content of the five training phases.

Phase	1. Developing	2. Transitional	3. Early Competition	4. Performance	5. High Performance
Weeks	7 weeks 29 March – 16 May †	4 weeks 17 May – 13 June †	6 weeks 28 June – 8 August	7 weeks 9 August – 3 October †	3 weeks 4 October – 24 October
Description of phases	The whole squad participated as one team in the Club league.	Western Province u/19 trials in the second and third week.	Players in the WP team starts in the WP league (Currie Cup), and the rest of the WPRI players continue playing in the Club league.	Club league and Currie Cup league continues.	Rugby season is coming to an end. WP u/19 played in the semi-finals and finals and won the Currie Cup for 2010.

† The WPRI had a down week from 10 to 16 May, where players were allowed to go home. They also had holiday breaks from 14 to 27 June as wells as from 20 to 26 September.

A total of 5283 player weeks were analyzed. A total of 1250 player weeks for the HIMS, 1366 player weeks for the STEMS, 1194 player weeks for the RPE, and 1095 player weeks for the Self-report were analyzed. For the RESTQ-76-Sport, a total of 378 player weeks were analyzed.

Ethical aspects

The study protocol was approved by the Ethics Committee of Research Subcommittee A at Stellenbosch University (Reference number 307/2010). Permission from the WPRI (Appendix I) was obtained to conduct the study with the rugby players as participants. During the introductory contact session between the researcher and the players, the study protocol and informed consent form (Appendix H) were verbally explained to all the players and opportunity for questions were provided. The study did not involve any invasive procedures or serious risks. Players were informed that participation was voluntary and they could withdraw from the study at any time, and without any penalty. The players then signed the consent forms.

4.4 TESTS AND MEASUREMENTS

The Heart Rate Interval-Monitoring Test (HIMS)

HIMS testing took place every Monday morning between 6h00 and 8h00. The players ran in groups of 15, in an indoor hall with an artificial surface. A CD-player was used to play the pacing tape. The HIMS consists of four two-minute running stages of increasing intensity (8.4 km/h, 9.6 km/h, 10.8 km/h, and 12.0 km/h) interspersed with one minute rest periods. During the rest periods players stood upright and motionless with their hands by their sides. The players stood for one minute after the fourth stage, during the recovery period. Therefore the intensity of the HIMS is controlled and constant for each test. The intra-class correlation coefficient of the heart rate on a day-to-day basis during the four stages and recovery periods ranged between r = 0.94 and 0.99 in a group of participants who maintained their training load (HIMS manual, Sport Science Institute, Cape Town).

Measuring heart rate recovery only once provides limited information. However, once a profile has been established for a player the interpretative information increases exponentially with each subsequent test, especially when this is related to training load and subjective symptoms of fatigue. For this reason the designers recommend that the test is done weekly at the same time of day, and at least two days after a competition.

Guidelines for interpretation of individual results:

- Similar = 0 – 2% change in recovery heart rate
- Slight increase/decrease = 2.1 – 4.9% change in recovery heart rate
- Significant increase/decrease = > 4.9% change in recovery heart rate
- Alarm = unusually large decreases in the recovery value >16%.

Weekly percentage recovery ratings are scored as follow:

- Very good >23 %
- Good 19-23 %
- Average 17-18 %
- Below average 14-16 %
- Poor <14 %

Participants ran the HIMS test as specified above. Protocol indicates that the players need to touch the ground on every turn, and should regulate their running speed according to the pre-recorded beeps of the pacing tape. Heart rate values were recorded with the Suunto Team Solution, making use of Suunto HR belts and a Team Pod (Suunto, Finland). This was very convenient, as live feed of the players' heart rates could be seen by using the software. This is especially useful in a more practical setup. The heart rate values of the 11^{th} and 12^{th} minute of the test were recorded and then used to calculate the percentage of heart rate recovery. Heart rate recovery for the group of forwards and backline players are shown in Appendix A.

The Stellenbosch Mood Scale (STEMS)

The STEMS questionnaire (Appendix B) was completed every Monday in a group setting. It provides measure of total mood disturbances and six mood states, namely Tension, Depression, Anger, Vigour, Fatigue, and Confusion. A Likert-type scale is used with values ranging from 0 ("not at all") to 4 ("extremely"). The total mood disturbance scores were calculated by adding all the negative factors and subtracting the positive factors. Factorial validity for this questionnaire was supported by confirmatory factor analysis. Acceptable criterion validity was also reported following correlations of the scores with previously validated recordings (Terry, *et al.* 2003).

Recovery self-monitoring system/Training diary (Self-Report)

The self-report questionnaire (Appendix D) was given to the players on every Monday and they had to complete it on their own everyday of the week. The completed sheets were then collected on the following Monday.

The "Recovery self-monitoring system" is adapted from Calder's proposed "training diary or logbook" (Calder, 2000). It measures variables by means of a Likert-type scale ranging from 1 ("awful") to 5 ("excellent/great"). The following variables were measured: quality of sleep, energy levels, motivation and enthusiasm for training, attitude to training, attitude to team, communication with coach, health, and recovery modalities used. A total value was estimated by adding the weekly scores of every variable.

Rate of Perceived Exertion (Session-RPE Method)

The session-RPE method (Borg's rating of perceived exertion) for monitoring and quantifying the training load has been developed to allow coaches to measure the training their players completed and consequently better control the periodisation of training (Borg, 1998; Foster *et al*., 2001). The session-RPE method of monitoring training load in team players requires each athlete to provide a Rating of Perceived Exertion (RPE) for each exercise session (Table 4.3) along with the amount of training time (Foster *et al*., 2001).

Table 4.3 The modified rating of perceived exertion (RPE) scale used for athletes to classify their perceived intensity of each training session (Foster *et al.*, 2001).

Rating	Descriptor
0	Rest
1	Very, Very Easy
2	Easy
3	Moderate
4	Somewhat Hard
5	Hard
6	
7	Very Hard
8	
9	
10	Maximal Effort

To calculate the intensity of a specific session or training bout, athletes are asked a simple question like "How hard was your workout?" Athletes then correspond to the chart by indication a number assigned to a descriptor of the difficulty of the session. A single number representing the magnitude of training load for each session is then calculated by multiplying the training intensity (RPE from Table 4.3) with the training session duration (min).

For the purpose of this study, RPE was calculated for all training sessions, including rehabilitation training, gymnasium hours and different field sessions. RPE was typed into a computer file three times a day, and every player had a password protected file, which were updated every week. The participants had to indicate the amount of time they trained during the session and how difficult they experienced the session to be. An example of the excel sheet can be seen in Appendix C. It was very important for individualisation that every player indicated the correct time, because not all the players practised/exercised for the same amount of time during each individual training session. The programme with training times and duration of sessions that were planned was available to the researcher.

Further simple determinations of training monotony and strain can also be made from session-RPE. Training monotony is a measure of day-to-day training variability that has been related to the onset of overtraining when combined to training loads (Foster, 1998). Training monotony is calculated by dividing the average daily training load by the standard deviation of the daily training load calculated over a week. Training strain is a useful method for monitoring training when players are undertaking high training loads. Training strain can be calculated by multiplying the weekly load with the training monotony. The monitoring of training strain becomes important when training loads are high and recovery time is inadequate, resulting in high training strain values. In a study conducted by Mendez-Villanueva *et al*. (2010) where they examine metabolic and perceptual responses to single tennis matches, RPE significantly correlated with the duration of rallies (training session duration) and the strokes per rally (intensity/endurance) during service games ($r = 0.80$-0.61; $p < 0.001$).

Recovery-Stress Questionnaire (RESTQ-76-Sport)

The RESTQ-76-Sport questionnaire (Appendix E) was completed in a group setting once a month on a Monday evening at either the players' residence or at the Department of Sport Science, Stellenbosch University, from 19h00 until 20h00. Players completed the questionnaire with pencil, which were provided.

A scale measures the extent to which the athlete took part in different activities within the previous three days or nights. A Likert-type scale is used with values ranging from 0 ("never") to 6 ("always"). The RESTQ-76-Sport consists of 19 subscales, which can be grouped in four major subscales, i.e. 12 general stress and general recovery scales, and seven sport-specific stress and sport-specific recovery scales. Acceptable test-retest reliability over a 24-hour period ($r > 0.79$), internal consistency (Cronbach alphas > 0.70 for most subscales) and construct validity have been reported for this instrument. Kellman and Kallus (2001) indicated that various studies involving German and American athletes showed high correlations between RESTQ-76-Sport and Profile of Mood States (POMS)-scales. RESTQ-76-Sport and POMS seem to be sensitive to changes in the recovery-stress state and mood states of athletes.

4.5 STATISTICAL ANALYSIS

For descriptive purposes means, standard deviations and ranges were reported for continuous measurements. Demographic variables were compared between forwards and the backline using t-tests. For the analysis of all the various measurement over the 5 training phases and between forwards and backs, two-way mixed model repeated measures ANOVA was used. Fisher least significant diferrence (LSD) post hoc corrections were used when reporting detailed differences. Spearman correlations were used to investigate relationships between variables. A 5% significance level ($p<0.05$) was used as guideline for determining significant results, but in some cases p-values significant at 10% ($p<0.1$) was also reported, but only as borderline significance.

CHAPTER FIVE

RESULTS

Analysis of the HIMS, STEMS, session-RPE, RESTQ-76-Sport and Self-report will be discussed in this chapter. The duration and content of each of the five training phases regarding all of the above-mentioned questionnaires and tests will also be explained.

5.1 DESCRIPTIVE CHARACTERISTICS

The physical and performance characteristics of the participants are summarised in Table 5.1 and Table 5.2. The 55 players that participated in this study were semi-professional union rugby players between the ages of 18 and 20 (at the start of the study). Players came from different provinces in South Africa to be full-time players at the Western Province Rugby Institute (WPRI). The WPRI competed at club level competitions and 23 (15 forwards and 8 backline) players from the WPRI also played for the WP U/19 team that participated in the Currie Cup tournament. The specific time and duration of the phases and a short explanation of the phases are shown in Table 5.3. Due to injuries and illnesses the number of participants who completed the tests differed between the five phases. Table 5.1 shows that the forwards were significantly heavier, and taller than the backline players. The forwards had a significantly larger waist circumference than the backline players. The backline players had a significantly lower body composition score than the forwards, as expected for rugby players. No significant difference was found between the forwards and backline players regarding their age.

Table 5.1. Physical characteristics of the players at the beginning of the year.

	Forwards		Backline players		
Participants	n = 31		n = 24		
	Mean ± SD	Range	Mean ± SD	Range	p < 0.05
Age (Years)	19 ± 0.6	18 – 20	19 ± 0.5	18 – 19	
Weight (kg)	102.7 ± 10.2	88 – 121.8	82.1 ± 8.2	66.4 – 95	*
Height (cm)	186.1± 8.9	172 – 203	117.8 ± 6.7	166 – 188	*
WC (cm)	96.4 ± 8.2	85 – 112.5	83.7 ± 6.4	24 – 103.2	*
BC	48.5 ± 19.3	72 – 96.5	30.9 ± 8.8	21.2 – 50.8	*

WC: Waist Circumference; BC: Body composition (Sum of 4 skin folds); * $p < 0.05$

Table 5.2 shows that there was no significant difference between the forwards and the backline players regarding their vertical jump height and 10m sprint times. The backline players ran significantly further distances in the repeated sprint test than the forwards. The backline players were significantly faster over 40m than the forwards in the sprint test.

Table 5.2. Performance characteristics of the players at the start of the training year.

	Forwards		Backline players		
	Mean ± SD	Range	Mean ± SD	Range	$p < 0.05$
VJ (cm)	56.8 ± 8.3	39 – 76	59.7 ± 8.1	48 – 84	
RS (m)	733.5 ± 29.4	680 – 795	761 ± 17	730 - 795	*
10m Sprint (s)	1.8 ± 0.1	1.59 – 1.97	1.7 ± 0.1	1.52 – 1.83	
40m Sprint (s)	5.4 ± 0.2	4.99 – 6.01	5.1 ± 0.2	4.82 – 5.42	*

VJ: Vertical Jump; RS: Repeated sprint. * $p < 0.05$

Table 5.3. Duration and content of the five training phases.

Phase	1. Developing	2. Transitional	3. Early Competition	4. Performance	5. High Performance
Weeks	7 weeks 29 March – 16 May	4 weeks 17 May – 13 June	6 weeks 28 June – 8 August	7 weeks 9 August – 3 October	3 weeks 4 October – 24 October
Description of phases	The whole squad participated in the club league.	Western Province u/19 trials in the second and third week.	Players in the WP team starts in the provincial tournament (Currie Cup), and the rest of the WPRI players continue playing in the club league.	Club league and Currie Cup league continues.	Rugby season is coming to an end. WP u/19 played in the semi-finals and finals and won the Currie Cup for 2010.

5.2 HEART RATE INTERVAL MONITORING SYSTEM (HIMS)

Table 5.4 shows the mean and standard deviation scores of the HIMS test for the group, and the forwards and the backline players separately, for every phase during the training year. The results per week for the forwards, backline players and the group are portrayed in Appendix A.

Table 5.4 Means and Standard Deviations scores for the HIMS test for all the phases.

	Developing phase			**Transitional phase**			**Early Competition phase**			**Performance phase**			**High Performance phase**		
	G	**F**	**B**	**G**	**F**	**B**	**G**	**F**	**B**	**G**	**F**	**B**	**G**	**F**	**B**
n	50	29	21	49	27	22	50	30	20	41	23	18	39	23	16
Testing sessions	7			4			6			7			3		
HIMS	22.13 ± 5.14	20.92 ± 4.75	23.82 ± 5.30	24.76 ± 8.39	21.99 ± 5.98	28.16 ± 9.73	23.86 ± 6.10	22.28 ± 5.37	26.22 ± 6.49	26.59 ± 7.12	25.19 ± 7.52	28.38 ± 6.34	23.45 ± 6.45	27.76 ± 5.65	25.88 ± 6.93

G: Group; F: Forwards; B: Backline players

Total group of rugby players

The recovery values from the HIMS indicated with means and standard deviations for the whole group over the five training phases can be seen in Figure 5.1. There was a significant increase in recovery scores from the Developing phase to the Transitional phase (p = 0.005), a significant increase in recovery scores from the Early Competition to the Performance phase (p = 0.004), and a significant decrease in recovery from the Performance to the High Performance phase (p = 0.001). Recovery scores as derived from the HIMS test were significantly lower in the Developing phase compared to the Performance phase (p = 0.00001).

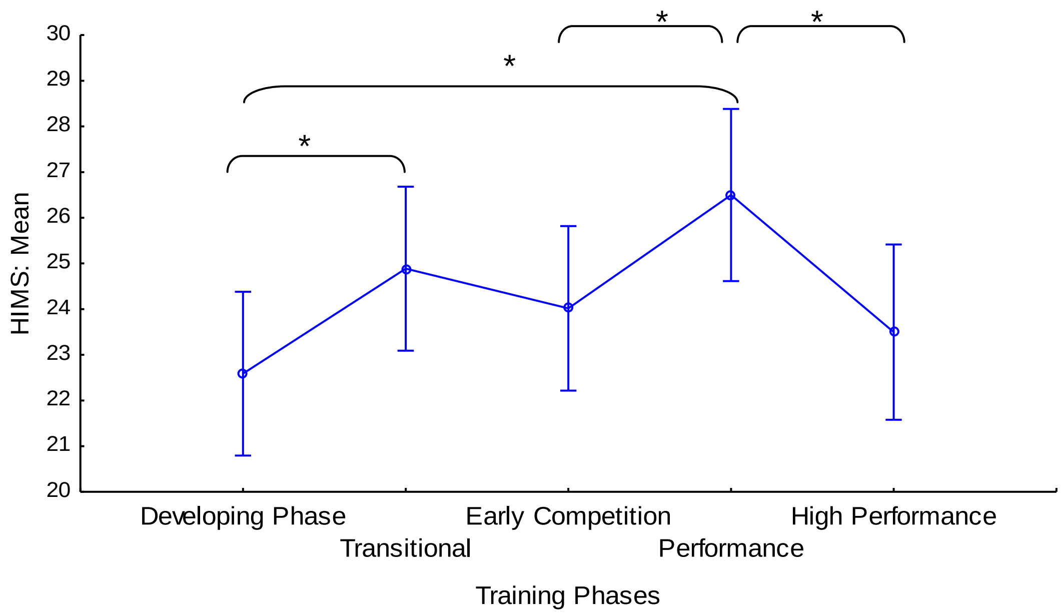

Figure 5.1. Mean recovery scores for HIMS for the total group of rugby players over the five training phases.

**p* < *0.05 Statistical significance between training phases.*

Forwards vs Backline players

There was a significant difference in the Recovery scores over the five training phases ($p = 0.0002$), as well as for the average seasonal HIMS recovery score between the forwards and the backs ($p = 0.01$), but no significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases ($p = 0.32$) (Figure 5.2). There was however tendencies in the data for interaction effects with the backline players reporting higher HIMS recovery scores than the forwards. Significant differences between the forwards and the backline players could be seen during the Developing phase ($p = 0.05$), the Transitional phase ($p = 0.0008$), and a borderline significance in the Early Competition phase ($p = 0.06$).

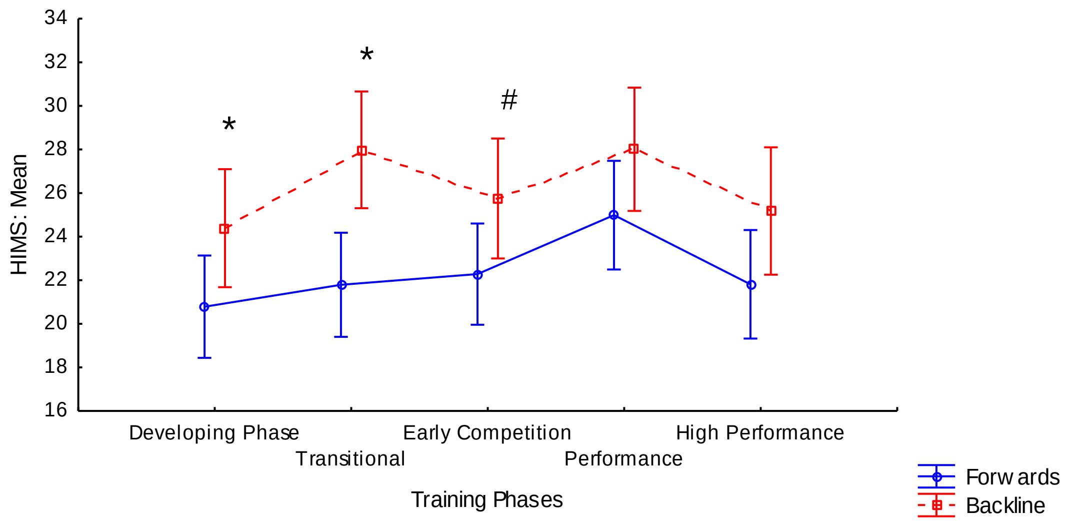

Figure 5.2. Comparison of the recovery scores from the HIMS between the forwards and the backline players.

** p < 0.05, significant difference between position over the phases; # p = 0.06, borderline significance.*

Forwards

The recovery score increased from the Developing phase to the Performance phase (p = 0.0003), the Transitional phase to the Performance phase (p = 0.006), and the Early Competition phase to the Performance phase (p = 0.02) as shown in Figure 5.3. The recovery score from the HIMS test decreased from the Performance phase to the High Performance phase (p = 0.008).

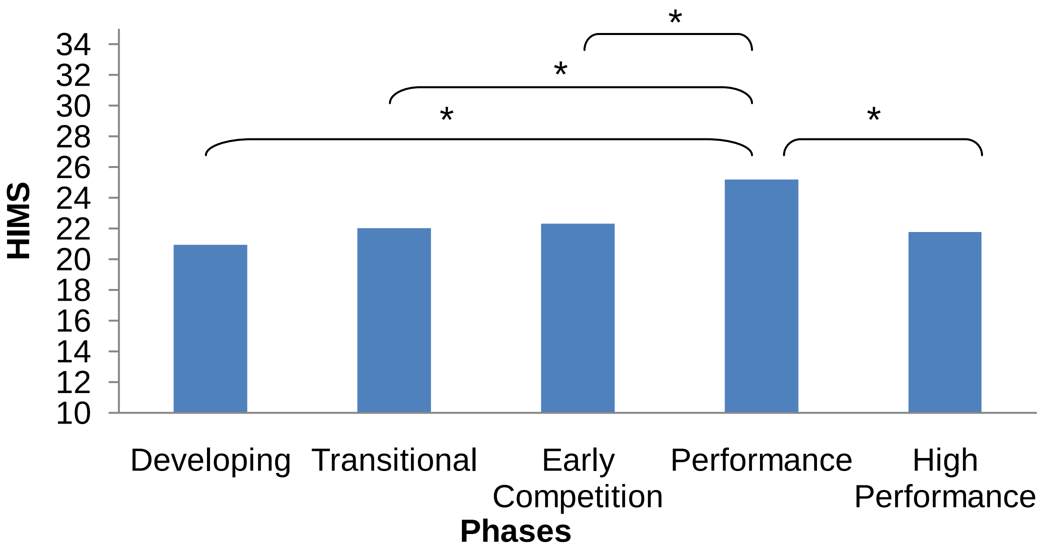

Figure 5.3. Differences in the HIMS mean recovery score for the forwards between the training phases.

** p < 0.05, significant difference between the phases*

Backline players

Recovery scores increased significantly from the Developing phase to the Transitional phase (p = 0.004), and from the Developing phase to the Performance phase (p = 0.006). Recovery scores decreased significantly from the

Transitional phase to the High Performance phase (p = 0.04), and from the Performance phase to the High Performance Phase (p = 0.04) as shown in Figure 5.4.

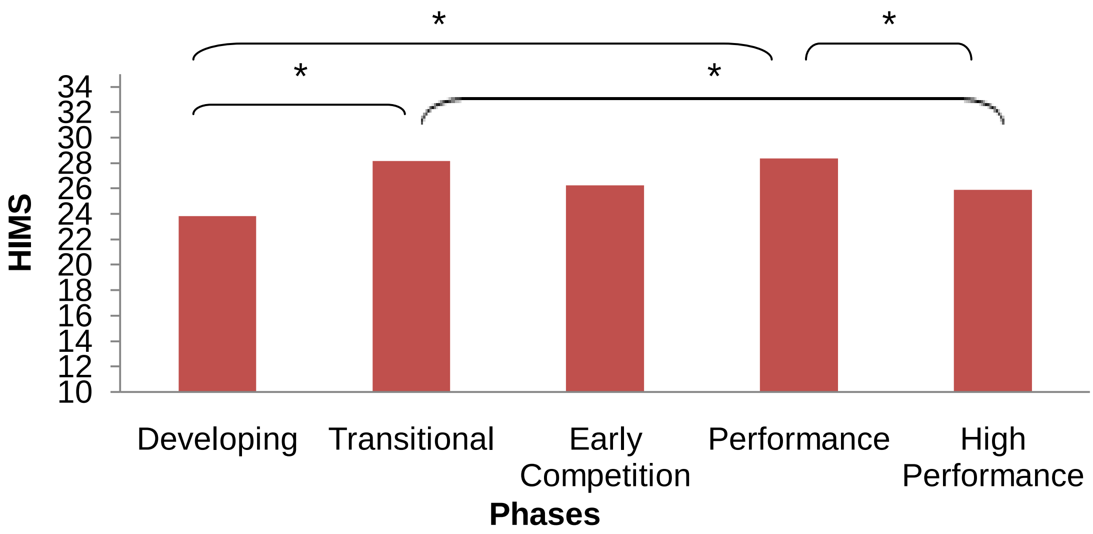

Figure 5.4. Differences in the HIMS mean recovery score for the backline players between the different training phases.

** p < 0.05, significant difference between the phases*

5.3 STELLENBOSCH MOOD STATES (STEMS)

Table 5.5 shows the mean and standard deviation scores of all the scales of the STEMS test for the total group, and the forwards and the backs separately, for every phase during the training year.

Table 5.5. Means and Standard Deviations scores for the STEMS test for all the phases.

STEMS	Developing phase			Transitional phase			Early Competition phase			Performance phase			High Performance phase		
n	G 55	F 31	B 24	G 55	F 31	B 24	G 51	F 31	B 20	G 47	F 28	B 19	G 42	F 24	B 18
Testing Sessions	7			4			6			7			3		
Total Mood Disturbance (TMD)	112.57 ± 7.32	112.54 ± 7.34	112.65 ± 7.45	113.41 ± 8.61	113.63 ± 8.16	113.14 ± 9.33	113.63 ± 8.91	113.54 ± 8.28	113.76 ±10.03	114.51 ± 0.69	112.19 ± 8.14	117.93 ±13.10	112.30 ±10.37	110.69 ± 8.85	114.44 ±12.04
Tension	2.85 ± 2.07	2.86 ± 2.18	2.83 ± 1.95	2.72 ± 2.26	2.73 ± 2.31	2.70 ± 2.25	2.61 ± 2.46	2.37 ± 2.42	2.99 ± 2.53	2.98 ± 2.70	2.40 ± 2.25	3.84 ± 3.12	5.54 ± 3.09	2.01 ± 3.04	3.26 ± 3.10
Depression	1.78 ± 1.77	1.87 ± 1.99	1.67 ± 1.47	1.78 ± 1.93	1.60 ± 1.98	2.01 ± 1.89	1.88 ± 1.74	1.81 ± 1.72	1.98 ± 1.80	2.30 ± 2.01	1.77 ± 1.64	3.08 ± 2.29	1.67 ± 1.95	1.23 ± 1.46	2.26 ± 2.37
Anger	1.78 ± 1.78	1.36 ± 1.86	1.99 ± 1.70	1.82 ± 2.40	1.41 ± 1.73	2.33 ± 3.01	2.13 ± 2.19	1.67 ± 1.79	2.85 ± 2.59	2.47 ± 2.51	1.69 ± 1.57	3.61 ± 3.19	1.93 ± 2.21	1.44 ± 1.81	2.57 ± 2.56
Vigour	9.78 ± 2.76	9.90 ± 2.92	9.63 ± 2.59	9.38 ± 2.91	9.33 ± 3.04	9.45 ± 2.80	9.25 ± 3.24	9.25 ± 3.27	9.25 ± 3.28	9.41 ± 2.73	9.63 ± 2.91	9.09 ± 2.48	9.60 ± 2.94	10.15 ± 2.61	8.87 ± 3.25
Fatigue	3.86 ± 2.45	3.95 ± 2.37	3.74 ± 2.60	4.70 ± 3.21	5.13 ± 3.15	4.14 ± 3.26	4.31 ± 2.95	4.72 ± 3.17	3.68 ± 2.52	3.98 ± 2.89	3.99 ± 2.71	3.97 ± 3.21	3.37 ± 2.89	3.30 ± 3.10	3.45 ± 2.68
Confusion	1.68 ± 1.76	1.45 ± 1.89	1.98 ± 1.57	1.67 ± 1.96	1.51 ± 1.87	1.88 ± 2.09	2.02 ± 2.34	1.84 ± 2.16	2.30 ± 2.63	2.38 ± 3.02	1.66 ± 2.22	3.45 ± 3.73	2.12 ± 2.80	1.80 ± 2.69	2.54 ± 2.97

G: Group; F: Forwards; B: Backline players

Total Mood Disturbance (TMD)

Total group of rugby players

The total Mood Disturbance scores for the group can be seen in Figure 5.5. There was a significant increase in total mood disturbance scores from the Developing phase to the Performance phase (p = 0.003), a significant increase from the Transitional phase to the Performance phase (p = 0.05), and a significant decrease in total mood disturbance scores from the Performance to the High Performance phase (p = 0.04).

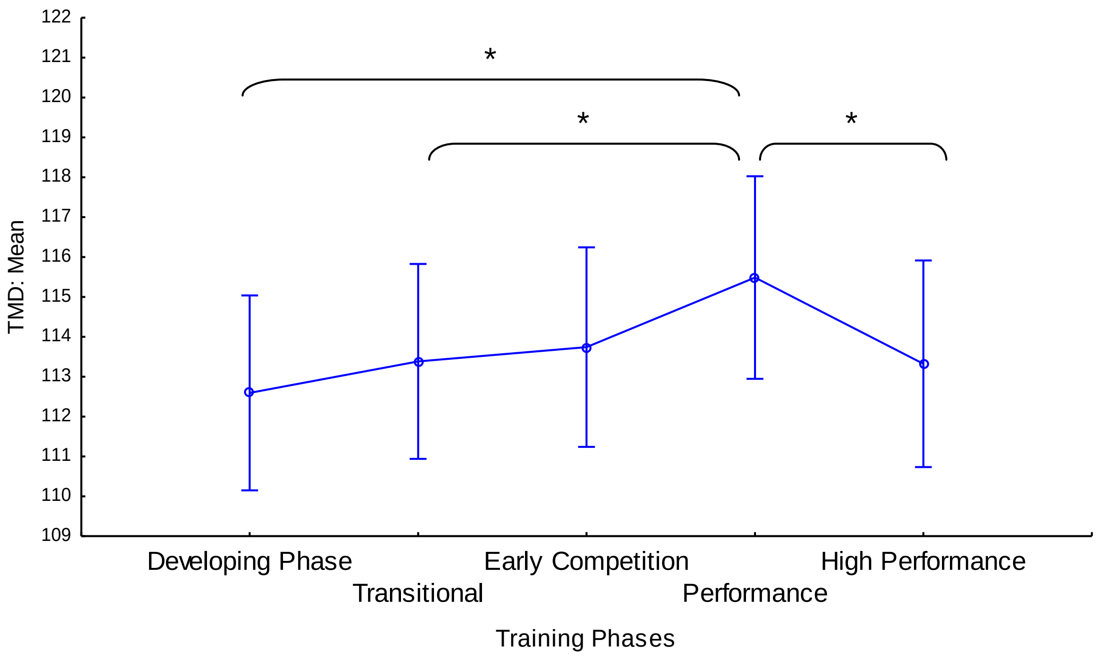

Figure 5.5. Mean Total Mood Disturbance scores for the group

**p < 0.05 Statistical significance between training phases.*

Forwards vs Backline players

There was a significant difference in Total Mood Disturbance score over the five training phases (p = 0.05), and no significant differences in average scores between the forwards and the backline players (p = 0.41), but there was a significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.02). The Backline players had significant higher Total Mood Disturbance scores than the forwards during the Performance phase (p = 0.03) (Figure 5.6).

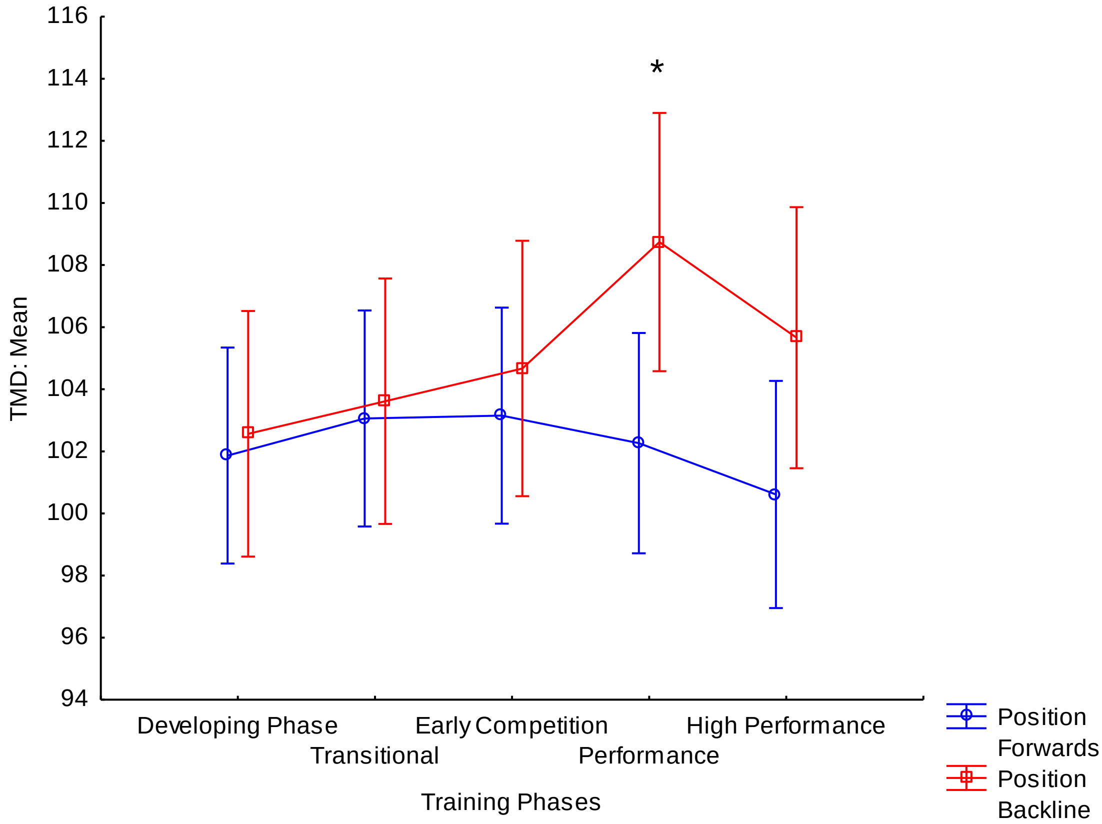

Figure 5.6.. Total Mood Disturbance (TMD) scale for STEMS between forwards and backline players.

** p < 0.05, significant difference between playing position over the phases*

Forwards

There was no significant difference in the mean Total Mood Disturbance score for the forwards between the five training phases.

Backline players

There was a significant increase in TMD scores from the Developing phase to the Performance phase ($p = 0.0003$), from the Transitional phase to the Performance phase ($p = 0.002$), and from the Early Competition phase to the Performance phase ($p = 0.02$) as shown in Figure 5.7.

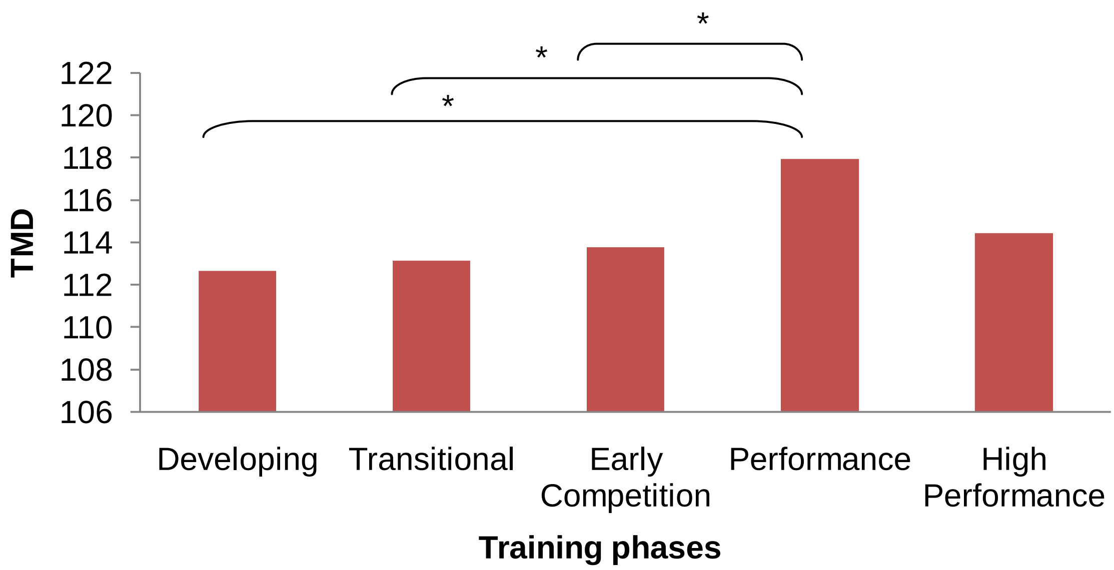

Figure 5.7. Differences in mean Total Mood Disturbance (TMD) scores for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Tension

Total group of rugby players

The mean scores of the Tension scale for the group can be seen in Figure 5.8. There was a significant increase in Tension from the Early Competition phase to the Performance phase ($p = 0.05$).

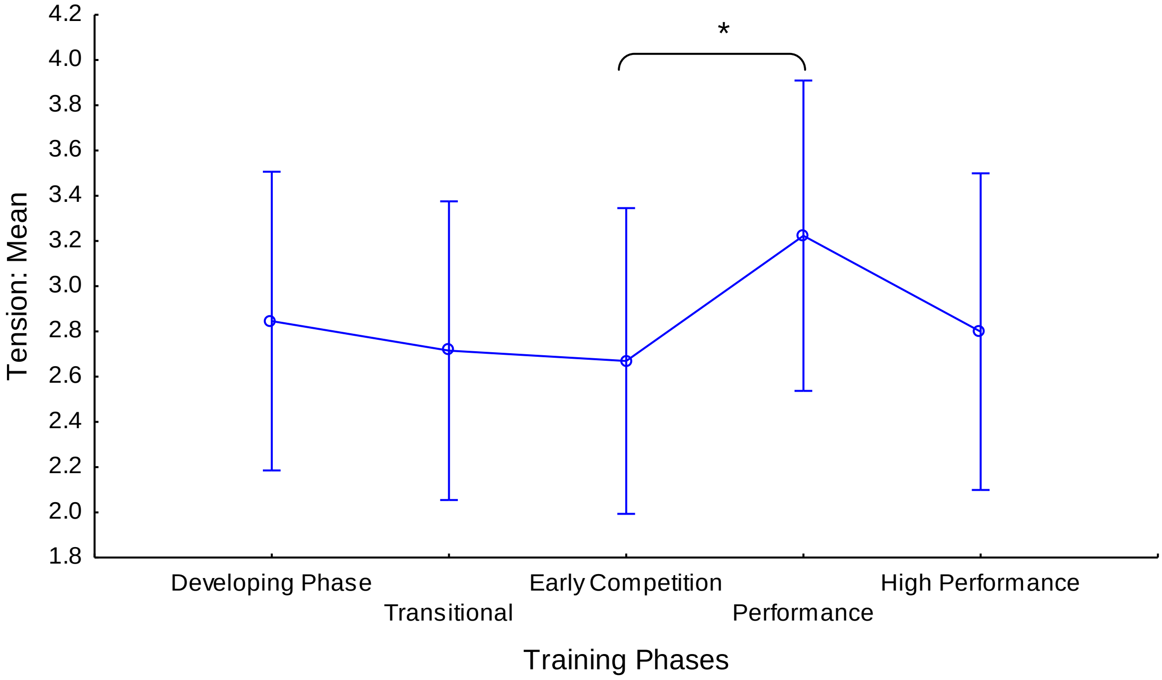

Figure 5.8. Mean scores of the Tensions scale for the group.

** p < 0.05*

Forwards vs Backline players

There was no significant difference in the Tension scale over the five training phases (p = 0.30), or the average score between the forwards and backline players for the season (p = 0.33). There was no significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.05). A strong tendency was observed during the Performance phase (p = 0.06) with the backline players having a higher score for the Tension scale than the forwards (Figure 5.9).

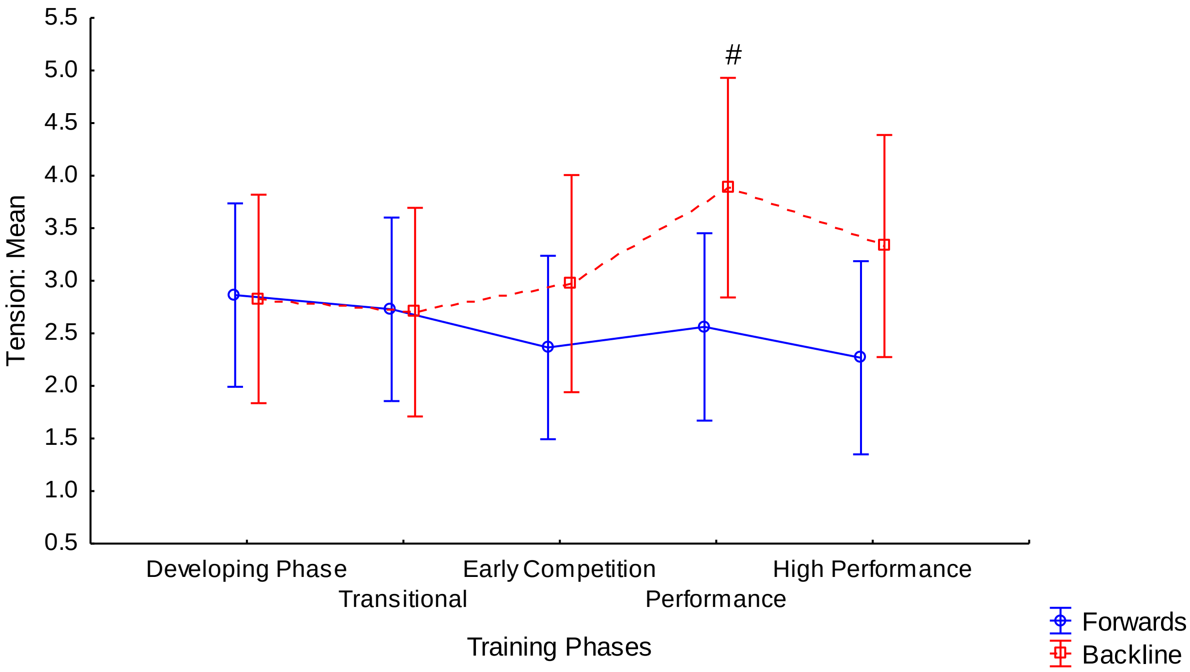

Figure 5.9. Tension score differences between forwards and backline players.

 # p = 0.06, borderline statistical significance.

Forwards

There was no significant difference in the mean Tension values for the forwards between the five training phases.

Backline players

The Tension scale increased significantly from the Developing phase to the Performance phase ($p = 0.01$), the Transitional phase to the Performance phase ($p = 0.006$), and from the Early Competition phase to the Performance phase ($p = 0.04$) as shown in Figure 5.10.

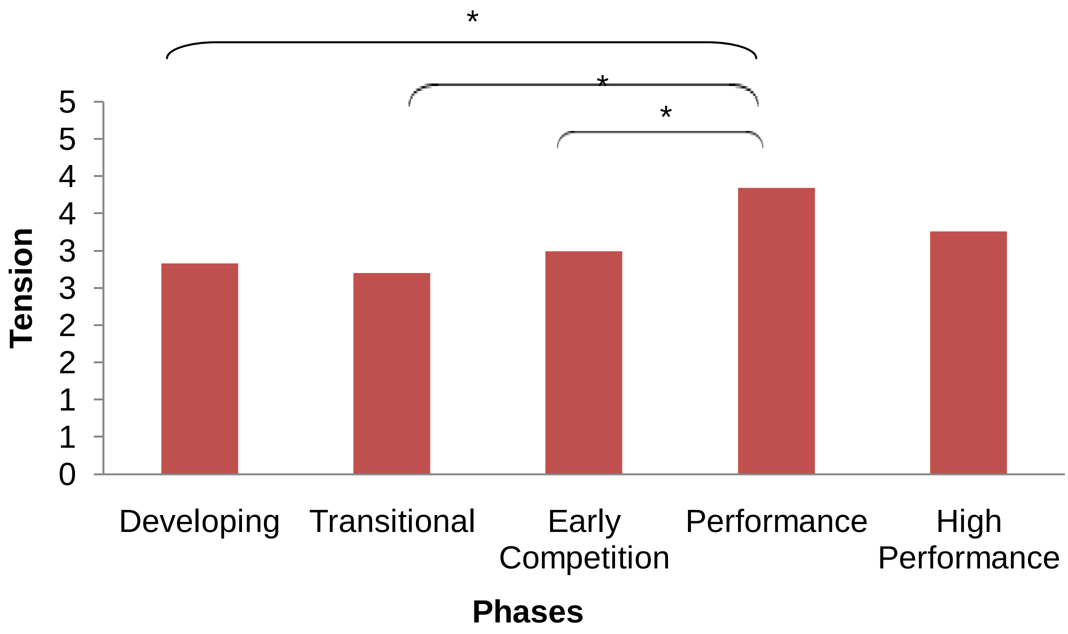

Figure 5.10. Mean scores for the Tension scale for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Depression

Total group of rugby players

Depression scores for the group can be seen in Figure 5.11. There was a significant increase from the Developing to Performance phase (p = 0.006), from the Transitional to the Performance phase (p = 0.009) and from the Early Competition to the Performance phase (p = 0.03). There were a significant decrease in the Depression scores from the Performance phase to the High Performance phase (p = 0.03).

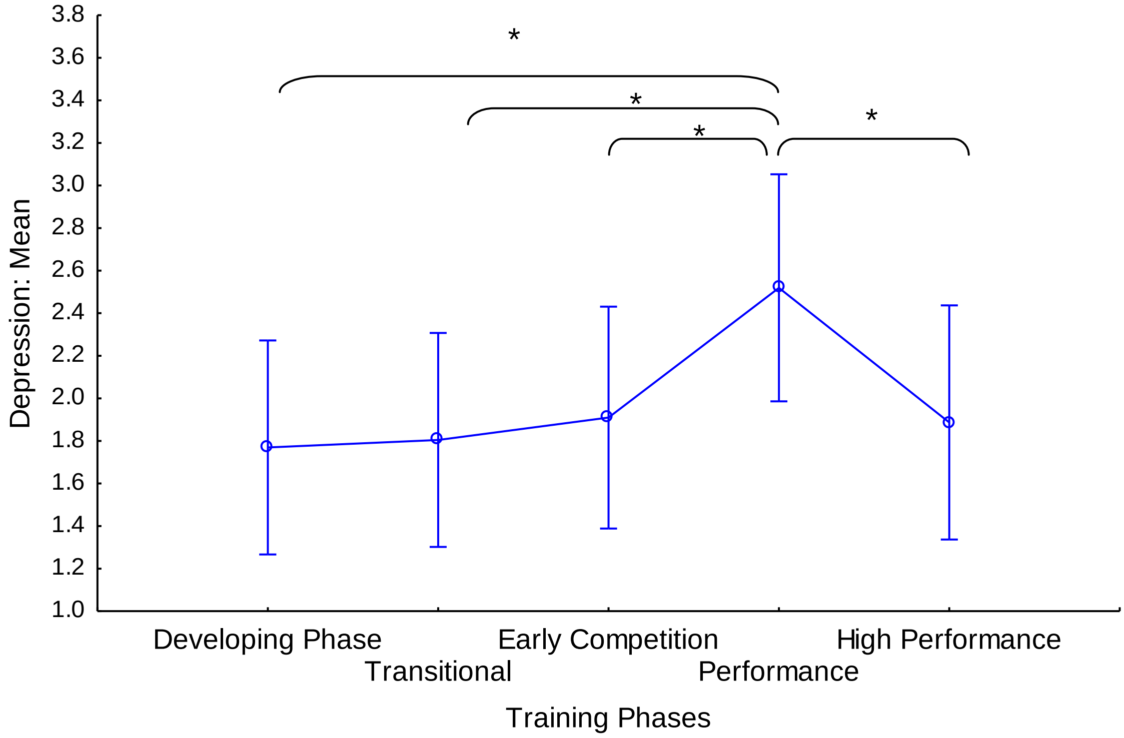

Figure 5.11. Mean scores for the Depression scale for the group.

** p < 0.05 Statistical significance*

Forwards vs Backline players

There was a significant difference in Depression scores over the five training phases (p = 0.05). No significant difference in the average Depression score between the forwards and the backline players (p = 0.23), and no significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.10). The backline players reported significantly higher Depression scores than the forwards during the Performance phase (p = 0.03) (Figure 5.12).

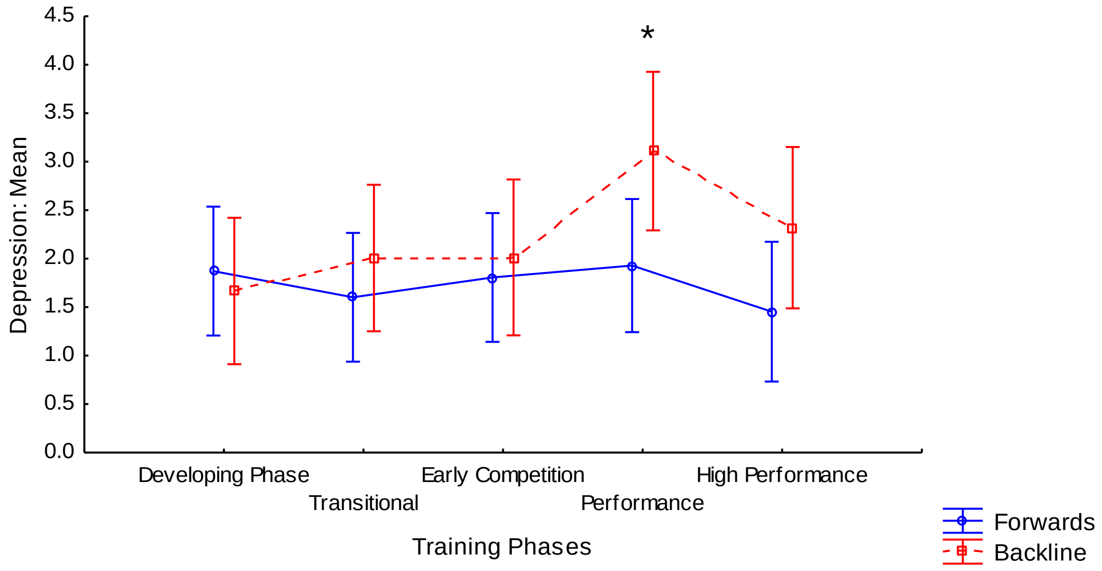

Figure 5.12. Depression scale for STEMS between forwards and backline players

** p < 0.05, significant difference between position over the phases*

Forwards

There was no significant difference in the mean Depression values among the forwards between the five training phases.

Backline players

Depression scores increased form the Developing phase to the Performance phase (p = 0.0006), from the Transitional phase to the Performance phase (p = 0.008), and from the Early Competition phase to the Performance phase (p = 0.01) as shown in Figure 5.13.

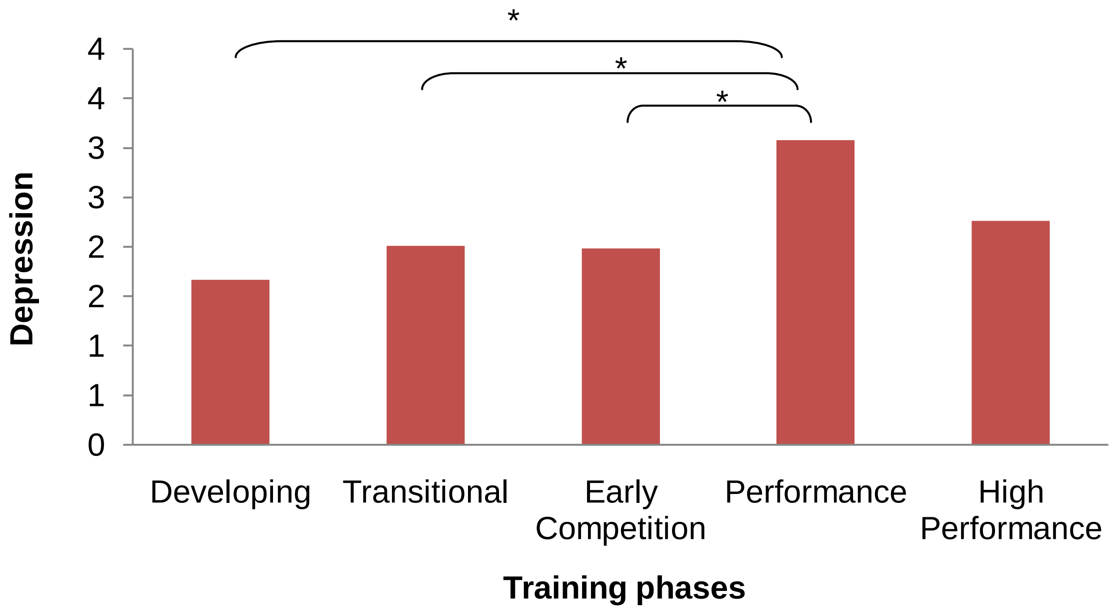

Figure 5.13. Mean Depression scores for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Anger

Total group of rugby players

The mean Anger scores for the group can be seen in Figure 5.14. There were no significant differences between the phases for the Anger scale of the STEMS for the total group.

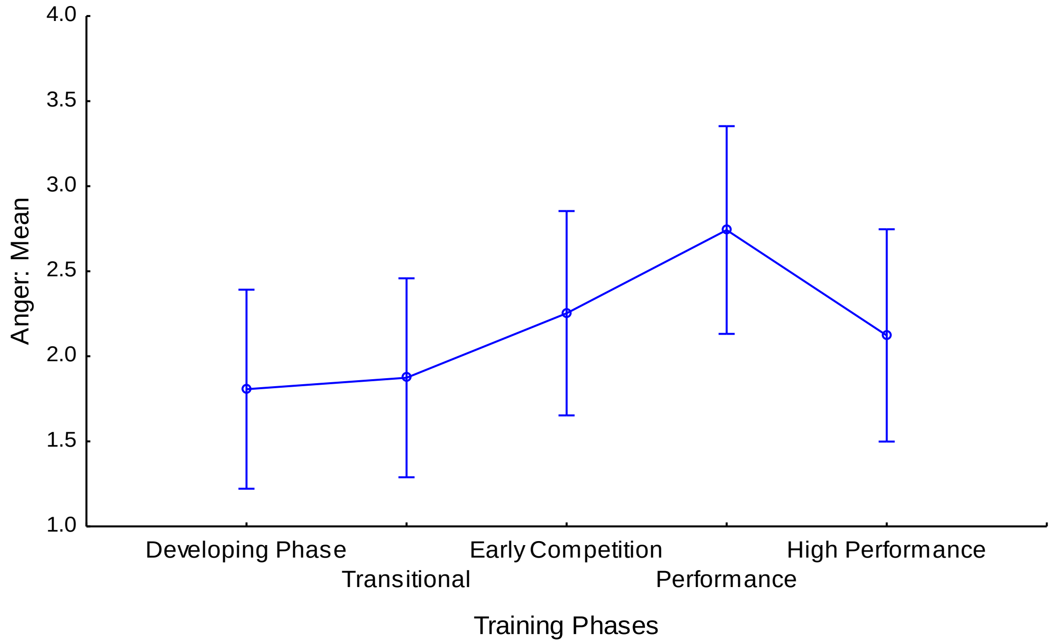

Figure 5.14. Mean scores for the Anger scale of STEMS for the group.

Forwards vs Backline players

There was a significant difference regarding Anger scores between the five training phases (p = 0.004). There was a borderline significance between the average anger score between the forwards and the backline players (p = 0.06), and no significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.17). The backline players had borderline significant higher Anger scores than the forwards during the Early Competition phase (p = 0.06), and the backline players had significant higher Anger scores than the forwards during the Performance phase (p = 0.009) (Figure 5.15).

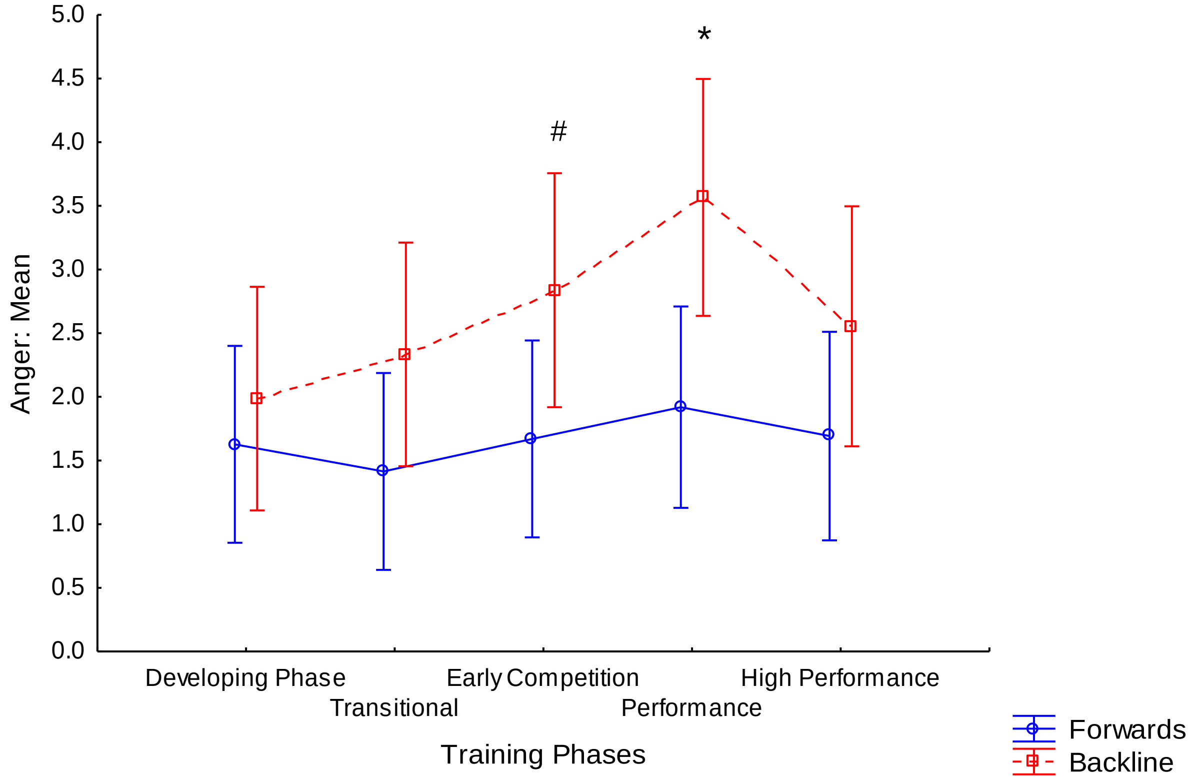

Figure 5.15. Anger scale for STEMS between forwards and backline players.

** p < 0.05, significant difference between position over the phases; # p = 0.06, borderline significance.*

Forwards

There was no significant difference in the mean Anger values for the forwards between the five training phases.

Backline players

The Anger scores increased significantly from the Developing phase to the Performance phase (p = 0.0001), and to the Early Competition phase (p = 0.03), respectively, and from the Transitional phase to the Performance phase (p = 0.002). The Anger scores decreased significantly at the end of the season from the Performance phase to the High Performance phase (p = 0.02) as shown in Figure 5.16.

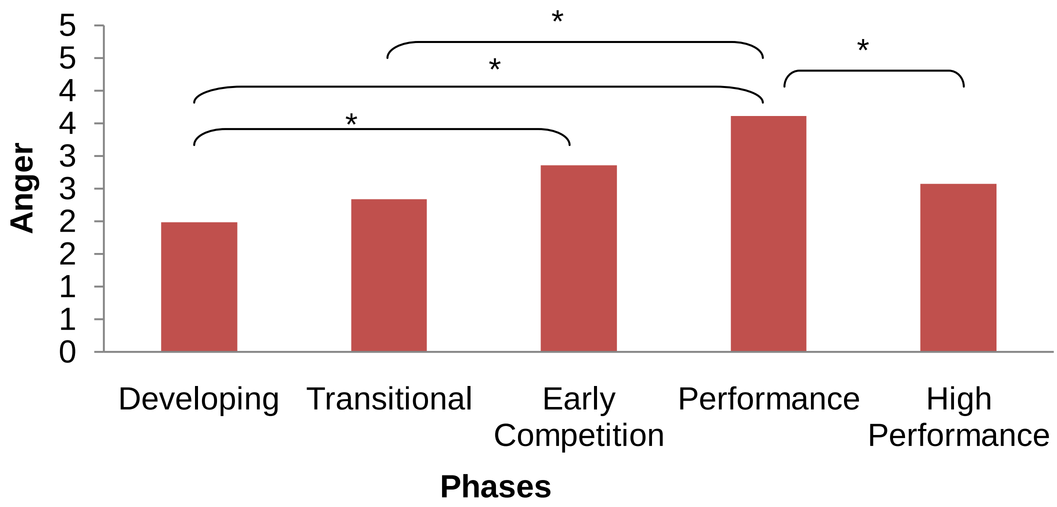

Figure 5.16. Differences in mean Anger scores for the backline players over the training phases.

** p < 0.05, significant difference between the phases*

Vigour

Total group of rugby players

The mean Vigour scores for the group can be seen in Figure 5.17. There were no significant differences between the phases for the Vigour scale of the STEMS for the total group of players.

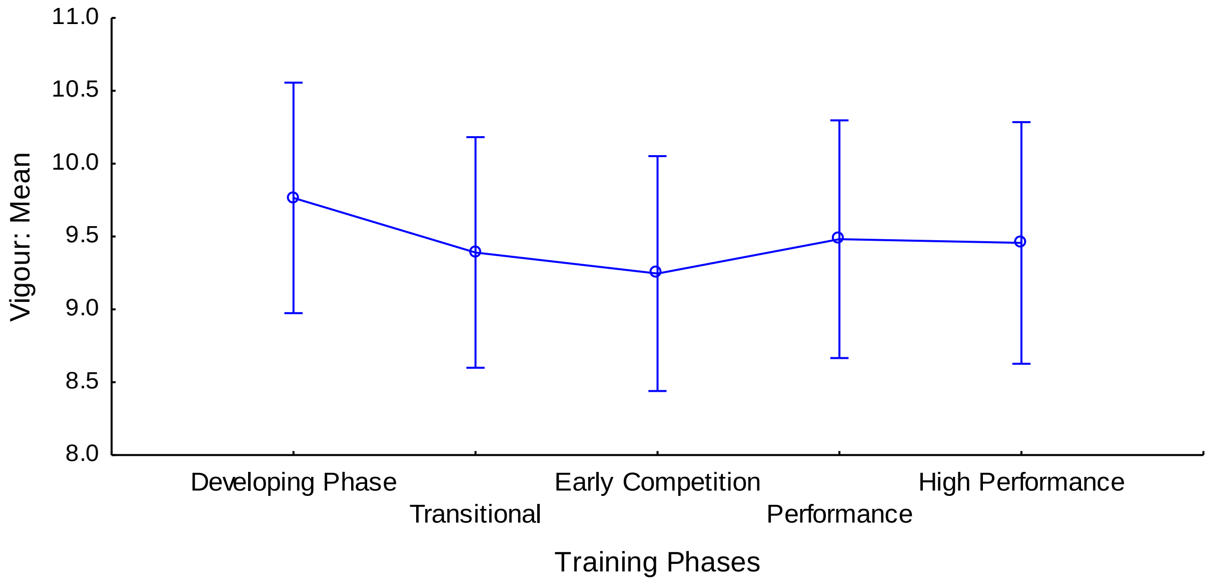

Figure 5.17. Mean scores of the Vigour scale for the group.

Forwards vs Backline players

There was no significant changes in Vigour scores over the five training phases ($p = 0.47$), no significant difference in the average score between the forwards and the backline players ($p = 0.54$), and no significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases ($p = 0.15$) (Figure 5.18).

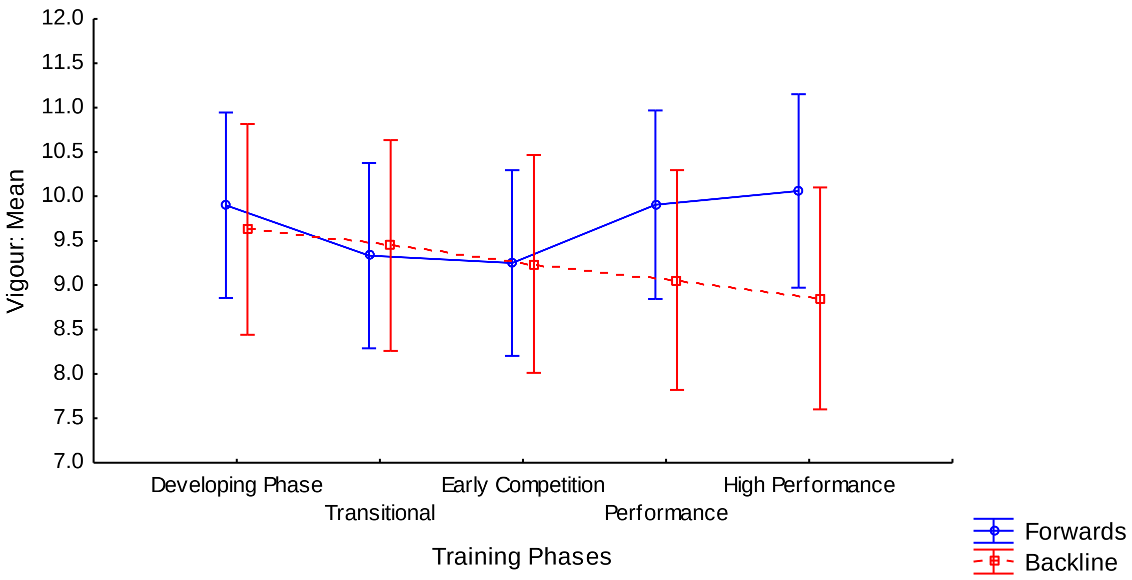

Figure 5.18. Vigour scale for STEMS between forwards and backline players.

Forwards

There was a significant increase in the Vigour score from the Early Competition phase to the High Performance phase (p = 0.04) as shown in Figure 5.19.

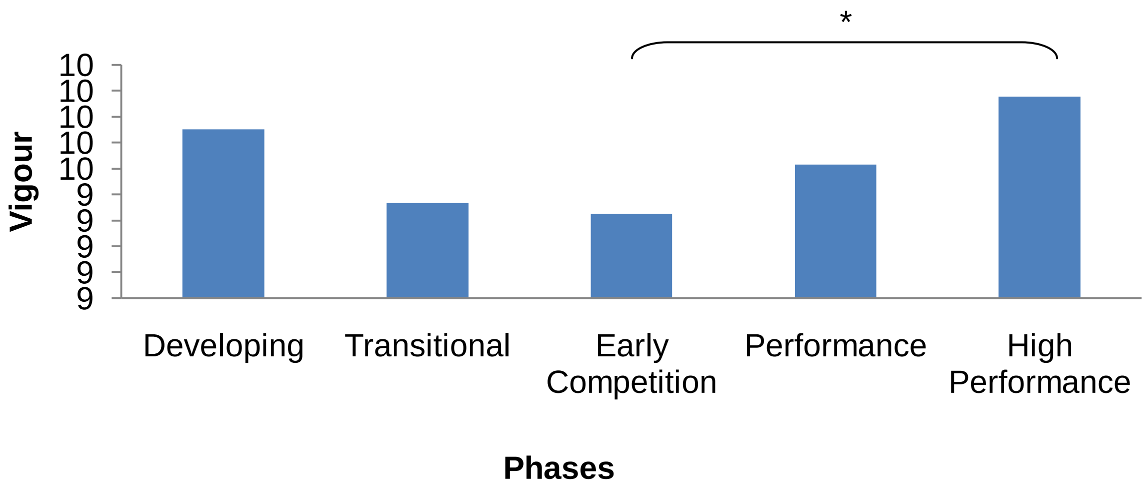

Figure 5.19. Differences in mean Vigour scores for the forwards over the training phases.

** p < 0.05, significant difference between the phases*

Backline players

There was no significant difference in the mean Vigour score for the backline players between the five training phases.

Fatigue

Total group of rugby players

The mean scores of the Fatigue scale for the group can be seen in Figure 5.20. There was a significant increase in the Fatigue scores from the Developing phase to the Transitional phase ($p = 0.003$). Significant decreases were seen from the Transitional phase to the Performance phase ($p = 0.009$), and the High Performance phase ($p = 0.00002$), respectively. The Fatigue scores also significantly decreased from the Early Competition phase to the High Performance phase ($p = 0.006$).

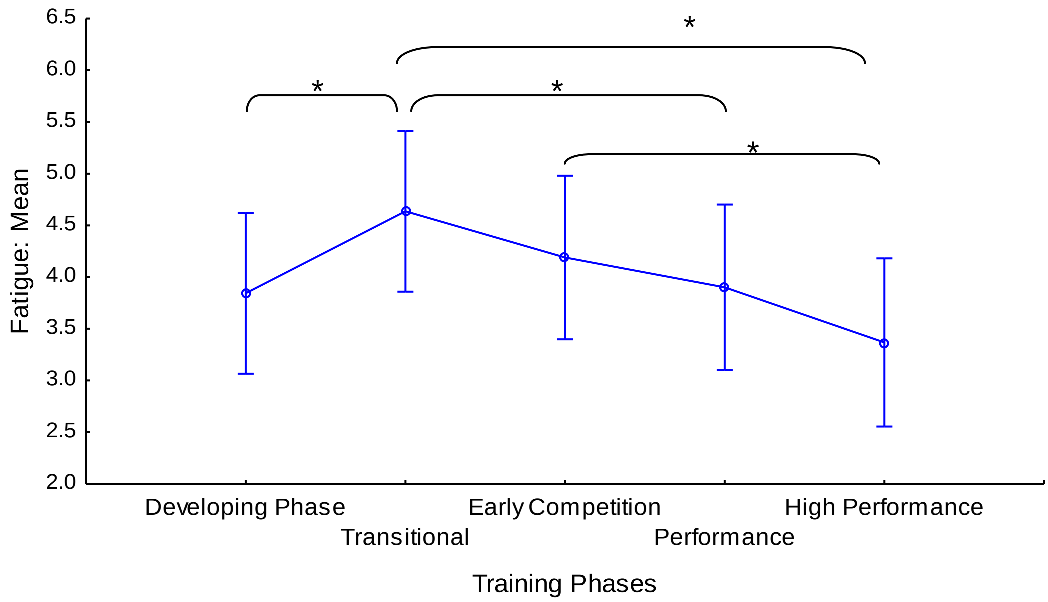

Figure 5.20. Mean Fatigue scores of the STEMS for the group.

** p < 0.05 Statistical significance*

Forwards vs Backline players

There was a significant change in the Fatigue scores over the five training phases (p = 0.0004), but no significant difference in the average fatigue scores between the forwards and backline players (p = 0.58). There was no significant interaction effect regarding the relationship between the forwards and backline players over the five training phases (p = 0.07) (Figure 5.21).

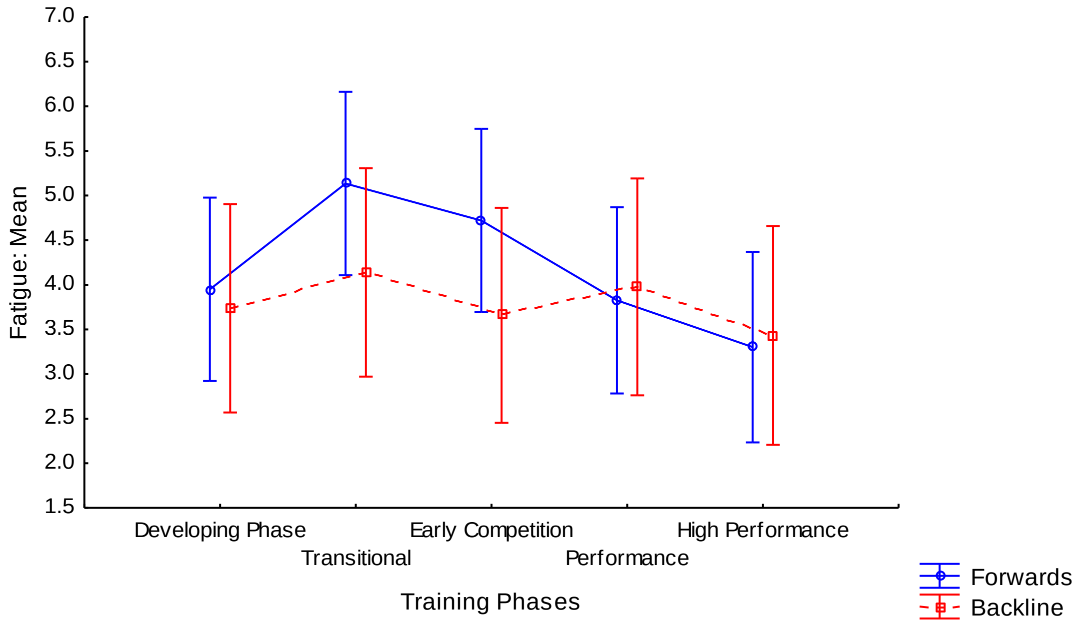

Figure 5.21. Fatigue scale for STEMS between forwards and backline players.

Forwards

The Fatigue score significantly increased from the Developing phase to the Transitional phase (p = 0.0008), and Early Competition phase (p = 0.03), respectively. The Fatigue scores significantly decreased from the Transitional phase to the Performance phase (p = 0.0004), and the High Performance phase (p = 0.000003), respectively, as well as from the Early Competition phase to the

Performance phase (p = 0.01) and from the Early Competition phase to the High Performance phase (p = 0.0002) as shown in Figure 5.22.

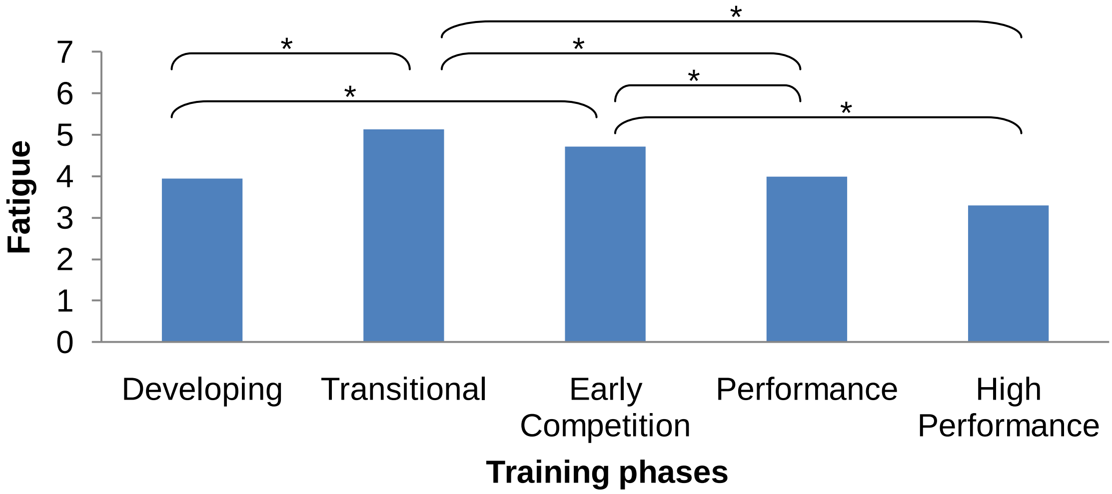

Figure 5.22. Differences in mean Fatigue scores for the Forwards over the training phases.

** p < 0.05, significant difference between the phases*

Backline players

There was no significant difference in the mean Fatigue scores for the backline players between the five training phases.

Confusion

Total group of players

The mean Confusion score for the group can be seen in Figure 5.23. There was a significant increase in Confusion scores from the Developing phase to the Performance phase (p = 0.007), and to the High Performance phase (p = 0.03) respectively. Significant increases were evident from the Transitional phase to the Performance phase (p = 0.0006), and to the High Performance phase (p = 0.03), respectively. The Confusion scores significantly increased from the Early Competition phase to the Performance phase (p = 0.05).

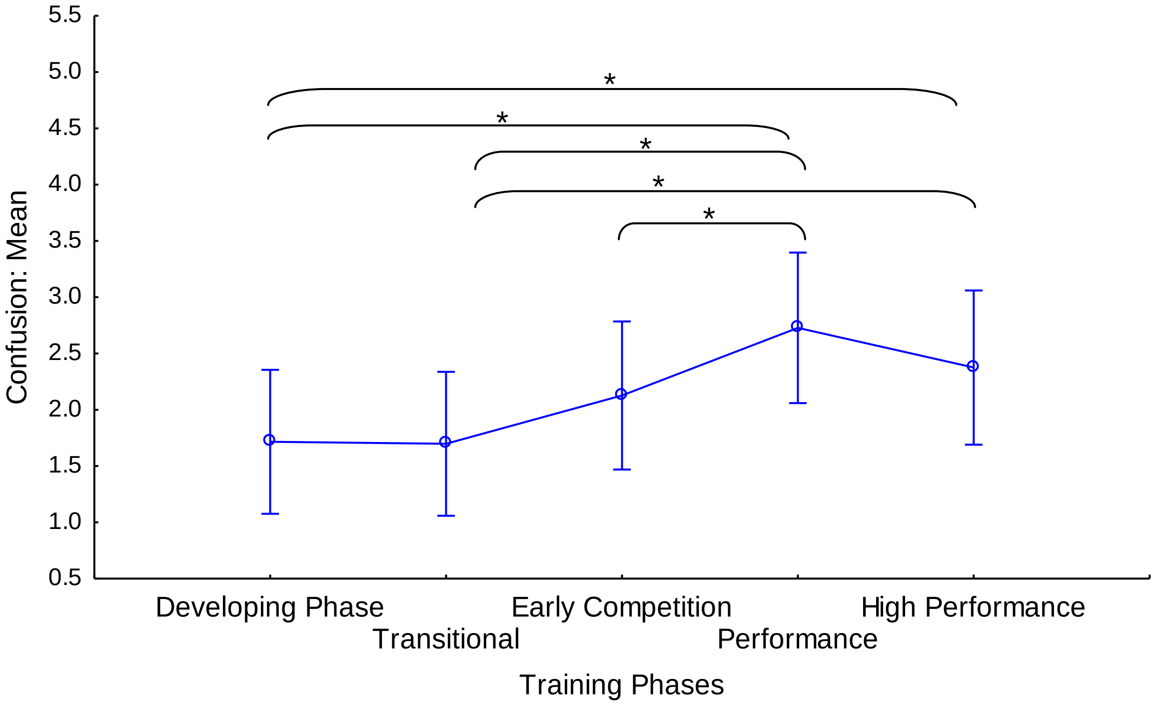

Figure 5.23. Mean Confusion scores for the group.

** p < 0.05 statistical significance*

Forwards vs Backline players

There was a significant change in the Confusion scores over the five training phases (p = 0.002), but no significant difference between the average score between the forwards and the backline players (p = 0.14), and no interaction effect regarding the relationship between the forwards and backline players over the five training phases (p = 0.18). The backline players did report significant higher confusion scores than the forwards during the Performance phase (p = 0.01) (Figure 5.24).

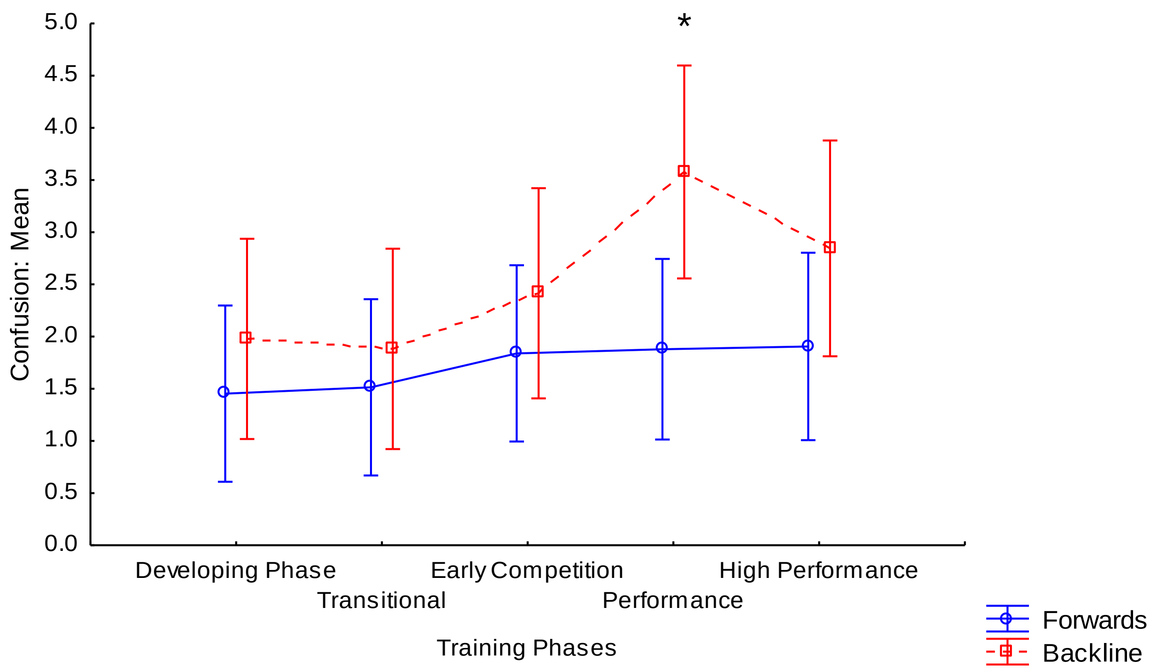

Figure 5.24. Confusion scale for STEMS between forwards and backline players.

** p < 0.05, significant difference between position over the phases*

Forwards

There was no significant difference in the mean Confusion score for the forwards between the five training phases.

Backline players

There was a significant increase in the Confusion from the Developing phase to the Performance phase (p = 0.0005), from the Transitional phase to the Performance phase (p = 0.0002), from the Transitional phase to the High Performance phase (p = 0.04), and from the Early Competition phase to the Performance phase (p = 0.01) as shown in Figure 5.25.

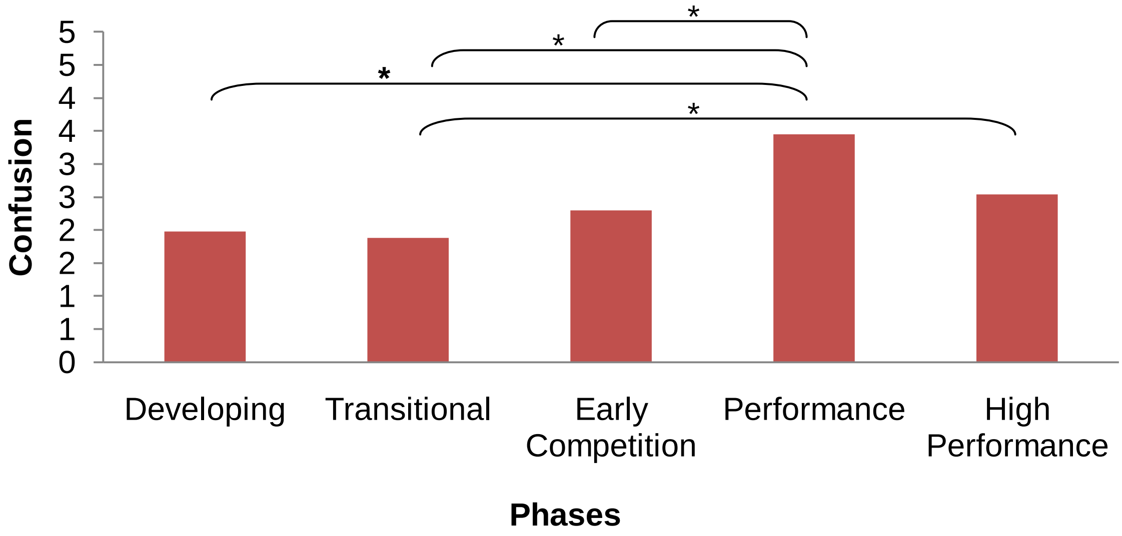

Figure 5.25. Differences in mean Confusion scores for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

5.4 SELF-REPORT

Table 5.6 shows the mean and standard deviation scores of the Self-Report for the group, and the forwards and the backs separately, for every phase during the training year.

Table 5.6. Means and Standard Deviation scores for the Self-Report Questionnaire.

	Developing phase			**Transitional phase**			**Early Competition phase**			**Performance phase**			**High Performance phase**		
n	**G** 54	**F** 31	**B** 23	**G** 50	**F** 27	**B** 23	**G** 37	**F** 24	**B** 13	**G** 31	**F** 18	**B** 13	**G** 26	**F** 15	**B** 11
Testing sessions	7			4			6			7			3		
Self-Report	205.10 ± 24.64	205.55 ± 28.23	204.48 ± 19.37	205.94 ± 26.36	207.32 ± 28.34	204.32 ± 24.36	214.81 ± 27.81	213.25 ± 24.97	217.69 ± 33.35	212.97 ± 30.14	218.42 ± 27.88	205.44 ± 32.61	212.50 ± 34.32	209.23 ± 33.38	216.96 ± 36.71

G: Group; F: Forwards; B: Backline players

Total group of players

The mean scores of the Self-Report test for the group can be seen in Figure 5.26. There were no significant differences in the scores reported for the group over the whole season.

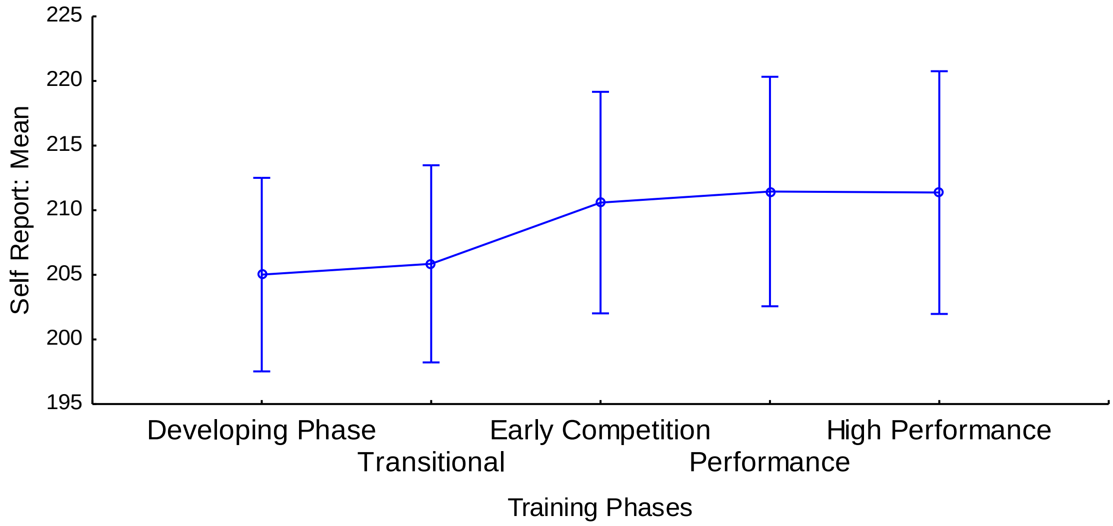

Figure 5.26. Mean scores for Self-Report for the group.

Forwards vs Backline players

There was no significant difference in the Self-Report scores over the five training phases ($p = 0.36$), or the average score between the forwards and backline players ($p = 0.61$). There was no significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases ($p = 0.47$) (Figure 5.27).

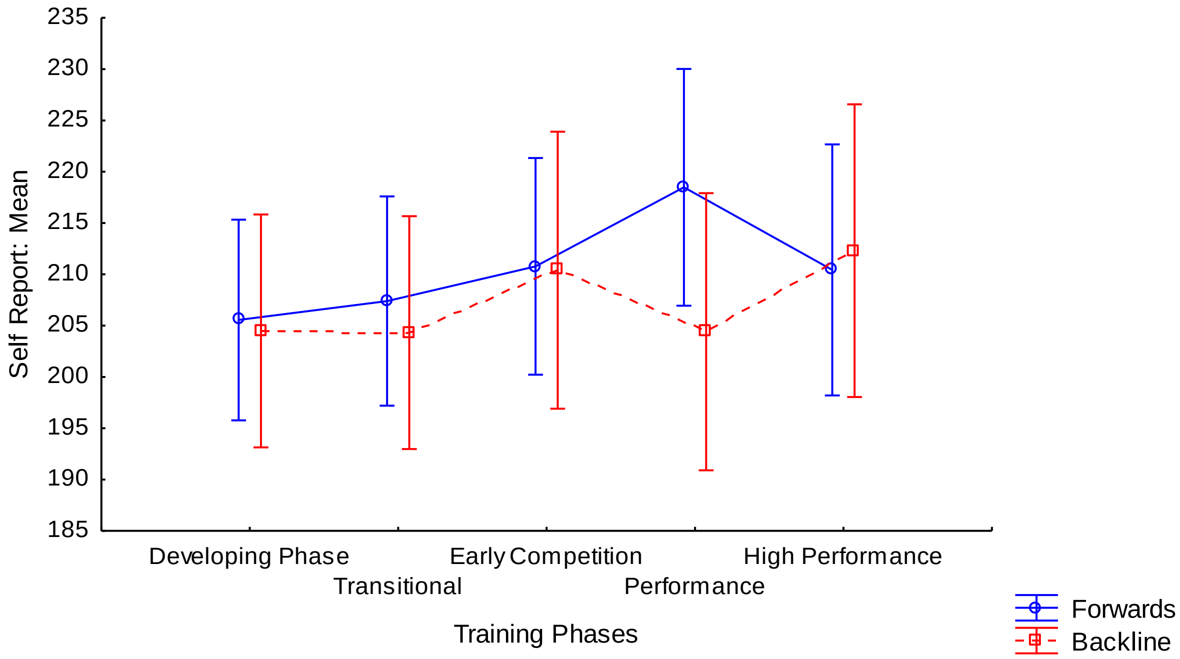

Figure 5.27. Self-Report scores between forwards and backline players.

Forwards

There was a significant increase from the Developing phase to the Performance phase ($p = 0.02$) and from the Transitional phase to the Performance phase ($p = 0.05$) as shown in Figure 5.28.

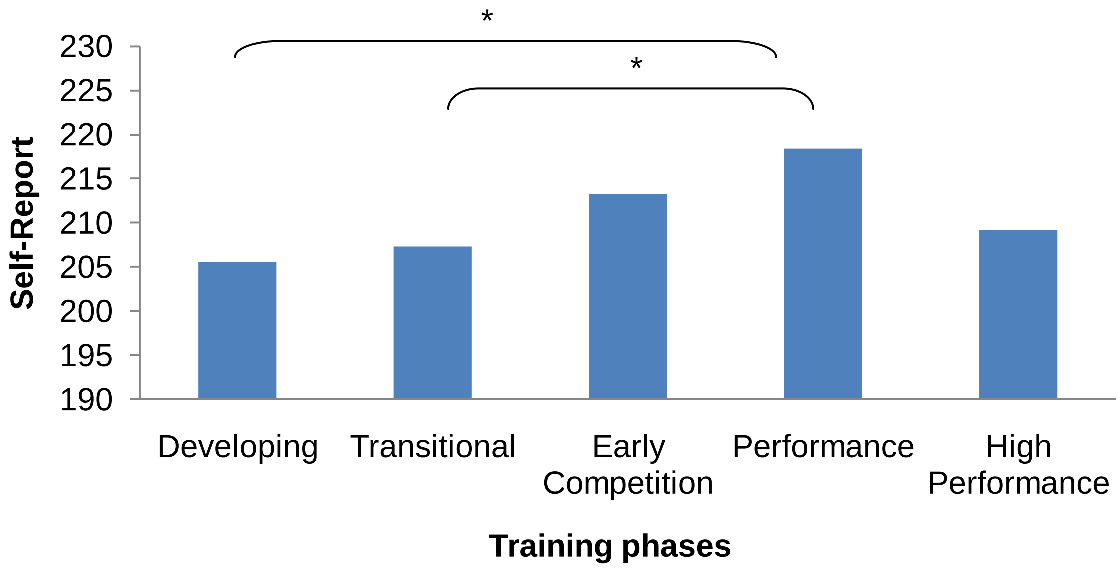

Figure 5.28. Differences in mean Self-Report scores for the Forwards over the training phases.

** p < 0.05, significant difference between the phases*

Backline players

There was no significant difference in the mean Self-report score for the backline players between the five training phases.

5.5 RATE OF PERCEIVED EXERTION (RPE)

Table 5.7 shows the mean and standard deviation scores of Training Load, Training Monotony, and the Training Strain for the group, and the forwards and the backs separately, for every phase during the training year.

Table 5.7. Mean and Standard Deviation scores of the RPE values.

	Developing phase			Transitional phase			Early Competition phase			Performance phase			High Performance phase		
n	**G** 55	**F** 31	**B** 24	**G** 51	**F** 29	**B** 22	**G** 49	**F** 31	**B** 18	**G** 35	**F** 21	**B** 14	**G** 22	**F** 13	**B** 9
Testing sessions	7			4			6			7			3		
TL	3117.71 ± 889.21	3034.48 ± 883.79	3213.57 ± 905.87	3141.58 ± 1084.99	3037.14 ± 1038.87	3279.24 ± 1152.81	2707.84 ± 922.20	2689.08 ± 858.45	2740.16 ± 1048.37	2804.63 ± 849.08	2654.89 ± 827.71	3029.24 ± 860.80	2758.64 ± 1027.05	2777.13 ± 1175.60	2731.93 ± 8333.37
TM	1.180 ± 0.31	1.12 ± 0.20	1.24 ± 0.41	1.02 ± 0.31	1.02 ± 0.25	1.03 ± 0.37	0.98 ± 0.29	0.98 ± 0.29	0.97 ± 0.29	1.01 ± 0.31	1.0 ± 0.36	1.04 ± 0.24	1.05 ± 0.54	1.14 ± 0.68	0.91 ± 0.20
TS	4108.97 ± 1879.13	3784.12 ± 1380.76	4528.56 ± 2340.47	3493.23 ± 1745.04	3313.68 ± 1434.42	3729.91 ± 2098.52	2899.27 ± 1369.76	2850.70 ± 1298.13	2982.90 ± 1520.59	3279.35 ± 1831.41	3041.76 ± 1976.04	3635.74 ± 1592.78	3390.29 ± 2700.94	3870.14 ± 3360.55	2697.17 ± 1137.98

TL: Training Load; TM: Training Monotony; TS: Training Strain; G: Group; F: Forwards; B: Backline players

Training Load

Total group of rugby players

The mean scores of the Training Load for the group can be seen in Figure 5.29. There was a significant decrease in Training Load from the Developing phase to the Early Competition phase (p = 0.0006), Performance phase (p = 0.001), and to the High Performance phase (p = 0.0003), respectively. There was a significant decrease in the Training Load form the Transitional phase to the Early Competition phase (p = 0.0008), Performance phase (p = 0.002), and the High Performance phase (p = 0.0004), respectively.

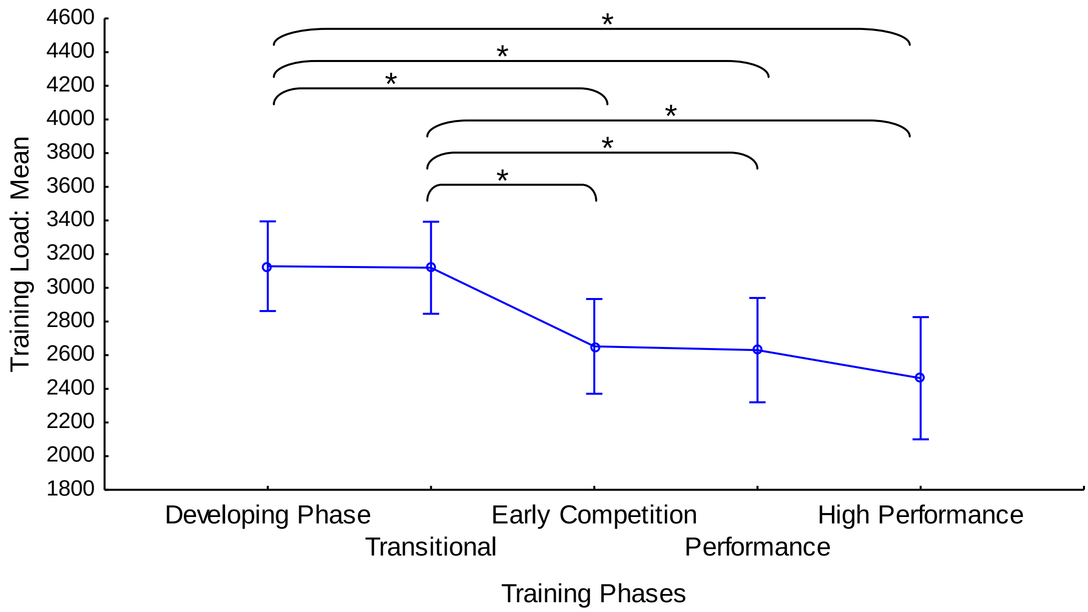

Figure 5.29. Mean Training Load scores for the group.

** p < 0.05 statistical significance*

Forwards vs Backline players

There was a significant change in training load over the five training phases (p = 0.00002), no significant difference in the average scores between the forwards and the backline players over the five training phases (p = 0.94), and no interaction effect regarding the relationship between the forwards and the backline players (p = 0.21) (Figure 5.30).

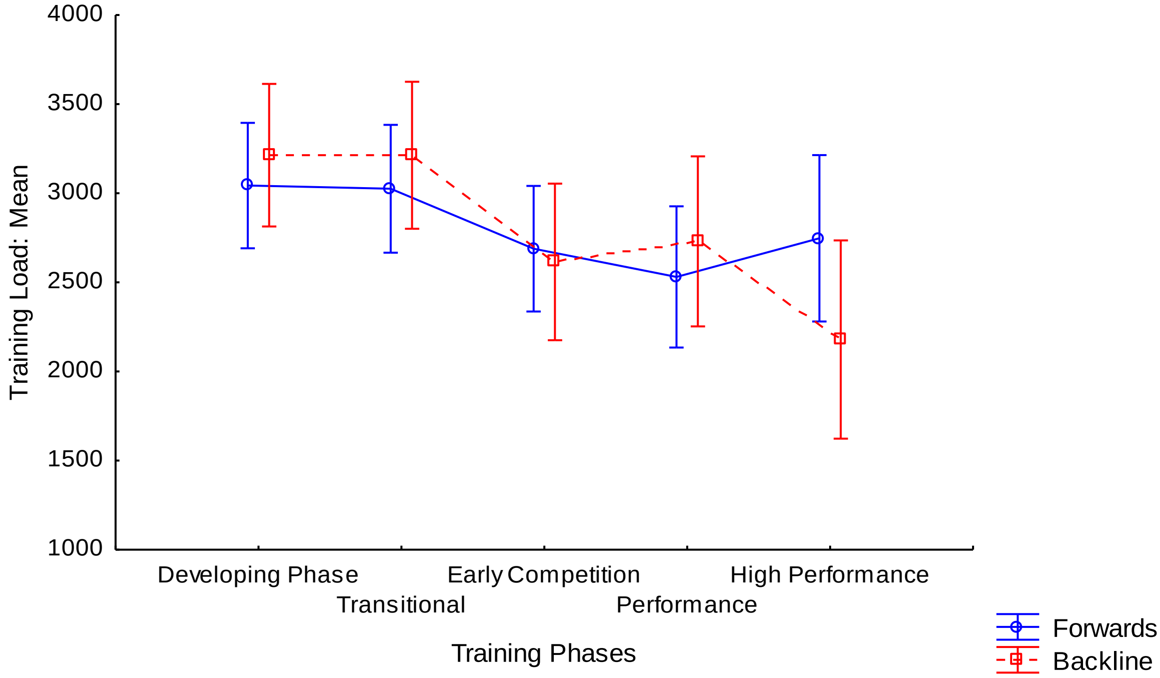

Figure 5.30. Training load scores between forwards and backline players.

Forwards.

There was a significant decrease from the Developing phase to the Early Competition phase (p = 0.04), and to the Performance phase (p = 0.008) respectively, as well as from the Transitional phase to the Performance phase (p = 0.01) among the forwards as shown in Figure 5.31.

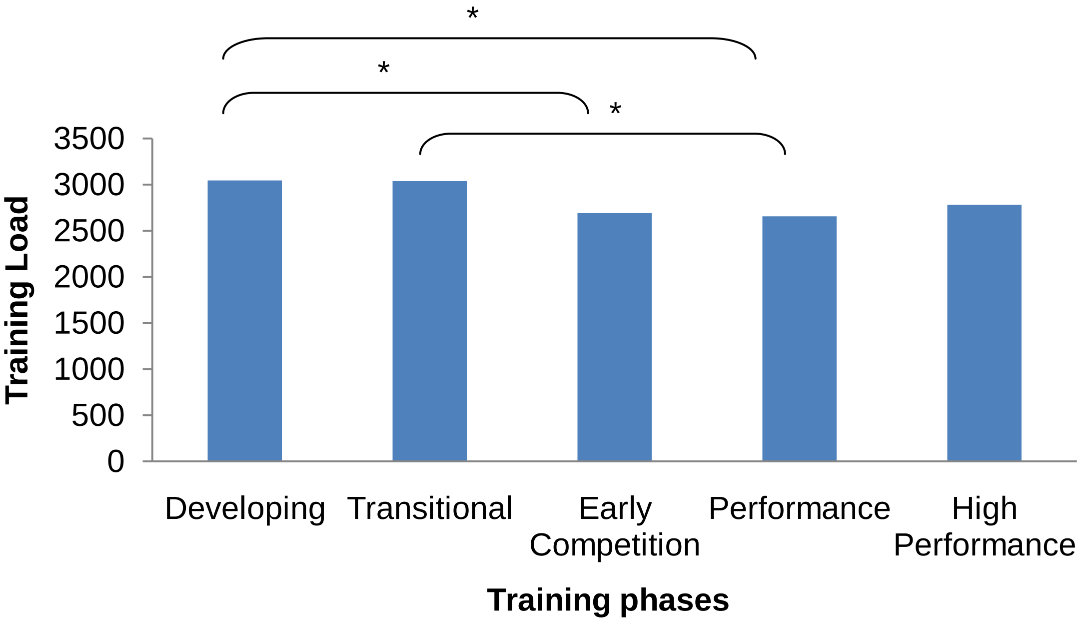

Figure 5.31. Differences in mean Training load scores for the Forwards over the training phases.

** p < 0.05, significant difference between the phases*

Backline players

There was a significant decrease from the Developing phase to the Early Competition phase (p = 0.005), the Performance phase (p = 0.04), and the Developing phase to the High Performance phase (p = 0.0002), respectively, as well as from the Transitional phase to the Early Competition phase (p = 0.006), the Performance phase (p = 0.04), and to the High Performance phase (p = 0.0002), respectively, as shown in Figure 5.32.

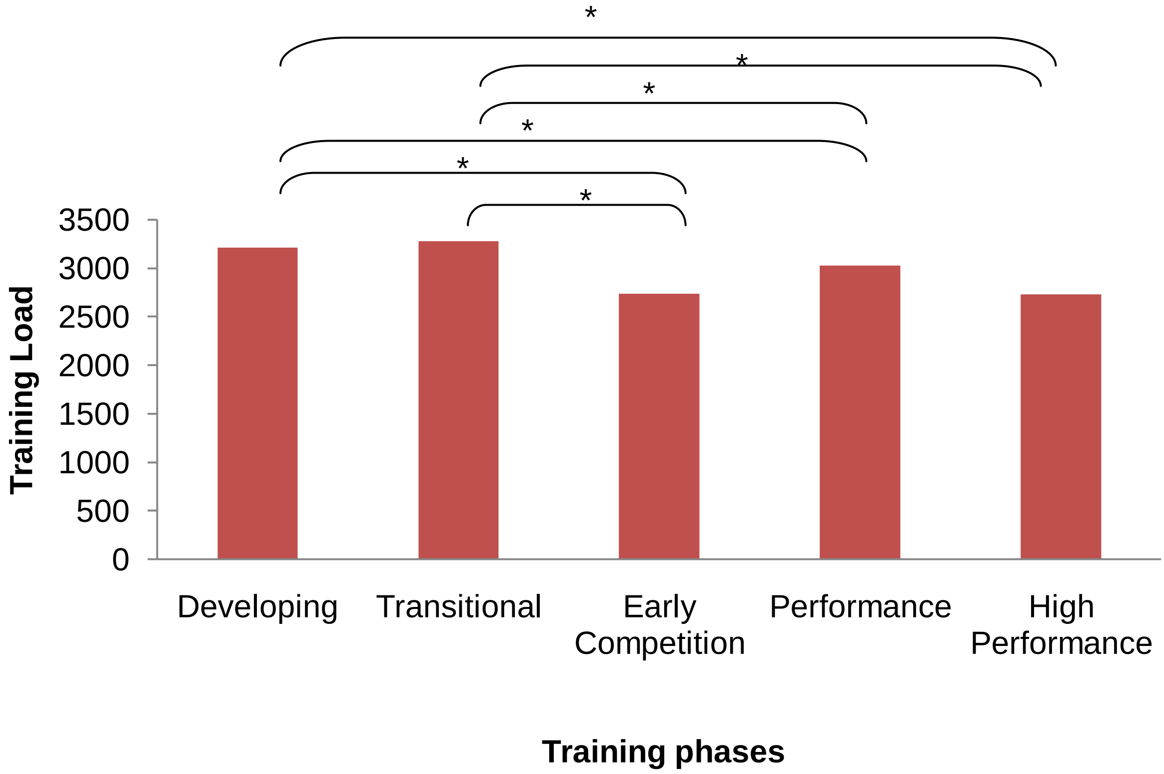

Figure 5.32. Differences in mean Training load scores for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Training Monotony

Total group of players

The mean Training Monotony scores for the group can be seen in Figure 5.33. There was a significant decrease in Training Monotony scores from the Developing phase to the Transitional phase (p = 0.006), the Early Competition phase (p = 0.0003), the Performance phase (p = 0.005), and the High Performance phase (p = 0.008), respectively.

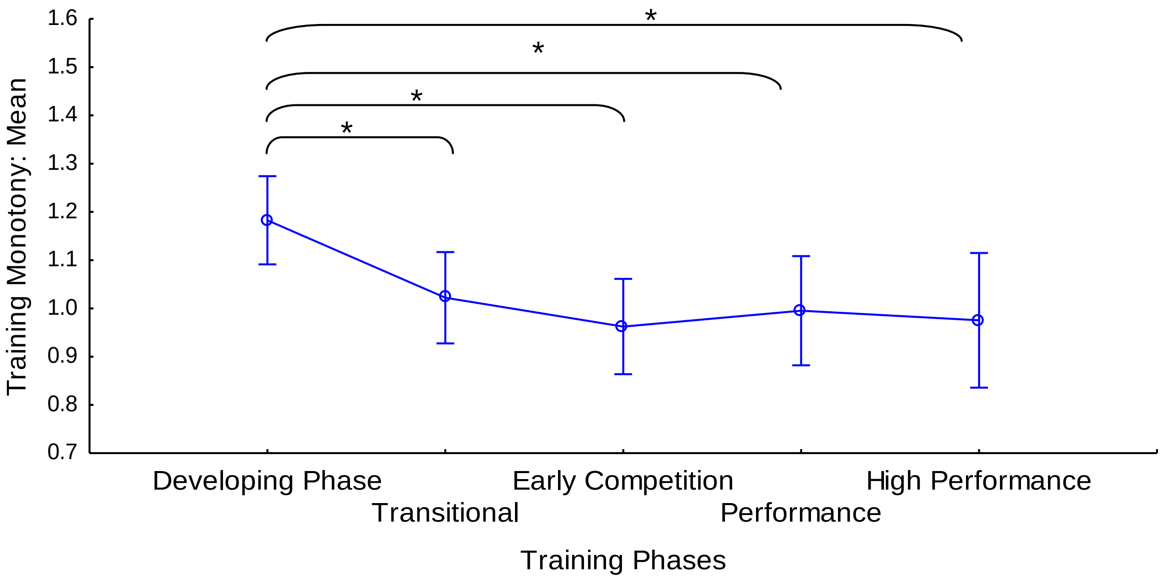

Figure 5.33. Mean Training Monotony scores for the group.

** p < 0.05 statistical significance*

Forwards vs Backline players

There was a significant change in training monotony over the five phases (p = 0.002), no significant difference in the average score between the forwards and backline players (p = 0.67), and no interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.19). The backline players had borderline significantly lower training monotony scores than the forwards during the High Performance phase (p = 0.07) (Figure 5.34).

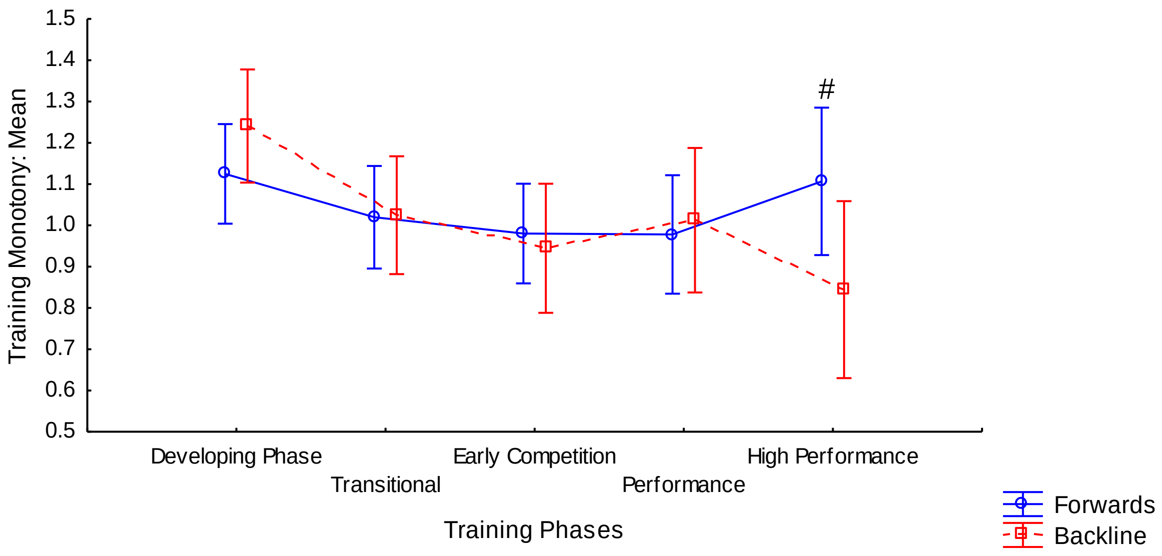

Figure 5.34. Training Monotony scores between forwards and backline players.

 # p = 0.07, borderline statistical significance

Forwards

There was no significant differences in the mean Training monotony score among the forwards between the five training phases.

Backline players

There was a significant decrease from the Developing phase to the Transitional phase ($p = 0.01$), the Early Competition phase ($p = 0.002$), the Performance phase ($p = 0.03$) and the High Performance phase ($p = 0.001$), respectively, as shown in Figure 5.35.

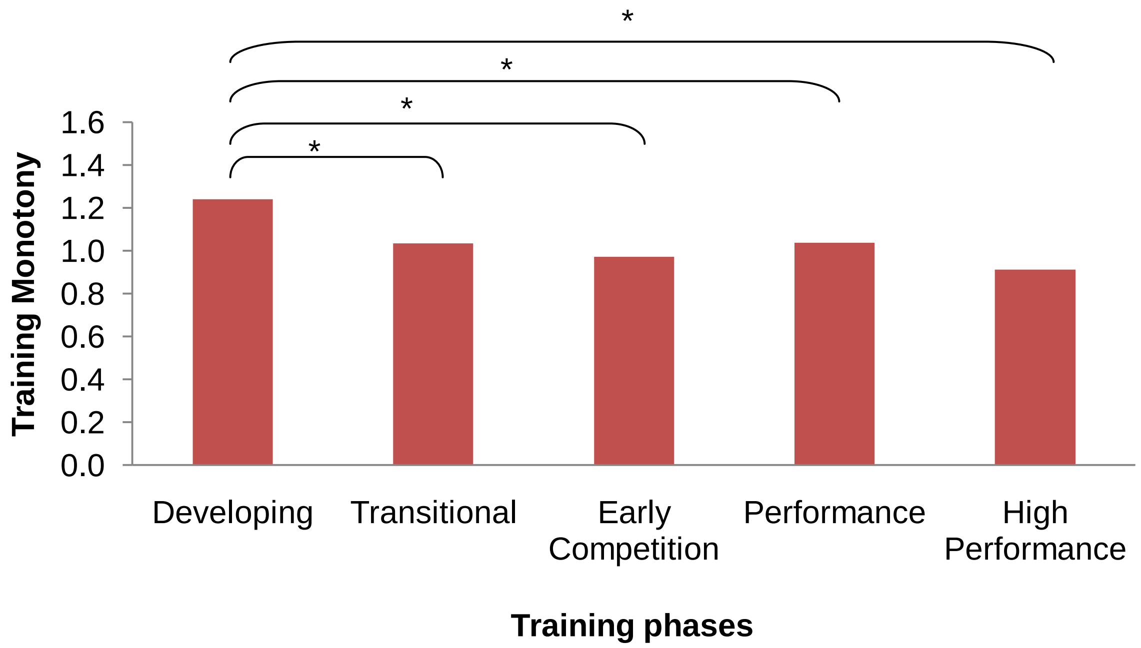

Figure 5.35. Differences in mean Training Monotony scores for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Training Strain

Total group of rugby players

The mean Training Strain scores for the group can be seen in Figure 5.36. There was a significant decrease in Training Strain from the Developing phase to the Transitional phase (p = 0.03), the Early Competition phase (p = 0.00002), the Performance phase (p = 0.002), and the High Performance phase (p = 0.002), respectively. The decrease in Training Strain from the Transitional phase to the Early Competition phase was also significant (p = 0.03).

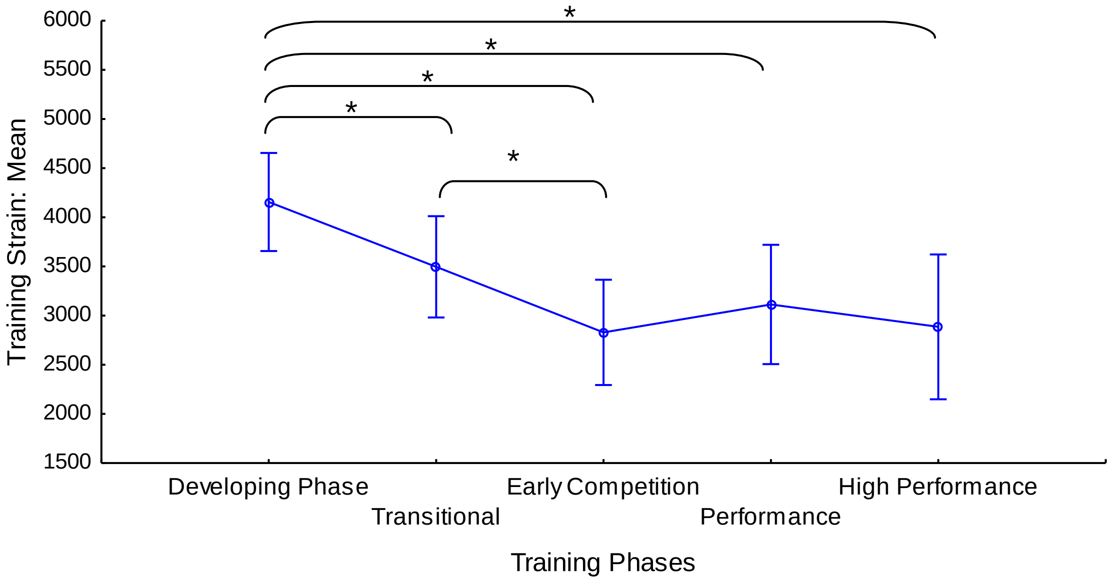

Figure 5.36. Mean Training Strain scores for the group.

** p < 0.05 statistical significance*

Forwards vs Backline players

There was a significant change in training strain over the five phases (p = 0.0002), no significant difference in the average training strain between the forwards and backline players (p = 0.90), and there was a significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.04). The forwards experienced significantly higher training strain than the backline players during the High Performance phase (p = 0.02) (Figure 5.37).

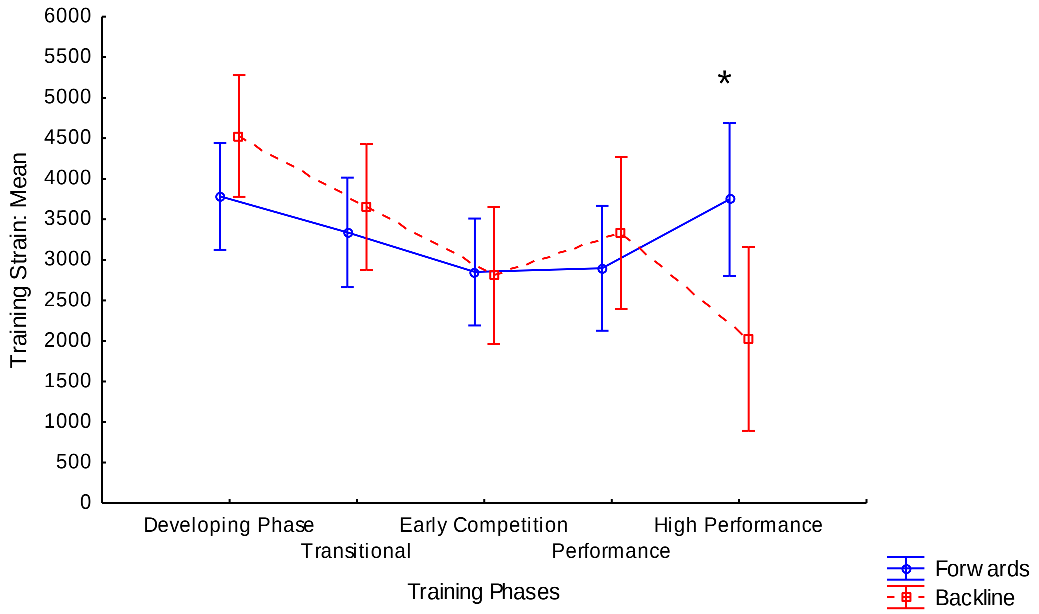

Figure 5.37. Training Strain scores between forwards and backline players.

** p < 0.05, significant difference between position over the phases*

Forwards

There was a significant decrease in training strain from the Developing phase to the Early Competition phase (p = 0.01), and the Performance phase (p = 0.04), respectively, as shown in Figure 5.38.

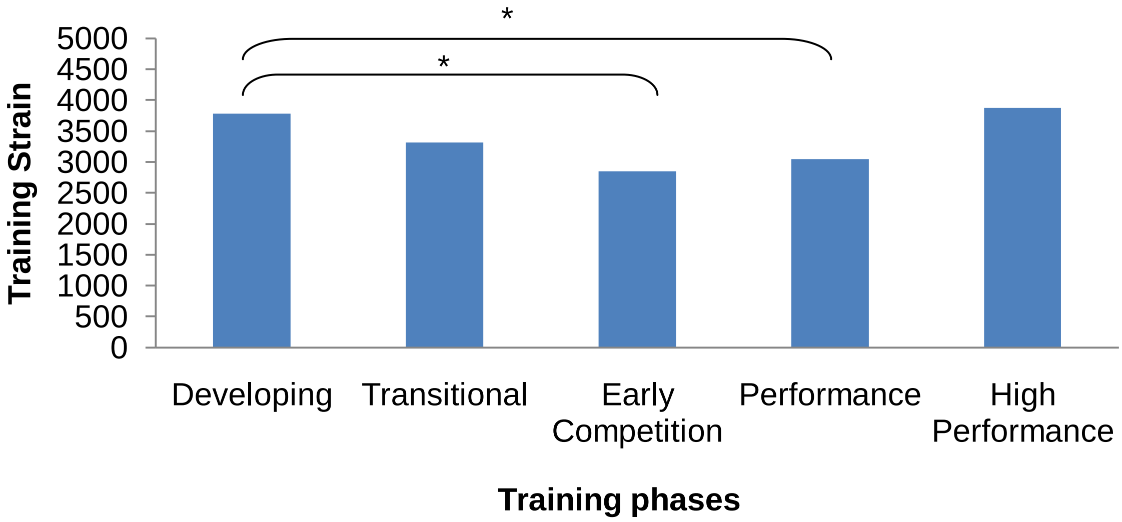

Figure 5.38. Differences in the mean Training Strain for the Forwards over the training phases.

** p < 0.05, significant difference between the phases*

Backline players

Training strain significantly decreased from the Developing phase to the Transition phase (p = 0.05), the Early Competition phase (p = 0.0004), the Performance phase (p = 0.02), and the High Performance phase (p = 0.00006), respectively, as well as from the Transitional phase to the High Performance phase (p = 0.009), and from the Performance phase to the High Performance phase (p = 0.05) as shown in Figure 5.39.

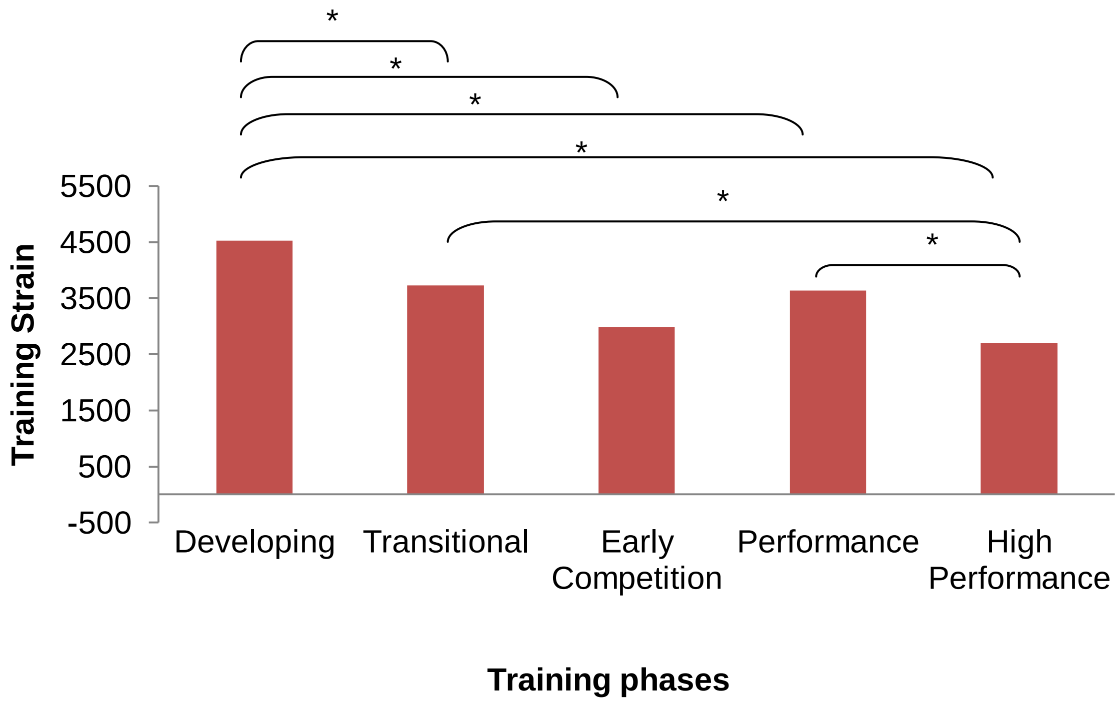

Figure 5.39. Differences in the mean Training Strain for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

5.6 RECOVERY-STRESS QUESTIONNAIRE (RESTQ-76-SPORT)

Table 5.8 shows the descriptive data for the RESTQ-76-Sport's Total Stress and Total Recovery values, and the Mean and Standard Deviations for all the subscales of the RESTQ-76-Sport questionnaire.

Data for each testing session for the RESTQ-76-Sport can be seen in Appendix F.

Table 5.8. Means and Standard Deviations for the RESTQ-76-Sport scales.

	Developing phase			**Transitional phase**			**Early Competition phase**			**Performance phase**			**High Performance phase**		
Testing Sessions	2			1			1			2			2		
RESTQ-76-Sport	**G** 55	**F** 31	**B** 24	**G** 45	**F** 28	**B** 17	**G** 47	**F** 29	**B** 18	**G** 47	**F** 28	**B** 19	**G** 41	**F** 26	**B** 15
Total Stress	16.42 ±6.04	16.75 ±6.42	15.99 ±5.6	18.25 ±6.85	17.25 ±7.38	19.91 ±5.68	16.69 ±6.11	16.13 ±6.38	15.97 ±6.79	17.63 ±6.79	15.97 ±6.36	20.08 ±6.82	18.86 ±7.22	15.86 ±6.75	21.33 ±6.89
Total Recovery	30.20 ±5.18	29.41 ±5.20	31.22 ±5.08	30.14 ±6.25	29.68 ±6.60	30.89 ±5.66	29.78 ±6.34	29.50 ±6.56	30.22 ±6.14	29.96 ±6.26	30.48 ±6.49	29.20 ±6.00	29.09 ±6.61	29.96 ±6.55	27.57 ±6.65
General Stress	1.03 ±0.70	1.13 ±0.73	0.91 ±0.65	1.19 ±0.91	1.09 ±0.94	1.37 ±0.85	1.08 ±0.78	1.03 ±0.74	1.17 ±0.85	1.21 ±0.74	1.00 ±0.66	1.52 ±0.77	1.32 ±0.93	1.07 ±0.64	1.74 ±1.19
Emotional Stress	1.38 ±0.71	1.37 ±0.76	1.39 ±0.65	1.38 ±0.75	1.28 ±0.71	1.56 ±0.80	1.34 ±0.83	1.22 ±0.71	1.54 ±0.97	1.47 ±0.79	1.20 ±0.60	1.88 ±0.88	1.52 ±0.85	1.35 ±0.78	1.81 ±0.91
Social Stress	1.53 ±1.00	1.51 ±0.99	1.55 ±1.04	1.66 ±0.98	0.46 ±0.95	1.99 ±0.97	1.56 ±1.05	1.47 ±1.10	1.71 ±0.96	1.67 ±0.94	1.42 ±0.79	2.04 ±1.02	1.58 ±0.91	1.42 ±0.97	1.85 ±0.74
Conflicts/ Pressure	2.59 ±0.89	2.62 ±0.91	2.54 ±0.87	2.48 ±1.02	2.39 ±1.08	2.63 ±0.92	2.49 ±1.07	2.46 ±1.08	2.54 ±1.08	2.39 ±0.92	2.26 ±0.87	2.57 ±0.99	2.32 ±0.94	2.20 ±1.04	2.52 ±0.73
Fatigue	2.07 ±0.91	2.13 ±1.03	1.99 ±0.73	2.36 ±0.97	2.32 ±0.95	2.43 ±1.03	2.09 ±0.91	2.02 ±0.99	2.21 ±0.76	2.15 ±0.91	2.13 ±1.02	2.17 ±0.73	2.10 ±0.79	1.85 ±0.72	2.53 ±0.74
Lack of Energy	1.58 ±0.68	1.60 ±0.75	1.55 ±0.57	1.72 ±0.80	1.70 ±0.89	1.77 ±0.65	1.61 ±0.68	1.54 ±0.61	1.71 ±0.79	1.72 ±0.78	1.51 ±0.66	2.04 ±0.86	1.75 ±0.85	1.49 ±0.87	2.22 ±0.59
Physical Complaints	1.46 ±0.63	1.49 ±0.69	1.41 ±0.56	1.71 ±0.75	1.69 ±0.80	1.75 ±0.69	1.50 ±0.79	1.50 ±0.87	1.49 ±0.67	1.72 ±0.78	1.57 ±0.75	1.94 ±0.80	1.77 ±0.96	1.49 ±0.73	2.27 ±1.14
Success	3.16 ±0.91	2.94 ±0.96	3.40 ±0.80	3.29 ±1.05	3.12 ±1.15	3.57 ±0.81	3.19 ±0.90	3.01 ±0.88	3.47 ±0.87	3.26 ±0.88	3.31 ±0.94	3.17 ±0.80	3.14 ±0.96	3.28 ±1.02	2.89 ±0.84

	Developing phase			Transitional phase			Early Competition phase			Performance phase			High Performance phase		
Social Recovery	4.10 ±0.92	4.14 ±1.02	4.06 ±0.79	4.07 ±1.00	4.05 ±1.05	4.10 ±0.94	4.06 ±1.00	4.10 ±1.10	4.01 ±0.94	4.16 ±1.03	4.33 ±1.05	3.91 ±0.98	3.78 ±1.20	4.02 ±1.09	3.35 ±1.30
Physical Recovery	3.30 ±0.62	3.17 ±0.52	3.46 ±0.72	3.26 ±0.82	3.25 ±0.83	3.28 ±0.82	3.22 ±0.94	3.13 ±0.95	3.38 ±0.92	3.28 ±0.82	3.26 ±0.88	3.32 ±0.74	3.16 ±0.95	3.20 ±1.01	3.08 ±0.85
General Well-Being	3.30 ±0.62	3.17 ±0.52	3.46 ±0.72	3.26 ±0.82	3.25 ±0.83	3.28 ±0.82	3.22 ±0.94	3.13 ±0.95	3.38 ±0.92	3.28 ±0.82	3.26 ±0.88	3.32 ±0.74	3.16 ±0.95	3.20 ±1.01	3.08 ±0.85
Sleep Quality	3.63 ±0.80	3.57 ±0.86	3.70 ±0.72	3.65 ±0.95	3.76 ±1.08	3.47 ±0.66	3.63 ±1.09	3.65 ±1.15	3.60 ±1.02	3.58 ±0.89	3.70 ±0.93	3.39 ±0.80	3.47 ±0.91	3.60 ±0.96	3.25 ±0.81
Disturbed Breaks	2.52 ±0.55	2.44 ±0.58	2.63 ±0.51	2.53 ±0.57	2.45 ±0.58	2.68 ±0.52	2.48 ±0.60	2.42 ±0.64	2.58 ±0.52	2.65 ±0.57	2.56 ±0.51	2.79 ±0.63	2.64 ±0.60	2.61 ±0.58	2.71 ±0.64
Emotional Exhaustion	1.32 ±0.89	1.51 ±0.97	1.07 ±0.73	1.62 ±0.86	1.50 ±0.86	1.82 ±0.85	1.37 ±0.85	1.38 ±0.94	1.36 ±0.70	1.51 ±0.82	1.45 ±0.78	1.59 ±0.89	1.57 ±0.85	1.38 ±0.80	1.9 0±0.85
Injury	2.21 ±0.82	2.22 ±0.86	2.19 ±0.78	2.57 ±1.02	2.51 ±1.22	2.68 ±0.60	2.41 ±1.00	2.44 ±1.02	2.35 ±1.00	2.34 ±0.85	2.20 ±0.82	2.54 ±0.87	2.39 ±0.87	2.27 ±0.89	2.59 ±0.82
Being in Shape	3.46 ±0.82	3.40 ±0.82	3.54 ±0.82	3.28 ±1.07	3.16 ±1.10	3.47 ±1.03	3.16 ±0.95	3.10 ±0.98	3.26 ±0.93	3.29 ±1.00	3.34 ±0.99	3.22 ±1.03	3.31 ±1.00	3.46 ±0.98	3.03 ±1.01
Personal Accomplishment	3.08 ±0.92	2.89 ±0.90	3.33 ±0.90	3.19 ±1.01	3.03 ±0.94	3.50 ±1.10	3.07 ±1.00	2.99 ±1.08	3.21 ±0.87	3.07 ±0.93	3.07 ±0.96	3.08 ±0.90	3.01 ±0.84	2.99 ±0.86	3.05 ±0.81
Self-Efficacy	3.40 ±0.77	3.28 ±0.80	3.54 ±0.71	3.54 ±0.91	3.57 ±0.93	3.50 ±0.90	3.55 ±0.96	3.59 ±0.94	3.50 ±1.03	3.35 ±0.83	3.51 ±0.82	3.12 ±0.82	3.37 ±0.95	3.53 ±1.00	3.09 ±0.82
Self-Regulation	3.58 ±0.87	3.59 ±0.84	3.56 ±0.92	3.32 ±1.00	3.30 ±1.06	3.35 ±0.92	3.41 ±1.00	3.54 ±1.03	3.21 ±0.94	3.32 ±0.84	3.39 ±0.78	3.21 ±0.94	3.02 ±1.00	3.26 ±0.95	3.12 ±0.98

G: Group; F: Forwards; B: Backline players

Recovery-Stress Relationship

Figure 5.40 indicates the difference between the mean Total Recovery and the mean Total Stress for the five training phases.

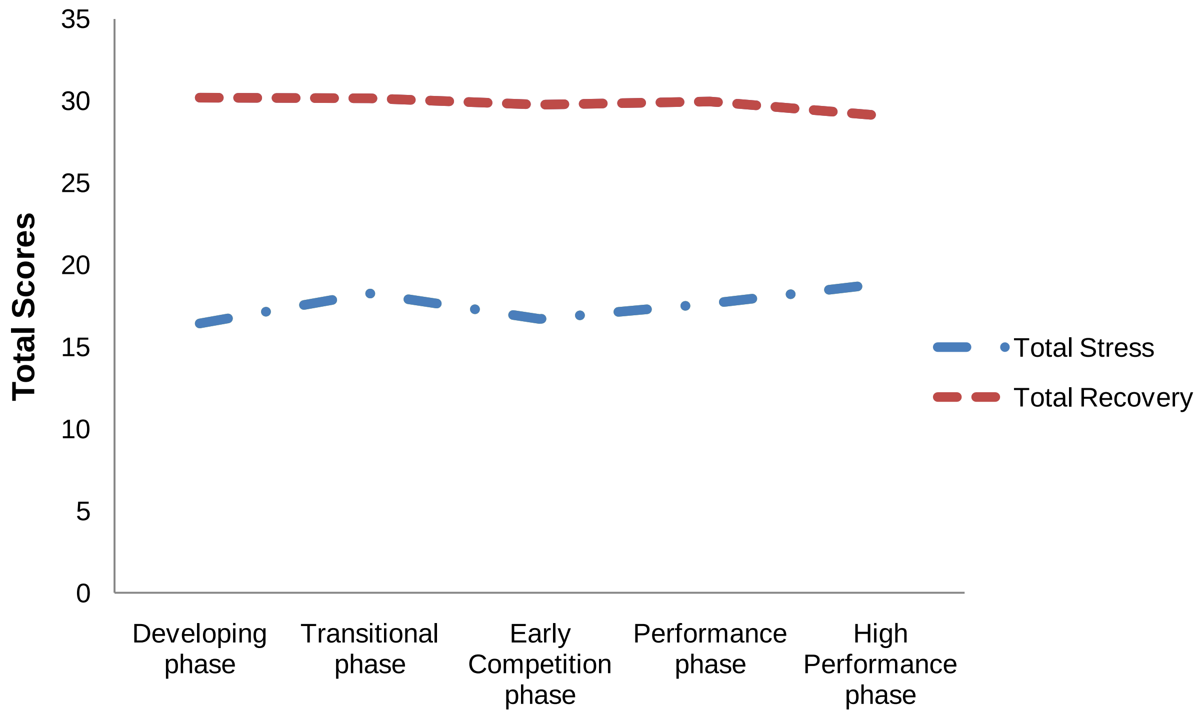

Figure 5.40. Total Recovery and Total Stress scores for the total group of players over the whole season.

Total Stress

Total group of rugby players

The Total Stress for the group can be seen in Figure 5.41. There was a significant increase in the Total Stress scores from the Developing phase to the Transitional phase ($p = 0.009$), and the High Performance phase ($p = 0.04$), respectively.

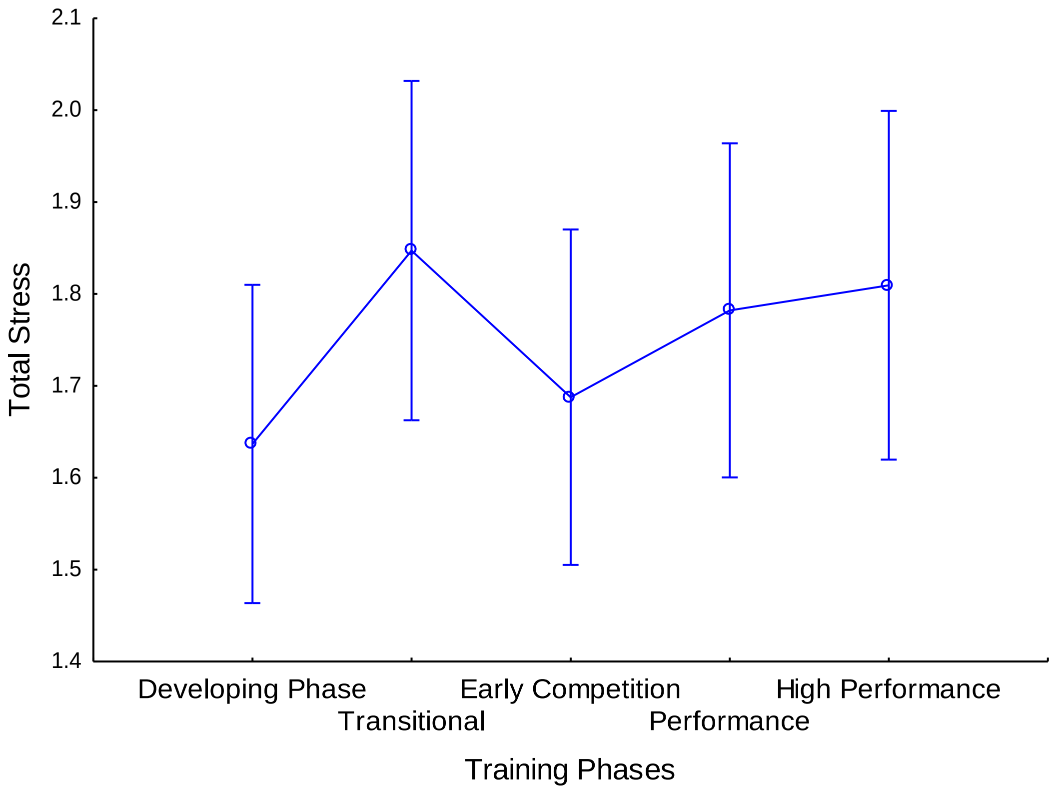

Figure 5.41. The mean Total Stress for the group.

Forwards vs Backline players

There was no significant change in the Total Stress score of the RESTQ-76-Sport over the five training phases (p = 0.05), no significant difference in the average Total Stress between the forwards and the backline players (p = 0.15). There was a significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.01). The backline players had significantly higher stress scores than the forwards during the Performance phase (p = 0.05), and the High Performance phase (p = 0.02) (Figure 5.42).

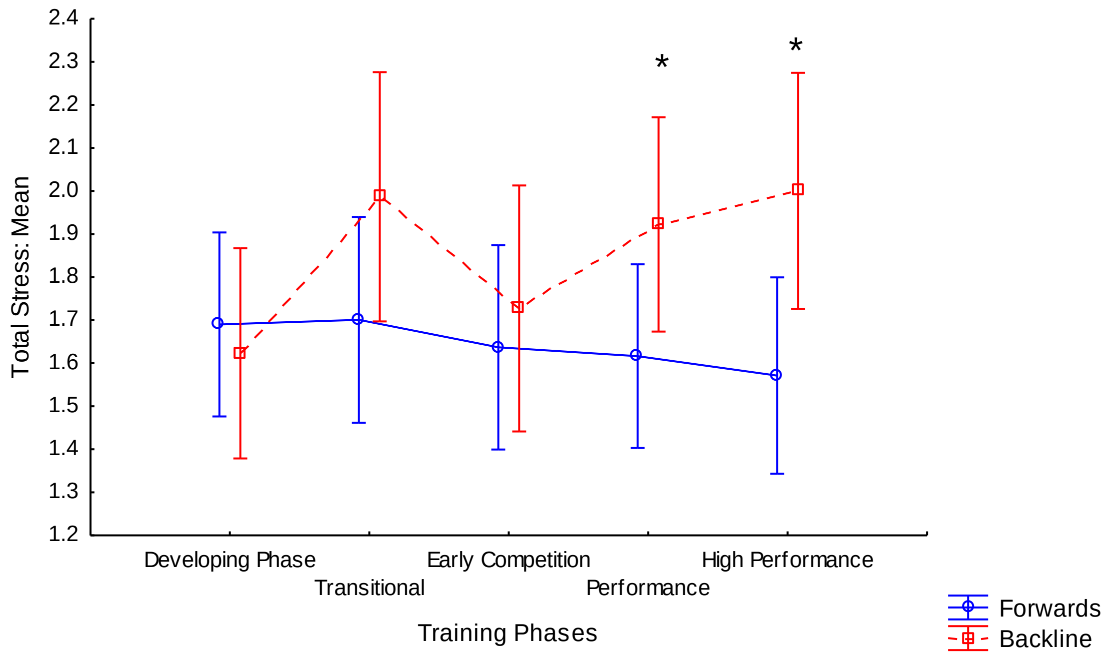

Figure 5.42. Total Stress scores for RESTQ-76-Sport between forwards and backline players.

** p < 0.05, significant difference between position over the phases.*

Forwards

There was no significant difference in the mean Total stress score for the forwards between the five training phases.

Backline players

There was a significant increase in the Total stress scores from the Developing phase to the Transitional phase (p = 0.002), the Performance phase (p = 0.003), and the High Performance phase (p = 0.001), respectively, as well as from the Transitional phase to the Early Competition phase (p = 0.04), and from the Early Competition phase to the High Performance phase (p = 0.03) as shown in Figure 5.43.

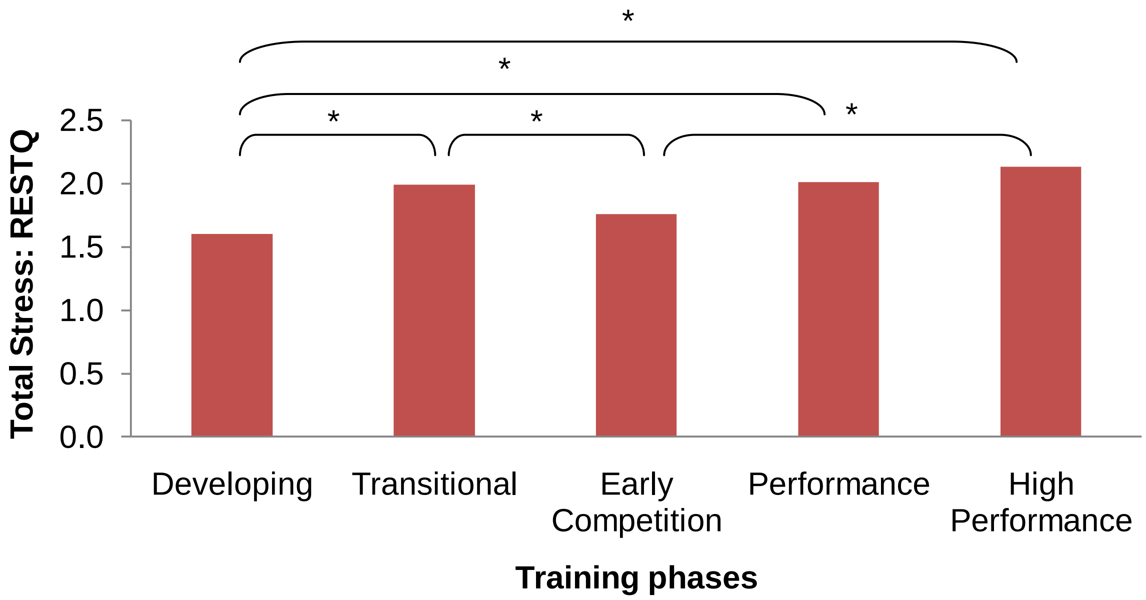

Figure 5.43. Differences in the mean Total Stress for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Total Recovery

Total group of rugby players

The mean Total Recovery scores for the group can be seen in Figure 5.44. There was a significant decrease from the Developing phase to the High Performance phase (p = 0.01), and a significant decrease in recovery from the Transitional phase to the High Performance phase (p = 0.05).

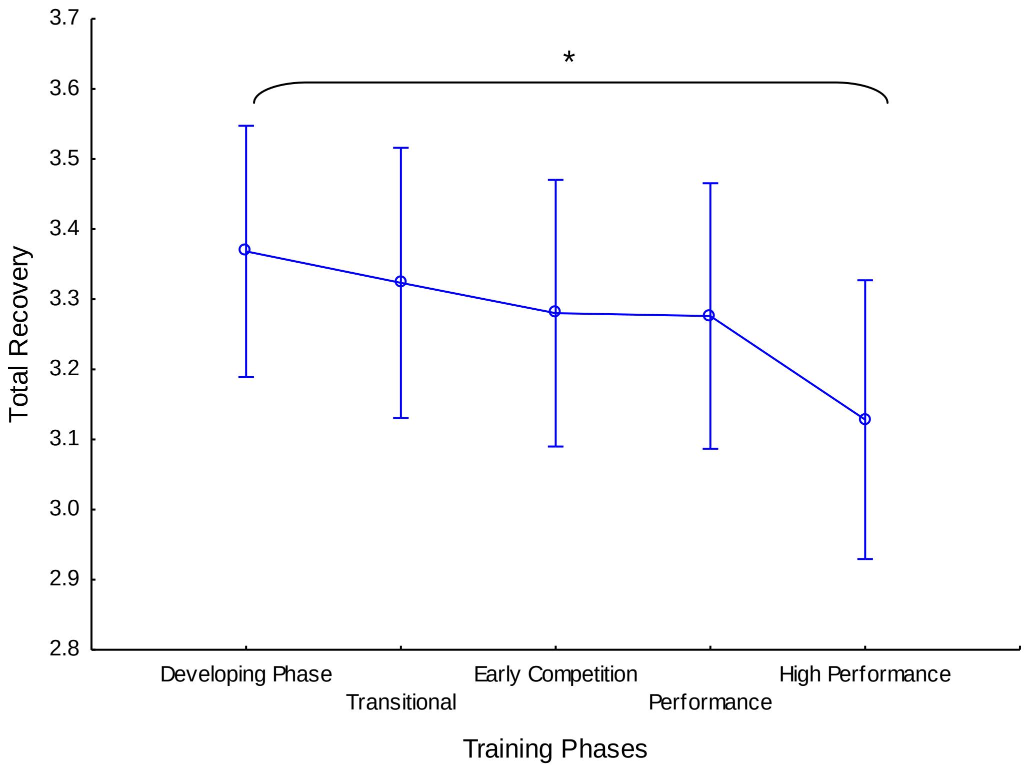

Figure 5.44. The mean Total Recovery scores for the group.

** p < 0.05, statistical significance*

Forwards vs Backline players

There was not a significant change in Total Recovery score of the RESTQ-76-Sport over the five training phases ($p = 0.13$), as well as no significant differences in the average score between the forwards and backline players ($p = 0.67$). There is a significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases ($p = 0.01$). The forwards had significant higher Total Recovery scores than the backline players during the High Performance phase ($p = 0.05$) (Figure 5.45).

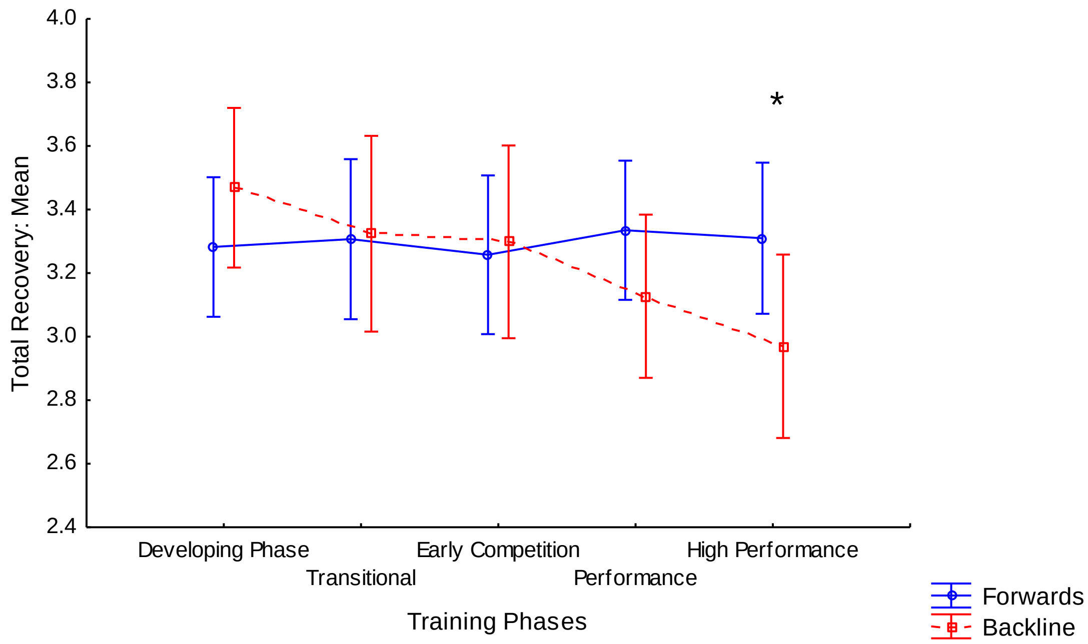

Figure 5.45. Total Recovery scores for RESTQ-76-Sport between forwards and backline players.

** $p < 0.05$, significant difference between position over the phases.*

Forwards

There was no significant difference in the mean Total Recovery score for the backline players between the five training phases.

Backline players

There was a significant decrease in Total Recovery score from the Developing phase to the Performance phase ($p = 0.03$), and the High Performance phase ($p = 0.0003$), from the Transitional phase to the High Performance phase ($p = 0.008$), and from the Early Competition phase to the High Performance phase ($p = 0.01$) as shown in Figure 5.46.

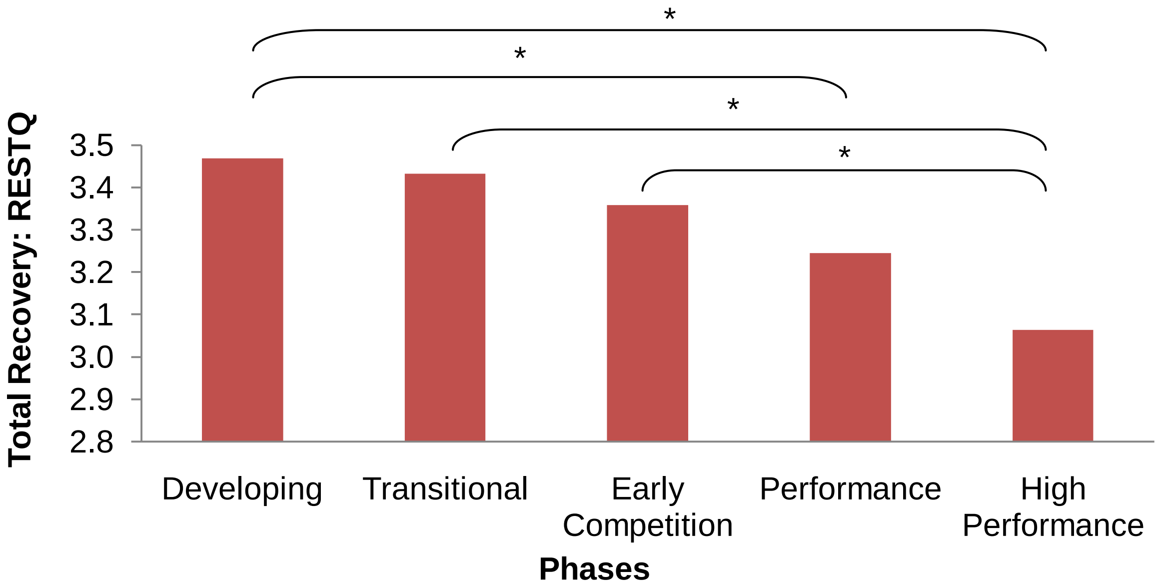

Figure 5.46. Differences in the mean Total Recovery for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

General Stress

Total group of rugby players

The mean General Stress scores for the group can be seen in Figure 5.47. There was a significant increase in General Stress scores from the Developing phase to the High Performance phase (p = 0.005) and from the Early Competition phase to the High Performance phase (p = 0.03).

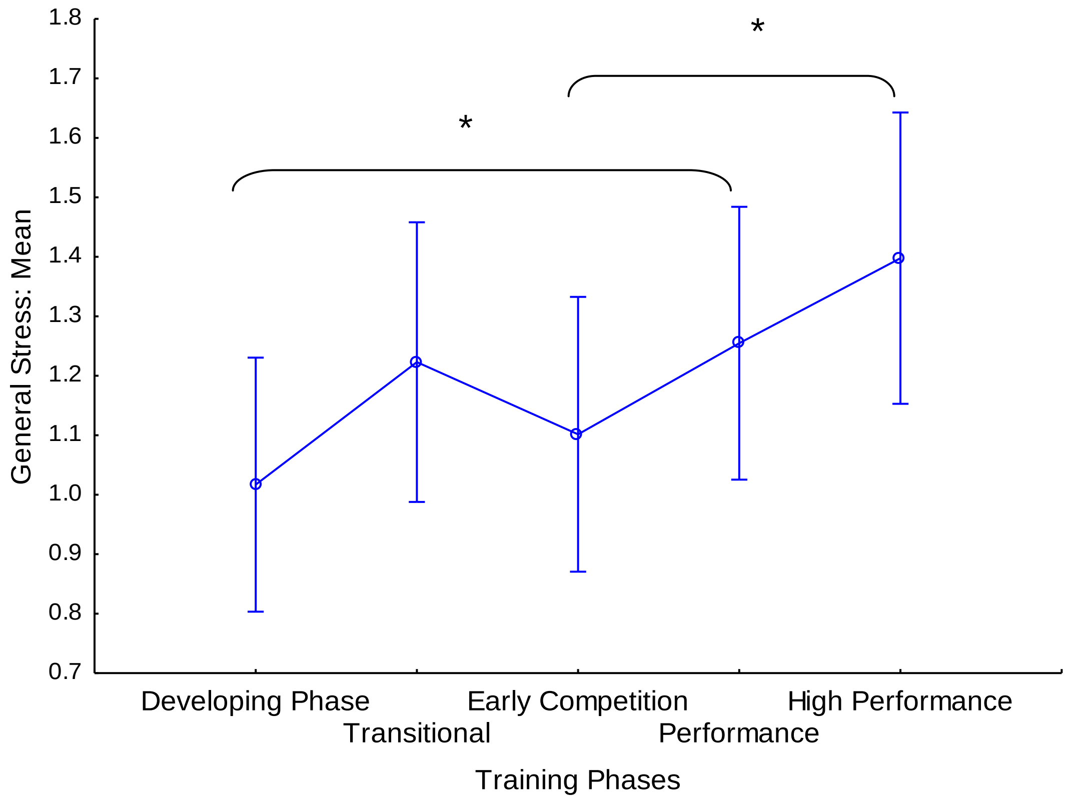

Figure 5.47. The mean General Stress scores for the group.

** $p < 0.05$ Statistical significance*

Forwards vs Backline players

There was a significant change in the General stress over the five training phases ($p = 0.05$), no significant difference in the average scores between the forwards and backline players ($p = 0.14$), but there was a significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases ($p = 0.01$). The Backline players reported significant higher General Stress scores than the forwards during the Performance phase ($p = 0.05$), and in the High Performance phase ($p = 0.02$) (Figure 5.48).

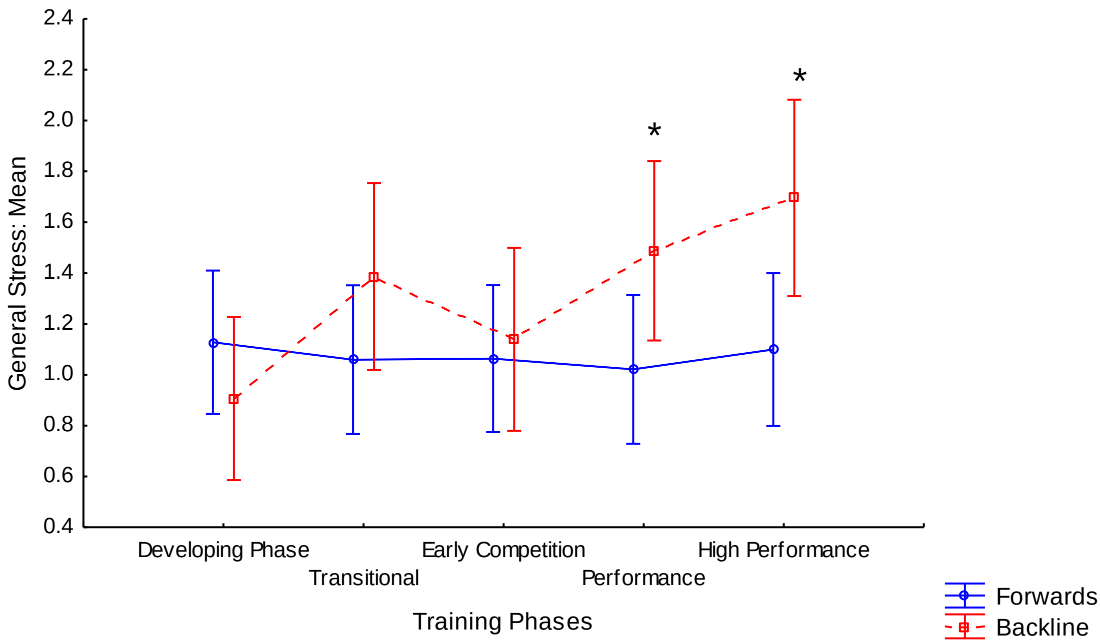

Figure 5.48. General Stress scores between forwards and backline players.

** p < 0.05, significant difference between position over the phases*

Forwards

There was no significant difference in the mean General Stress scale of the RESTQ-76-Sport for the forwards between the five training phases.

Backline players

There was a significant increase in General Stress scores from the Developing phase to the Transitional phase (p = 0.02), the Performance phase (p = 0.003), and the High Performance phase (p = 0.0002), respectively, as well as from the Early Competition phase to the High Performance phase (p = 0.01) as shown in Figure 5.49.

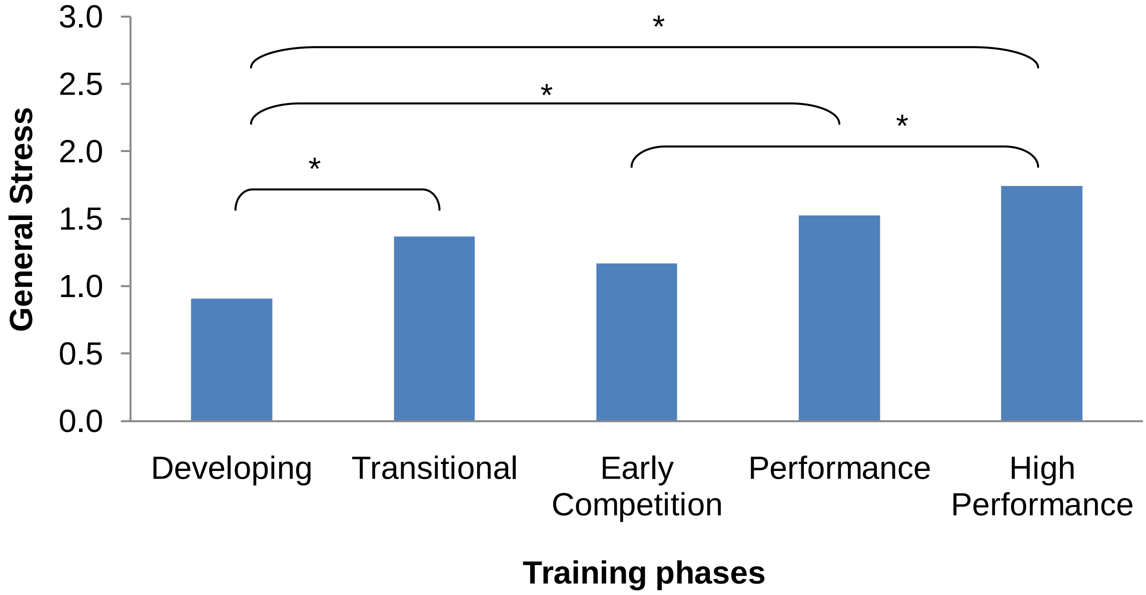

Figure 5.49. Differences in the mean General Stress for the Forwards over the training phases.

** $p < 0.05$, significant difference between the phases*

Emotional Stress

Total group of rugby players

The mean Emotional Stress for the group can be seen in Figure 5.50. There was no significant difference in the scores for the Emotional Stress scale for the group over the season.

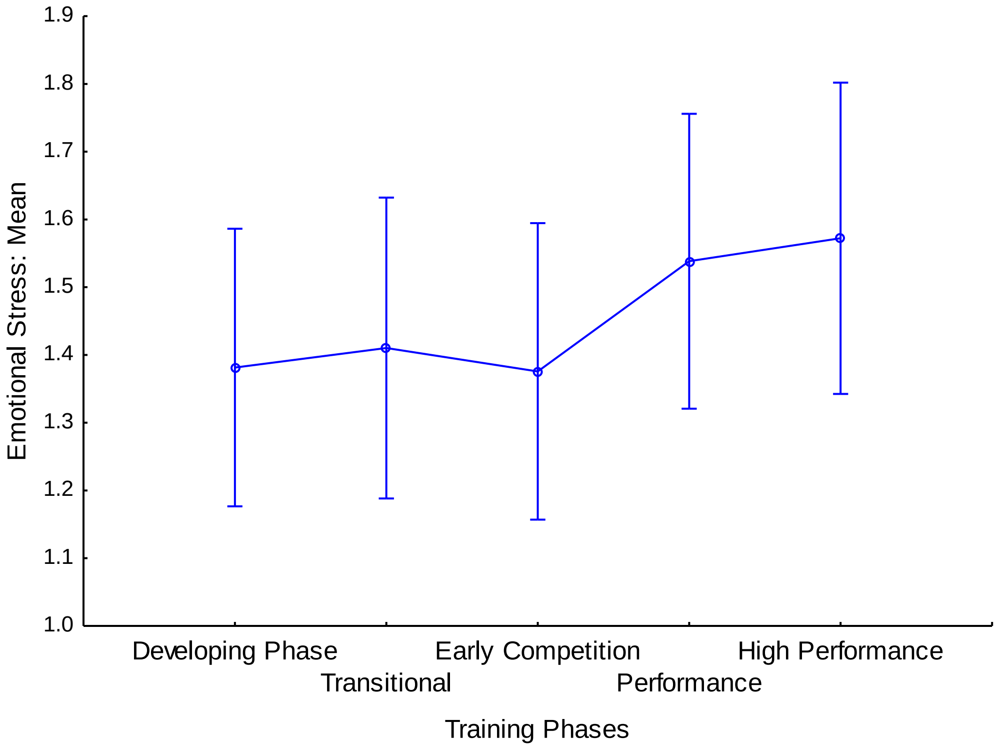

Figure 5.50. Mean Emotional Stress for the group.

Forwards vs Backline players

There was no significant changes in Emotional Stress over the five training phases (p = 0.26), no significant difference in the average scores between the forwards and the backline players (p = 0.06), and no significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.07). There was a significant difference in Emotional Stress scores during the Performance phase (p = 0.004) where the backline players recorded higher Emotional stress scores than the forwards (Figure 5.51).

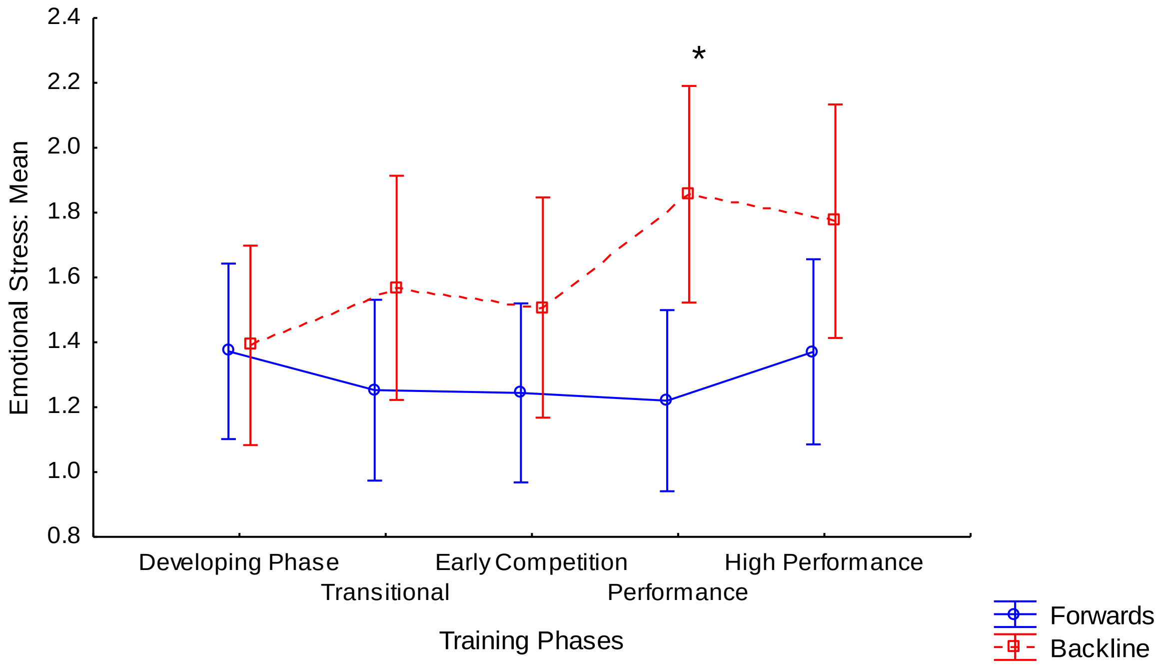

Figure 5.51. Emotional Stress scores between forwards and backline players.

** p < 0.05, significant difference between position over the phases*

Forwards

There was no significant difference in the mean Emotional Stress scale for the forwards between the five training phases.

Backline players

There was a significant increase in Emotional Stress from the Developing phase to the Performance phase ($p = 0.005$), and the High Performance ($p = 0.03$), respectively, and from the Early Competition phase to the Performance phase ($p = 0.05$) as shown in Figure 5.52.

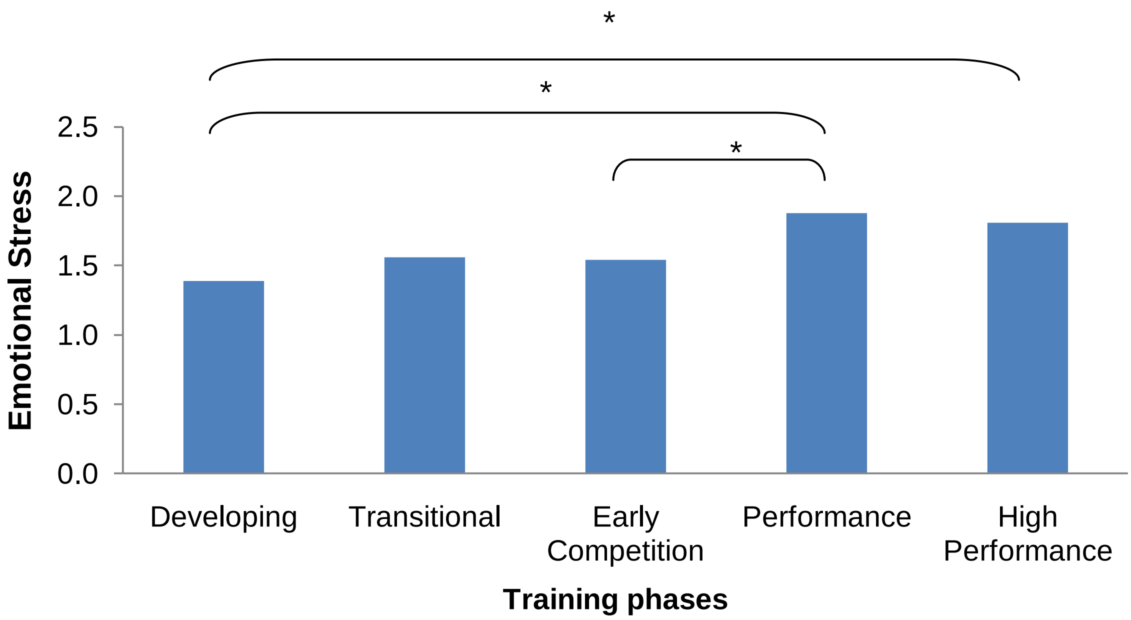

Figure 5.52. Differences in the mean General Stress for the Forwards over the training phases.

** $p < 0.05$, significant difference between the phases*

Social Stress

Total group of rugby players

The mean scores for the Social Stress scale for the group can be seen in Figure 5.53. There were no significant differences between the phases for the Social Stress scale.

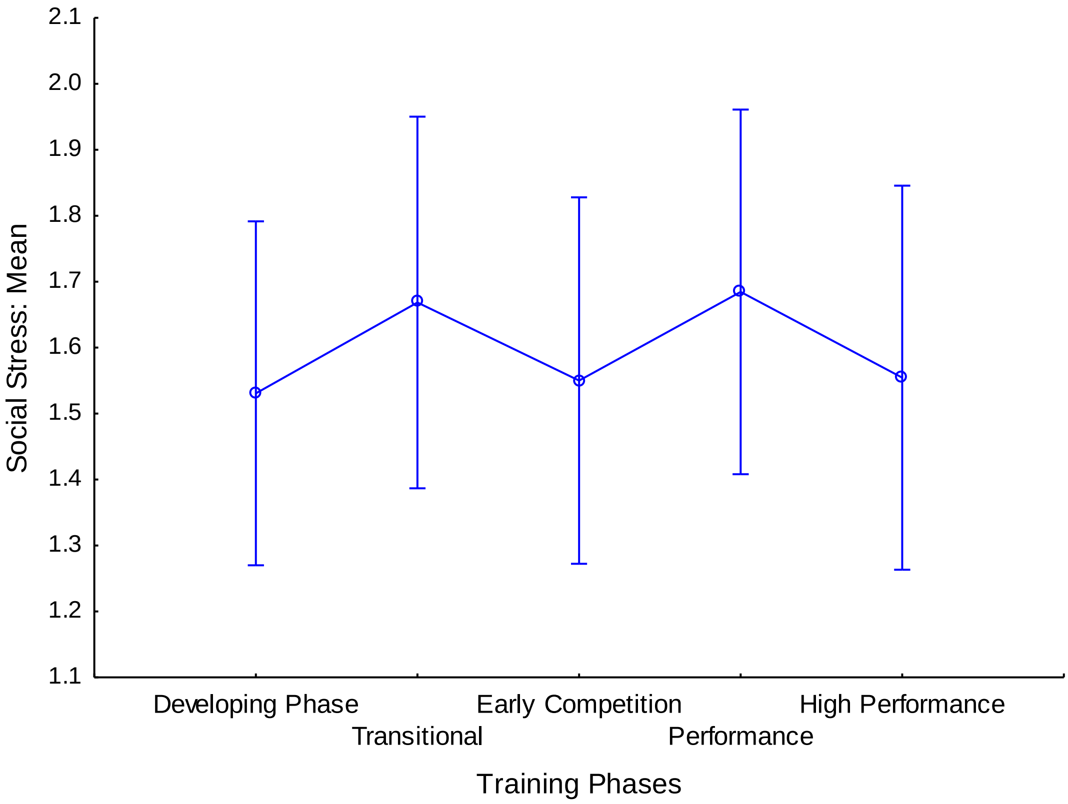

Figure 5.53. The mean Social Stress scores for the group.

Forwards vs Backline players

There was no significant changes in Social Stress over the five training phases (p = 0.69), no significant difference in the average scores between the forwards and the backline players (p = 0.26), and no significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.33) (Figure 5.54).

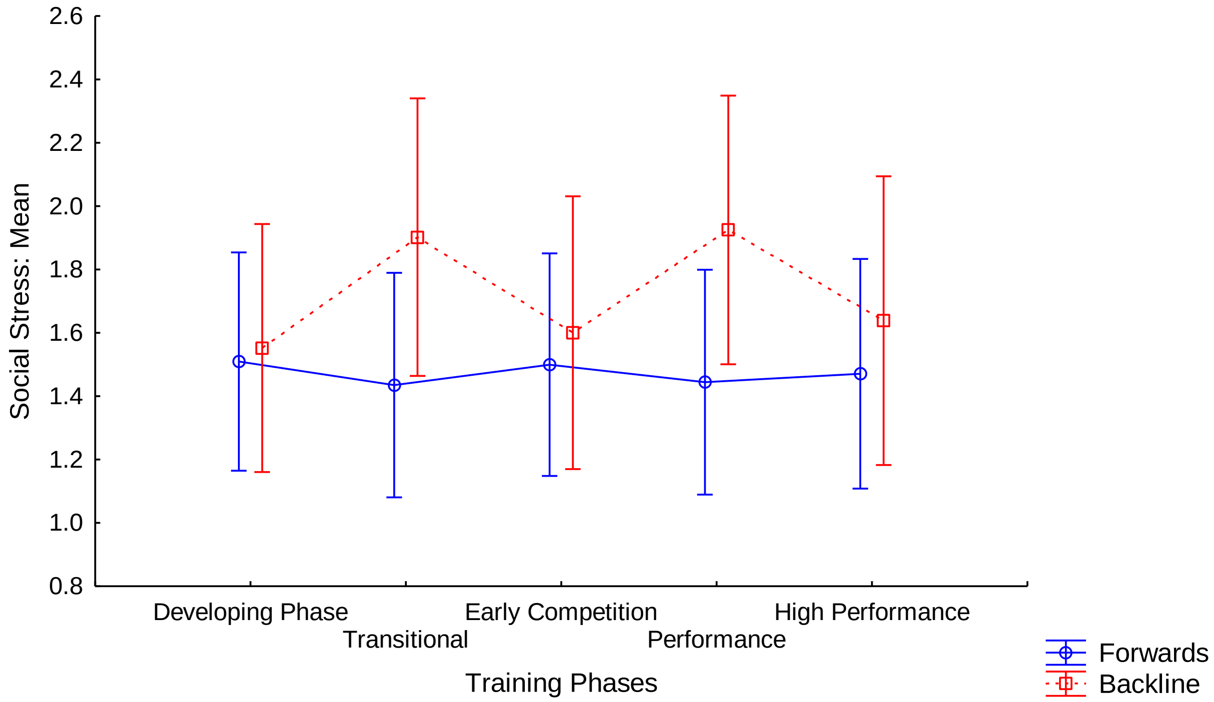

Figure 5.54. Social Stress scores between forwards and backline players.

Forwards

There was no significant difference in the mean Social Stress scale for the forwards between the five training phases.

Backline players

There was no significant difference in the mean Social Stress scale for the backline players between the five training phases.

Conflicts/Pressure

Total group of rugby players

The mean Conflicts/Pressure values for the group can be seen in Figure 5.55. There were no significant differences in Conflicts/Pressure scores for the group between the phases.

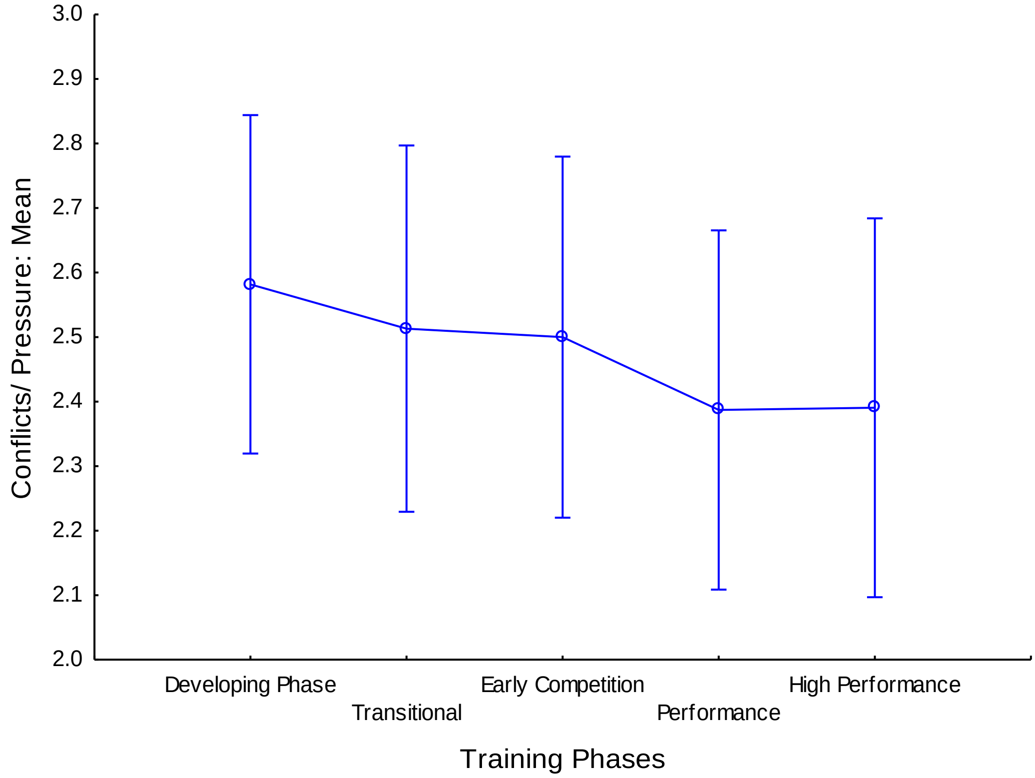

Figure 5.55. The mean Conflicts/Pressure scores for the group.

Forwards vs Backline players

There was no significant changes in Social Stress over the five training phases (p = 0.58), no significant difference in the average scores between the forwards and the backline players (p = 0.49), and no significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.45) (Figure 5.56).

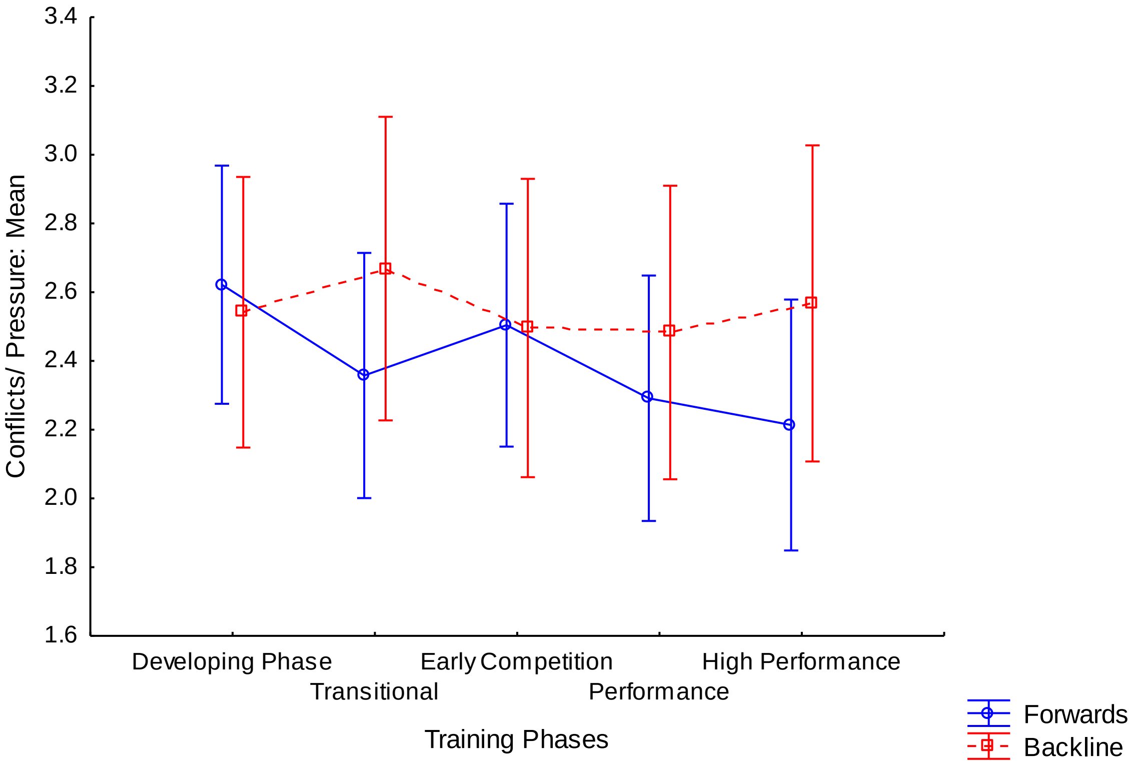

Figure 5.56. Conflicts/Pressure scores between forwards and backline players.

Forwards

There was a significant decrease in the Conflicts/Pressure score from the Developing phase to the High Performance phase (p = 0.02) as shown in Figure 5.57.

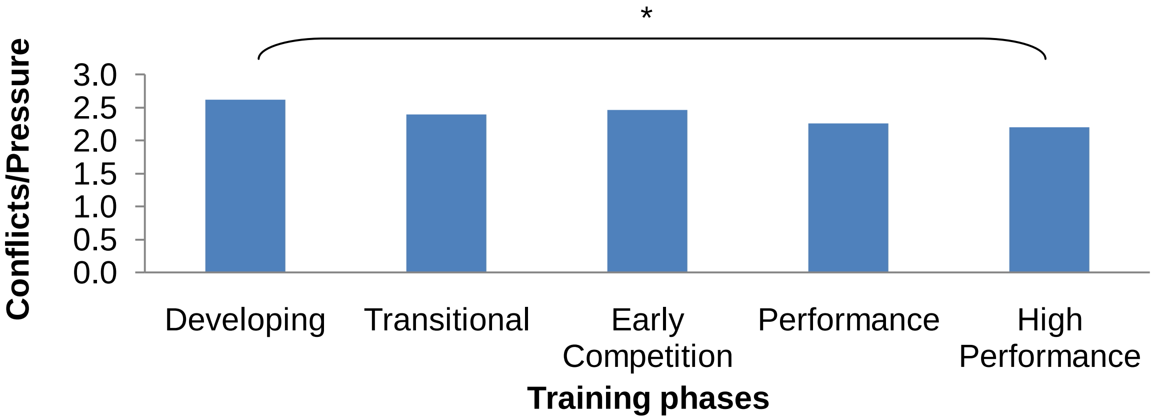

Figure 5.57. Differences in the mean Conflicts/Pressure for the Forwards over the training phases.

** p < 0.05, significant difference between the phases*

Backline players

There was no significant difference in the mean Conflicts/Pressure score for the backline players between the five training phases.

Fatigue

Total group of rugby players

The mean Fatigue score for the group can be seen in Figure 5.58. There was a significant increase in Fatigue scores from the Developing phase to the Transitional phase (p = 0.02), and a significant decrease in Fatigue scores from the Transitional to the High Performance phase (p = 0.03).

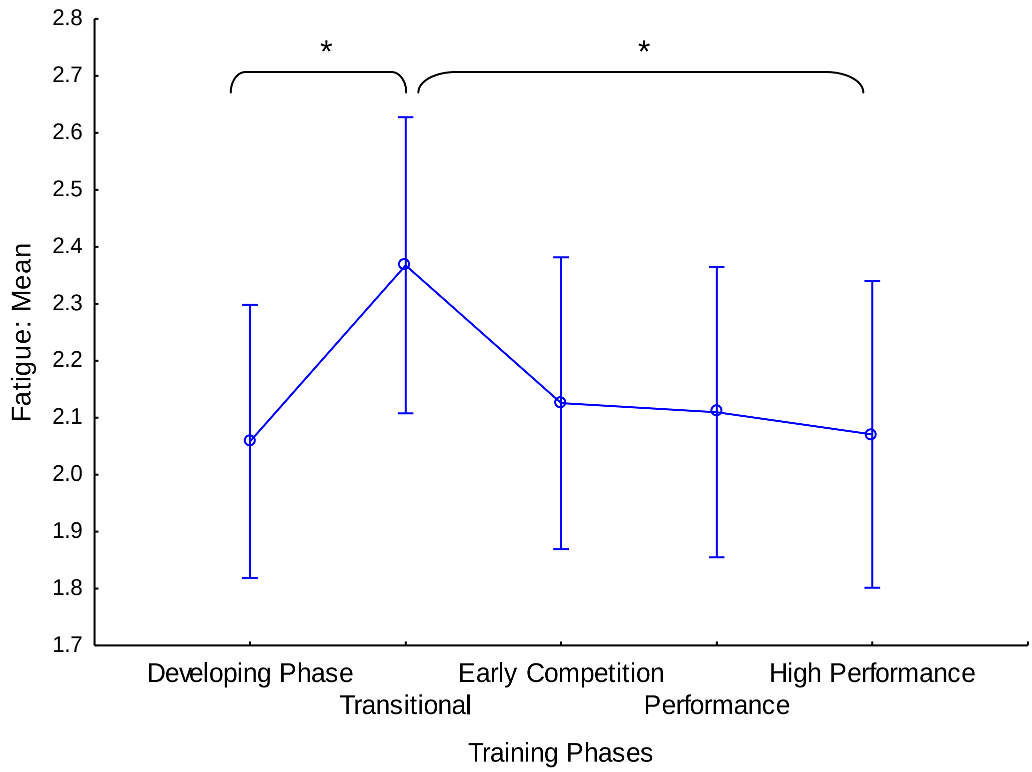

Figure 5.58. The mean Fatigue score for the group.

** p < 0.05 Statistical significance*

Forwards vs Backline players

There was no significant changes in Fatigue over the five training phases (p = 0.13), no significant difference in the average scores between the forwards and the backline players (p = 0.47), and no significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.15). There was a significant difference during the High Performance phase where the backline players expressed higher fatigues scores that the forwards (p = 0.05) (Figure 5.59).

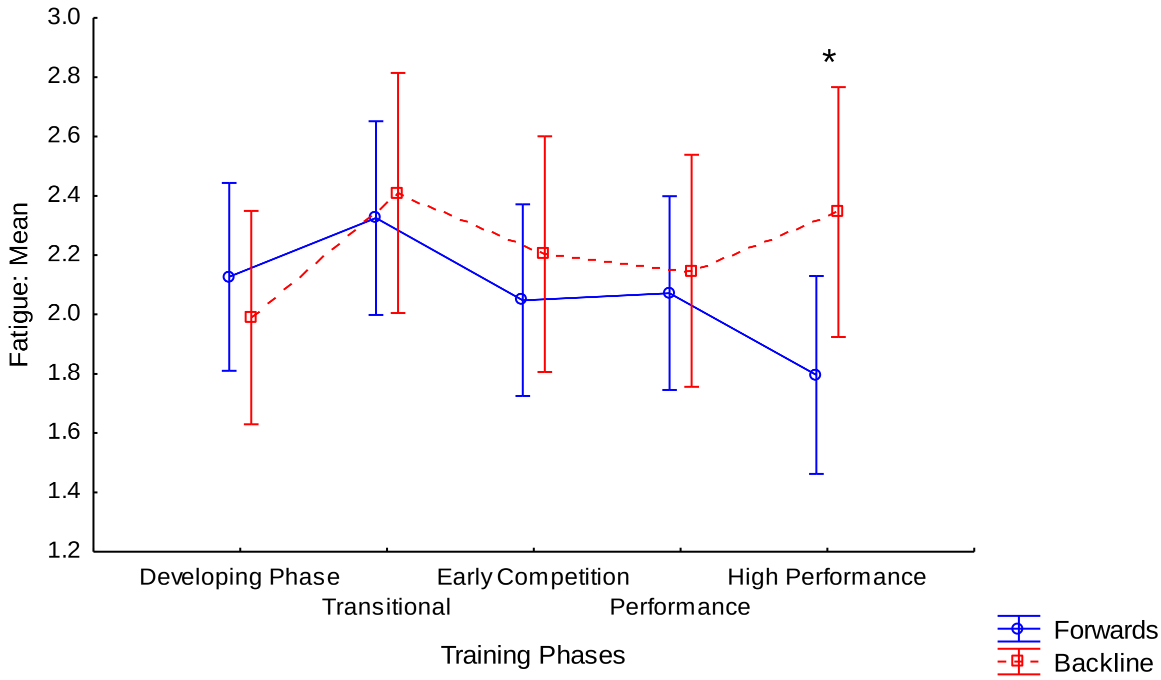

Figure 5.59. Fatigue scores for RESTQ-76-Sport between forwards and backline players.

** $p < 0.05$, significant difference between position over the phase*

Forwards

There was a significant decrease in Fatigue scores from the Developing phase to the High Performance phase (p = 0.05), and from the Transitional phase to the High Performance phase (p = 0.002) as shown in Figure 5.60.

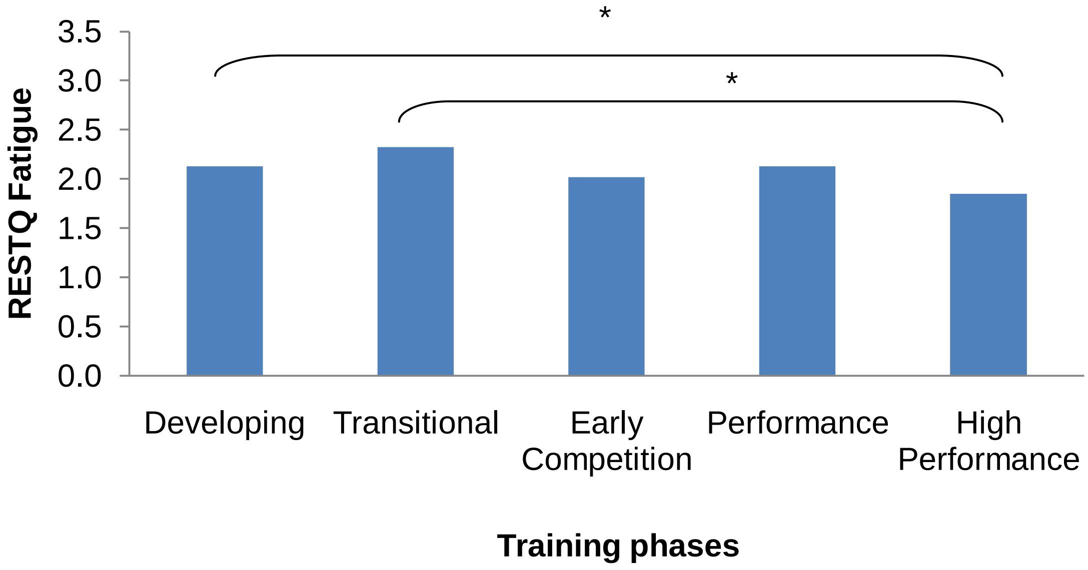

Figure 5.60. Differences in the mean RESTQ-76-Sport Fatigue scores for the Forwards over the training phases.

** $p < 0.05$, significant difference between the phases*

Backline players

There was a significant increase in Fatigue scores from the Developing Phase to the Transitional phase ($p = 0.04$) as shown in Figure 5.61.

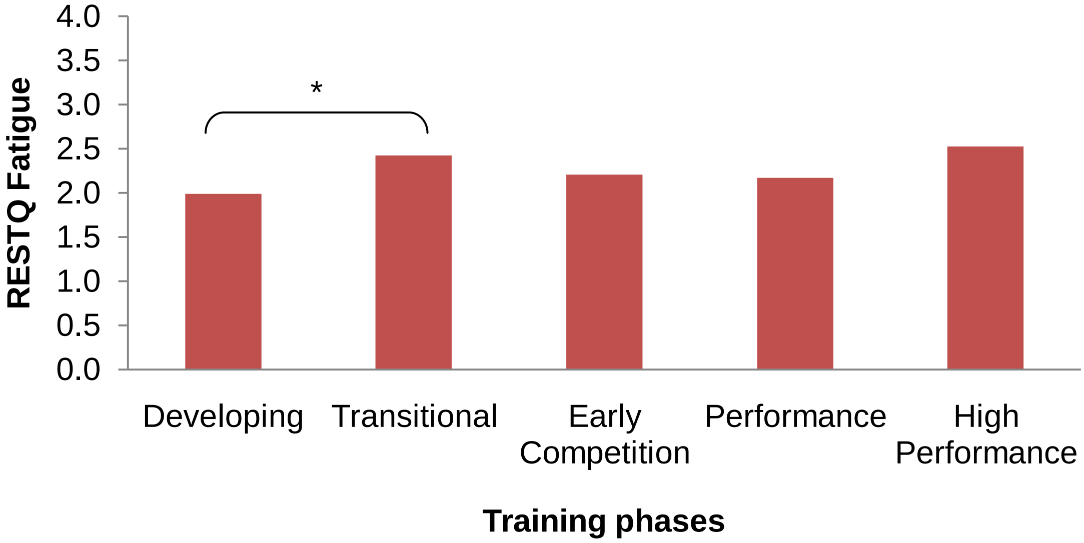

Figure 5.61. Differences in the mean RESTQ-76-Sport Fatigue scores for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Lack of Energy

Total group of rugby players

The mean Lack of Energy values for the group can be seen in Figure 5.62. There was a significant increase in Lack of Energy from the Developing phase to the High Performance phase ($p = 0.03$).

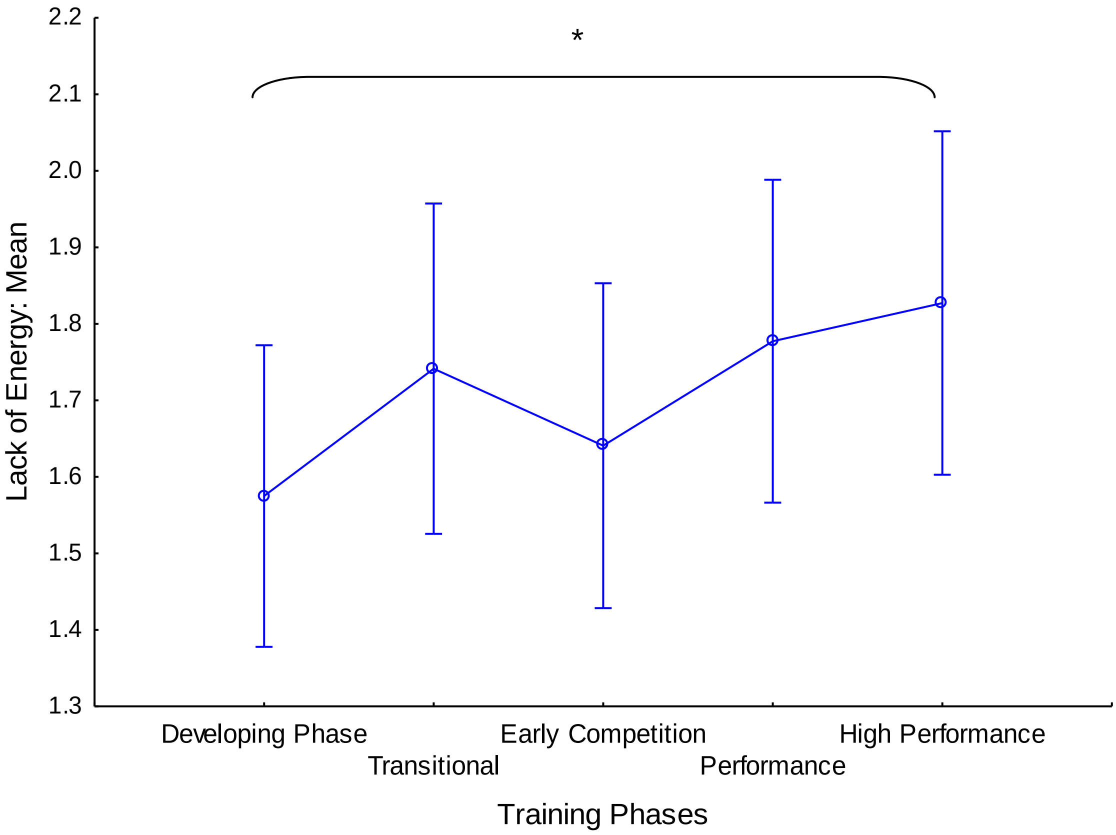

Figure 5.62. The mean Lack of Energy scores for the group.

** p < 0.05 Statistical significance*

Forwards vs Backline players

There was no significant changes in Lack of Energy over the five phases (p = 0.18), and no significant difference in the average scores between the forwards and the backline players (p = 0.07). There was a significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.008). The backline players reported significantly higher scores than the forwards for Lack of Energy in the Performance phase (p = 0.01), and the High Performance phase (p = 0.003) (Figure 5.63).

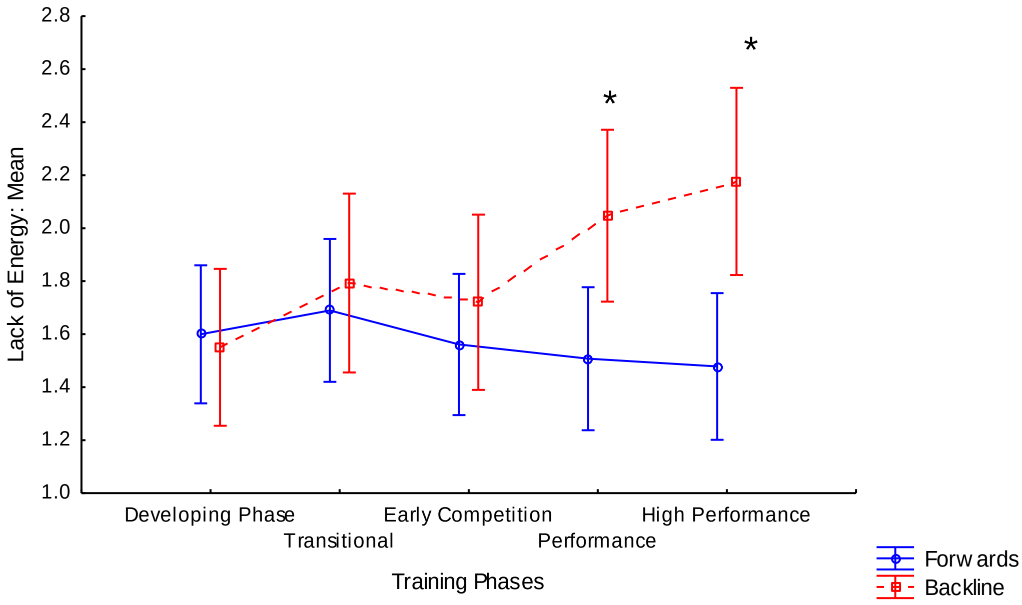

Figure 5.63. Lack of Energy scores between forwards and backline players.

** p < 0.05, significant difference between position over the phases*

Forwards

There was no significant difference in the mean Lack of Energy score for the forwards over the five training phases.

Backline players

There was a significant increase in Lack of Energy scores from the Developing phase to the Performance phase (p = 0.004), the High Performance phase (p = 0.0009), respectively, as well as from the Early Competition phase to the High Performance phase (p = 0.02) as shown in Figure 5.64.

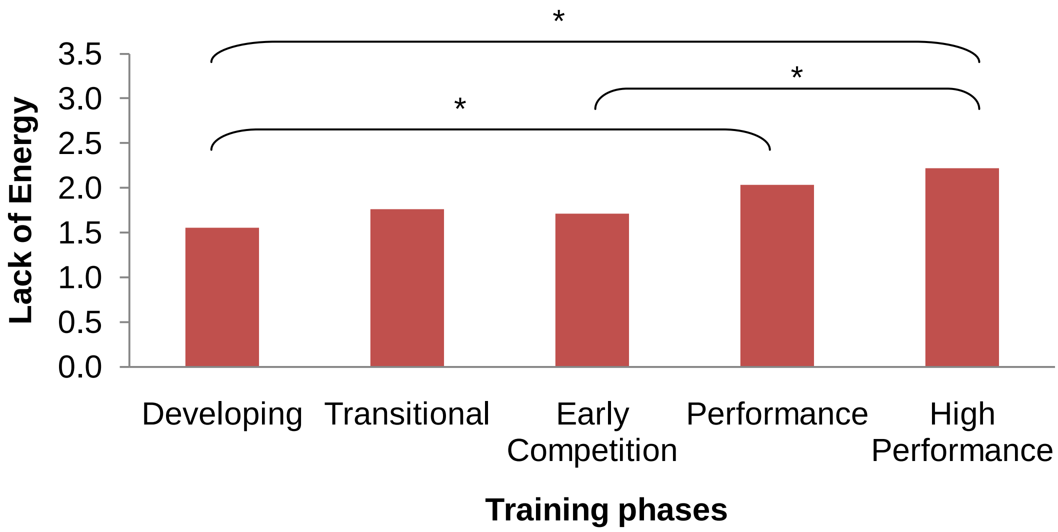

Figure 5.64. Differences in the mean Lack of Energy for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Physical Complaints

Total group of rugby players

The mean Physical Complaints scores for the season for the group can be seen in Figure 5.65. There was a significant increase in Physical Complaints from the Developing phase to the Transitional phase (p = 0.04), the Performance phase (p = 0.02) and the High Performance phase (p = 0.003), respectively. There were also significant increases in Physical complaints from the Early Competition phase to the Performance phase (p = 0.05) and to the High Performance phase (p = 0.009).

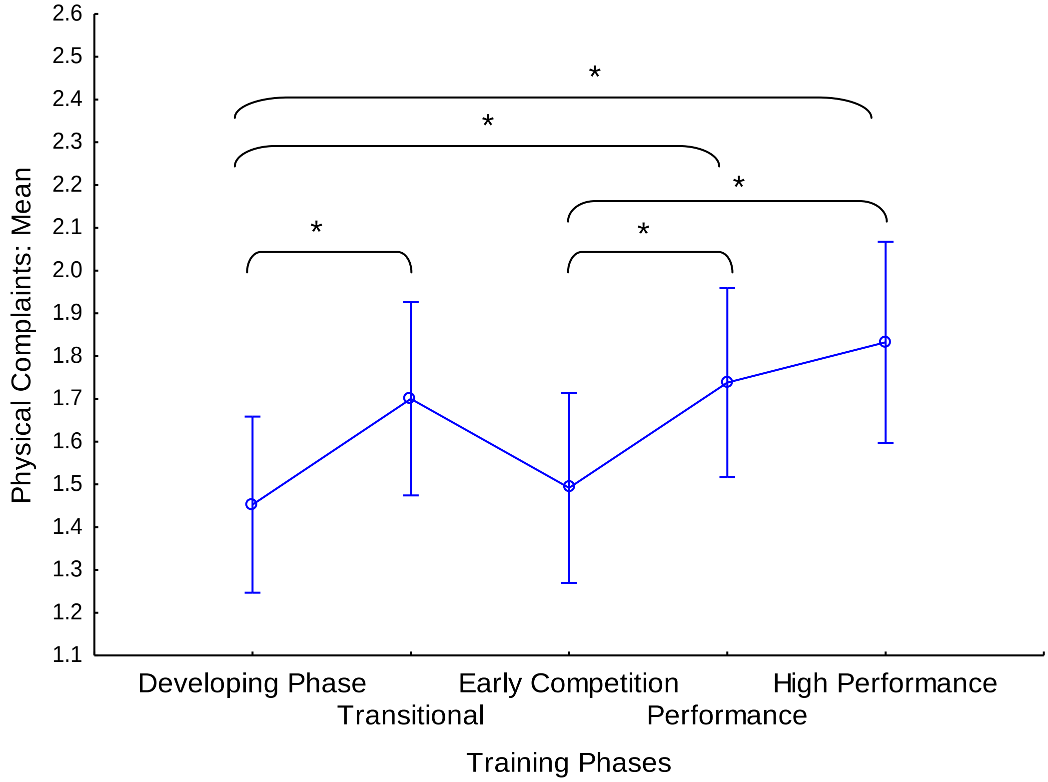

Figure 5.65. The mean Physical Complaints scores for the group.

** p < 0.05 Statistical significance*

Forwards vs Backline players

There was a significant change over the five training phases (p = 0.009), no significant difference in the average score between the forwards and the backline players (p = 0.21). There was a significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.007). The backline players reported significantly higher scores than the forwards for the Physical complaints scale in the High Performance phase (p = 0.003) (Figure 5.66).

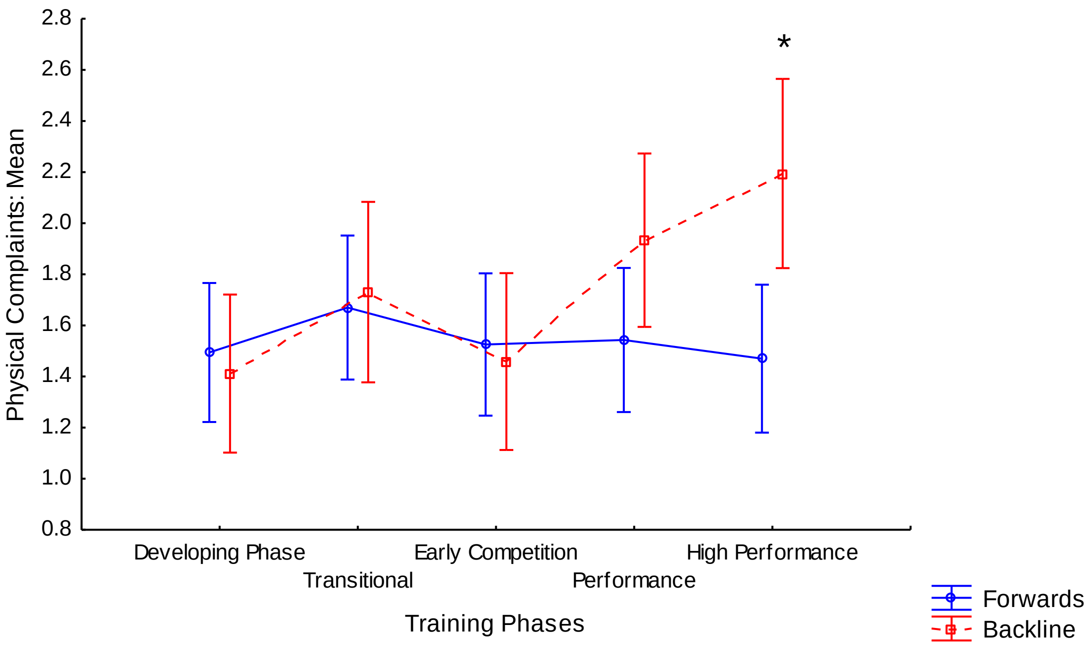

Figure 5.66. Physical Complaints scores between forwards and backline players.

** p < 0.05, significant difference between position over the phases*

Forwards

There was no significant differences in the mean Physical complaint score for the forwards between the five training phases.

Backline players

There was a significant increase in Physical Complaints from the Developing phase to the Performance phase (p = 0.004), and the High Performance phase (p = 0.00009), respectively, as well as from the Transitional phase to the High Performance phase (p = 0.03), and from the Early Competition to the Performance phase (p = 0.01), and the High Performance phase (p = 0.0004), respectively, as shown in Figure 5.67.

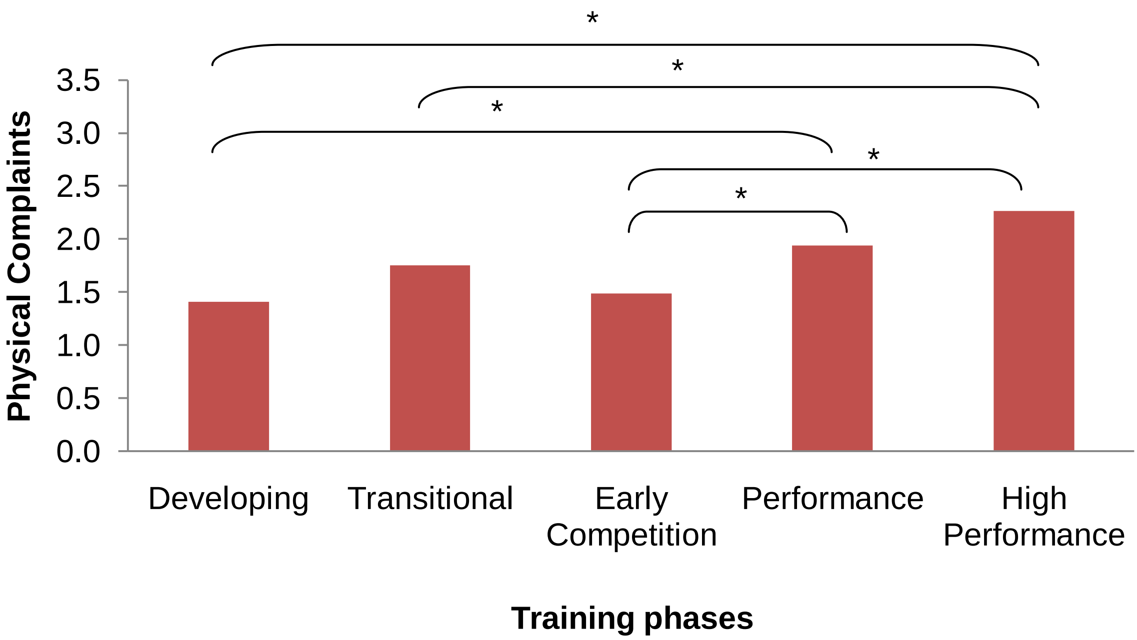

Figure 5.67. Differences in the mean Physical Complaints for the Backline players over the training phases.

** $p < 0.05$, significant difference between the phases*

Success

Total group of rugby players

The mean Success scores for the group can be seen in Figure 5.68. There was a significant decrease in Success scores from the Transitional phase to the High Performance phase ($p = 0.03$).

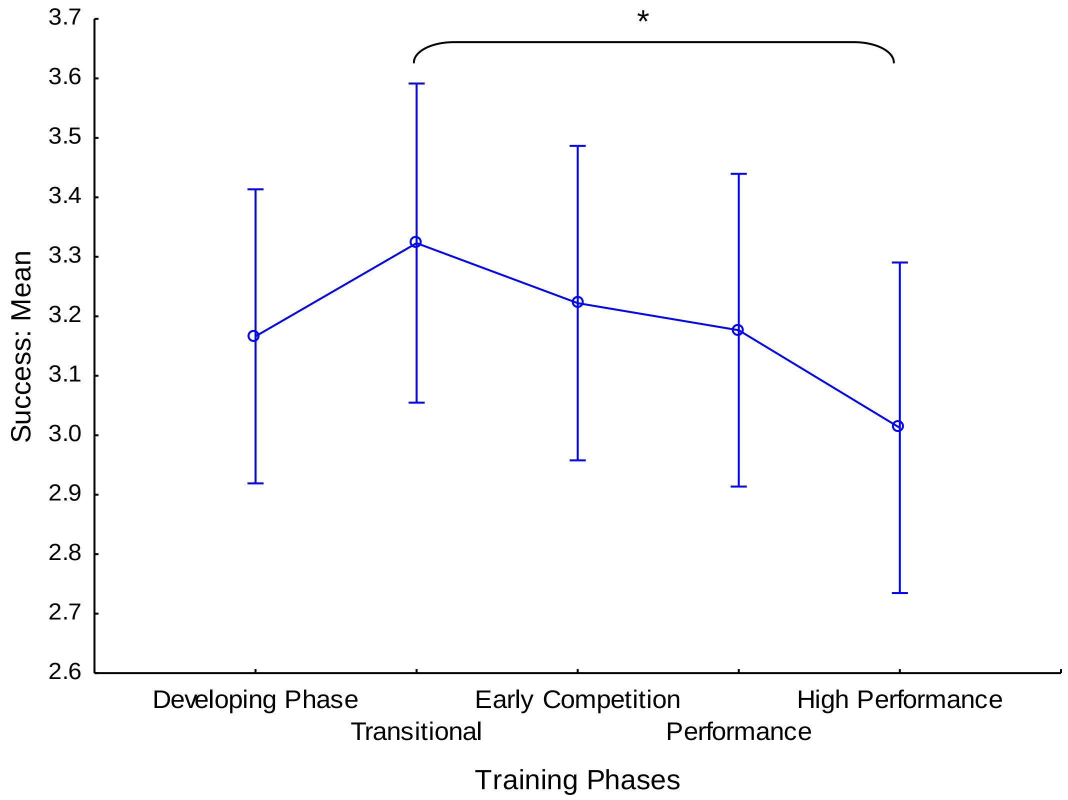

Figure 5.68. The mean Success scores for the group.

** p < 0.05 Statistical significance*

Forwards vs Backline players

There was no significant changes over the five phases (p = 0.31), no significant difference in the average Success score between the forwards and the backline players (p = 0.48). There was a significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.003). The backline players had borderline significantly higher Success scores than the forwards during the Developing phase (p = 0.07) (Figure 5.69).

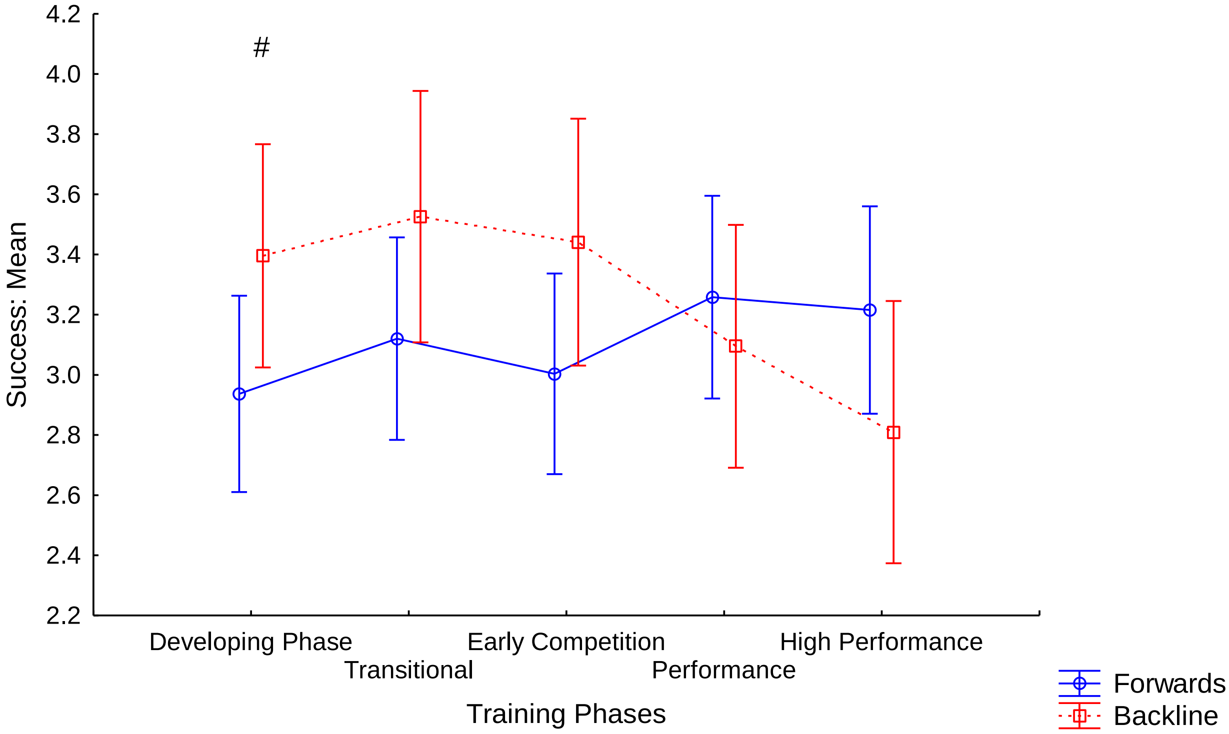

Figure 5.69. Success scores between forwards and backline players.

 # p = 0.07, borderline statistical significance.

Forwards

There was no significant difference in the mean Success score for the forwards between the five training phases.

Backline players

There was a significant decrease in Success scores from the Developing phase to the High Performance phase (p = 0.008), from the Transitional phase to the Performance phase (p = 0.05), and the High Performance phase (p = 0.002), respectively, and from the Early Competition to the High Performance phase (p = 0.006) as shown in Figure 5.70.

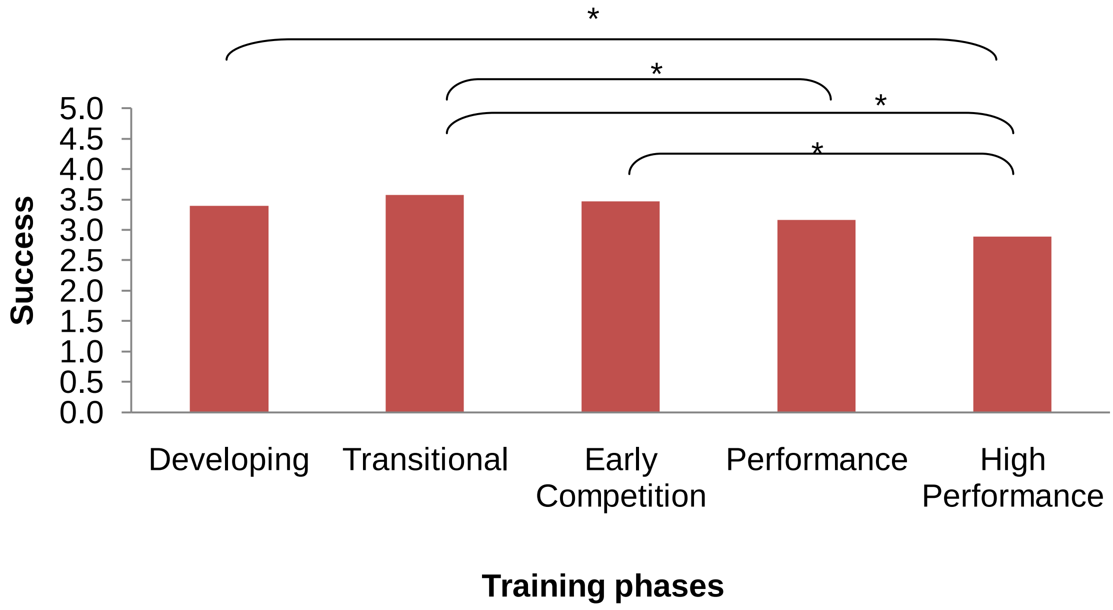

Figure 5.70. Differences in the mean Success for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Social Recovery

Total group of rugby players

The mean Social Recovery scores for the group can be seen in Figure 5.71. There was a significant decrease in Social Recovery from the Developing phase to the High Performance phase (p = 0.0002), from the Transitional phase to the High Performance phase (p = 0.001), from the Early Competition phase to the High Performance phase (p = 0.003), and from the Performance to the High Performance phase (p = 0.0005).

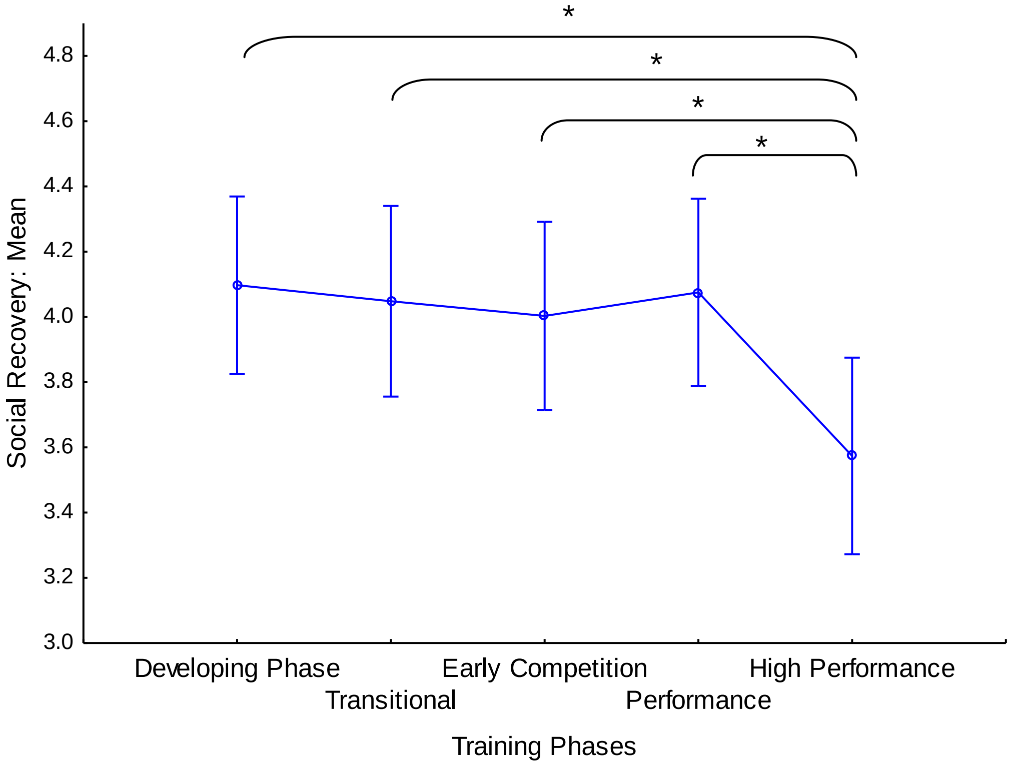

Figure 5.71. The mean Social Recovery scores for the group.

** p < 0.05 Statistical significance*

Forwards vs Backline players

There is a significant change in Social Recovery scores over the phases (p = 0.002), no significant difference in the average scores between the backline players and forwards (p = 0.16), and there was a significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.03). The backline players reported significantly lower Social Recovery scores than the forwards during the High Performance phase (p = 0.005) (Figure 5.72).

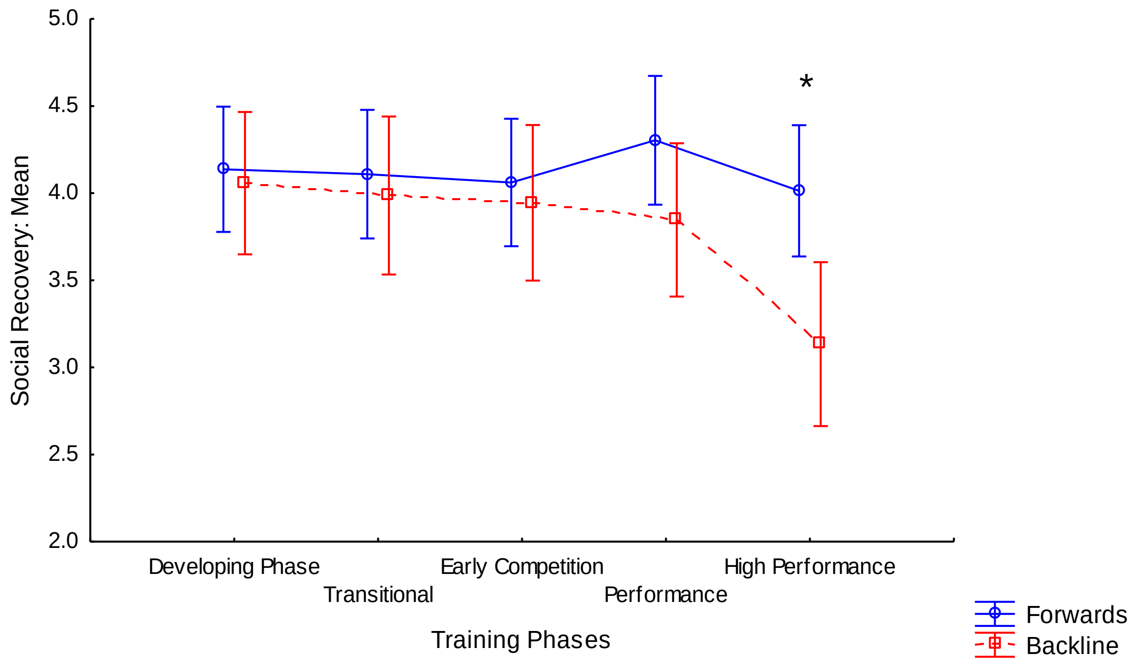

Figure 5.72. Social Recovery scores between forwards and backline players.

** p < 0.05, significant difference between position over the phases*

Forwards

There was no significant difference in the mean Social Recovery score for the forwards between the five training phases.

Backline players

There was a significant decrease in Social Recovery scores from the Developing phase to the High Performance phase (p = 0.00004), from the Transitional phase to the High Performance phase (p = 0.0003), from the Early Competition phase to the High Performance phase (p = 0.0005), and from the Performance phase to the High Performance phase (p = 0.002) as shown in Figure 5.73.

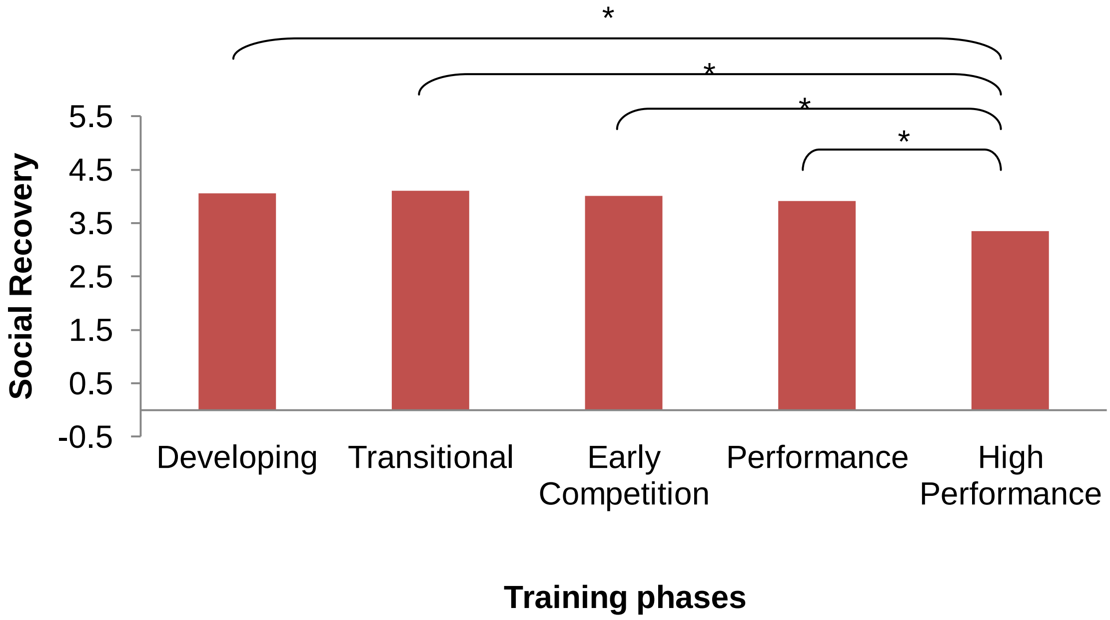

Figure 5.73. Differences in the mean Social Recovery for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Physical Recovery

Total group of rugby players

The mean Physical Recovery scores for the group can be seen in Figure 5.74. There were no significant differences for the group regarding Physical Recovery scores between the phases.

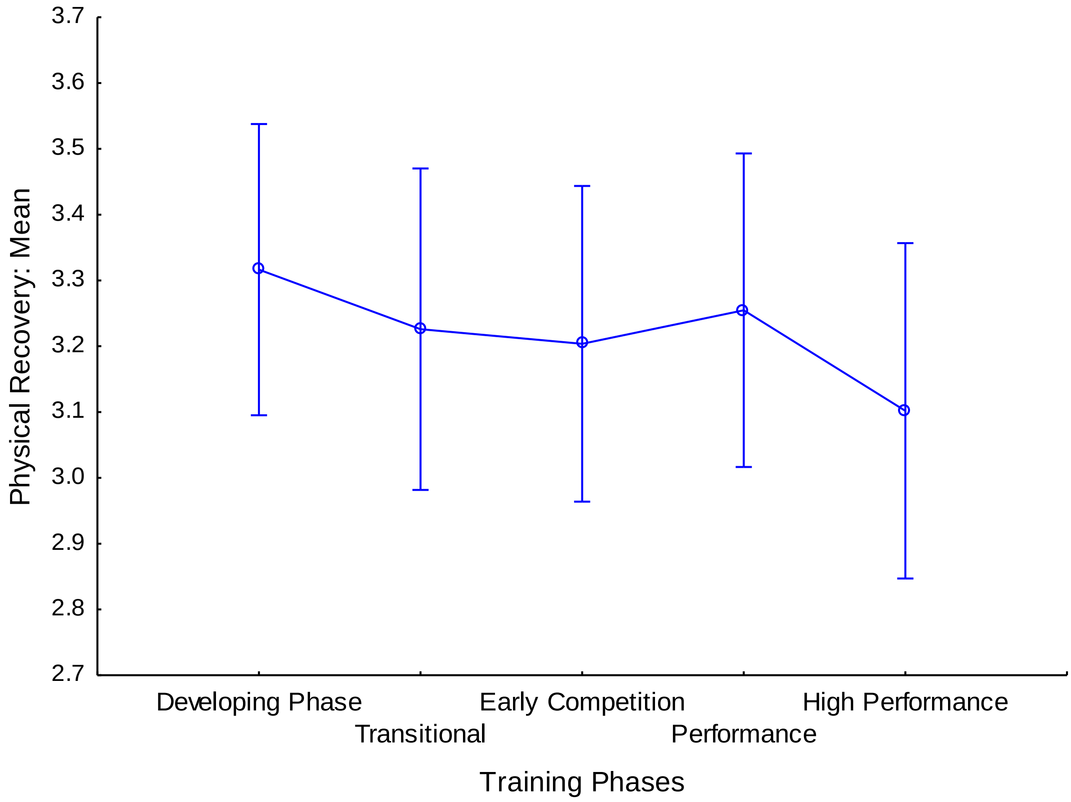

Figure 5.74. The mean Physical Recovery scores for the group.

Forwards vs Backline players

There was no significant change in the Physical Recovery over the five phases (p = 0.65), no significant difference in the average scores between the forwards and the backline players (p = 0.73), and no significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.44) (Figure 5.75).

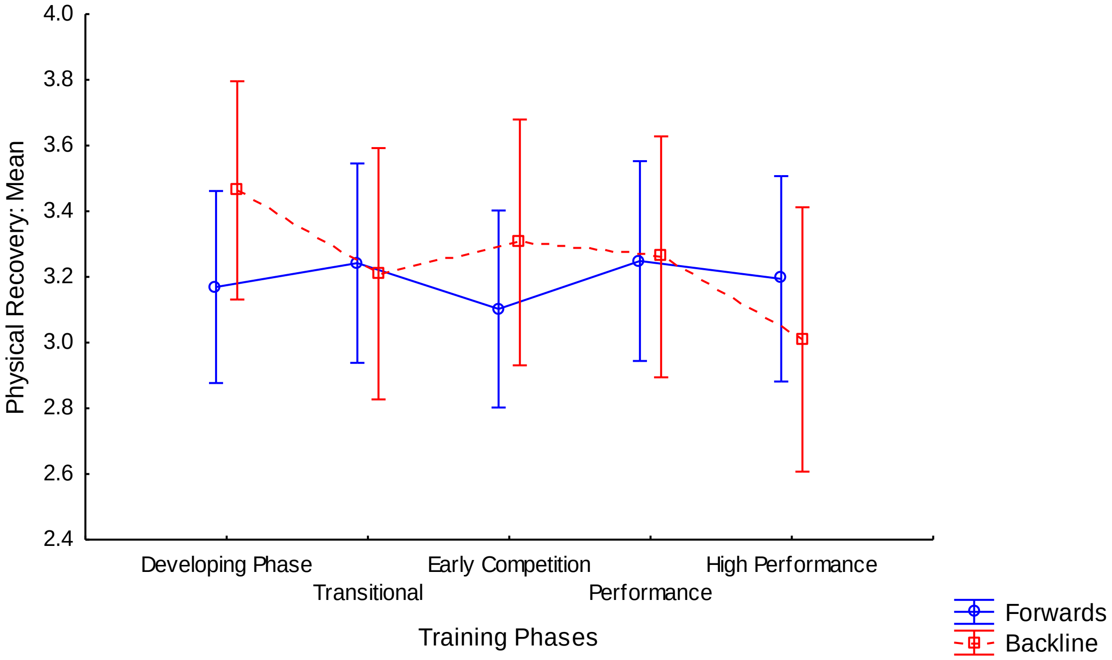

Figure 5.75. Physical Recovery scores between forwards and backline players.

Forwards

There was no significant difference in the mean Physical Recovery score for the forwards between the five training phases.

Backline players

There was a decrease in Physical Recovery from the Developing phase to the High Performance phase (p = 0.04) as shown in Figure 5.76.

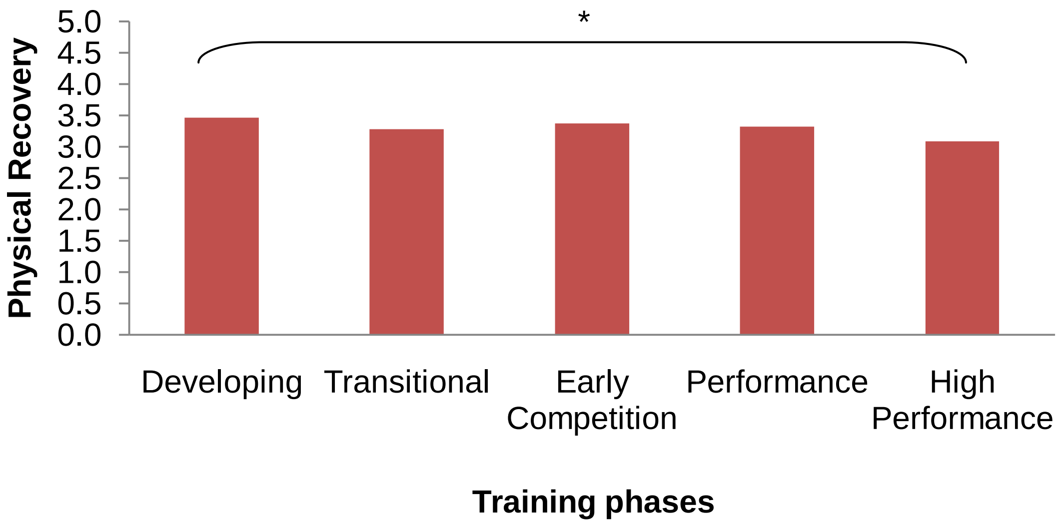

Figure 5.76. Differences in the mean Physical Recovery for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

General Well-Being

Total group of rugby players

The mean General Well-Being scores for the group can be seen in Figure 5.77. There were no significant differences for the group regarding General Well-Being scores between the phases.

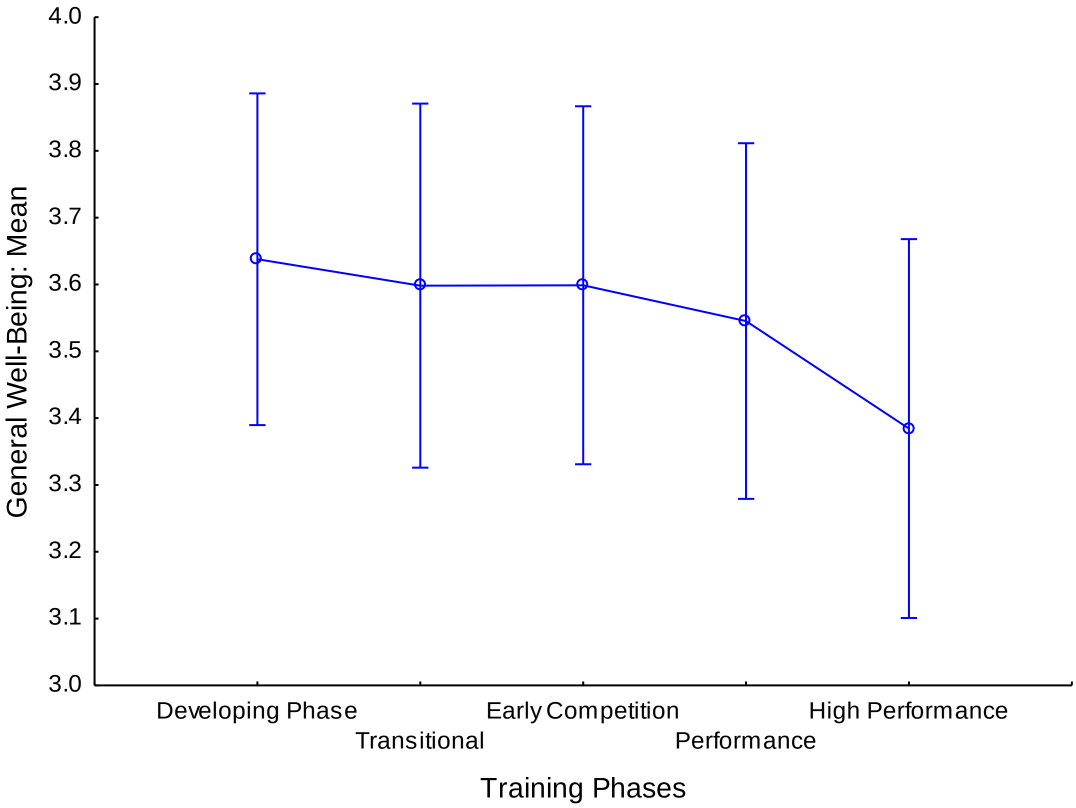

Figure 5.77. The mean General Well-Being scores for the group.

Forwards vs Backline players

There was no significant change in the General Well-Being over the five phases ($p = 0.52$), no significant difference in the average scores between the forwards and the backline players ($p = 0.29$), and no significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases ($p = 0.22$) (Figure 5.78).

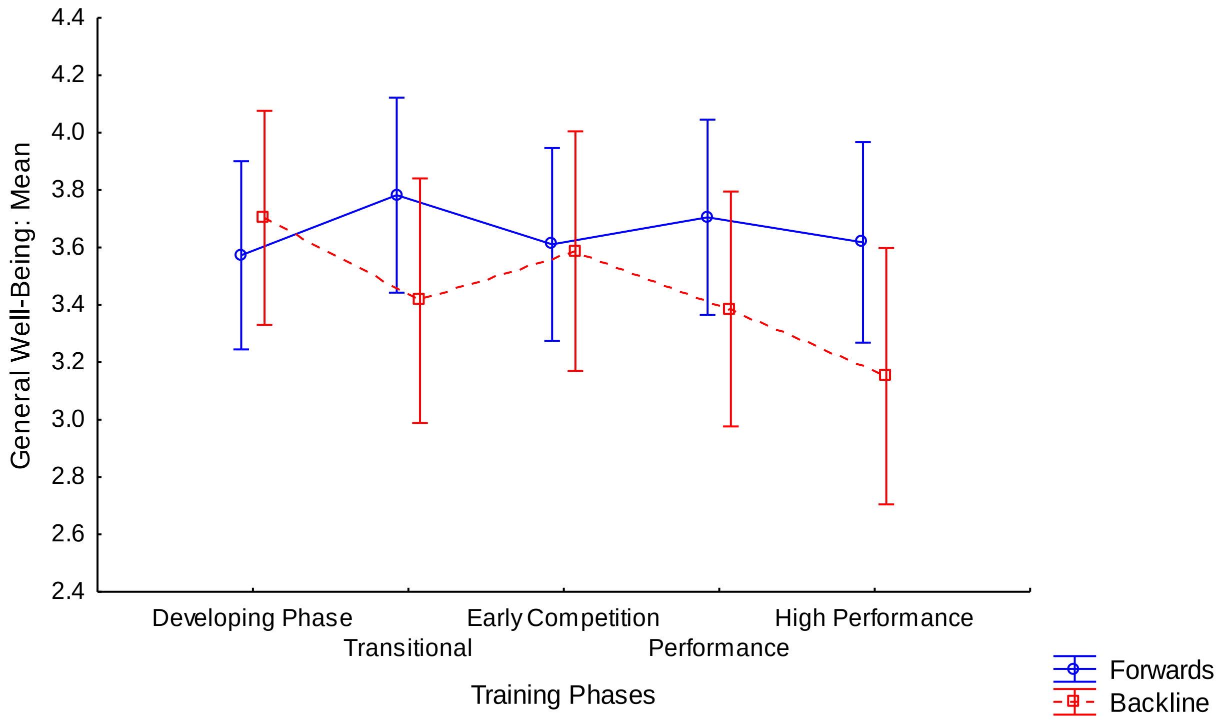

Figure 5.78. General Well-Being scores between forwards and backline players.

Forwards

There was no significant difference in the mean General Well-Being scores for the forwards between the five training phases.

Backline players

There was a decrease in General Well-Being from the Developing phase to the High Performance phase (p = 0.02) as shown in Figure 5.79.

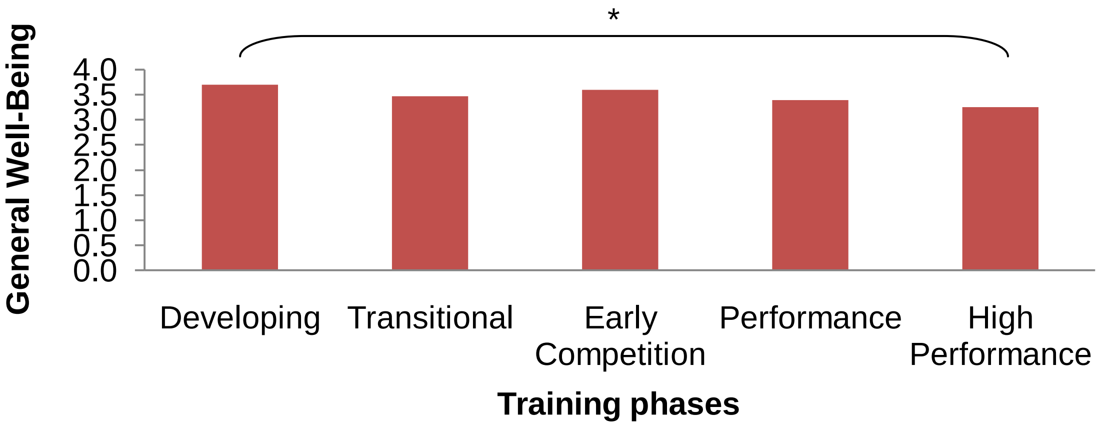

Figure 5.79. Differences in the mean General Well-Being for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Sleep Quality

Total group of rugby players

The mean Sleep Quality score for the group can be seen in Figure 5.80. There were no significant differences in Sleep Quality reported by the group between the phases.

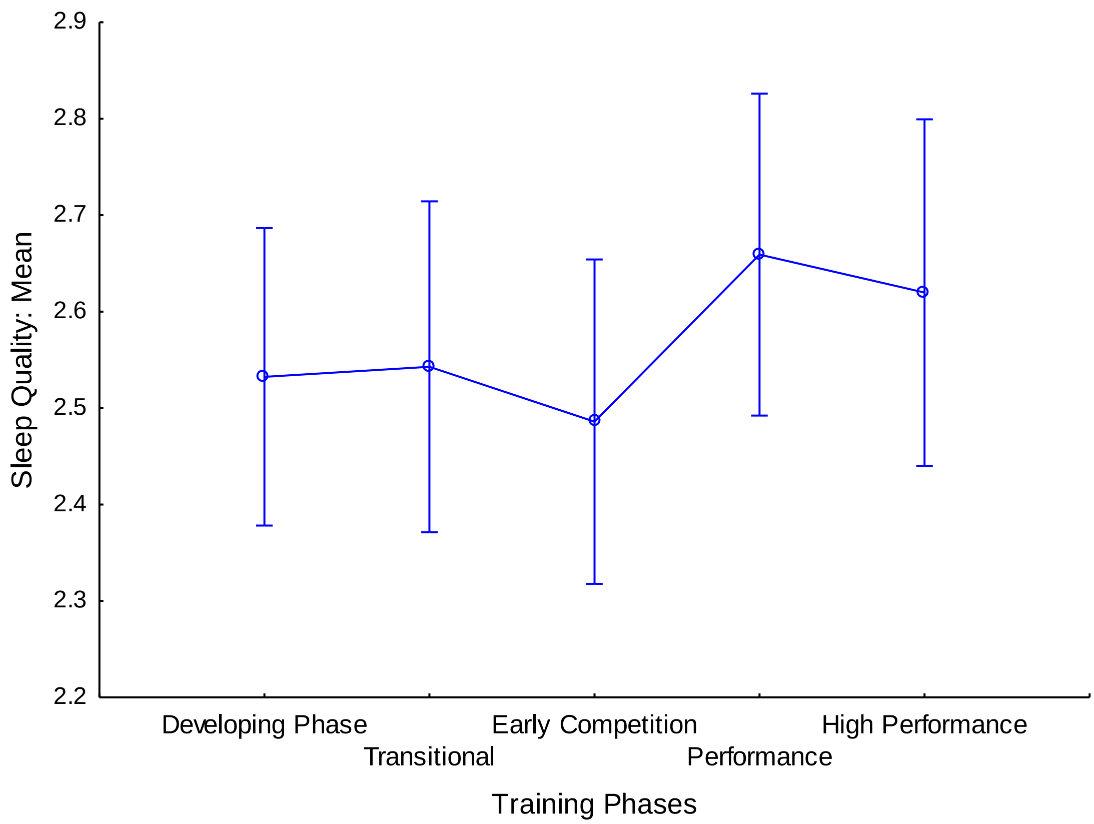

Figure 5.80. The mean Sleep Quality scores for the group.

Forwards vs Backline players

There was no significant change in the Sleep Quality over the five phases ($p = 0.45$), no significant difference in the average scores between the forwards and the backline players ($p = 0.18$), and no significant interaction effect regarding the relationship between the forwards and backline players over the five training phases ($p = 0.92$) (Figure 5.81).

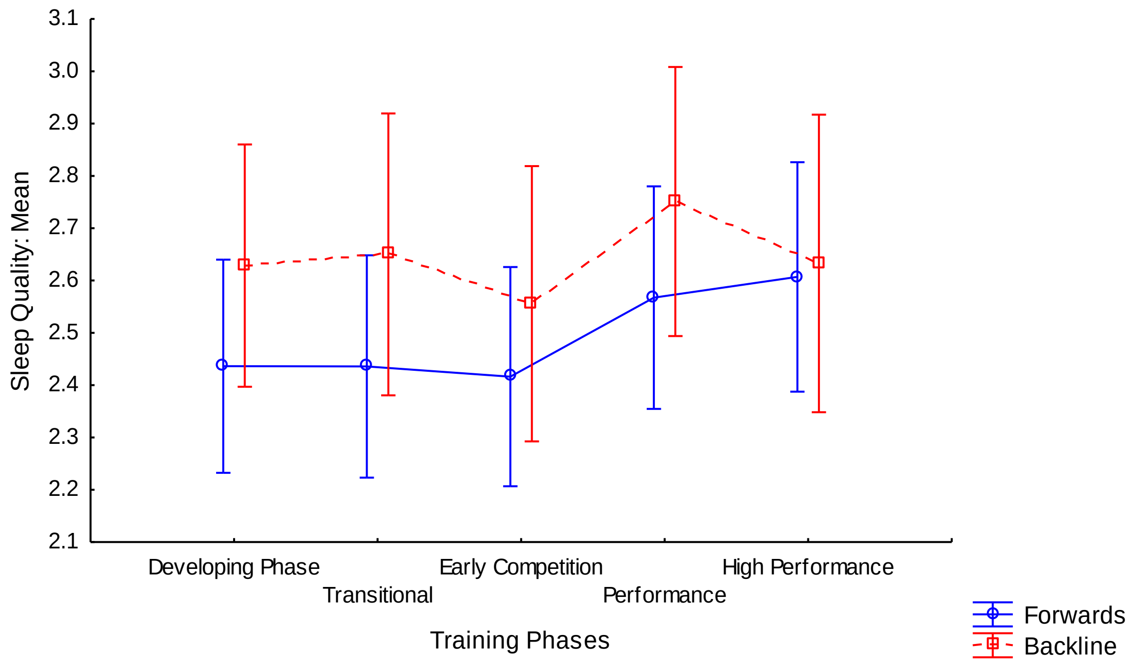

Figure 5.81. Sleep Quality scores between forwards and backline players.

Forwards

There was no significant difference in the mean Sleep Quality scores for the forwards between the five training phases.

Backline players

There was no significant difference in the mean Sleep Quality scores for the backline players between the five training phases.

Disturbed Breaks

Total group of rugby players

The mean Disturbed Breaks values for the group can be seen in Figure 5.82. There was a significant increase in Disturbed Breaks from the Developing phase to the Transitional phase (p = 0.0007), to the Performance phase (p = 0.03), and to the High Performance phase (p = 0.03). There was a significant decrease in

Disturbed Breaks from the Transitional phase to the Early Competition phase (p = 0.01).

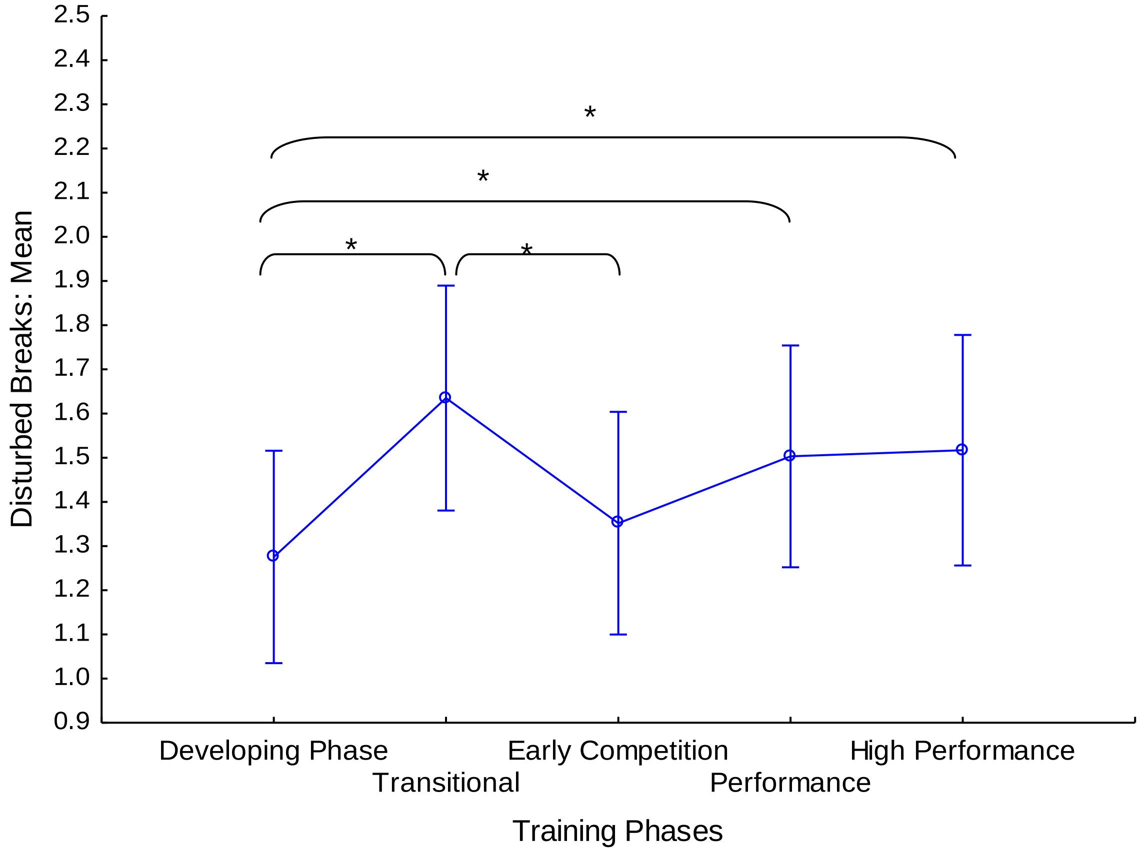

Figure 5.82. The mean Disturbed Breaks scores for the group.

** p < 0.05 Statistical significance*

Forwards vs Backline players

There was a significant change in Disturbed Breaks over the five phases (p = 0.007), and a significant difference in the average scores between the forwards and the backline players (p = 0.03). There was no significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.19). The backline players reported significant higher scores than the forwards for Disturbed Breaks during the Transitional phase (p = 0.008), and during the Performance phase (p = 0.02) (Figure 5.83).

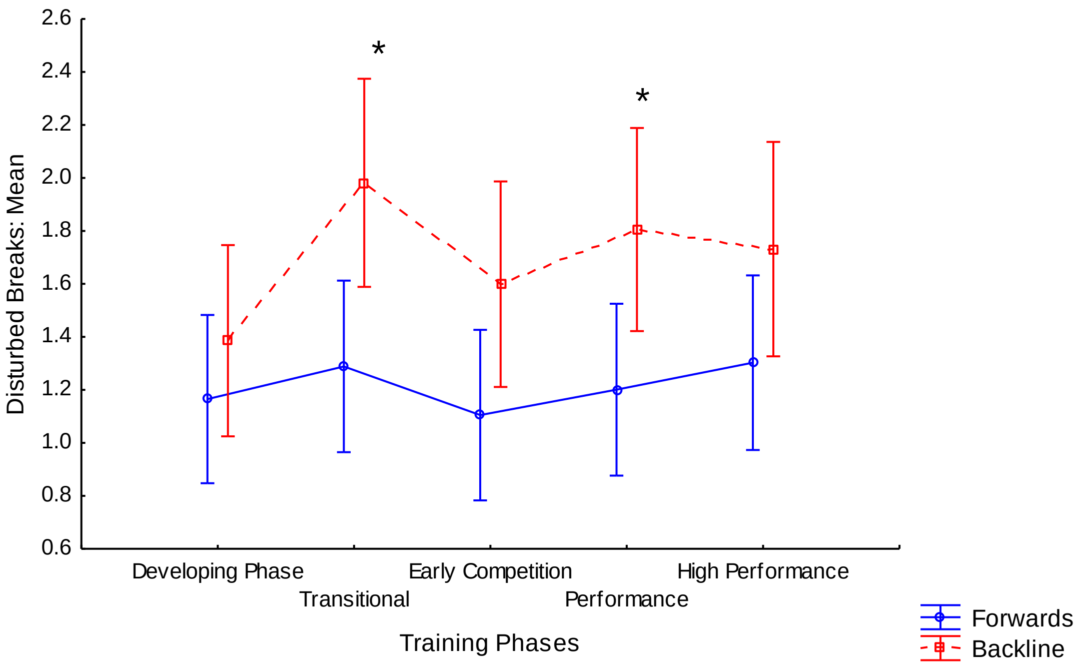

Figure 5.83. Disturbed Breaks scores between forwards and backline players.

** p < 0.05, significant difference between position over the phases*

Forwards

There was no significant difference in the mean Disturbed Breaks scores for the forwards between the five training phases.

Backline players

There was a significant increase in Disturbed Breaks from the Developing phase to the Transitional phase (p = 0.0003, the Performance phase (p = 0.008), and the High Performance phase (p = 0.04), respectively. There was a significant decrease in Disturbed Breaks from the Transitional phase to the Early Competition phase (p = 0.03) as shown in Figure 5.84.

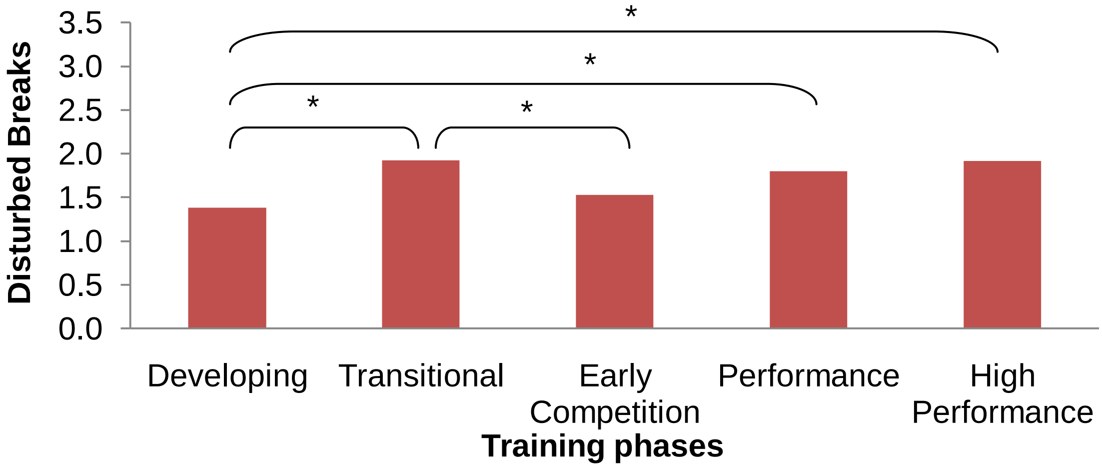

Figure 5.84. Differences in the mean Disturbed Breaks for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Emotional Exhaustion

Total group of rugby players

The mean Emotional Exhaustion values for the group can be seen in Figure 5.85. There was a significant increase in Emotional Exhaustion from the Developing phase to the Transitional phase (p = 0.004), and to the High Performance phase (p = 0.02). There was a significant decrease in Emotional Exhaustion from the Transitional phase to the Early Competition phase (p = 0.03).

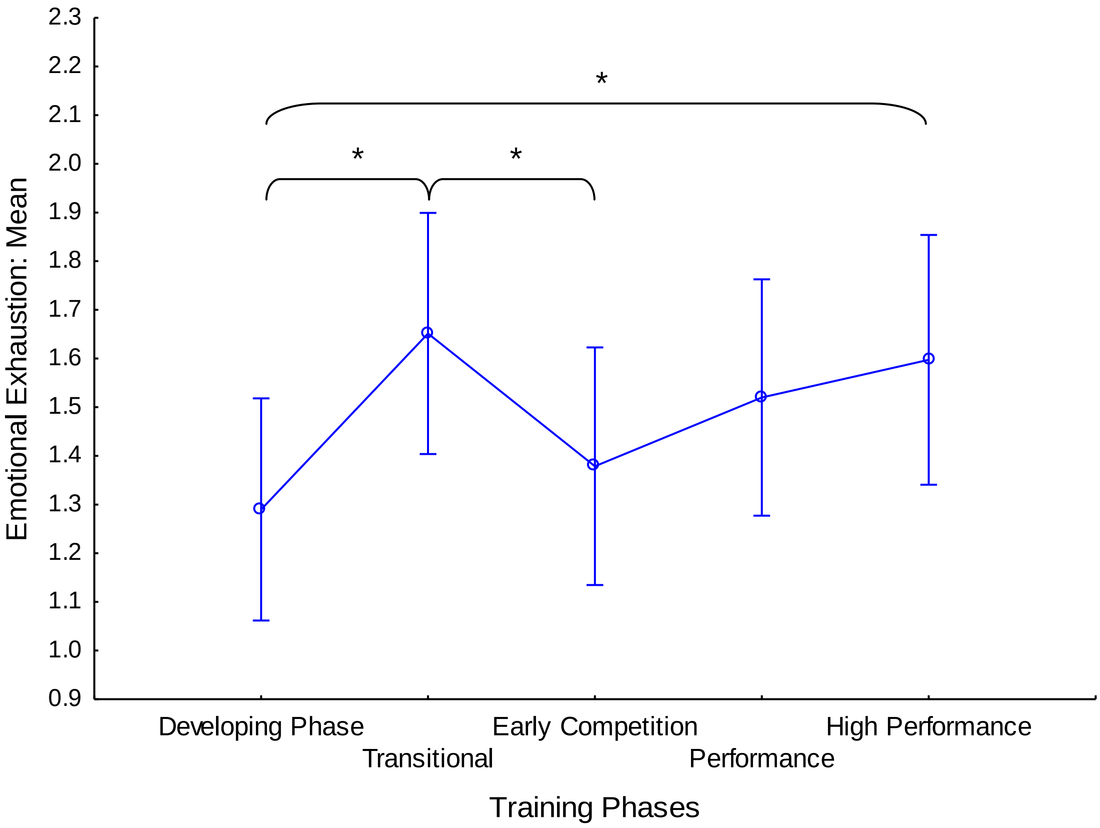

Figure 5.85. The mean Emotional Exhaustion scores for the group.

** p < 0.05 Statistical significance*

Forwards vs Backline players

There was a significant change in Emotional Exhaustion over the five training phases (p = 0.02), no significant difference in the average score between the forwards and the backline players (p = 0.60). There was a significant interaction effect regarding the relationship between the forwards and the backline players (p = 0.002). There is a strong tendency for the backline players to experience less emotional exhaustion than the forwards in the Developing phase (p = 0.06), and a weak tendency for the backline players to experience more emotional exhaustion than the forwards in the High Performance phase (p = 0.08) (Figure 5.86).

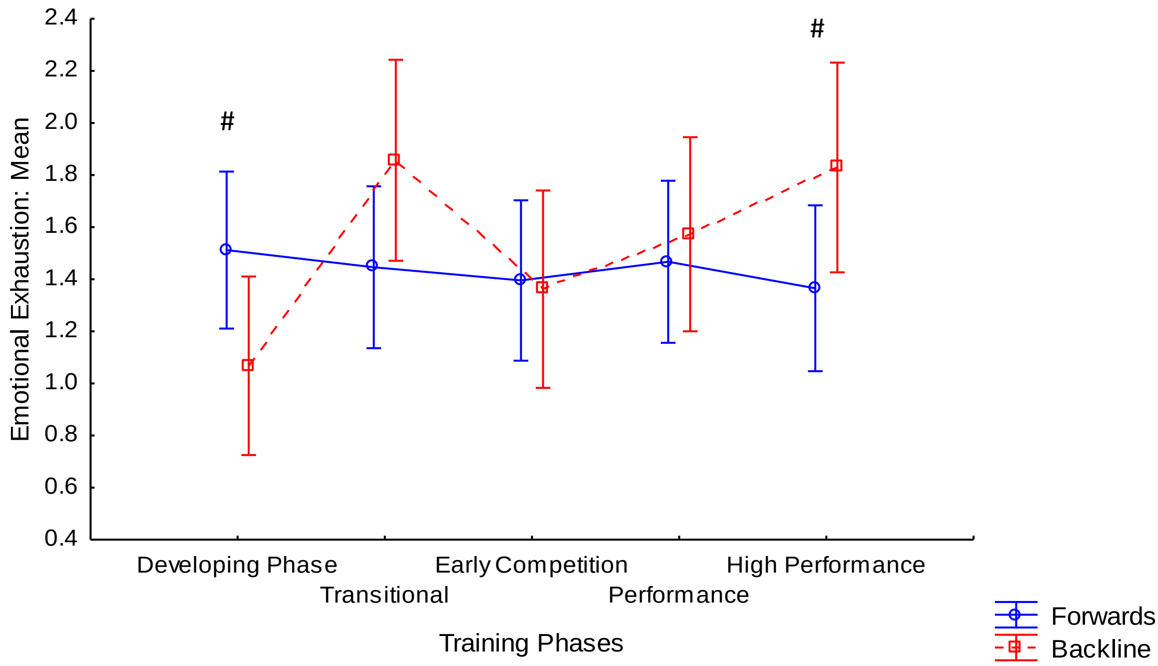

Figure 5.86. Emotional Exhaustion scores between forwards and backline players.

 # 0.05 < p < 0.09, indicating a tendency for an interaction effect.

Forwards

There was no significant difference in the mean Emotional Exhaustion scores for the forwards between the five training phases.

Backline players

There was a significant increases in Emotional Exhaustion from the Developing phase to the Transitional phase (p = 0.00006), the Performance phase (p = 0.007), and the High Performance phase (p = 0.0002), respectively, as well as from the Early Competition phase to the High Performance phase (p = 0.03). There was a significant decrease in Emotional Exhaustion from the Transitional phase to the Early Competition phase (p = 0.02) as shown in Figure 5.87.

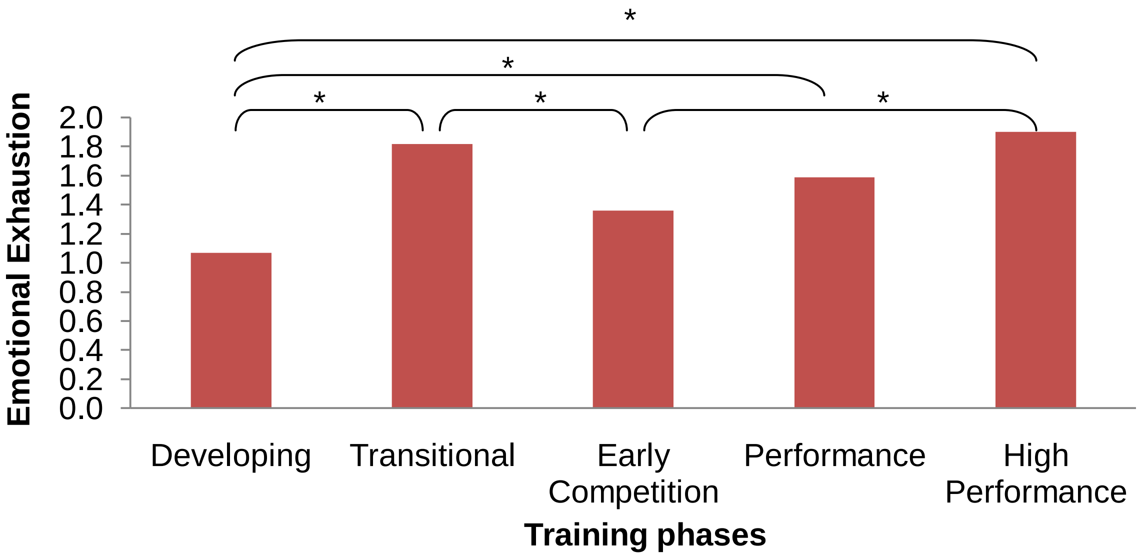

Figure 5.87. Differences in the mean Emotional Exhaustion for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Injury

Total group of rugby players

The mean Injury scores for the group can be seen in Figure 5.88. There was a significant increase in Injury scores from the Developing phase to the Transitional phase (p = 0.004).

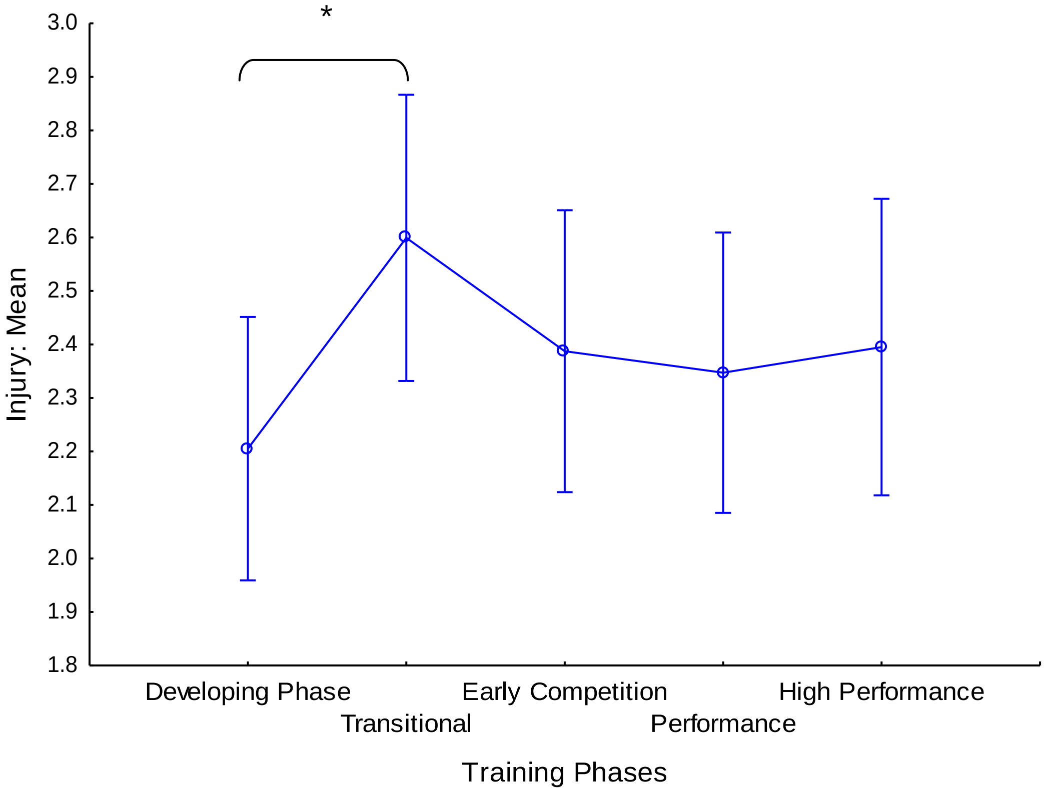

Figure 5.88. The mean Injury scores for the group.

** p < 0.05 Statistical significance*

Forwards vs Backline players

There was no significant changes in Injury over the five training phases (p = 0.07), no significant differences in the average Injury scores between the forwards and the backline players (p = 0.67), and no significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.46) (Figure 5.89).

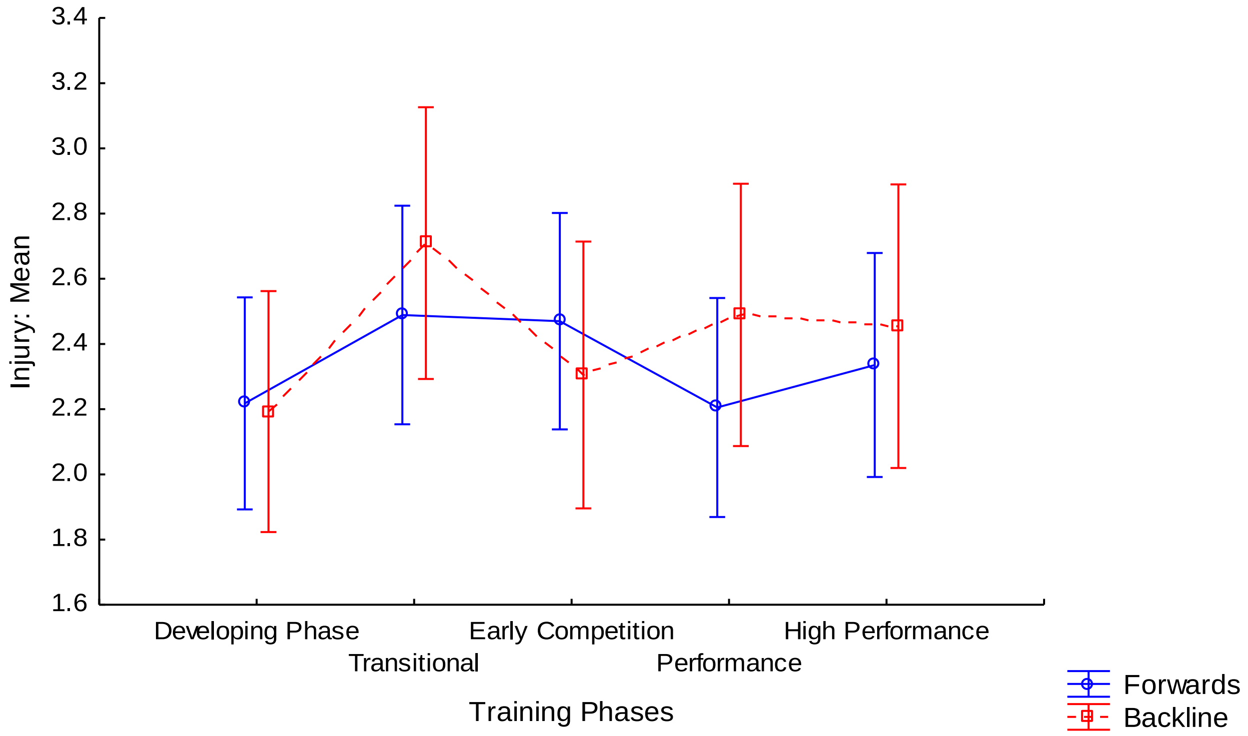

Figure 5.89. Injury scores between forwards and backline players.

Forwards

There was no significant difference in the mean Injury scores for the forwards between the five training phases.

Backline players

There was a significant increase in Injury score from the Developing phase to the Transitional phase (p = 0.01) as shown in Figure 5.90.

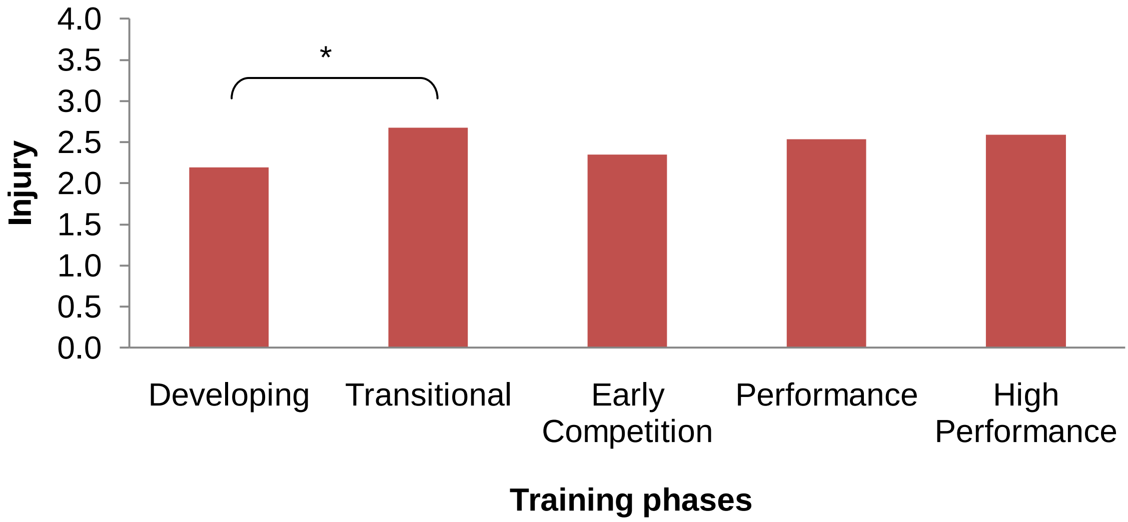

Figure 5.90. Differences in the mean Injury for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Being in Shape

Total group of rugby players

The mean Being in Shape scores for the group can be seen in Figure 5.91. There was a significant decrease in Being in Shape scores from the Developing phase to the Early Competition phase (p = 0.02).

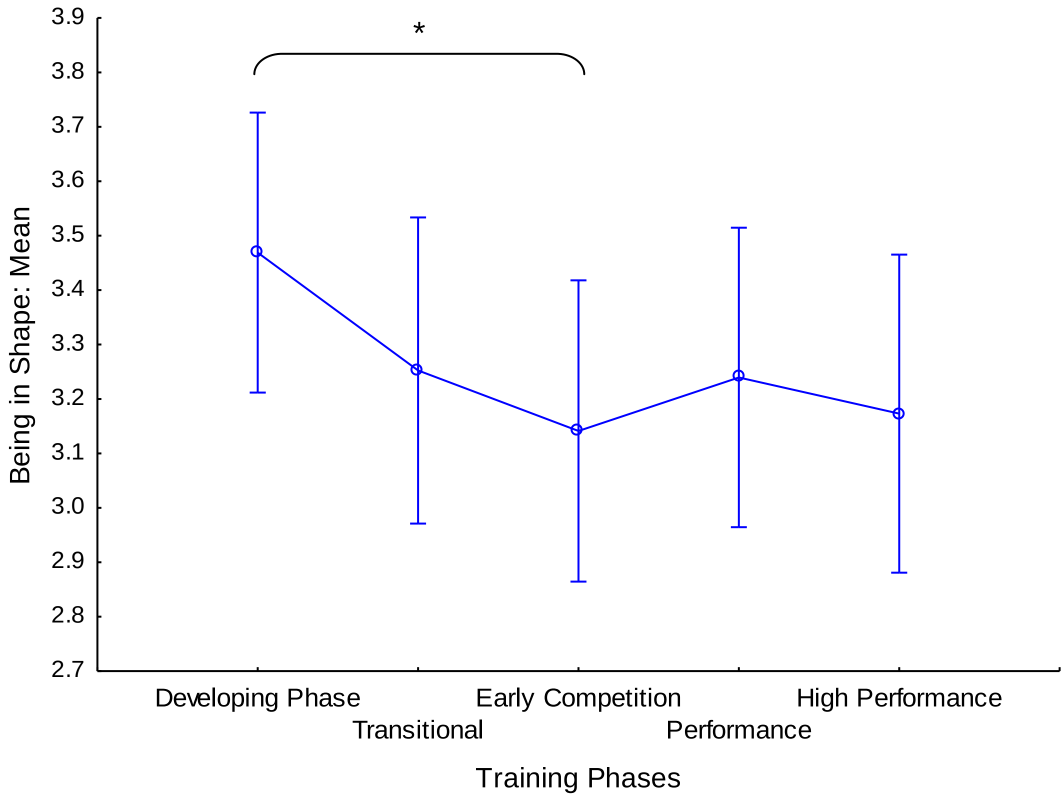

Figure 5.91. The mean Being in Shape scores for the group.

** p < 0.05 Statistical significance*

Forwards vs backline players

There was no significant changes in the Being in Shape scores over the five training phases (p = 0.18), no significant differences in the average score between the forwards and the backline players (p = 0.75), and no significant interaction effects regarding the relationship between the forwards and the backline players over the five training phases (p = 0.06). The backline players reported lower Being in Shape scores than the forwards during the High Performance phase (p = 0.05) (Figure 5.92).

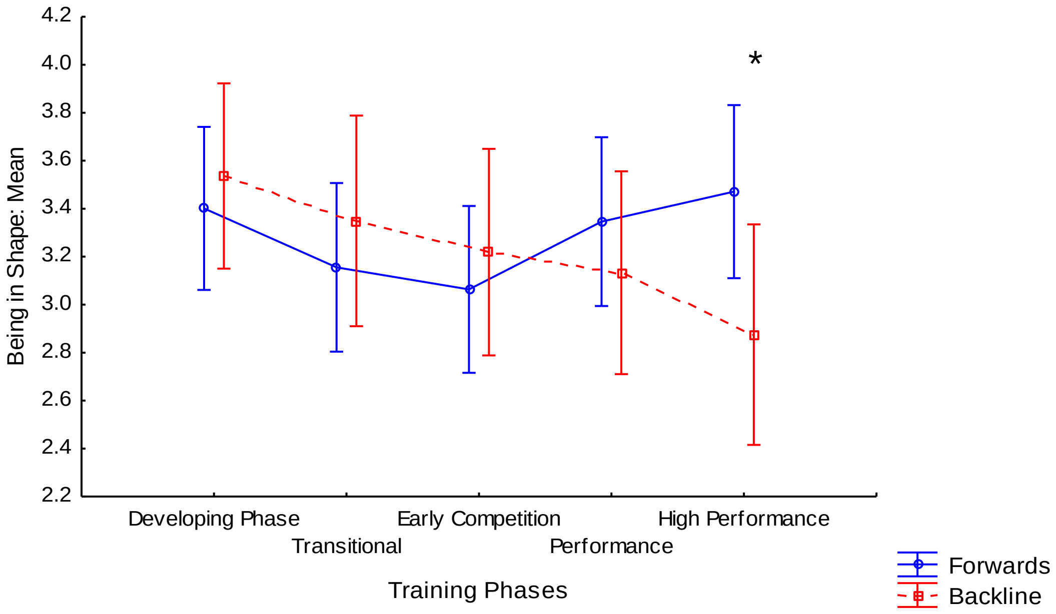

Figure 5.92. Being in Shape scores between forwards and backline players.

** p < 0.05, significant difference between position over the phases*

Forwards

There was a significant increase in Being in Shape score from the Early Competition phase to the High Performance Phase (p = 0.03) as shown in Figure 5.93.

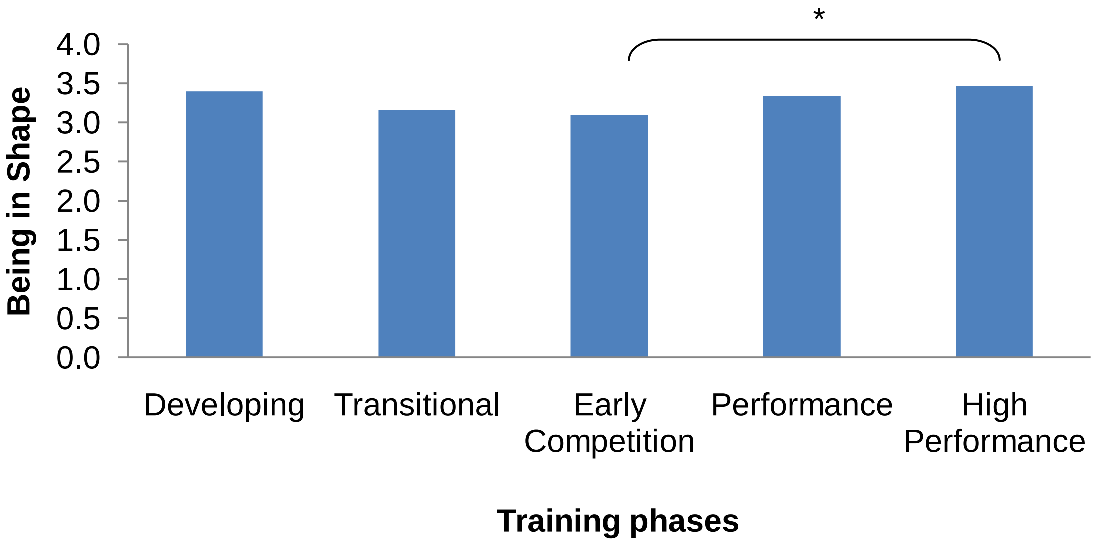

Figure 5.93. Differences in the mean Being in Shape for the forwards over the training phases.

** p < 0.05, significant difference between the phases*

Backline players

There was a significant decrease in Being in Shape score from the Developing phase to the High Performance phase (p = 0.006) as shown in Figure 5.94.

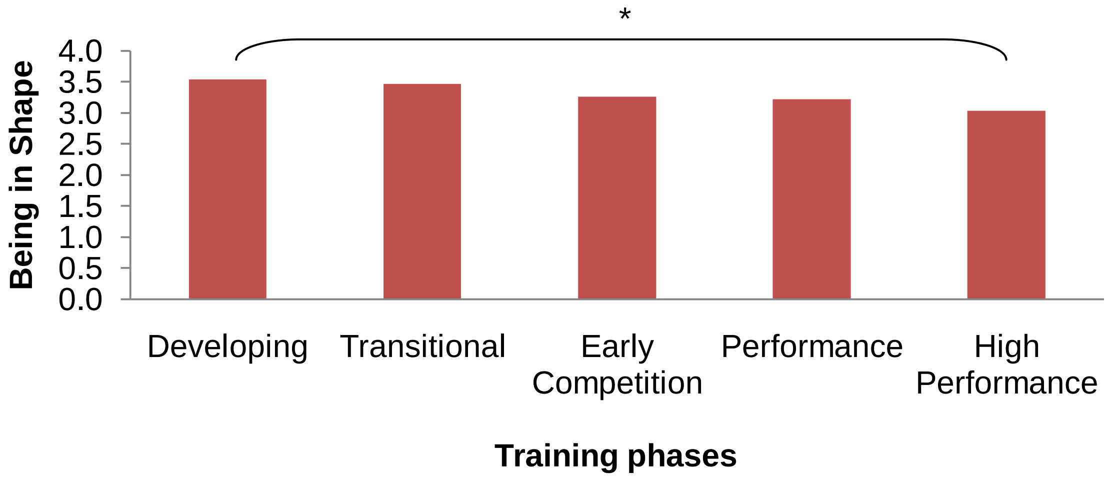

Figure 5.94. Differences in the mean Being in Shape for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Personal Accomplishment

Total group of rugby players

The mean Personal Accomplishment scores can be seen in Figure 5.95. There were no significant differences between the phases for the group.

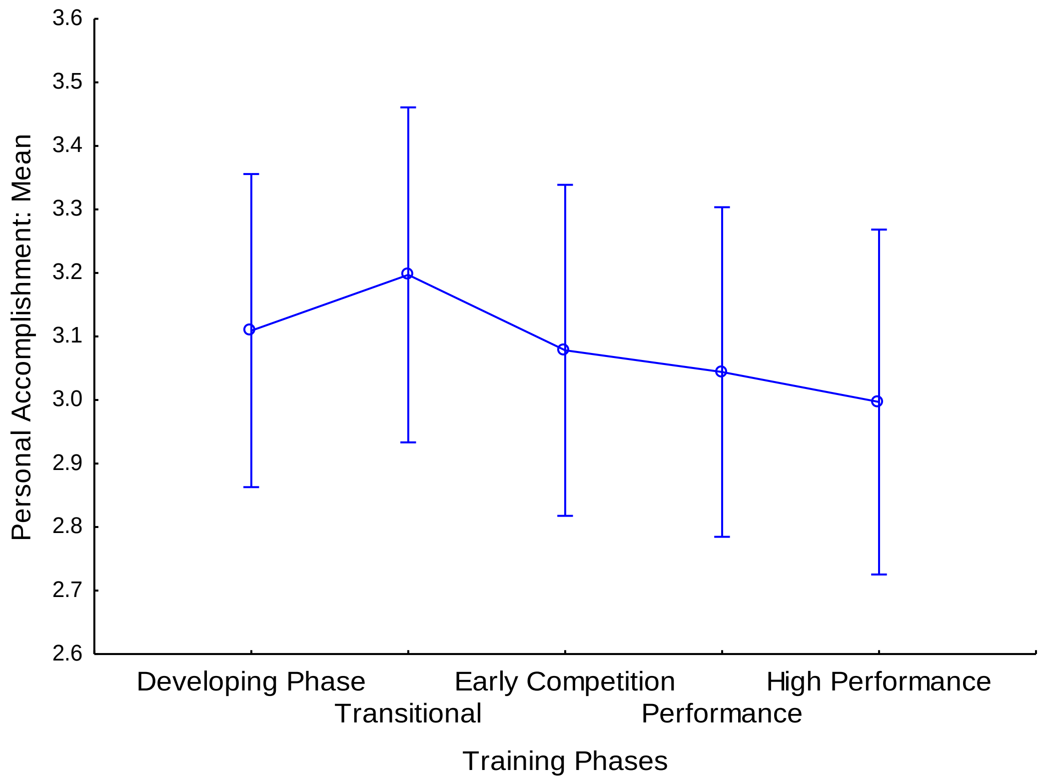

Figure 5.95. The mean Personal Accomplishment scores for the group.

Forwards vs Backline players

There was no significant changes over the five training phases for (p = 0.58), no significant differences in the average scores between the forwards and the backline players (p = 0.41), and no significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.15). The backline players had a borderline significantly higher Personal Accomplishment scores than the forwards during the Developing phase (p = 0.08) (Figure 5.96).

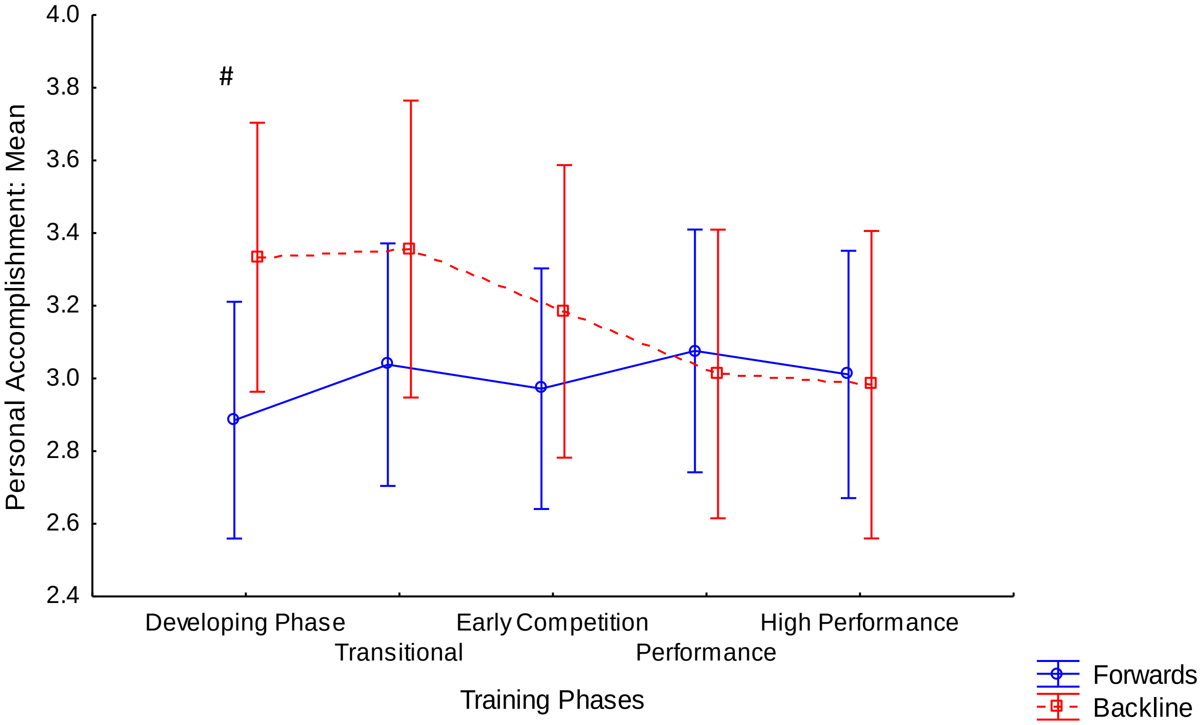

Figure 5.96. Personal Accomplishment scores between forwards and backline players.

 # p = 0.08, borderline statistical significance.

Forwards

There was no significant difference in the mean Personal Accomplishment scores for the forwards between the five training phases.

Backline players

There was no significant difference in the mean Personal Accomplishment scores for the backline players between the five training phases.

Self-Efficacy

Total group of rugby players

The mean Self-Efficacy scores for the group can be seen in Figure 5.97. There were no significant differences in the Self-Efficacy scores for the group.

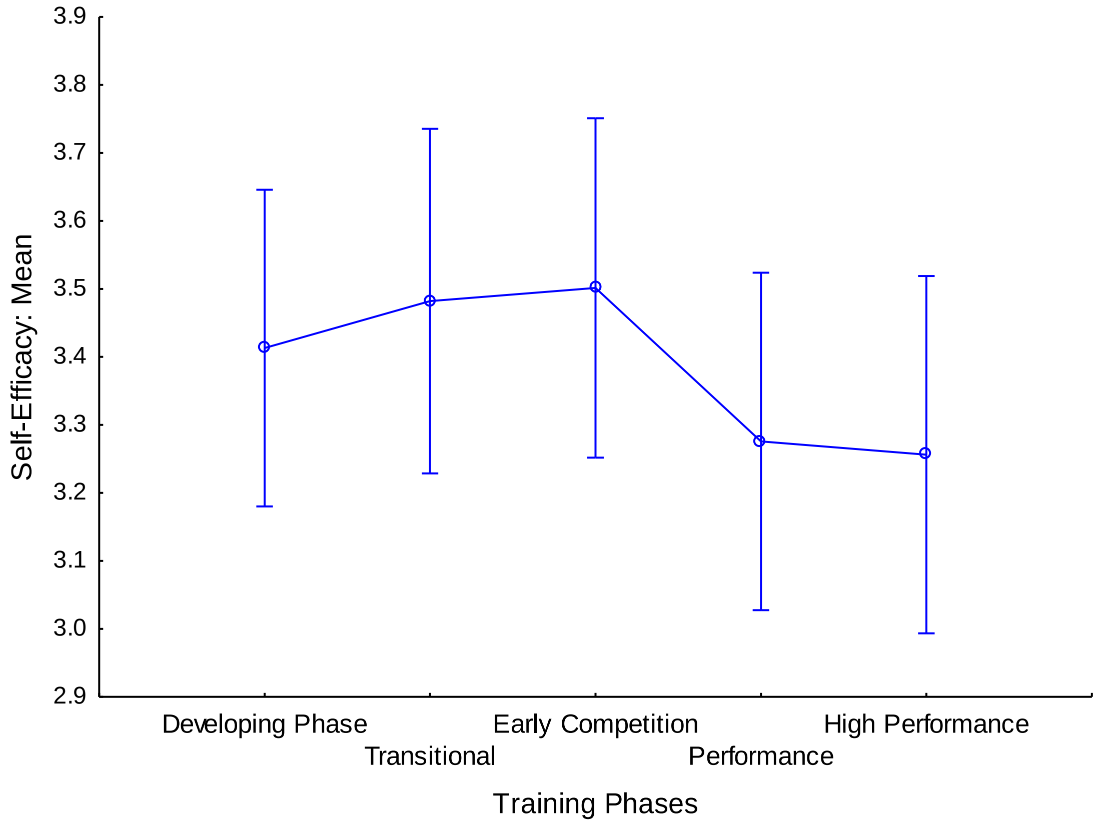

Figure 5.97. The mean Self-Efficacy scores for the group.

Forwards vs Backline players

There was no significant changes in Self-Efficacy over the five training phases ($p = 0.23$), no significant differences in the average score between the forwards and the backline players ($p = 24$). There is a significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases ($p = 0.01$). There was a strong tendency for the backline players to experience less Self-Efficacy than the backline players during the Performance phase (p = 0.05). The backline players experiencee significantly lower Self-Efficacy scores than the forwards during the High Performance phase (p = 0.03) (Figure 5.98).

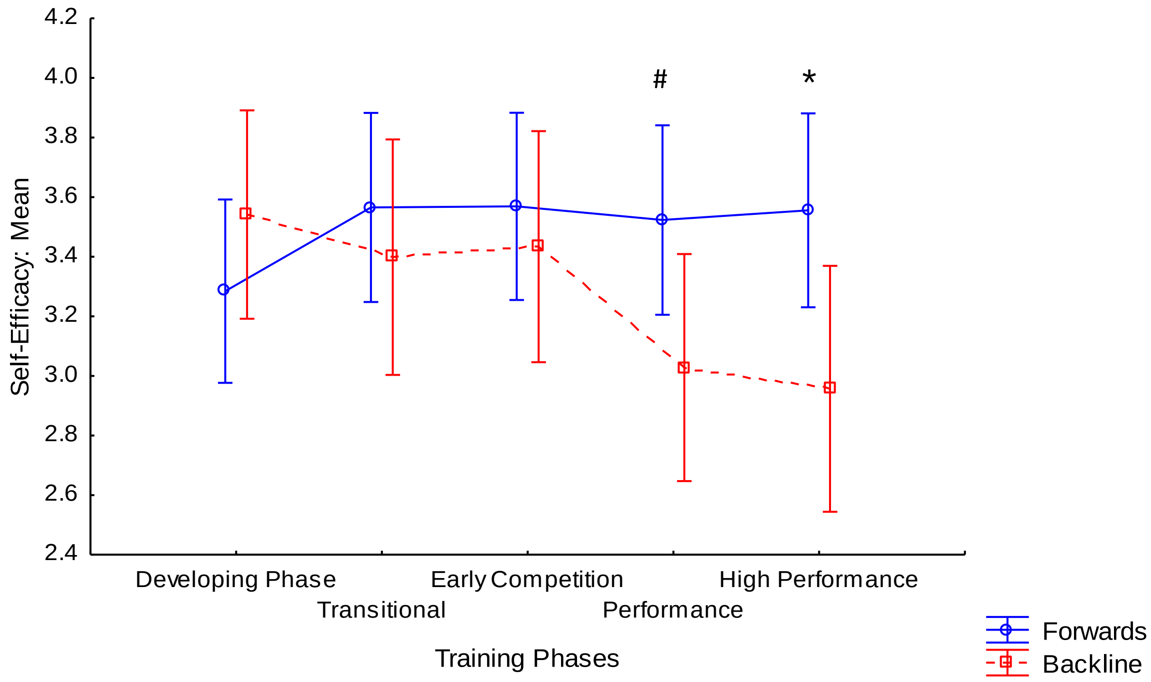

Figure 5.98. Self-Efficacy scores between forwards and backline players.

** p < 0.05, significant difference between position over the phases; # p = 0.05, indicating a tendency for an interaction effect.*

Forwards

There was no significant difference in the mean Self-Efficacy scores for the forwards between the five training phases.

Backline players

There was a significant decrease in Self-Efficacy from the Developing phase to the Performance phase (p = 0.008), and the High Performance phase (p = 0.006), respectively, as well as from the Transitional phase to the High Performance phase (p = 0.05), and from the Early Competition phase to the Performance phase (p = 0.05), and the High Performance phase (p = 0.03), respectively, as shown in Figure 5.99.

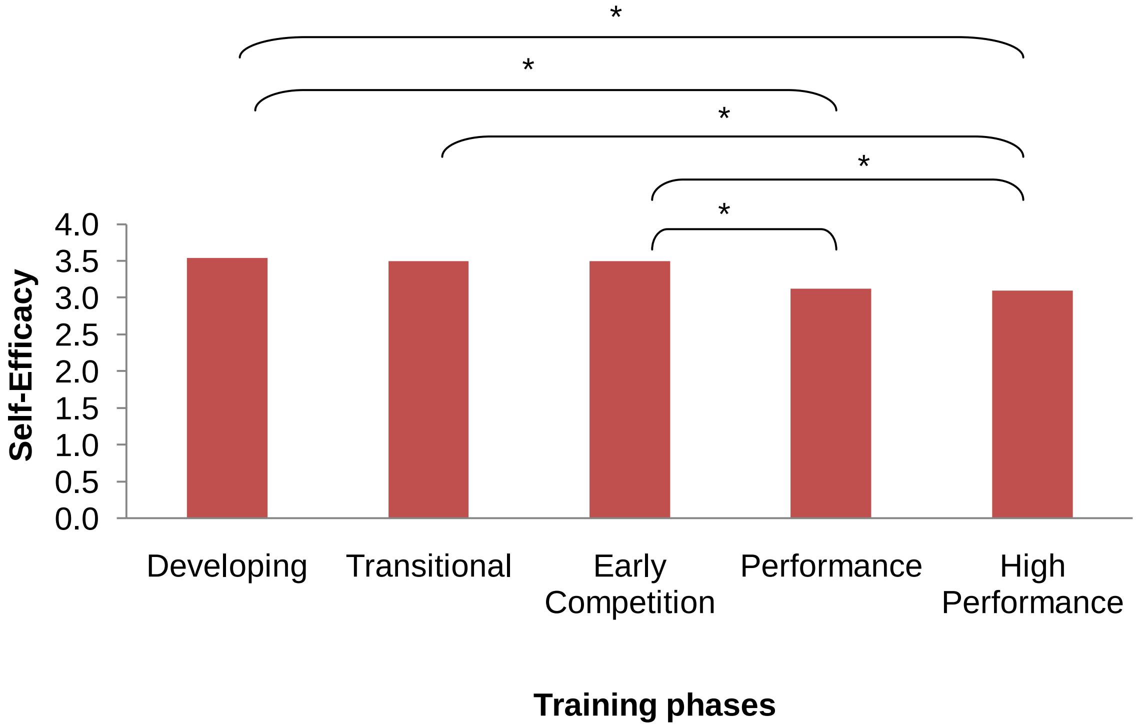

Figure 5.99. Differences in the mean Self-Efficacy for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Self-Regulation

Total group of rugby players

The mean Self-Regulation scores for the group can be seen in Figure 5.100. There was a significant decrease in Self-Regulation from the Developing phase to the Transitional phase (p = 0.01), to the Early Competition phase (p = 0.04), to the Performance phase (p = 0.007), and to the High Performance phase (p = 0.0002).

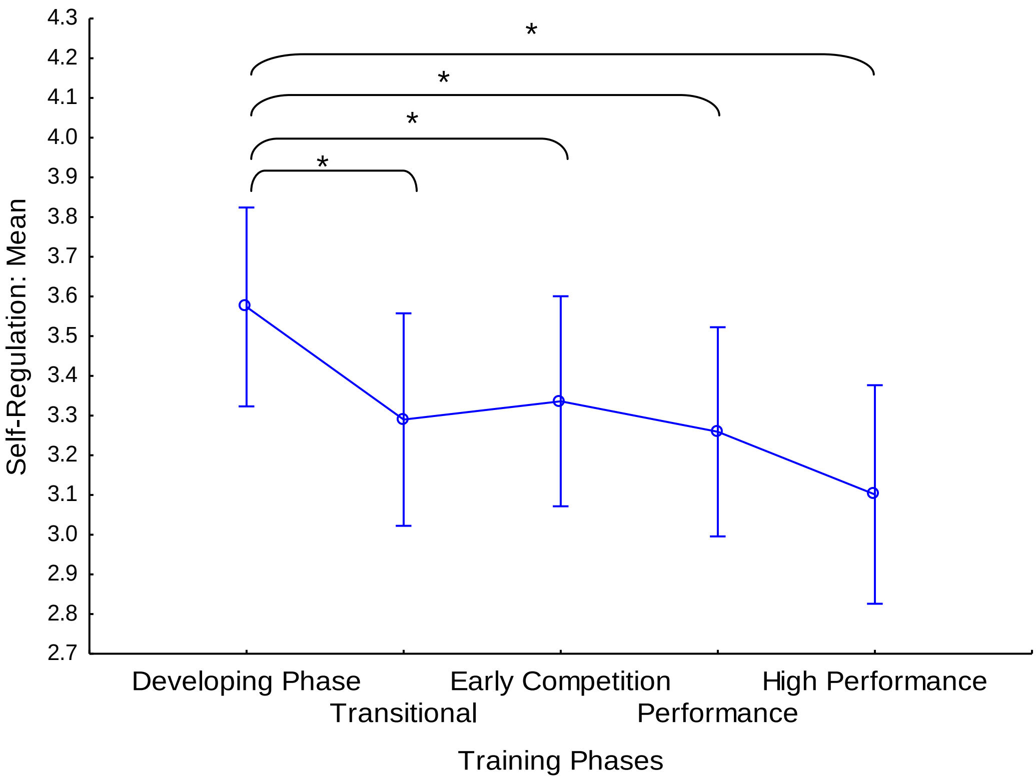

Figure 5.100. The mean Self-Regulation scores for the group.

** p < 0.05 Statistical significance*

Forwards vs Backline players

There was a significant change in Self-Regulation over the five training phases (p = 0.003), no significant differences in average scores between the forwards and the backline players (p = 0.33), and no significant interaction effect regarding the relationship between the forwards and the backline players over the five training phases (p = 0.47) (Figure 5.101).

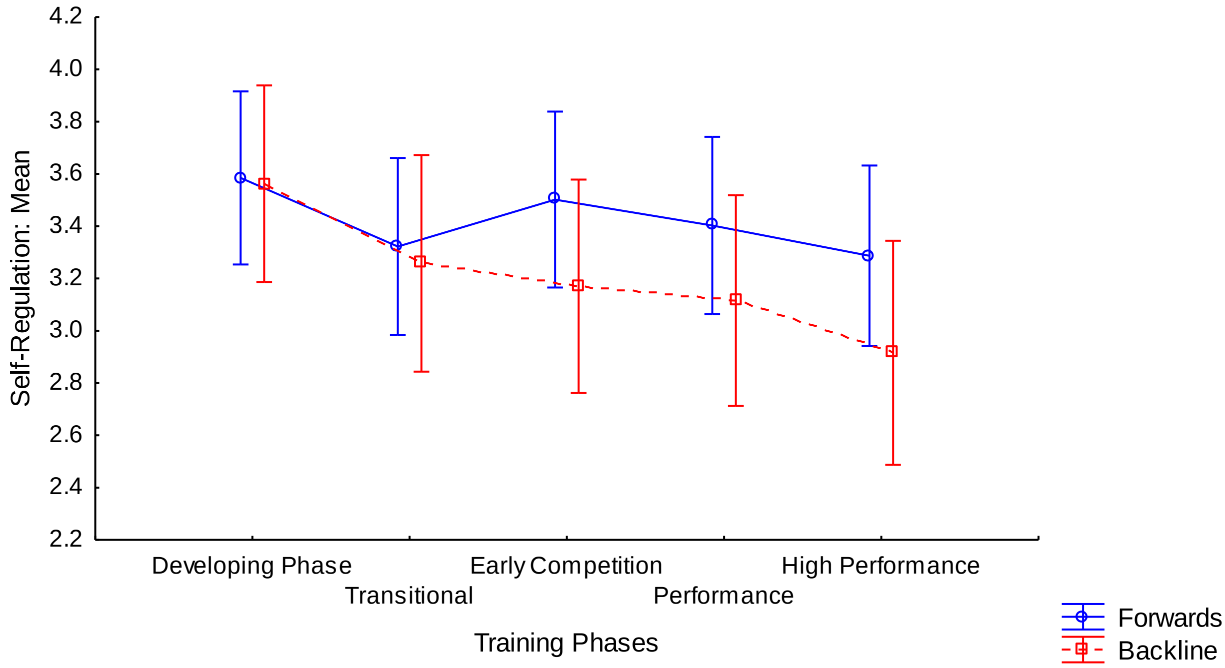

Figure 5.101. Self-Regulation scores between forwards and backline players.

Forwards

There was a significant decrease in Self-Regulation from the Developing phase to the High Performance phase (p = 0.05) as shown in Figure 5.102.

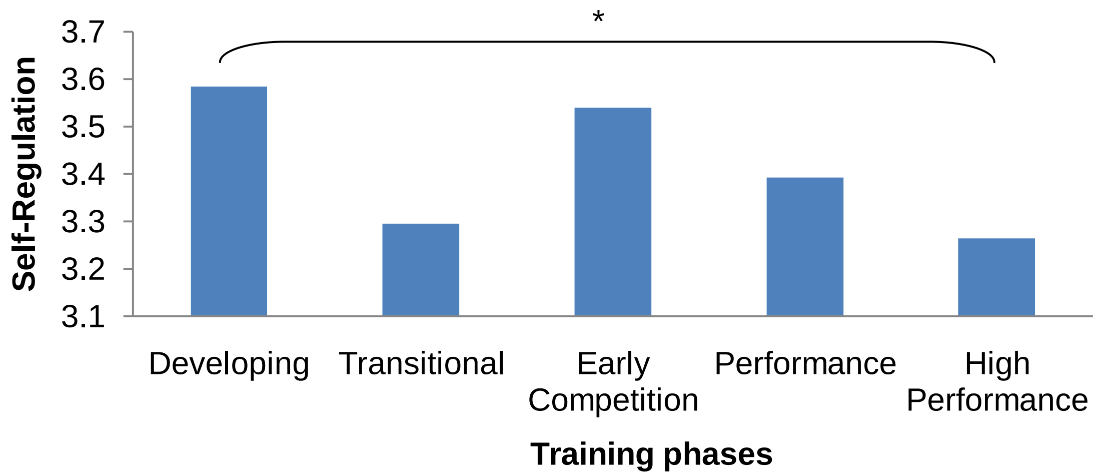

Figure 5.102. Differences in the mean Self-Regulation for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

Backline players

There was a significant decrease in Self-Regulation from the Developing phase to the Early Competition phase (p = 0.03), from the Developing phase to the Performance phase (p = 0.01), and from the Developing phase to the High Performance phase (p = 0.001) as shown in Figure 5.103.

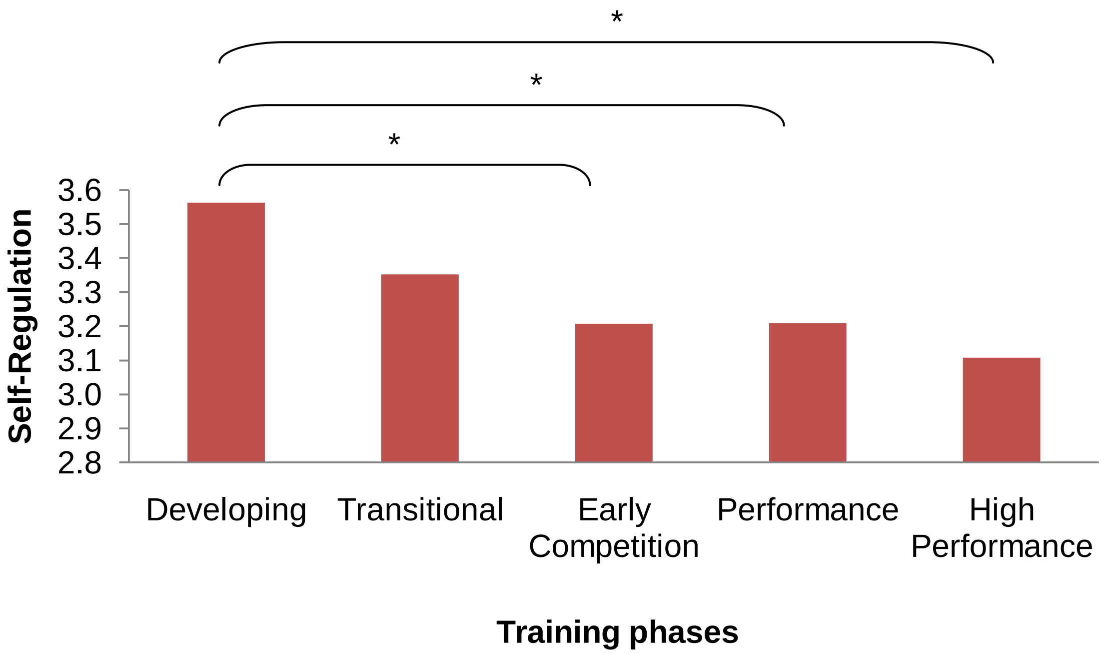

Figure 5.103. Differences in the mean Self-Regulation for the Backline players over the training phases.

** p < 0.05, significant difference between the phases*

5.6 RELATIONSHIP BETWEEN VARIABLES

Spearman correlations were calculated to determine the relationship between different variables from the different tests used to monitor physiological and psychological changes among the players. The Spearman correlations and accompanying p values can be seen from Tables 5.9. to 5.12. Positive Spearman values indicate a positive correlation between the two variables. Negative Spearman values indicate a negative correlation between the two variables. The correlations between all the variables can be seen in Appendix G.

Table 5.9. Relationship between HIMS and RESTQ-76-Sport over the different training phases expressed as Spearman values and p-values.

Variable 1	**Variable 2**	**Phase**	**Spearman**	**p-value**
HIMS	Physical Complaints	Developing Phase	-0.29	0.04*
HIMS	Self-Efficacy	Developing Phase	0.29	0.04*
HIMS	Injury	Early Competition	-0.34	0.02*

* $p < 0.05$

Table 5.10. Relationship between Training Load and different scales of RESTQ-76-Sport and STEMS expressed as Spearman values and p-values.

Variable 1	**Variable 2**	**Phase**	**Spearman**	**p-value**
Training Load	Being in Shape	Developing Phase	0.32	0.02*
Training Load	Conflicts/ Pressure	Developing Phase	0.27	0.05*
Training Load	Personal Accomplishment	Developing Phase	0.43	<0.01*
Training Load	Personal Accomplishment	Transitional	0.31	0.04*
Training Load	Success	Transitional	0.39	<0.01*
Training Load	Being in Shape	Early Competition	0.42	<0.01*
Training Load	Physical Recovery	Early Competition	0.38	<0.01*
Training Load	Self-Efficacy	Early Competition	0.54	<0.01*

Variable 1	Variable 2	Phase	Spearman	p-value
Training Load	Self-Regulation	Early Competition	0.32	0.03*
Training Load	Success	Early Competition	0.30	0.05*
Training Load	Vigour	Early Competition	0.31	0.03*
Training Load	Total Recovery	Early Competition	0.46	<0.01*
Training Load	Physical Recovery	Performance	0.41	0.01*

* $p < 0.05$

Table 5.11. Relationship between Training Monotony and different scales of RESTQ-76-Sport and STEMS expressed as Spearman values and p-values.

Variable 1	Variable 2	Phase	Spearman	p-value
Training Monotony	Being in Shape	Developing Phase	0.27	0.05*
Training Monotony	Personal Accomplishment	Developing Phase	0.27	0.04*
Training Monotony	Social Recovery	Developing Phase	-0.27	0.05*
Training Monotony	Success	Transitional	0.41	<0.01*
Training Monotony	Lack of Energy	Transitional	-0.32	0.04*
Training Monotony	Being in Shape	Early Competition	0.31	0.03*
Training Monotony	Sleep Quality	Early Competition	0.30	0.04*

Variable 1	Variable 2	Phase	Spearman	p-value
Training Monotony	Success	Early Competition	0.31	0.03*
Training Monotony	Total Recovery	Early Competition	0.34	0.02*
Training Monotony	Self-Efficacy	Early Competition	0.36	0.02*
Training Monotony	Physical Recovery	Performance	0.43	<0.01*
Training Monotony	Fatigue (STEMS)	High Performance	-0.43	0.04*
Training Monotony	Vigour	High Performance	0.51	0.02*

* $p < 0.05$

Table 5.12. Relationship between Training Strain and different scales of RESTQ-76-Sport and STEMS expressed as Spearman values and p-values.

Variable 1	Variable 2	Phase	Spearman	p-value
Training Strain	Being in Shape	Developing Phase	0.32	0.02*
Training Strain	Conflicts/ Pressure	Developing Phase	0.29	0.03*
Training Strain	Personal Accomplishment	Developing Phase	0.36	<0.01*
Training Strain	Being in Shape	Transitional	0.33	0.03*
Training Strain	Personal Accomplishment	Transitional	0.31	0.04*
Training Strain	Self-Efficacy	Transitional	0.31	0.04*

Variable 1	Variable 2	Phase	Spearman	p-value
Training Strain	Success	Transitional	0.50	<0.01*
Training Strain	Being in Shape	Early Competition	0.39	<0.01*
Training Strain	Physical Recovery	Early Competition	0.38	<0.01*
Training Strain	Self-Efficacy	Early Competition	0.49	<0.01*
Training Strain	Success	Early Competition	0.31	0.04*
Training Strain	Total Recovery	Early Competition	0.43	<0.01*
Training Strain	Physical Recovery	Performance	0.51	<0.01*
Training Strain	Self-Regulation	Performance	0.39	0.02*
Training Strain	Fatigue (STEMS)	High Performance	-0.46	0.03*
Training Strain	Vigour	High Performance	0.58	<0.01*

* $p < 0.05$

CHAPTER SIX

DISCUSSION

6.1 INTRODUCTION

The present study examined the effects of a training season on the stress and recovery states of U/20 semi-professional rugby union players. Monitoring the athletes throughout a training season could be of great importance to the coaching staff as it provides feedback relative to the periodization of the training year, and also assist in future planning regarding athlete management recovery strategies. This study used monitoring tools that were easy to administer, non-invasive and inexpensive, which has great practical application value.

The main finding of this study is that the stress and recovery state of players changed over a training season. The study also showed that there was a significant difference in stress and recovery variables between the forwards and backline players.

The importance of optimizing the recovery-stress state is very critical, especially throughout a training season where the conditioning of the athletes in the beginning of the season still plays a role in performance at the end of season. Stress from training, competition and lifestyle are acknowledged as major causes of overtraining and underperformance (Lehmann *et al*., 1997). Recovery is equally important in maintaining a balanced stress-recovery state. It is believed that enhanced recovery allow athletes to train more effectively which leads to improved fitness, technique, and training efficiency (Kellmann, 2010).

6.2 DESCRIPTIVE CHARACTERISTICS

The backline players players started the season physically fitter than the forwards. The backline players were significantly faster in the 40meter sprint test than the forwards, and also performed better in the repeated sprint test. As expected in rugby union the forwards weighed more than the backline players, was on average taller, and had a bigger waist circumference and higher body composition scores than the backline players.

6.3 AIM AND OBJECTIVES OF THE STUDY

The primary aim of this study was to monitor the stress and recovery states among U/20 semi-professional rugby union players over a training year. With this aim in mind, the following objectives were stated:

1. To assess changes in heart rate recovery (measured by the HIMS) over the training year, and to determine differences between forwards and backline players.

2. To assess changes in mood states (measured by the Stellenbosch Mood Scale)(STEMS) over a training year, and to determine differences between forwards and backline players.

3. To assess changes in Self-Report measurements over the training year, and to determine differences between forwards and backline players.

4. To examine the Rating of Perceived Exertion (RPE) for each training session, and assess the changes in training load, training monotony, and training strain over a training year, and to determine differences between forwards and backline players.

5. To assess changes in the recovery-stress state (measured by the Recovery-Stress Questionnaire)(RESTQ-76-Sport) of the players, and to determine differences between forwards and backline players.

6. To determine the relationships between the heart rate recovery (HIMS data), mood states, training load, training monotony, training strain, self-report and the recovery-stress state among the total group of rugby players.

The main findings will be discussed according to the objectives of the study.

1. **Assessment of heart rate recovery (measured by HIMS) over the training phases of the year for the total group of players, as well as for the forwards and backline players separately.**

Heart rate recovery scores for the total group on the HIMS test improved from the Developing phase to the Competitive phase, but then decreased again towards the end of the season. The backline players had higher recovery scores than the forwards during the Developing phase and this could be attributed to the fact that the backline players had better fitness scores than the forwards at the beginning of the training season. It is supported by Bunc *et al.* (1988), who found heart rate recovery after exercise to be faster among more physically active people. Backline players players are accustomed to run at higher velocities for a period of time, where the forward players rarely reach peak speeds (Bompa & Claro, 2009: 39). This could have played a role in the running quality and ability of the forwards to run the fourth stage of the HIMS test, and thus influencing heart rate recovery.

Improved fitness levels could have contributed to overall improved recovery scores for the HIMS over the season. Within group changes showed that the heart rate recovery scores improved significantly from the Developing phase to the Performance phase for both the forwards and backline players. The Developing phase was characterised by high training loads and training volumes, and the fact that heart rate recovery decreases after an acute increase in training load (Borresen & Lambert, 2008) could possibly explain the low heart rate recovery scores during this phase. The decreased heart rate recovery scores measured during the High Performance phase could be as a result of accumulative fatigue due to the total of 10 provincial (23 WP u/19 players) and 12 club league (32 WPRI rugby players) games played over the period of 11 weeks during the Performance and High Performance phases.

Lamberts *et al.* (2010) found improved heart rate recovery after a recovery period. This finding is supported by the current study where there was significant improvement in heart rate recovery from the Developing phase to the Transitional phase among the backline players after a one-week holiday break. There was also an improvement in the recovery scores of the forwards, although not significant.

2. Assessment of mood states (measured by the Stellenbosch Mood Scale) (STEMS) over the training phases of the year for the total group of players, as well as for the forwards and backline players separately.

This study found significant differences in mood states between the forwards and backline players. The backline players experienced greater changes in mood states during the training year than the forwards. High mood disturbance scores were observed during the Performance phase where the backline players showed higher scores than the forwards in Tension, Depression, Anger, Confusion, and Total Mood Disturbance. This is in contrast to a study by Grobbelaar *et al.* (2010) who examined 41 rugby union players and no significant differences regarding mood states between the forwards and backline players were found. The difference between the two studies can be attributed to the fact that Grobbelaar *et al.* (2010) only conducted seven assessments and the mean age of the participants were 2 years older than the participants in this study. The older participants could have had better coping mechanisms to handle the different stressors. Even though this study did not examine the relationship between changes in mood states and performance, research has found that increases in depression, tension, fatigue, and anger scores were related to poor performance (Filaire *et al*., 2003).

The forwards exhibited more positive mood states throughout the whole training year and had lower Fatigue scores at the end of the season than the backline players. The forwards also reported higher Vigour scores than the backline players, although not significant. Vigour and Fatigue scores have been found to be possible markers in identifying overtraining (Main & Grove, 2009). Bresciani *et al.* (2010) found Vigour scores to be higher during Competition phases compared to Preparatory phases, and Anger scores to be significantly higher in the beginning of the Competitive phases than the Preparatory phases. The present study did not investigate the relationship between performance and changes in mood states, but it is suggested that changes in mood states among the backline players cannot be linked exclusively to performance, as mentioned by Filaire *et al.* (2003). This is supported by Hoffman *et al.* (1999) who found that the players' mood were affected by more variables than only performance and that social or coach specific events could also play a vital role in changes in mood states. In addition they could not discover whether it was the performance that affected the mood states or whether performance was influenced by the change in mood states.

Hoffman *et al.* (1999) found that Vigour scores decreased during periods of poor performance, but returned to normal levels as soon as a team's performance improved. Goss (1994) found that athletes with better coping mechanisms had lower Depression, Anger, Fatigue, Tension and Confusion scores and higher Vigour scores over a training season. This corresponds to findings in the current study and might indicate that the forwards were more able to cope with physical stress than the backline players. Another possibility is that unknown social factors together with possible overtraining might have resulted in the changes in the Backline players' mood state scores.

3. Assessment of changes in Self-Report measurements over the training year, as well as differences between the forwards and backline players.

The self-report questionnaire asked questions regarding perceived sleep quality, communication with the coach and team mates, and recovery. Results indicated good perceived social recovery as well as good perceived physical recovery. Players attended recovery sessions together as a team, and stayed together in the same hostel. This could have contributed to the high perceived physical and social recovery. The backline players had lower scores than the forwards over the training year, with significantly improved scores among the forwards from the Developing phase to the Performance phase. The backline players reached the lowest self-report scores during the Performance phase, whereas the forwards reported their highest score for the training year during the same phase. The forwards had video-analysis sessions with the head coach before each game, where they analysed the opponents' line-outs. This extra time spend with the head coach might have been a factor contributing to the forwards having higher "communication with coach" scores, and subsequently higher Self-Report scores than the backline players, especially during the Early Competition and Performance phases.

4. Assessment of session RPE, changes in training load, training monotony, and training strain over a training year, as well as differences between forwards and backline players.

Training Load

Kelly and Coutts (2007) suggested that RPE measurements should be taken over the entire training season, as well as for every training session and training day. They also suggested that information from the RPE measurements can be monitored and used to determine and adjust in-season training loads to ensure optimal physical preparation, although not implemented in this study for the aim was only to assess the session RPE. RPE measures in this study were taken after every training session every day of the week and an average weekly RPE value for each player was calculated. RPE values were then used to calculate weekly Training Load, Training Monotony, and Training Strain.

The training load significantly decreased from the Developing phase to the High Performance phase. This is expected as the training load should be high during the Developing phases of a training year as it is characterized by high training loads and volumes regarding strength, speed, fitness, and technical and tactical skills training. As the training year reaches competition phases, the training load should be decreased in order to accommodate strain associated with competitive games. There was no difference between the forwards and the backline players regarding Training loads which is an indication of a well balanced training periodization between different playing positions.

Training Monotony

Training monotony is a measure of day-to-day training variability that has been related to the onset of overtraining when combined with training loads (Foster, 1998). Training monotony significantly decreased over the training phases, with the backline players showing a tendency to have lower scores than the forwards during the High Performance phase. The forwards had slightly higher monotony scores at the end of season than at the beginning, whereas the backline players showed the opposite with the lowest scores at the end of the training year and the highest scores at the beginning. Foster (1998) demonstrated that monotony was lower when practices varied considerably in volume and intensity. Therefore, lower monotony values indicate variation in practice. Although the difference in monotony between the forwards and the backline players during the Developing phase was not significant, higher scores for the backline players might indicate that the backline players had less variation in their training during the Developing phase.

Variation in Training load is very important as high Training monotony may result in symptoms of overreaching. Lower monotony or variation of training loads may contribute to prevent the occurrence of injuries, illness and possibly improve performance (Venter, 2008).

Training Strain

Training strain is a useful method for monitoring training when players are undertaking high training loads, as monitoring recovery becomes important when an athlete undertakes high training loads. There was a significant difference in training strain over the training phases and a significant difference between the forwards and the backline players over the training season. These results can be related to the changes in Training Monotony as it has an effect on the calculations of Training strain.

The forwards experienced significantly higher strain than the backline players during the High Performance phase, which relates to increases in Training monotony reported by the forwards during the High Performance phase. Training strain in the forwards was high during the Developing phase, but lowered towards the Early Competition phase before returning to high levels during the High Performance phase. The backline players experienced the highest strain levels at the Developing phase. Strain then gradually decreased to the High Performance phase where training strain was at the lowest levels. High Training strain has been associated with incidence of poor performance (Putlur *et al*., 2004), and in this study it was evident that Training strain was lower during the Performance phases than in the Developing phase which could have contributed to the good performance of the players in their respective leagues.

5. The assessment of the effects of a training year on the recovery-stress state (measured by the Recovery-Stress Questionnaire) (RESTQ-76-Sport) of the players, and whether there is a difference between forwards and backline players.

The RESTQ-76-Sport gives an indication of the Total Recovery and Total Stress, as well as 19 subscales, namely General Stress, Emotional Stress, Social Stress, Conflicts/Pressure, Fatigue, Lack of Energy, Physical Complaints, Success, Social Recovery, Physical Recovery, General Well-Being, Sleep Quality, Disturbed Breaks, Emotional Exhaustion, Injury, Being in Shape, Personal Accomplishment, Self-Efficacy, and Self-Regulation.

Davis *et al.* (2007) found the RESTQ-76-Sport to be a valid general measure of under-recovery, but many of the individual items combine to form different subscales than originally formulated by Kellmann and Kallus (2001). They observed that the RESTQ-76-Sport questionnaire measures Social Recovery, General Well-Being, Being in Shape and Self-Efficacy together. Davis *et al*. (2007) suggested that the RESTQ-76-Sport can be applied practically to assist coaches in monitoring their athletes during training sessions. This enables coaches to identify specific signs of under-recovery and can modify the athlete's training programme to increase recovery.

Bresciani *et al.* (2010) claimed to be the first published study in which the RESTQ-76-Sport questionnaire was used as monitor psychological changes throughout a whole training season of team sports, when they monitored handball players over a whole training season. They found no significant changes across the season. In contrast, the current study found significant changes over the training phases as well as changes between different playing positions over the season for some of the RESTQ-76-Sport scales. The RESTQ-76-Sport could be used to identify potential sources of excessive stress or reduced recovery and thereby serve as a tool for the monitoring of training activities (Kellman & Kallus, 2001). King *et al.* (2010) found the RESTQ-76-Sport questionnaire reflected how the players were dealing with the effects of amateur participation and other requirements in their own life. Previous studies have examined changes in RESTQ-76-Sport measures during strenuous training of rowers (Kellman & Kallus, 2001; Mäestu *et al*., 2005, 2006), mountain bikers (Kellmann & Kallus, 1999), triathletes (Coutts *et al*., 2007), and speed skaters (Nederhof *et al*., 2007). Steinacker *et al.* (2000) reported that changes in the RESTQ-76-Sport scores occured before physical symptoms of overtraining were visible.

Meister *et al.* (2011) monitored U/19 league male football players, during a three week period of high match exposure and stated that psychological assessment is widely accepted as a sensitive and practical marker for the early recognition of high physical strain and overload, but found that neither the Total stress nor the Total Recovery score or any of the subscale-scores indicated significant alterations in the recovery stress state. There was only a tendency toward slightly higher values in Physical Complaints at high exposure. The current study did not find any significant change in Total Stress or Total Recovery over the training year, but significant differences were found between the Forwards and the Backline players in Total Stress and Total Recovery, as well as some subscales.

The forwards maintained constant Total Stress levels throughout the training year. The backline players had lower stress levels than the forwards in the Developing phase, but experienced an increase towards the Transitional phase. Stress levels then declined towards the Early Competition phase, but still remained higher in the backline players than among the forwards. The backline players also experienced increased Total Stress towards the Performance phase and the High Performance phase, resulting in a tendency for the backline players to experience significantly more stress than the forwards during the Performance phase and statistically significant more stress during the High Performance phase.

The Total Recovery scores for the backline players were higher than those reported by the forwards from the Developing phase to the Early Competition phase. The recovery scores of the backline players decreased towards the Performance phase and the High Performance phase. The forwards maintained Total Recovery scores, with a slight increase towards the High Performance phase. There was a weak tendency for the backline players to have lower recovery scores than the forwards during the High Performance phase.

The backline players experienced more feelings of stress and fewer feelings associated with recovery over the training year. They reported varying scores over the training phases for most of the RESTQ-76-Sport scales, except for the Conflicts/Pressure, Physical Recovery, and Sleep Quality scales which showed a more moderate irregular pattern. The backline players showed sharp increases in Social Stress during the Early Competition phase as well as in the Performance phase, although not significantly different from the backline players. Bresciani *et al.* (2010) found an increase in Social Stress scores reported in late Competition when compared to Preparatory scores during examination of fourteen handball players completing 40 weeks of training.

The forwards showed a better recovery-stress profile, than the backline players, regarding all the RESTQ-76-Sport scales. This coincides with Grobbelaar *et al.* (2010) who found that forwards had more favourable scores than the backline players. In the current study the forwards maintained constant levels for most of the RESTQ-76-Sport scales except for the Conflicts/Pressure, Fatigue, Success, Sleep Quality and Being in Shape scales where they exhibited improved scores towards the end of season. The only scale where the forwards showed less favourable scores was in the Injury scale. They reported higher injury scores in the Transitional, Early Competition, and High Performance phases. This might be due to increased contact sessions in practise as well as more game time during the week. Theisen *et al*. (2012) found that higher exposure time to competitions increased the risk for injury. There was no significant difference between the forwards and the backline players regarding recovery scores, although the backline players had a significant higher injury score in the Early Competition phase compared to the Developing phase.

The backline players and the forwards had significantly different values for each of the RESTQ-76-Sport scales during the Performance and High Performance phases, with a large difference in some scales in the Transitional phase. Significant differences between the forwards and the backline players, where the backline players reported higher scores than the forwards during the Performance phase, were found in the General Stress, Emotional Stress, Lack of Energy, and Disturbed Breaks scales. The backline players experienced more pressure during the competitive phases regarding performance as injuries and poor performance played a role whether or not they will get a playing contract for the next year.

The backline players reported significantly higher scores than the forwards in the High Performance phase in the General Stress, Fatigue, Lack of Energy, Physical Complaints, Being in Shape, and Self-Efficacy scales. The backline players had significantly more Disturbed Breaks than the forwards in the Transitional phase. Coutts and Reaburn (2008) found significant decreases in Physical Recovery, Self-Regulation, Self-Efficacy, and Social Recovery and significant increases in General Stress, Fatigue, and Disturbed Breaks following a period of overload training. The forwards were physically well developed and conditioned and according to the strength-and-conditioning coach were sure of receiving contracts for the following year, regardless of injuries and whether they played for the WP

U/19's until the end of the season. The backline players had more stress regarding a position on the team, as it was the decisive factor in qualifying for a contract to play for the Western-Province for the following year. This might also have contributed to the players' feeling of success towards the end of the season.

There was a tendency for the backline players to have higher feelings of success during the Developing phase than the forwards. The backline players felt less successful towards the Performance and High Performance phases, whereas the forwards felt more successful during the same phases and recorded higher success values than the backline players. Social Recovery remained unchanged over the first three phases of the training year, with the backline players reporting slightly lower scores than the forwards. The backline players had a sudden decline in Social Recovery towards the Performance and High Performance phases resulting in a significant difference between the forwards and the backline players during the High Performance phase. After a conversation with some of the coaching staff it was established that the forwards and the backline players had equal opportunities to participate in social recovery activities. There might be inter-positional factors we were not aware of, and this might play a role on the lower Social Recovery scores. It may also be just a coincidence for the backline players to have lower scores than the forwards and be related to incorrect reporting.

The forwards had a slight decrease in Physical Recovery during the Early Competition, but no significant difference in scores was reported over the training year. During the Early Competition phase there were extra technical training sessions for the forwards depending on their performance during previous games, especially for line-outs and scrums. The backline players did not have extra training session, and this could have resulted in the forwards reporting less Physical Recovery in the Early Competition phase. The backline players had higher Physical Recovery scores than the forwards during the Developing phase, but their Physical Recovery decreased towards the end of the season resulting in lower Physical Recovery than the forwards in the High Performance phase. The backline players reported lower General Well-Being scores than the forwards during the Transitional, Performance, and High Performance phases. General Well-being significantly decreased among the backline players from the Developing phase to the High Performance phase. Coutts and Reaburn (2008) found that after a tapering phase there was increased General Well-Being and improved Physical Recovery.

The backline players had higher Sleep Quality scores than the forwards over the whole training season although the forwards reported improved Sleep Quality during the Performance and High Performance phases. The backline players reported lower Sleep Quality during the Early Competition and the High Performance phase. Davis *et al.* (2007) found the Sleep Quality scale to be unreliable. This can be argued to be true due to the fact that athletes report Sleep Quality scores in comparison to whether they had undisturbed sleep, and the duration of undisturbed sleep. Venter (2008) highlighted the importance of an athlete’s understanding of the sequence, duration and characteristics of the different sleep phases: Non-rapid eye movement (NREM) and Rapid eye movement (REM). The better the athletes understand how these influence “quality of sleep" the more they can appreciate the importance of sleep as a recovery strategy. Whether Sleep Quality were related to personal stress situations, or whether the athletes reported it correctly or incorrectly cannot be determined as a certainty.

The backline players felt more in Shape than the forwards during the Developing, Transitional and Early Competition phases, even though both groups felt less in Shape from the Developing phase to the Early Competition phase. Bresciani *et al.* (2010) found feelings of Being in Shape to be higher in the Competitive phases compared to Preparatory phases. This correspond to this study's finding where the forwards reported increased scores for the Being in Shape scale towards the Performance and High Performance phases. The backline players, however, reported decreased scores for Being in Shape towards the Performance and the High Performance phases.

The backline players had higher feelings of personal accomplishment than the forwards in the beginning of the training year, but this feeling decreased towards the Performance and High Performance phases where the backline players reported lower scores for Personal Accomplishment than the forwards. The forwards had no significant or big changes in their feeling of Personal Accomplishment over the whole training year. They did, however, report slightly higher scores towards the end of the season. This can be explained in relation to the forwards being sure of their place in the team and contracts for the next year, whereas the backline players did not have the same reassurance.

The backline players reported higher scores than the forwards for Self-Efficacy during the Developing phase. A decline in Self-Efficacy reported by the backline players and an increase in Self-Efficacy reported by the forwards resulted in the forwards having higher scores for Self-Efficacy than the backline players from the Transitional to the High Performance phase. The backline players experienced a decline in Self-Efficacy towards the last two phases, showing a tendency to have lower Self-Efficacy than the forwards in the Performance phase, and reporting significantly lower scores during the High Performance phase.

Self-Regulation scores decreased in both groups from the Developing phase to the Transitional phase. The forwards reported more Self-Regulation than the backline players over the whole training season, except during the Developing phase where the backline players had a slightly higher score for Self-Regulation. After a slight increase in Self-Regulation reported by the forwards towards the Early Competition phase, they reported less Self-Regulation towards the end of the season. The forwards had significantly less Self-Regulation during the High Performance phase than in the Developing phase. The backline players reported less Self-Regulation during all the phases, having significantly less Self-Regulation during the Early Competition, Performance, and High Performance phases as compared to the Developing phase. The players had no psychological training and goal setting/motivation skills were enforced by conversations between the different coaches and players, but the players underwent no formal psychological skills training programme.

6. Assessment of the relationships between the heart rate recovery, mood states, training load, training monotony, training strain, self-report and the recovery-stress state.

The HIMS test were shown to correlate with three sub-scales of the RESTQ-76-Sport questionnaire. A negative correlation was found with Injury during the Early Competition phase, indicating that a decrease in HIMS recovery score might be an indicator of increased injury occurrence. A negative correlation with Physical Complaints in the Developing Phase, and a positive correlation were found with Self-Efficacy in the Developing Phase. Positive correlations were found between the HIMS test and Training Load during the Transitional and Performance phases. The HIMS test also correlated positively with Training Monotony and Training Strain in the Performance phase. The HIMS test might be a possible indicator of Training Load conditions, especially during the Performance/Competitive phases.

Vigour, as determined by the STEMS questionnaire, was positively correlated with Training Load during the Early Competition phase, with Training Monotony during the High Performance phase, and with Training Strain during the High Performance phase. The Fatigue scale from the STEMS questionnaire was negatively correlated with Training Monotony during the High Performance phase and with Training Strain during the High Performance phase. In a team-sport setting the motivational aspects of teammates, and the support structure regarding training might play a role on an individual’s vigour scores even though he might feel fatigued. It is a very competitive environment where players will often train harder just to look better or perform better than a teammate. This training vigour can thus result in the player exhibiting positive mood states.

In previous reviews, authors have indicated that training intensity is of great importance when incorporating a taper phase in your training periodization (Houmard & Johns, 1994; Kubukeli *et al*., 2002; Mujika, 1998; Neufer, 1989). McNeely and Sandler (2007) indicated that race-paced intensity of training intervals in the final session before a competition is important for psychological and physiological gains, and should leave the athlete with feelings of speed, power and confidence. The athletes should feel energized rather than fatigued. Reducing training loads can be acquired by reducing the intensity, volume, or frequency. Reduced training intensity can result in detraining and, therefore, training intensity should rather be maintained during a taper phase. High-quality training can enhance physiological and performance adaptations. For maximum performance outcomes, training volume should be diminished up to within 41% to 60% of pre-taper volumes. Reduction in training frequency between 30% and 50% of pre-taper values might assist moderately trained subjects to maintain physiological and performance adaptations. Highly trained individuals should maintain frequencies during taper, it has been suggested that they might lose their “will” to participate with decreased training frequencies (Mujika, 2009).

The periodization-plan of the WPRI included a taper phase, namely the Transitional phase. During this phase the conditioning coach only decreased training volume, and the focus stayed on intensity and frequency. It can thus be concluded that the training sessions were adapted accordingly to accommodate a taper phase, and the necessary measures were taken to maintain training intensity and trying to prevent athletes to experience more “Emotional Exhaustion”, i.e. losing their will to participate due to either too high or too low training loads. This system seemed to be successful as this study did not find any correlation between training load and Emotional Exhaustion. This is in agreement with the data from the different playing positions where there was no significant difference in Emotional Exhaustion between the forwards and the backline players.

Correlations between Training Load, Training Monotony, and Training Strain and the different scales of the RESTQ-76-Sport questionnaire were examined.

Training load correlated positively with Self-Efficacy and Self-Regulation during the Early Competition phase and with Conflicts/Pressure during the Developing phase. More positive correlations were found with Being in Shape during the Developing and Early Competition phases and with Personal Accomplishment during the Developing and Transitional phases. Physical Recovery during the Early Competition and Performance phases and Success during the Transitional and Early Competition phases were also found to have a positive correlation with Training Load. There was also a positive correlation between Training Load and Total Recovery during the Early Competition phase.

Coutts and Reaburn (2008) found that intensified training resulted in increase in Fatigue, General Stress and Disturbed Breaks. The current study did not find any correlations between training load and fatigue, general stress or disturbed breaks. Coutts and Reaburn (2008) found a negative correlation in Physical Recovery, Self-Regulation, Self-Efficacy, and Social Recovery with Training Load. Bresciani *et al.* (2010) found positive correlations between Training Load and Physical Recovery, and Being in Shape. Bresciani *et al.* (2010) found a significant positive correlation between Training Load and Injury. In the current study no significant correlations between Training Load and Injury were found.

Training Monotony correlated positively with Being in Shape during the Developing and Early Competition phases and with Success during the Transitional and Early Competition phases. More positive correlations were found with Personal Accomplishment during the Developing phase, with Physical Recovery during the Performance phase, and with Self-Efficacy and Sleep Quality during the Early Competition phase. Negative correlations were found with Training Monotony and Lack of Energy during the Transitional phase, as well as with Training Monotony and Social Recovery during the Developing phase. A positive correlation was found between Training Monotony and Total Recovery during the Early Competition phase.

Kellmann (2010) found that in rowing, increases in training volume was reflected by elevated stress and reduced recovery scores measured by the RESTQ-76-Sport. The current study only found the Social Recovery scale to decrease significantly in the Developing phase during which high Training Monotony levels were reported.

Training Strain correlated positively with Conflicts/Pressure in the Developing phase, and with Self-Regulation in the Performance phase. Success and Self-Efficacy correlated with Training strain in the Transitional and Early Competition phases. More correlations were found with Being in Shape in the Developing, Transitional, and Early Competition phases, with Personal Accomplishment in the Developing and Transitional phases, and with Physical Recovery in the Early Competition and Performance phases. A positive correlation was found between Training Strain and Total Recovery during the Early Competition phase.

Kalda *et al.* (2004) found a negative correlation between Emotional Exhaustion and performance, also between Physical Complaints and performance. A positive correlation was found between General Well-Being and performance. Hartwig *et al.* (2009) found that players with the highest training and physical activity often had more favourable recovery-stress states. In contrast with this, research supports a dose-response relationship with increase in training volume and increased mood disturbances and decreased recovery (Armstrong & VanHeest, 2002; Coutts *et al*., 2007c). Hartwig *et al*. (2009) suggested that it is possible that talented, successful, and fit players appeared to cope better with training and external stressors and had better recovery profiles. The positive role of sport and physical activity in psychosocial health is well established (Scully *et al*., 1998), and it is, therefore, possible that high-volume players often experience psychosocial benefits from optimal participation in sport and exercise. The authors found no correlations between change in volume and change in stress and recovery, and they indicated that incorrect report of training volumes might have played a role.

The positive correlations found in this study between training load and recovery sub-scales of the RESTQ-76-Sport supports the findings of Hartwig *et al.* (2009) in that players with the highest training load often had favourable recovery-stress states, because of increased fitness and the ability to adjust to external physical stressors.

6.4 CONCLUSION

This study confirmed position-specific differences in recovery-stress states of rugby union players over the various training phases of a competitive year. The backline players recovered physically better and faster than the forwards throughout the training year, while the forwards exhibited better psychological coping methods. The backline players had significant higher scores for the STEMS scales; depression, anger, and confusion during the Performance phase. The Total Mood disturbance score was also significantly higher for the backline players than the forwards during the Performance phase. The backline players experienced increased stress and decreased feelings of well-being during the competitive phases when compared to the forwards. The backline players had better physical recovery than the forwards after the high intensity and high volume Developing phase. Grobbelaar *et al.* (2010) observed the level of experience of rugby players may influence their RESTQ-76-Sport and STEMS scores. Novice players often showed better mood states and Recovery-Stress state than the more experienced players. This could have played a role in the difference the present study found between the forwards and the backline players, as the level of rugby they played before coming to the WPRI differed. Lack of psychological skills training and coping strategies might also have resulted in the players not knowing how to properly handle stressful situations and how to regulate their stress and recovery states. The lack of an educational system regarding recovery strategies, and the reinforcement thereof, especially during the Developing phases might play a role in the later increased fatigue and injury rates among the players. Due to the novelty of this study it is difficult to say for certain whether the result of this study is of significant value and whether some of the results are due to coincidence. (Only a few studies have used the RESTQ-76-Sport and STEMS to monitor team-sports athletes over a whole training season, and over different training phases.)

Positive correlations were evident between the HIMS test and the RESTQ-76-Sport subscales. Additional correlations were found between training load, as well as training monotony and training strain, and scales of the RESTQ-76-Sport and STEMS questionnaires. The HIMS test showed favourable scores in recovery measurements, and was found to correlate with injury and training loads which can be beneficial for coaches to monitor their training sessions and might be an early indicator of the athletes' susceptibility to the occurrence of an injury. No conclusive findings regarding the HIMS and the incidence of injuries or changes in mood states have been established in previous research. The positive correlations found between the various instruments used in the study, could be an indication that these instruments could complement each other in the psychological and physiological monitoring of athletes.

Training loads were found to have positive correlations with the recovery sub-scales of the RESTQ-76-Sport. This indicates that perceived recovery and stress states are influenced by more than just increases or decreases in training loads. Relationships between Training loads and the Vigour and Fatigue scales of the STEMS questionnaire was established, but not exactly in the way expected. This can be explained by the fact that in team sports you have intra-player factors playing a role in a player's reaction to specific training environments which could influence their Vigour and Fatigue scores. Motivational and social aspects in team sports might serve as mood "uplifters" even though training loads or intensities are increased and suspected to create the opposite effect on mood states.

During the Performance phase, an increase in the group's Total Mood Disturbance, combined with a slight increase in heart rate recovery, can be an indication of a lack of coping mechanisms and a lack of soundly developed psychological skills as there was no formal training programme to this extent. The High Performance phase emphasized this by showing a still high Total Mood Disturbance score, together with an increase in Total Stress and a decrease in Total Recovery (measured by the RESTQ-76-Sport questionnaire). It can be recommended that for rugby union, psychological skills training and teaching the players coping mechanisms should receive greater attention during the competitive phases.

6.5 STUDY LIMITATIONS AND FUTURE RESEARCH

Subjective data has the limitation in that measurements of the variables are relative to the subject's feelings and knowledge on the subject matter. Another limitation in the study was that the test sample was smaller during the competitive phases than during the earlier phases, and the smaller numbers may have influenced the results. The players also did not receive any feedback with regard to their stress-recovery states. Future intervention studies could address this aspect. This study also focused on Rugby union players only, and future researches are encouraged to examine athletes from different sports over the different training phases. Given findings in this study, researchers are also encouraged to record short-term and long-term injuries, occurrences of Upper Respiratory Tract Infections (URTI's), and competitive level participating at.

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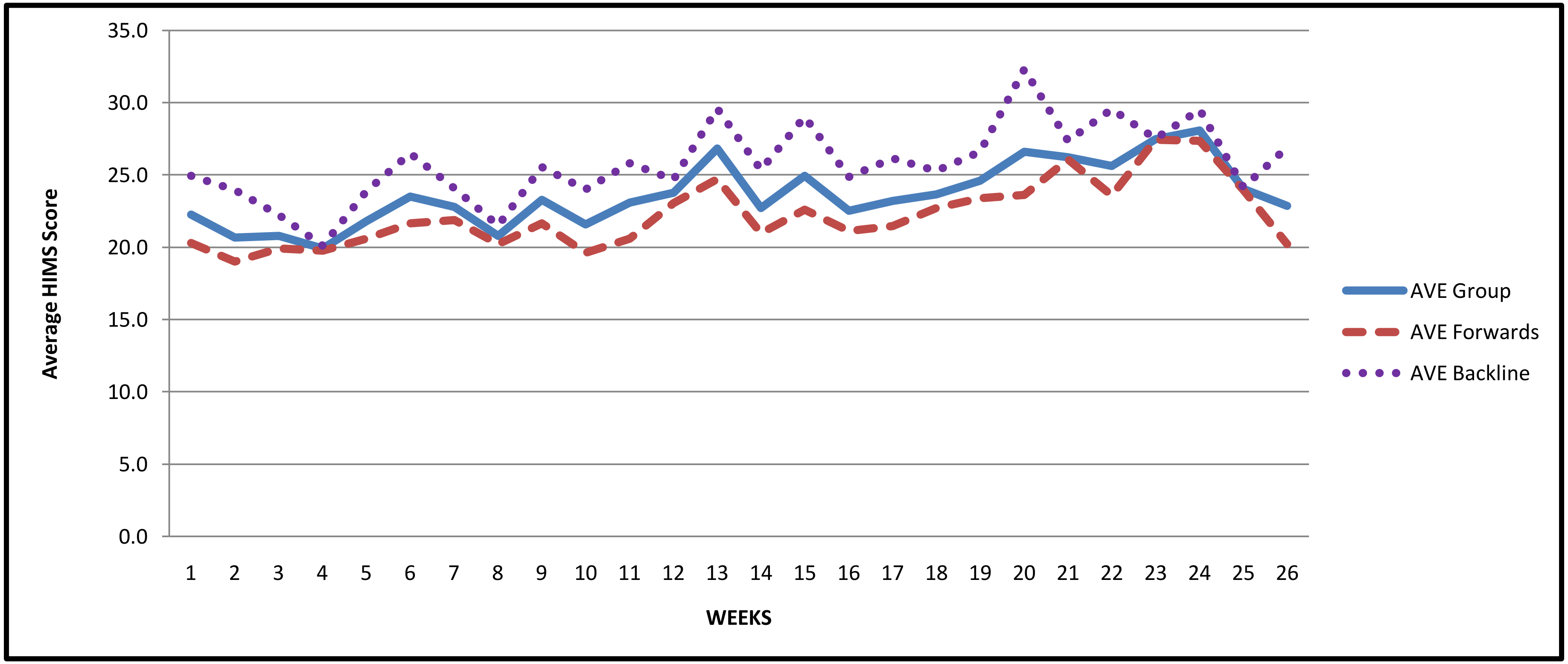
APPENDIX A



Average HIMS Score
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
WEEKS
AVE Group
AVE Forwards
AVE Backline

APPENDIX B

STEMS

Below is a list of words that describe feelings people have. Please read each one carefully. Then circle the answer which best describes **how you feel right now**.

Hieronder is 'n lys van woorde wat die gevoelens van mense beskryf. Lees asseblief elkeen noukeurig. Omsirkel daarna die antwoord wat die beste beskryf **hoe jy op hierdie oomblik voel.**

	Not at all Glad nie	***A little Effens***	***Moderately Taamlik***	***Quite a bit Baie***	***Extremely Uiters***	
Panicky	0	1	2	3	4	Paniekerig
Lively	0	1	2	3	4	Lewendig
Confused	0	1	2	3	4	Verward
Worn out	0	1	2	3	4	Vermoeid
Depressed	0	1	2	3	4	Neerslagtig
Downhearted	0	1	2	3	4	Mismoedig
Annoyed	0	1	2	3	4	Vererg
Exhausted	0	1	2	3	4	Uitgeput
Mixed-up	0	1	2	3	4	Deurmekaar
Sleepy	0	1	2	3	4	Vaak
Bitter	0	1	2	3	4	Verbitterd
Unhappy	0	1	2	3	4	Ongelukkig
Anxious	0	1	2	3	4	Angstig
Worried	0	1	2	3	4	Bekommerd
Energetic	0	1	2	3	4	Energiek
Miserable	0	1	2	3	4	Ellendig
Muddled	0	1	2	3	4	Ontwrig
Nervous	0	1	2	3	4	Senuweeagtig
Angry	0	1	2	3	4	Kwaad
Active	0	1	2	3	4	Aktief
Tired	0	1	2	3	4	Moeg
Bad tempered	0	1	2	3	4	Humeurig
Alert	0	1	2	3	4	Op en wakker
Uncertain	0	1	2	3	4	Onseker

Name: **Naam:**	**Date:** **Datum:**

APPENDIX C

SELF-REPORT QUESTIONNAIRE

Recovery self-monitoring system

Training phase: Date: Week: Name:___________________

1=Awful 2= Poor 3=OK 4=Good 5=Excellent/great	**Day 1 Monday**	**Day 2 Tuesday**	**Day 3 Wednesday**	**Day 4 Thursday**	**Day 5 Friday**	**Day 6 Saturday**	**Day 7 Sunday**
Quality of sleep	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Energy levels	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Motivation and enthusiasm for training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Attitude to training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Attitude to team	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Communication with coach	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Health	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Recovery modalities used	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

APPENDIX D

	Training Session (minutes)	RPE (0 – 10)
Gym (morning)		
Speed		
Black & Green		
Rugby (Team)		
Mongrel		
Rugby (Individual)		
Gym (Evening)		
Rehabilitation		
Game Time		
Extra Gym		
Extra Fitness		
Extra Skill		
Total Daily RPE		

APPENDIX E

RECOVERY STRESS QUESTIONNAIRE (RESTQ-76-Sport)

R E S T Q - 76 Sport

Single Code: ______________________ Group Code: ______________________

Name (Last): ______________________ **(First):** ______________________

Date: __________ Time: __________ Age: __________ Gender: __________

Sport/Event(s): ____

This questionnaire consists of a series of statements. These statements possibly describe your mental, emotional, or physical well-being or your activities during the past few days and nights.

Please select the answer that most accurately reflects your thoughts and activities. Indicate how often each statement was right in your case in the past days.

The statements related to performance should refer to performance during competition as well as during practice.

For each statement there are seven possible answers.

Please make your selection by marking the number corresponding to the appropriate answer.

Example:

In the past (3) days/nights

... I read a newspaper

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

In this example, the number 5 is marked. This means that you read a newspaper very often in the past three days.

Please do not leave any statements blank.

If you are unsure which answer to choose, select the one that most closely applies to you.

Please turn the page and respond to the statements in order without interruption.

 C.1

In the past (3) days/nights

1) ... *I watched TV*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

2) ... *I did not get enough sleep*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

3) ... *I finished important tasks*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

4) ... *I was unable to concentrate well*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

5) ... *everything bothered me*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

6) ... *I laughed*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

7) ... *I felt physically bad*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

8) ... *I was in a bad mood*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

9) ... *I felt physically relaxed*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

10) ... *I was in good spirits*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

11) ... *I had difficulties in concentrating*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

12) ... *I worried about unresolved problems*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

C.2 From *Recovery-Stress Questionnaire for Athletes: User Manual* by Michael Kellmann and K. Wolfgang Kallus, 2001, Champaign, IL: Human Kinetics.

In the past (3) days/nights

13) ... *I felt at ease*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

14) ... *I had a good time with friends*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

15) ... *I had a headache*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

16) ... *I was tired from work*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

17) ... *I was successful in what I did*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

18) ... *I couldn't switch my mind off*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

19) ... *I fell asleep satisfied and relaxed*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

20) ... *I felt uncomfortable*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

21) ... *I was annoyed by others*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

22) ... *I felt down*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

23) ... *I visited some close friends*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

24) ... *I felt depressed*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

From *Recovery-Stress Questionnaire for Athletes: User Manual* by Michael Kellmann and K. Wolfgang Kallus, 2001, Champaign, IL: Human Kinetics. C3

In the past (3) days/nights

25) ... *I was dead tired after work*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

26) ... *other people got on my nerves*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

27) ... *I had a satisfying sleep*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

28) ... *I felt anxious or inhibited*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

29) ... *I felt physically fit*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

30) ... *I was fed up with everything*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

31) ... *I was lethargic*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

32) ... *I felt I had to perform well in front of others*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

33) ... *I had fun*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

34) ... *I was in a good mood*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

35) ... *I was overtired*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

36) ... *I slept restlessly*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

In the past (3) days/nights

37) *... I was annoyed*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

38) *... I felt as if I could get everything done*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

39) *... I was upset*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

40) *... I put off making decisions*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

41) *... I made important decisions*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

42) *... I felt physically exhausted*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

43) *... I felt happy*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

44) *... I felt under pressure*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

45) *... everything was too much for me*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

46) *... my sleep was interrupted easily*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	alwayss

47) *... I felt content*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

48) *... I was angry with someone*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

From *Recovery-Stress Questionnaire for Athletes: User Manual* by Michael Kellmann and K. Wolfgang Kallus, 2001, Champaign, IL: Human Kinetics. C.5

In the past (3) days/nights

49) ... *I had some good ideas*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

50) ... *parts of my body were aching*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

51) ... *I could not get rest during the breaks*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

52) ... *I was convinced I could achieve my set goals during performance*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

53) ... *I recovered well physically*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

54) ... *I felt burned out by my sport*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

55) ... *I accomplished many worthwhile things in my sport*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

56) ... *I prepared myself mentally for performance*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

57) ... *my muscles felt stiff or tense during performance*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

58) ... *I had the impression there were too few breaks*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

59) ... *I was convinced that I could achieve my performance at any time*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

60) ... *I dealt very effectively with my teammates' problems*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

C.6 From *Recovery-Stress Questionnaire for Athletes: User Manual* by Michael Kellmann and K. Wolfgang Kallus, 2001, Champaign, IL: Human Kinetics.

In the past (3) days/nights

61) ... *I was in a good condition physically*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

62) ... *I pushed myself during performance*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

63) ... *I felt emotionally drained from performance*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

64) ... *I had muscle pain after performance*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

65) ... *I was convinced that I performed well*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

66) ... *too much was demanded of me during the breaks*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

67) ... *I psyched myself up before performance*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

68) ... *I felt that I wanted to quit my sport*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

69) ... *I felt very energetic*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

70) ... *I easily understood how my teammates felt about things*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

71) ... *I was convinced that I had trained well*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

72) ... *the breaks were not at the right times*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

 C.7

In the past (3) days/nights

73) ... *I felt vulnerable to injuries*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

74) ... *I set definite goals for myself during performance*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

75) ... *my body felt strong*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

76) ... *I felt frustrated by my sport*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

77) ... *I dealt with emotional problems in my sport very calmly*

0	1	2	3	4	5	6
never	seldom	sometimes	often	more often	very often	always

Thank you very much!

APPENDIX F

	General Stress	Emotional Stress	Social Stress	Conflicts/ Pressure	Fatigue
Trial Session 1	1.13	1.46	2.61	2.60	2.04
Trial Session 2	0.95	1.32	1.38	2.57	2.10
Trial Session 3	1.19	1.38	1.66	2.48	2.36
Trial Session 4	1.08	1.34	1.56	2.49	2.09
Trial Session 5	1.07	1.45	1.63	2.41	2.29
Trial Session 6	1.29	1.56	1.83	2.56	2.21
Trial Session 7	1.18	1.33	1.49	2.09	1.89
Trial Session 8	1.36	1.61	1.58	2.31	2.05
	Lack of Energy	**Physical Complaints**	**Success**	**Social Recovery**	**Physical Recovery**
Trial Session 1	1.60	1.50	3.17	4.10	3.26
Trial Session 2	1.54	1.42	3.16	4.09	3.32
Trial Session 3	1.72	1.71	3.29	4.07	3.26
Trial Session 4	1.61	1.49	3.19	4.06	3.22

Trial Session 5	1.69	1.81	14.61	4.30	3.28
Trial Session 6	1.69	1.71	3.11	4.02	3.21
Trial Session 7	4.77	1.59	3.27	4.05	3.37
Trial Session 8	1.68	1.77	3.09	3.68	3.15
	General Well-Being	**Sleep Quality**	**Disturbed Breaks**	**Emotional Exhaustion**	**Injury**
Trial Session 1	3.59	2.50	1.25	3.70	10.94
Trial Session 2	3.69	2.55	1.28	1.30	2.14
Trial Session 3	4.32	2.53	1.55	1.62	2.57
Trial Session 4	3.63	2.48	1.26	1.37	2.41
Trial Session 5	3.68	2.56	1.52	1.48	2.25
Trial Session 6	3.45	2.69	1.44	1.54	2.28
Trial Session 7	3.58	2.63	1.48	1.47	6.36
Trial Session 8	3.35	2.58	1.53	1.55	2.44

	Being in Shape	Personal Accomplishment	Self-Efficacy	Self-Regulation
Trial Session 1	3.48	3.09	3.43	3.68
Trial Session 2	3.46	3.07	3.34	3.46
Trial Session 3	3.28	3.19	3.54	3.32
Trial Session 4	3.16	3.07	3.55	3.41
Trial Session 5	3.46	3.18	3.50	4.07
Trial Session 6	3.24	3.04	3.25	3.51
Trial Session 7	3.33	2.93	12.38	3.05
Trial Session 8	3.24	3.04	3.23	3.13

APPENDIX G

Variable 1	Variable 2	Pearson	Pearson p-value	Spearman	Spearman p-value	# cases	subgroup
Training Load	Fatigue(Rest Q)	0.22	0.10	0.25	0.06	55	Developing Phase
Training Load	Fatigue(Rest Q)	-0.04	0.81	-0.12	0.44	43	Transitional
Training Load	Fatigue(Rest Q)	0.04	0.82	0.01	0.93	46	Early Competition
Training Load	Fatigue(Rest Q)	-0.30	0.08	-0.28	0.11	35	Performance
Training Load	Fatigue(Rest Q)	-0.24	0.28	-0.35	0.11	22	High Performance
Training Load	Anger	0.10	0.49	0.10	0.46	55	Developing Phase
Training Load	Anger	0.00	0.99	-0.05	0.73	51	Transitional
Training Load	Anger	0.02	0.89	-0.02	0.86	49	Early Competition
Training Load	Anger	0.19	0.28	0.15	0.40	35	Performance
Training Load	Anger	-0.03	0.91	-0.16	0.48	22	High Performance
Training Load	Being in Shape	0.29	**0.03**	0.32	**0.02**	55	Developing Phase
Training Load	Being in Shape	0.24	0.13	0.22	0.15	43	Transitional
Training Load	Being in Shape	0.42	**<0.01**	0.42	**<0.01**	46	Early Competition
Training Load	Being in Shape	0.33	**0.05**	0.28	0.10	35	Performance
Training Load	Being in Shape	0.16	0.47	0.10	0.67	22	High Performance
Training Load	Conflicts/ Pressure	0.28	**0.04**	0.27	**0.05**	55	Developing Phase
Training Load	Conflicts/ Pressure	0.09	0.55	0.08	0.61	43	Transitional
Training Load	Conflicts/ Pressure	-0.14	0.34	-0.06	0.67	46	Early Competition
Training Load	Conflicts/ Pressure	-0.07	0.70	-0.11	0.53	35	Performance
Training Load	Conflicts/ Pressure	0.12	0.59	-0.06	0.78	22	High Performance
Training Load	Confusion	0.10	0.45	0.12	0.40	55	Developing Phase
Training Load	Confusion	-0.01	0.96	0.06	0.65	51	Transitional
Training Load	Confusion	-0.13	0.39	-0.19	0.19	49	Early Competition

Training Load	Confusion	0.20	0.25	0.23	0.19	35	Performance
Training Load	Confusion	0.12	0.58	0.07	0.74	22	High Performance
Training Load	Depression	0.01	0.97	0.15	0.29	55	Developing Phase
Training Load	Depression	-0.05	0.71	0.02	0.90	51	Transitional
Training Load	Depression	-0.10	0.51	-0.11	0.46	49	Early Competition
Training Load	Depression	0.12	0.48	0.12	0.48	35	Performance
Training Load	Depression	-0.10	0.67	-0.13	0.58	22	High Performance
Training Load	Disturbed Breaks	0.22	0.11	0.16	0.25	55	Developing Phase
Training Load	Disturbed Breaks	0.26	0.09	0.22	0.16	43	Transitional
Training Load	Disturbed Breaks	0.08	0.62	0.08	0.61	46	Early Competition
Training Load	Disturbed Breaks	-0.18	0.29	-0.17	0.33	35	Performance
Training Load	Disturbed Breaks	-0.03	0.90	-0.26	0.24	22	High Performance
Training Load	Emotional Exhaustion	0.00	0.99	-0.02	0.89	55	Developing Phase
Training Load	Emotional Exhaustion	0.13	0.42	0.18	0.25	43	Transitional
Training Load	Emotional Exhaustion	-0.05	0.75	-0.06	0.71	46	Early Competition
Training Load	Emotional Exhaustion	-0.10	0.55	-0.10	0.56	35	Performance
Training Load	Emotional Exhaustion	-0.08	0.74	-0.27	0.23	22	High Performance
Training Load	Emotional Stress	0.17	0.21	0.18	0.19	55	Developing Phase
Training Load	Emotional Stress	0.13	0.40	0.13	0.41	43	Transitional
Training Load	Emotional Stress	-0.10	0.51	-0.15	0.30	46	Early Competition
Training Load	Emotional Stress	0.07	0.69	-0.04	0.80	35	Performance
Training Load	Emotional Stress	0.04	0.86	-0.11	0.63	22	High Performance
Training Load	Fatigue(STEMS)	0.19	0.16	0.16	0.23	55	Developing Phase
Training Load	Fatigue(STEMS)	0.15	0.29	0.14	0.34	51	Transitional
Training Load	Fatigue(STEMS)	0.01	0.93	0.04	0.79	49	Early Competition
Training Load	Fatigue(STEMS)	-0.05	0.80	-0.03	0.85	35	Performance

Training Load	Fatigue(STEMS)	-0.18	0.42	-0.31	0.16	22	High Performance
Training Load	General Stress	0.17	0.22	0.20	0.14	55	Developing Phase
Training Load	General Stress	0.12	0.46	0.07	0.65	43	Transitional
Training Load	General Stress	-0.13	0.39	-0.18	0.24	46	Early Competition
Training Load	General Stress	-0.14	0.43	-0.19	0.28	35	Performance
Training Load	General Stress	-0.09	0.70	-0.28	0.21	22	High Performance
Training Load	General Well-Being	-0.07	0.63	-0.05	0.74	55	Developing Phase
Training Load	General Well-Being	-0.12	0.43	-0.10	0.54	43	Transitional
Training Load	General Well-Being	0.25	0.09	0.22	0.13	46	Early Competition
Training Load	General Well-Being	0.29	0.09	0.19	0.26	35	Performance
Training Load	General Well-Being	0.22	0.33	0.23	0.31	22	High Performance
Training Load	HIMS	0.17	0.24	0.13	0.37	50	Developing Phase
Training Load	HIMS	0.24	0.11	0.35	**0.02**	47	Transitional
Training Load	HIMS	0.06	0.68	0.03	0.85	47	Early Competition
Training Load	HIMS	0.41	**0.02**	0.36	**0.04**	33	Performance
Training Load	HIMS	-0.12	0.62	-0.29	0.22	20	High Performance
Training Load	Injury	0.20	0.13	0.15	0.28	55	Developing Phase
Training Load	Injury	0.29	0.06	0.27	0.07	43	Transitional
Training Load	Injury	0.16	0.30	0.14	0.37	46	Early Competition
Training Load	Injury	-0.11	0.52	-0.14	0.42	35	Performance
Training Load	Injury	-0.19	0.40	-0.30	0.17	22	High Performance
Training Load	Lack of Energy	0.13	0.34	0.10	0.49	55	Developing Phase
Training Load	Lack of Energy	-0.09	0.55	-0.17	0.28	43	Transitional
Training Load	Lack of Energy	0.00	0.99	-0.03	0.83	46	Early Competition
Training Load	Lack of Energy	-0.02	0.90	-0.06	0.71	35	Performance
Training Load	Lack of Energy	-0.01	0.96	-0.16	0.47	22	High Performance

Training Load	Personal Accomplishment	0.36	**<0.01**	0.43	**<0.01**	55	Developing Phase
Training Load	Personal Accomplishment	0.29	0.06	0.31	**0.04**	43	Transitional
Training Load	Personal Accomplishment	0.26	0.08	0.26	0.09	46	Early Competition
Training Load	Personal Accomplishment	0.24	0.17	0.15	0.39	35	Performance
Training Load	Personal Accomplishment	0.09	0.71	-0.02	0.93	22	High Performance
Training Load	Physical Complaints	0.24	0.08	0.21	0.11	55	Developing Phase
Training Load	Physical Complaints	0.14	0.37	0.08	0.60	43	Transitional
Training Load	Physical Complaints	-0.21	0.16	-0.24	0.11	46	Early Competition
Training Load	Physical Complaints	-0.12	0.48	-0.13	0.45	35	Performance
Training Load	Physical Complaints	-0.02	0.94	-0.31	0.16	22	High Performance
Training Load	Physical Recovery	0.13	0.33	0.16	0.24	55	Developing Phase
Training Load	Physical Recovery	0.01	0.94	0.05	0.73	43	Transitional
Training Load	Physical Recovery	0.39	**<0.01**	0.38	**<0.01**	46	Early Competition
Training Load	Physical Recovery	0.39	**0.02**	0.41	**0.01**	35	Performance
Training Load	Physical Recovery	0.29	0.20	0.18	0.42	22	High Performance
Training Load	Self-confidence	-0.22	0.10	-0.21	0.13	55	Developing Phase
Training Load	Self-confidence	-0.15	0.30	-0.22	0.12	51	Transitional
Training Load	Self-confidence	0.26	0.07	0.21	0.14	49	Early Competition
Training Load	Self-confidence	0.05	0.80	0.05	0.76	35	Performance
Training Load	Self-confidence	0.47	**0.03**	0.43	**0.05**	22	High Performance
Training Load	Self-Efficacy	0.17	0.23	0.23	0.09	55	Developing Phase
Training Load	Self-Efficacy	0.16	0.31	0.19	0.21	43	Transitional
Training Load	Self-Efficacy	0.55	**<0.01**	0.54	**<0.01**	46	Early Competition
Training Load	Self-Efficacy	0.31	0.07	0.32	0.06	35	Performance
Training Load	Self-Efficacy	0.31	0.16	0.20	0.36	22	High Performanc

							e
Training Load	Self-Regulation	0.18	0.19	0.21	0.12	55	Developing Phase
Training Load	Self-Regulation	0.08	0.60	0.11	0.48	43	Transitional
Training Load	Self-Regulation	0.36	**0.01**	0.32	**0.03**	46	Early Competition
Training Load	Self-Regulation	0.38	**0.02**	0.33	0.05	35	Performanc e
Training Load	Self-Regulation	0.41	0.06	0.39	0.07	22	High Performanc e
Training Load	Sleep Quality	0.11	0.40	0.05	0.72	55	Developing Phase
Training Load	Sleep Quality	0.09	0.58	0.05	0.77	43	Transitional
Training Load	Sleep Quality	0.18	0.23	0.17	0.26	46	Early Competition
Training Load	Sleep Quality	-0.06	0.73	-0.02	0.89	35	Performanc e
Training Load	Sleep Quality	0.40	0.07	0.14	0.54	22	High Performanc e
Training Load	Social Recovery	-0.12	0.37	-0.09	0.49	55	Developing Phase
Training Load	Social Recovery	-0.16	0.30	-0.20	0.20	43	Transitional
Training Load	Social Recovery	0.27	0.08	0.23	0.12	46	Early Competition
Training Load	Social Recovery	0.19	0.27	0.21	0.23	35	Performanc e
Training Load	Social Recovery	0.13	0.57	0.27	0.23	22	High Performanc e
Training Load	Social Stress	0.27	**0.05**	0.24	0.08	55	Developing Phase
Training Load	Social Stress	0.13	0.40	0.04	0.80	43	Transitional
Training Load	Social Stress	0.03	0.84	0.07	0.65	46	Early Competition
Training Load	Social Stress	-0.01	0.95	-0.07	0.68	35	Performanc e
Training Load	Social Stress	-0.06	0.78	-0.22	0.33	22	High Performanc e
Training Load	Success	0.06	0.67	0.11	0.44	55	Developing Phase
Training Load	Success	0.34	**0.03**	0.39	**<0.01**	43	Transitional
Training Load	Success	0.32	**0.03**	0.30	**0.05**	46	Early Competition
Training Load	Success	0.29	0.09	0.23	0.19	35	Performanc e
Training Load	Success	0.29	0.19	0.28	0.22	22	High Performanc e
Training Load	Tension	0.21	0.13	0.21	0.12	55	Developing Phase

Training Load	Tension	0.15	0.29	0.16	0.26	51	Transitional
Training Load	Tension	-0.09	0.56	-0.10	0.51	49	Early Competition
Training Load	Tension	0.28	0.10	0.28	0.10	35	Performanc e
Training Load	Tension	0.22	0.32	0.06	0.80	22	High Performanc e
Training Load	TMD	0.11	0.42	0.14	0.32	55	Developing Phase
Training Load	TMD	0.07	0.63	0.11	0.46	51	Transitional
Training Load	TMD	-0.09	0.54	-0.09	0.53	49	Early Competition
Training Load	TMD	0.15	0.38	0.13	0.44	35	Performanc e
Training Load	TMD	0.01	0.96	-0.06	0.79	22	High Performanc e
Training Load	Vigour	-0.05	0.72	-0.06	0.69	55	Developing Phase
Training Load	Vigour	-0.10	0.47	-0.17	0.25	51	Transitional
Training Load	Vigour	0.33	**0.02**	0.31	**0.03**	49	Early Competition
Training Load	Vigour	0.07	0.67	0.06	0.72	35	Performanc e
Training Load	Vigour	0.55	**<0.01**	0.40	0.07	22	High Performanc e

Variable 1	**Variable 2**	**Pearson**	**Pearson p-value**	**Spearman**	**Spearman p-value**	**# cases**	**subgroup**
Training Monotony	Fatigue(Rest Q)	-0.10	0.47	-0.15	0.28	55	Developing Phase
Training Monotony	Fatigue(Rest Q)	-0.25	0.11	-0.27	0.08	43	Transitional
Training Monotony	Fatigue(Rest Q)	-0.08	0.62	-0.15	0.32	46	Early Competition
Training Monotony	Fatigue(Rest Q)	-0.19	0.27	-0.03	0.85	35	Performance
Training Monotony	Fatigue(Rest Q)	-0.16	0.48	-0.19	0.40	22	High Performance
Training Monotony	Anger	0.10	0.45	0.07	0.63	55	Developing Phase
Training Monotony	Anger	-0.06	0.70	-0.21	0.15	51	Transitional
Training Monotony	Anger	-0.08	0.59	-0.10	0.50	49	Early Competition
Training Monotony	Anger	0.15	0.38	0.11	0.52	35	Performance
Training Monotony	Anger	0.04	0.87	0.05	0.82	22	High Performance
Training Monotony	Being in Shape	0.26	0.06	0.27	**0.05**	55	Developing Phase
Training Monotony	Being in Shape	0.31	**0.04**	0.27	0.08	43	Transitional

Training Monotony	Being in Shape	0.16	0.28	0.31	**0.03**	46	Early Competition
Training Monotony	Being in Shape	0.19	0.28	0.21	0.23	35	Performance
Training Monotony	Being in Shape	0.06	0.78	0.12	0.60	22	High Performance
Training Monotony	Conflicts/ Pressure	0.11	0.43	0.19	0.17	55	Developing Phase
Training Monotony	Conflicts/ Pressure	0.08	0.62	0.00	0.99	43	Transitional
Training Monotony	Conflicts/ Pressure	0.03	0.85	-0.04	0.80	46	Early Competition
Training Monotony	Conflicts/ Pressure	-0.21	0.22	-0.17	0.33	35	Performance
Training Monotony	Conflicts/ Pressure	0.48	**0.03**	0.13	0.57	22	High Performance
Training Monotony	Confusion	0.11	0.44	0.19	0.17	55	Developing Phase
Training Monotony	Confusion	0.00	0.99	-0.06	0.67	51	Transitional
Training Monotony	Confusion	-0.22	0.13	-0.27	0.06	49	Early Competition
Training Monotony	Confusion	0.07	0.69	0.08	0.67	35	Performance
Training Monotony	Confusion	0.30	0.17	0.02	0.94	22	High Performance
Training Monotony	Depression	0.09	0.50	0.17	0.22	55	Developing Phase
Training Monotony	Depression	-0.02	0.91	-0.21	0.15	51	Transitional
Training Monotony	Depression	0.01	0.94	-0.03	0.85	49	Early Competition
Training Monotony	Depression	0.03	0.88	0.03	0.88	35	Performance
Training Monotony	Depression	-0.02	0.92	-0.07	0.77	22	High Performance
Training Monotony	Disturbed Breaks	0.02	0.89	0.00	0.99	55	Developing Phase
Training Monotony	Disturbed Breaks	-0.03	0.86	-0.03	0.87	43	Transitional
Training Monotony	Disturbed Breaks	-0.04	0.78	-0.10	0.51	46	Early Competition
Training Monotony	Disturbed Breaks	-0.24	0.16	-0.16	0.37	35	Performance
Training Monotony	Disturbed Breaks	-0.09	0.68	0.02	0.92	22	High Performance
Training Monotony	Emotional Exhaustion	-0.09	0.50	-0.16	0.25	55	Developing Phase
Training Monotony	Emotional Exhaustion	-0.12	0.45	-0.16	0.30	43	Transitional
Training Monotony	Emotional Exhaustion	-0.02	0.92	-0.09	0.53	46	Early Competition
Training Monotony	Emotional Exhaustion	0.06	0.73	0.12	0.49	35	Performance
Training Monotony	Emotional Exhaustion	-0.16	0.48	-0.13	0.57	22	High Performance
Training Monotony	Emotional Stress	0.01	0.91	0.01	0.94	55	Developing Phase

Training Monotony	Emotional Stress	-0.14	0.37	-0.20	0.19	43	Transitional
Training Monotony	Emotional Stress	-0.01	0.94	-0.13	0.39	46	Early Competition
Training Monotony	Emotional Stress	0.05	0.79	-0.09	0.61	35	Performance
Training Monotony	Emotional Stress	0.17	0.46	0.24	0.29	22	High Performance
Training Monotony	Fatigue(STEMS)	-0.09	0.50	-0.14	0.32	55	Developing Phase
Training Monotony	Fatigue(STEMS)	-0.20	0.16	-0.18	0.20	51	Transitional
Training Monotony	Fatigue(STEMS)	-0.08	0.58	-0.06	0.69	49	Early Competition
Training Monotony	Fatigue(STEMS)	-0.16	0.36	-0.12	0.51	35	Performance
Training Monotony	Fatigue(STEMS)	-0.34	0.13	-0.43	**0.04**	22	High Performance
Training Monotony	General Stress	0.11	0.42	0.14	0.31	55	Developing Phase
Training Monotony	General Stress	-0.13	0.39	-0.23	0.15	43	Transitional
Training Monotony	General Stress	0.07	0.66	-0.03	0.83	46	Early Competition
Training Monotony	General Stress	-0.10	0.59	-0.09	0.62	35	Performance
Training Monotony	General Stress	-0.06	0.80	0.04	0.85	22	High Performance
Training Monotony	General Well-Being	-0.03	0.85	-0.06	0.66	55	Developing Phase
Training Monotony	General Well-Being	0.09	0.56	0.13	0.39	43	Transitional
Training Monotony	General Well-Being	-0.02	0.90	0.11	0.47	46	Early Competition
Training Monotony	General Well-Being	0.26	0.14	0.14	0.44	35	Performance
Training Monotony	General Well-Being	0.22	0.33	0.07	0.74	22	High Performance
Training Monotony	HIMS	0.42	**<0.01**	0.26	0.07	50	Developing Phase
Training Monotony	HIMS	0.24	0.10	0.26	0.07	47	Transitional
Training Monotony	HIMS	0.28	**0.05**	0.15	0.33	47	Early Competition
Training Monotony	HIMS	0.54	**<0.01**	0.41	**0.02**	33	Performance
Training Monotony	HIMS	-0.40	0.08	-0.21	0.38	20	High Performance
Training Monotony	Injury	0.15	0.28	0.06	0.64	55	Developing Phase
Training Monotony	Injury	0.12	0.43	0.10	0.52	43	Transitional
Training Monotony	Injury	0.07	0.65	0.11	0.48	46	Early Competition

Training Monotony	Injury	-0.11	0.53	-0.10	0.55	35	Performance
Training Monotony	Injury	0.08	0.73	0.16	0.48	22	High Performance
Training Monotony	Lack of Energy	-0.04	0.75	-0.06	0.68	55	Developing Phase
Training Monotony	Lack of Energy	-0.21	0.17	-0.32	**0.04**	43	Transitional
Training Monotony	Lack of Energy	-0.05	0.76	-0.04	0.80	46	Early Competition
Training Monotony	Lack of Energy	0.00	0.99	-0.06	0.71	35	Performance
Training Monotony	Lack of Energy	0.17	0.45	0.20	0.37	22	High Performance
Training Monotony	Personal Accomplishment	0.29	**0.03**	0.27	**0.04**	55	Developing Phase
Training Monotony	Personal Accomplishment	0.25	0.10	0.26	0.09	43	Transitional
Training Monotony	Personal Accomplishment	-0.02	0.88	0.06	0.68	46	Early Competition
Training Monotony	Personal Accomplishment	0.16	0.35	0.01	0.94	35	Performance
Training Monotony	Personal Accomplishment	0.29	0.19	-0.05	0.83	22	High Performance
Training Monotony	Physical Complaints	0.01	0.97	-0.02	0.89	55	Developing Phase
Training Monotony	Physical Complaints	-0.04	0.80	-0.13	0.41	43	Transitional
Training Monotony	Physical Complaints	-0.12	0.41	-0.22	0.13	46	Early Competition
Training Monotony	Physical Complaints	-0.08	0.63	-0.05	0.76	35	Performance
Training Monotony	Physical Complaints	-0.05	0.84	-0.05	0.84	22	High Performance
Training Monotony	Physical Recovery	0.23	0.09	0.13	0.33	55	Developing Phase
Training Monotony	Physical Recovery	0.17	0.27	0.21	0.18	43	Transitional
Training Monotony	Physical Recovery	0.18	0.24	0.28	0.06	46	Early Competition
Training Monotony	Physical Recovery	0.35	**0.04**	0.43	**<0.01**	35	Performance
Training Monotony	Physical Recovery	0.39	0.08	0.20	0.38	22	High Performance
Training Monotony	Self-confidence	-0.08	0.57	-0.07	0.62	55	Developing Phase
Training Monotony	Self-confidence	0.14	0.34	0.14	0.33	51	Transitional

Training Monotony	Self-confidence	0.19	0.20	0.22	0.13	49	Early Competition
Training Monotony	Self-confidence	0.19	0.29	0.11	0.54	35	Performance
Training Monotony	Self-confidence	0.27	0.23	0.38	0.08	22	High Performance
Training Monotony	Self-Efficacy	0.10	0.47	0.09	0.52	55	Developing Phase
Training Monotony	Self-Efficacy	0.30	**0.05**	0.27	0.07	43	Transitional
Training Monotony	Self-Efficacy	0.20	0.17	0.36	**0.02**	46	Early Competition
Training Monotony	Self-Efficacy	0.23	0.18	0.17	0.33	35	Performance
Training Monotony	Self-Efficacy	0.49	**0.02**	0.05	0.81	22	High Performance
Training Monotony	Self-Regulation	0.09	0.53	0.13	0.35	55	Developing Phase
Training Monotony	Self-Regulation	0.22	0.16	0.13	0.39	43	Transitional
Training Monotony	Self-Regulation	0.14	0.34	0.26	0.08	46	Early Competition
Training Monotony	Self-Regulation	0.36	**0.03**	0.31	0.07	35	Performance
Training Monotony	Self-Regulation	0.64	**<0.01**	0.26	0.25	22	High Performance
Training Monotony	Sleep Quality	0.17	0.21	0.14	0.29	55	Developing Phase
Training Monotony	Sleep Quality	0.05	0.77	0.00	0.99	43	Transitional
Training Monotony	Sleep Quality	0.21	0.16	0.30	**0.04**	46	Early Competition
Training Monotony	Sleep Quality	0.02	0.91	0.15	0.38	35	Performance
Training Monotony	Sleep Quality	0.49	**0.02**	0.30	0.17	22	High Performance
Training Monotony	Social Recovery	-0.23	0.09	-0.27	**0.05**	55	Developing Phase
Training Monotony	Social Recovery	-0.04	0.81	-0.06	0.71	43	Transitional
Training Monotony	Social Recovery	0.08	0.58	0.17	0.27	46	Early Competition
Training Monotony	Social Recovery	0.19	0.27	0.19	0.28	35	Performance
Training Monotony	Social Recovery	0.19	0.39	0.02	0.94	22	High Performance
Training Monotony	Social Stress	0.18	0.18	0.10	0.45	55	Developing Phase
Training Monotony	Social Stress	-0.01	0.95	-0.08	0.61	43	Transitional
Training Monotony	Social Stress	0.00	0.98	-0.03	0.85	46	Early Competition

Training Monotony	Social Stress	0.01	0.97	-0.06	0.73	35	Performance
Training Monotony	Social Stress	-0.12	0.60	0.10	0.67	22	High Performance
Training Monotony	Success	0.10	0.47	0.14	0.31	55	Developing Phase
Training Monotony	Success	0.39	**0.01**	0.41	**<0.01**	43	Transitional
Training Monotony	Success	0.18	0.23	0.31	**0.03**	46	Early Competition
Training Monotony	Success	0.23	0.18	0.10	0.55	35	Performance
Training Monotony	Success	0.38	0.08	0.20	0.38	22	High Performance
Training Monotony	Tension	0.00	0.98	0.06	0.66	55	Developing Phase
Training Monotony	Tension	0.10	0.51	0.04	0.76	51	Transitional
Training Monotony	Tension	-0.02	0.92	-0.05	0.71	49	Early Competition
Training Monotony	Tension	0.06	0.75	0.08	0.63	35	Performance
Training Monotony	Tension	0.36	0.10	0.00	0.98	22	High Performance
Training Monotony	TMD	0.01	0.97	0.04	0.77	55	Developing Phase
Training Monotony	TMD	-0.08	0.57	-0.12	0.39	51	Transitional
Training Monotony	TMD	-0.08	0.60	-0.09	0.52	49	Early Competition
Training Monotony	TMD	0.02	0.92	-0.02	0.91	35	Performance
Training Monotony	TMD	0.06	0.79	-0.12	0.59	22	High Performance
Training Monotony	Vigour	0.02	0.87	0.08	0.55	55	Developing Phase
Training Monotony	Vigour	0.17	0.23	0.10	0.47	51	Transitional
Training Monotony	Vigour	0.12	0.41	0.15	0.31	49	Early Competition
Training Monotony	Vigour	0.21	0.23	0.21	0.22	35	Performance
Training Monotony	Vigour	0.43	**0.05**	0.51	**0.02**	22	High Performance
Variable 1	**Variable 2**	**Pearson**	**Pearson p-value**	**Spearman**	**Spearman p-value**	**# cases**	**subgroup**
Training Strain	Fatigue(Rest Q)	0.02	0.86	0.07	0.62	55	Developing Phase
Training Strain	Fatigue(Rest Q)	-0.15	0.33	-0.22	0.16	43	Transitional
Training Strain	Fatigue(Rest Q)	-0.05	0.76	-0.06	0.68	46	Early Competition

Training Strain	Fatigue(Rest Q)	-0.28	0.10	-0.16	0.35	35	Performance
Training Strain	Fatigue(Rest Q)	-0.21	0.35	-0.24	0.28	22	High Performance
Training Strain	Anger	0.09	0.52	0.08	0.56	55	Developing Phase
Training Strain	Anger	-0.05	0.73	-0.11	0.45	51	Transitional
Training Strain	Anger	-0.10	0.51	-0.08	0.58	49	Early Competition
Training Strain	Anger	0.20	0.25	0.19	0.28	35	Performance
Training Strain	Anger	0.00	1.00	0.01	0.97	22	High Performance
Training Strain	Being in Shape	0.33	**0.02**	0.32	**0.02**	55	Developing Phase
Training Strain	Being in Shape	0.32	**0.04**	0.33	**0.03**	43	Transitional
Training Strain	Being in Shape	0.36	**0.01**	0.39	**<0.01**	46	Early Competition
Training Strain	Being in Shape	0.30	0.08	0.32	0.06	35	Performance
Training Strain	Being in Shape	0.11	0.62	0.17	0.45	22	High Performance
Training Strain	Conflicts/ Pressure	0.16	0.23	0.29	**0.03**	55	Developing Phase
Training Strain	Conflicts/ Pressure	0.06	0.71	0.06	0.69	43	Transitional
Training Strain	Conflicts/ Pressure	-0.13	0.40	-0.10	0.53	46	Early Competition
Training Strain	Conflicts/ Pressure	-0.16	0.36	-0.14	0.41	35	Performance
Training Strain	Conflicts/ Pressure	0.42	**0.05**	0.05	0.81	22	High Performance
Training Strain	Confusion	0.07	0.59	0.14	0.29	55	Developing Phase
Training Strain	Confusion	-0.02	0.90	-0.01	0.96	51	Transitional
Training Strain	Confusion	-0.25	0.08	-0.27	0.06	49	Early Competition
Training Strain	Confusion	0.12	0.49	0.15	0.38	35	Performance
Training Strain	Confusion	0.24	0.27	-0.04	0.86	22	High Performance
Training Strain	Depression	0.03	0.82	0.18	0.19	55	Developing Phase
Training Strain	Depression	-0.02	0.88	-0.06	0.66	51	Transitional
Training Strain	Depression	-0.11	0.43	-0.12	0.42	49	Early Competition
Training Strain	Depression	0.08	0.67	0.10	0.57	35	Performance
Training Strain	Depression	-0.08	0.71	-0.23	0.30	22	High Performance
Training Strain	Disturbed Breaks	0.05	0.70	0.07	0.61	55	Developing Phase

Training Strain	Disturbed Breaks	0.11	0.48	0.10	0.53	43	Transitional
Training Strain	Disturbed Breaks	0.00	1.00	-0.01	0.96	46	Early Competition
Training Strain	Disturbed Breaks	-0.27	0.12	-0.21	0.23	35	Performance
Training Strain	Disturbed Breaks	-0.11	0.61	-0.03	0.90	22	High Performance
Training Strain	Emotional Exhaustion	-0.09	0.52	-0.09	0.52	55	Developing Phase
Training Strain	Emotional Exhaustion	-0.01	0.93	0.01	0.96	43	Transitional
Training Strain	Emotional Exhaustion	-0.08	0.61	-0.09	0.55	46	Early Competition
Training Strain	Emotional Exhaustion	-0.05	0.76	-0.07	0.68	35	Performance
Training Strain	Emotional Exhaustion	-0.20	0.38	-0.18	0.43	22	High Performance
Training Strain	Emotional Stress	0.06	0.66	0.12	0.38	55	Developing Phase
Training Strain	Emotional Stress	0.00	0.99	-0.03	0.86	43	Transitional
Training Strain	Emotional Stress	-0.16	0.30	-0.21	0.15	46	Early Competition
Training Strain	Emotional Stress	0.08	0.66	-0.10	0.57	35	Performance
Training Strain	Emotional Stress	0.11	0.63	0.13	0.55	22	High Performance
Training Strain	Fatigue(STEMS)	0.00	0.99	0.00	0.99	55	Developing Phase
Training Strain	Fatigue(STEMS)	-0.08	0.59	-0.06	0.69	51	Transitional
Training Strain	Fatigue(STEMS)	-0.07	0.65	-0.01	0.93	49	Early Competition
Training Strain	Fatigue(STEMS)	-0.17	0.33	-0.12	0.50	35	Performance
Training Strain	Fatigue(STEMS)	-0.34	0.12	-0.46	**0.03**	22	High Performance
Training Strain	General Stress	0.09	0.50	0.20	0.15	55	Developing Phase
Training Strain	General Stress	-0.02	0.91	-0.08	0.63	43	Transitional
Training Strain	General Stress	-0.11	0.46	-0.15	0.31	46	Early Competition
Training Strain	General Stress	-0.13	0.46	-0.18	0.30	35	Performance
Training Strain	General Stress	-0.11	0.64	-0.06	0.79	22	High Performance
Training Strain	General Well-Being	-0.06	0.69	-0.10	0.47	55	Developing Phase
Training Strain	General Well-Being	0.00	0.98	0.00	0.98	43	Transitional
Training Strain	General Well-Being	0.19	0.20	0.20	0.18	46	Early Competition
Training Strain	General Well-Being	0.31	0.07	0.20	0.24	35	Performance
Training Strain	General Well-Being	0.27	0.22	0.19	0.39	22	High Performance

Training Strain	HIMS	0.37	**<0.01**	0.21	0.14	50	Developing Phase
Training Strain	HIMS	0.28	0.06	0.28	0.06	47	Transitional
Training Strain	HIMS	0.17	0.25	0.11	0.46	47	Early Competition
Training Strain	HIMS	0.49	**<0.01**	0.40	**0.02**	33	Performance
Training Strain	HIMS	-0.41	0.08	-0.19	0.41	20	High Performance
Training Strain	Injury	0.14	0.32	0.11	0.41	55	Developing Phase
Training Strain	Injury	0.24	0.13	0.27	0.08	43	Transitional
Training Strain	Injury	0.13	0.40	0.13	0.41	46	Early Competition
Training Strain	Injury	-0.12	0.48	-0.18	0.30	35	Performance
Training Strain	Injury	0.03	0.88	0.03	0.88	22	High Performance
Training Strain	Lack of Energy	0.00	1.00	0.02	0.86	55	Developing Phase
Training Strain	Lack of Energy	-0.19	0.23	-0.25	0.11	43	Transitional
Training Strain	Lack of Energy	-0.07	0.63	-0.07	0.65	46	Early Competition
Training Strain	Lack of Energy	0.00	0.99	-0.10	0.56	35	Performance
Training Strain	Lack of Energy	0.11	0.63	0.06	0.80	22	High Performance
Training Strain	Personal Accomplishment	0.36	**<0.01**	0.36	**<0.01**	55	Developing Phase
Training Strain	Personal Accomplishment	0.32	**0.04**	0.31	**0.04**	43	Transitional
Training Strain	Personal Accomplishment	0.18	0.22	0.18	0.24	46	Early Competition
Training Strain	Personal Accomplishment	0.24	0.16	0.15	0.39	35	Performance
Training Strain	Personal Accomplishment	0.30	0.18	-0.07	0.75	22	High Performance
Training Strain	Physical Complaints	0.06	0.68	0.12	0.37	55	Developing Phase
Training Strain	Physical Complaints	0.04	0.82	-0.01	0.95	43	Transitional
Training Strain	Physical Complaints	-0.25	0.10	-0.27	0.06	46	Early Competition
Training Strain	Physical Complaints	-0.10	0.58	-0.15	0.38	35	Performance
Training Strain	Physical Complaints	-0.09	0.70	-0.08	0.73	22	High Performance
Training Strain	Physical Recovery	0.27	**0.05**	0.14	0.31	55	Developing Phase
Training Strain	Physical Recovery	0.13	0.41	0.17	0.28	43	Transitional
Training Strain	Physical Recovery	0.38	**<0.01**	0.38	**<0.01**	46	Early Competition
Training Strain	Physical Recovery	0.43	**0.01**	0.51	**<0.01**	35	Performance

Training Strain	Physical Recovery	0.40	0.06	0.19	0.40	22	High Performance
Training Strain	Self-confidence	-0.18	0.18	-0.19	0.17	55	Developing Phase
Training Strain	Self-confidence	-0.04	0.79	-0.08	0.58	51	Transitional
Training Strain	Self-confidence	0.25	0.09	0.24	0.10	49	Early Competition
Training Strain	Self-confidence	0.18	0.31	0.16	0.37	35	Performance
Training Strain	Self-confidence	0.36	0.10	0.54	**<0.01**	22	High Performance
Training Strain	Self-Efficacy	0.15	0.27	0.17	0.22	55	Developing Phase
Training Strain	Self-Efficacy	0.29	0.06	0.31	**0.04**	43	Transitional
Training Strain	Self-Efficacy	0.48	**<0.01**	0.49	**<0.01**	46	Early Competition
Training Strain	Self-Efficacy	0.29	0.09	0.29	0.09	35	Performance
Training Strain	Self-Efficacy	0.51	**0.02**	0.07	0.76	22	High Performance
Training Strain	Self-Regulation	0.15	0.28	0.22	0.11	55	Developing Phase
Training Strain	Self-Regulation	0.23	0.14	0.23	0.14	43	Transitional
Training Strain	Self-Regulation	0.31	**0.04**	0.28	0.06	46	Early Competition
Training Strain	Self-Regulation	0.42	**0.01**	0.39	**0.02**	35	Performance
Training Strain	Self-Regulation	0.66	**<0.01**	0.31	0.15	22	High Performance
Training Strain	Sleep Quality	0.13	0.34	0.11	0.42	55	Developing Phase
Training Strain	Sleep Quality	0.06	0.69	0.06	0.69	43	Transitional
Training Strain	Sleep Quality	0.23	0.12	0.24	0.11	46	Early Competition
Training Strain	Sleep Quality	0.01	0.96	0.06	0.72	35	Performance
Training Strain	Sleep Quality	0.48	**0.02**	0.20	0.37	22	High Performance
Training Strain	Social Recovery	-0.21	0.12	-0.21	0.13	55	Developing Phase
Training Strain	Social Recovery	-0.12	0.44	-0.15	0.33	43	Transitional
Training Strain	Social Recovery	0.25	0.10	0.24	0.11	46	Early Competition
Training Strain	Social Recovery	0.22	0.21	0.23	0.18	35	Performance
Training Strain	Social Recovery	0.23	0.30	0.08	0.73	22	High Performance
Training Strain	Social Stress	0.22	0.11	0.22	0.11	55	Developing Phase
Training Strain	Social Stress	0.05	0.75	-0.02	0.88	43	Transitional
Training Strain	Social Stress	-0.03	0.83	-0.03	0.87	46	Early Competition

Training Strain	Social Stress	0.03	0.85	-0.09	0.60	35	Performance
Training Strain	Social Stress	-0.15	0.50	-0.02	0.92	22	High Performance
Training Strain	Success	0.10	0.49	0.12	0.38	55	Developing Phase
Training Strain	Success	0.46	**<0.01**	0.50	**<0.01**	43	Transitional
Training Strain	Success	0.32	**0.03**	0.31	**0.04**	46	Early Competition
Training Strain	Success	0.31	0.07	0.21	0.22	35	Performance
Training Strain	Success	0.42	**0.05**	0.21	0.35	22	High Performance
Training Strain	Tension	0.07	0.62	0.16	0.26	55	Developing Phase
Training Strain	Tension	0.16	0.28	0.13	0.36	51	Transitional
Training Strain	Tension	-0.13	0.38	-0.14	0.33	49	Early Competition
Training Strain	Tension	0.13	0.47	0.18	0.30	35	Performance
Training Strain	Tension	0.32	0.14	0.03	0.91	22	High Performance
Training Strain	TMD	0.01	0.94	0.10	0.46	55	Developing Phase
Training Strain	TMD	-0.03	0.82	-0.01	0.94	51	Transitional
Training Strain	TMD	-0.17	0.25	-0.14	0.32	49	Early Competition
Training Strain	TMD	0.06	0.74	0.04	0.84	35	Performance
Training Strain	TMD	0.02	0.91	-0.11	0.63	22	High Performance
Training Strain	Vigour	-0.02	0.88	-0.02	0.89	55	Developing Phase
Training Strain	Vigour	0.02	0.86	-0.03	0.86	51	Transitional
Training Strain	Vigour	0.26	0.07	0.25	0.09	49	Early Competition
Training Strain	Vigour	0.21	0.22	0.24	0.16	35	Performance
Training Strain	Vigour	0.49	**0.02**	0.58	**<0.01**	22	High Performance

variable 1	variable 2	Pearson	Pearson p-val	Spearman	Spearman p-val	# cases	subgroup
HIMS	Anger	0.25	0.09	0.11	0.45	50	Developing Phase
HIMS	Anger	0.05	0.74	-0.12	0.40	49	Transitional
HIMS	Anger	0.00	0.99	-0.01	0.97	49	Early Competition
HIMS	Anger	0.19	0.23	0.15	0.36	41	Performance

HIMS	Anger	0.05	0.79	-0.03	0.86	35	High Performance
HIMS	Being in Shape	0.26	0.07	0.24	0.10	50	Developing Phase
HIMS	Being in Shape	0.04	0.79	0.04	0.79	42	Transitional
HIMS	Being in Shape	0.00	0.98	0.02	0.92	45	Early Competition
HIMS	Being in Shape	-0.01	0.93	-0.07	0.68	41	Performance
HIMS	Being in Shape	0.08	0.65	0.11	0.51	35	High Performance
HIMS	Conflicts/ Pressure	-0.02	0.90	0.00	0.99	50	Developing Phase
HIMS	Conflicts/ Pressure	-0.19	0.22	-0.21	0.17	42	Transitional
HIMS	Conflicts/ Pressure	-0.07	0.64	-0.02	0.87	45	Early Competition
HIMS	Conflicts/ Pressure	-0.09	0.58	-0.15	0.33	41	Performance
HIMS	Conflicts/ Pressure	-0.25	0.15	-0.20	0.25	35	High Performance
HIMS	Confusion	0.17	0.24	0.09	0.54	50	Developing Phase
HIMS	Confusion	0.07	0.65	0.17	0.23	49	Transitional
HIMS	Confusion	-0.06	0.66	0.00	0.99	49	Early Competition
HIMS	Confusion	0.18	0.26	0.17	0.27	41	Performance
HIMS	Confusion	-0.12	0.50	-0.07	0.67	35	High Performance
HIMS	Depression	0.05	0.72	0.01	0.93	50	Developing Phase
HIMS	Depression	0.10	0.48	0.01	0.97	49	Transitional
HIMS	Depression	-0.05	0.71	-0.05	0.75	49	Early Competition
HIMS	Depression	0.16	0.31	0.19	0.24	41	Performance
HIMS	Depression	0.14	0.42	-0.03	0.86	35	High Performance
HIMS	Disturbed Breaks	-0.11	0.47	-0.08	0.58	50	Developing Phase
HIMS	Disturbed Breaks	0.04	0.79	0.02	0.88	42	Transitional
HIMS	Disturbed Breaks	0.04	0.78	0.00	0.99	45	Early Competition
HIMS	Disturbed Breaks	0.15	0.34	0.12	0.44	41	Performance
HIMS	Disturbed Breaks	0.07	0.70	0.09	0.60	35	High Performance
HIMS	Emotional Exhaustion	-0.10	0.49	-0.07	0.65	50	Developing Phase
HIMS	Emotional	0.34	**0.03**	0.25	0.11	42	Transitional

	Exhaustion						
HIMS	Emotional Exhaustion	-0.21	0.16	-0.15	0.31	45	Early Competition
HIMS	Emotional Exhaustion	0.18	0.26	0.11	0.50	41	Performanc e
HIMS	Emotional Exhaustion	0.13	0.46	0.18	0.29	35	High Performanc e
HIMS	Emotional Stress	0.02	0.89	-0.08	0.57	50	Developing Phase
HIMS	Emotional Stress	0.12	0.46	0.12	0.43	42	Transitional
HIMS	Emotional Stress	0.00	0.98	-0.07	0.67	45	Early Competition
HIMS	Emotional Stress	0.06	0.71	0.02	0.92	41	Performanc e
HIMS	Emotional Stress	-0.07	0.69	-0.08	0.65	35	High Performanc e
HIMS	Fatigue(Rest Q)	-0.22	0.12	-0.22	0.12	50	Developing Phase
HIMS	Fatigue(Rest Q)	-0.19	0.22	-0.19	0.22	42	Transitional
HIMS	Fatigue(Rest Q)	-0.04	0.79	0.04	0.80	45	Early Competition
HIMS	Fatigue(Rest Q)	0.00	0.98	-0.09	0.59	41	Performanc e
HIMS	Fatigue(Rest Q)	0.07	0.67	0.11	0.55	35	High Performanc e
HIMS	Fatigue(STEMS)	-0.19	0.18	-0.20	0.16	50	Developing Phase
HIMS	Fatigue(STEMS)	-0.23	0.11	-0.18	0.21	49	Transitional
HIMS	Fatigue(STEMS)	-0.24	0.10	-0.25	0.09	49	Early Competition
HIMS	Fatigue(STEMS)	-0.06	0.72	-0.07	0.66	41	Performanc e
HIMS	Fatigue(STEMS)	-0.20	0.24	-0.18	0.31	35	High Performanc e
HIMS	General Stress	-0.08	0.57	-0.12	0.40	50	Developing Phase
HIMS	General Stress	0.13	0.41	0.15	0.33	42	Transitional
HIMS	General Stress	0.02	0.92	-0.02	0.90	45	Early Competition
HIMS	General Stress	0.04	0.79	0.05	0.77	41	Performanc e
HIMS	General Stress	0.24	0.16	0.13	0.44	35	High Performanc e
HIMS	General Well-Being	0.11	0.46	0.13	0.35	50	Developing Phase
HIMS	General Well-Being	-0.22	0.17	-0.26	0.09	42	Transitional
HIMS	General Well-Being	-0.06	0.71	-0.05	0.76	45	Early Competition
HIMS	General Well-Being	-0.06	0.71	-0.05	0.74	41	Performanc e
HIMS	General Well-	-0.06	0.73	-0.03	0.86	35	High

	Being						Performance
HIMS	Injury	-0.08	0.57	-0.09	0.52	50	Developing Phase
HIMS	Injury	0.01	0.96	0.08	0.63	42	Transitional
HIMS	Injury	-0.37	**0.01**	-0.34	**0.02**	45	Early Competition
HIMS	Injury	-0.17	0.29	-0.19	0.22	41	Performance
HIMS	Injury	-0.10	0.56	0.00	0.98	35	High Performance
HIMS	Lack of Energy	-0.24	0.09	-0.22	0.12	50	Developing Phase
HIMS	Lack of Energy	-0.06	0.71	-0.09	0.56	42	Transitional
HIMS	Lack of Energy	-0.10	0.53	0.00	1.00	45	Early Competition
HIMS	Lack of Energy	0.08	0.63	0.08	0.63	41	Performance
HIMS	Lack of Energy	0.10	0.55	0.08	0.64	35	High Performance
HIMS	Personal Accomplishment	0.29	**0.04**	0.25	0.08	50	Developing Phase
HIMS	Personal Accomplishment	0.07	0.66	0.07	0.66	42	Transitional
HIMS	Personal Accomplishment	-0.01	0.94	-0.03	0.86	45	Early Competition
HIMS	Personal Accomplishment	0.05	0.77	0.12	0.47	41	Performance
HIMS	Personal Accomplishment	0.20	0.26	0.10	0.56	35	High Performance
HIMS	Physical Complaints	-0.32	**0.03**	-0.29	**0.04**	50	Developing Phase
HIMS	Physical Complaints	-0.03	0.87	0.07	0.68	42	Transitional
HIMS	Physical Complaints	-0.12	0.45	-0.10	0.52	45	Early Competition
HIMS	Physical Complaints	-0.03	0.83	-0.01	0.95	41	Performance
HIMS	Physical Complaints	0.33	0.06	0.21	0.22	35	High Performance
HIMS	Physical Recovery	0.21	0.15	0.14	0.33	50	Developing Phase
HIMS	Physical Recovery	0.02	0.92	0.06	0.69	42	Transitional
HIMS	Physical Recovery	-0.02	0.90	-0.05	0.75	45	Early Competition
HIMS	Physical Recovery	0.00	0.98	-0.01	0.96	41	Performance
HIMS	Physical Recovery	0.02	0.93	0.07	0.71	35	High Performance
HIMS	Self-confidence	0.11	0.46	0.10	0.48	50	Developing Phase
HIMS	Self-confidence	0.01	0.97	-0.03	0.84	49	Transitional

HIMS	Self-confidence	0.01	0.92	0.03	0.83	49	Early Competition
HIMS	Self-confidence	0.15	0.34	0.09	0.57	41	Performance
HIMS	Self-confidence	0.02	0.92	0.06	0.72	35	High Performance
HIMS	Self-Efficacy	0.29	**0.04**	0.29	**0.04**	50	Developing Phase
HIMS	Self-Efficacy	-0.03	0.85	0.00	0.98	42	Transitional
HIMS	Self-Efficacy	0.10	0.52	0.12	0.43	45	Early Competition
HIMS	Self-Efficacy	-0.02	0.92	-0.04	0.79	41	Performance
HIMS	Self-Efficacy	-0.10	0.56	-0.06	0.72	35	High Performance
HIMS	Self-Regulation	0.08	0.57	0.12	0.40	50	Developing Phase
HIMS	Self-Regulation	-0.19	0.22	-0.17	0.29	42	Transitional
HIMS	Self-Regulation	-0.22	0.16	-0.20	0.20	45	Early Competition
HIMS	Self-Regulation	-0.15	0.34	-0.15	0.34	41	Performance
HIMS	Self-Regulation	-0.09	0.60	0.05	0.79	35	High Performance
HIMS	Sleep Quality	0.10	0.50	0.09	0.54	50	Developing Phase
HIMS	Sleep Quality	-0.03	0.85	-0.05	0.74	42	Transitional
HIMS	Sleep Quality	-0.16	0.30	-0.14	0.36	45	Early Competition
HIMS	Sleep Quality	-0.08	0.64	0.05	0.76	41	Performance
HIMS	Sleep Quality	0.01	0.95	0.07	0.68	35	High Performance
HIMS	Social Recovery	-0.09	0.54	-0.03	0.84	50	Developing Phase
HIMS	Social Recovery	-0.21	0.19	-0.12	0.44	42	Transitional
HIMS	Social Recovery	0.06	0.69	0.07	0.67	45	Early Competition
HIMS	Social Recovery	-0.22	0.17	-0.19	0.23	41	Performance
HIMS	Social Recovery	-0.10	0.58	-0.04	0.84	35	High Performance
HIMS	Social Stress	0.06	0.69	-0.03	0.82	50	Developing Phase
HIMS	Social Stress	0.21	0.19	0.09	0.58	42	Transitional
HIMS	Social Stress	-0.07	0.66	-0.08	0.59	45	Early Competition
HIMS	Social Stress	-0.05	0.77	-0.16	0.32	41	Performance
HIMS	Social Stress	0.06	0.72	0.04	0.83	35	High Performance

HIMS	Success	0.23	0.10	0.26	0.07	50	Developing Phase
HIMS	Success	0.09	0.57	0.11	0.48	42	Transitional
HIMS	Success	0.23	0.13	0.29	0.06	45	Early Competition
HIMS	Success	0.01	0.96	0.02	0.91	41	Performanc e
HIMS	Success	0.01	0.94	0.09	0.62	35	High Performanc e
HIMS	Tension	0.02	0.91	0.08	0.60	50	Developing Phase
HIMS	Tension	0.09	0.54	0.15	0.29	49	Transitional
HIMS	Tension	0.00	0.99	0.05	0.71	49	Early Competition
HIMS	Tension	0.16	0.33	0.12	0.44	41	Performanc e
HIMS	Tension	-0.04	0.82	0.00	0.98	35	High Performanc e
HIMS	TMD	0.02	0.87	0.00	1.00	50	Developing Phase
HIMS	TMD	-0.08	0.58	-0.05	0.71	49	Transitional
HIMS	TMD	-0.10	0.52	-0.06	0.69	49	Early Competition
HIMS	TMD	0.16	0.33	0.14	0.39	41	Performanc e
HIMS	TMD	-0.05	0.77	-0.04	0.80	35	High Performanc e
HIMS	Vigour	0.14	0.32	0.17	0.23	50	Developing Phase
HIMS	Vigour	0.11	0.44	0.03	0.82	49	Transitional
HIMS	Vigour	-0.01	0.94	0.01	0.94	49	Early Competition
HIMS	Vigour	0.09	0.59	0.06	0.73	41	Performanc e
HIMS	Vigour	-0.03	0.86	0.07	0.69	35	High Performanc e

APPENDIX H

STELLENBOSCH UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

An assessment model for monitoring training distress and recovery in team athletes.

You are asked to participate in a research study conducted by Miss. T Nel and Dr. RE Venter, from the Sport Science Department at Stellenbosch University. The results of this study will contribute to my thesis. You were selected as a possible participant in this study because you are an elite sportsperson and you play rugby at a semi-professional level for the Western Province Rugby Institute (WPRI).

1. PURPOSE OF THE STUDY

The primary aim of the study is to develop an assessment tool to monitor training distress and recovery in team athletes. By using self-report measures i.e. RPE, STEMS and combining it with the RESTQ-76-Sport and the HIMS, we would like to identify one or two non-invasive tools to measure recovery status.

2. PROCEDURES

If you volunteer to participate in this study, we would ask you to do the following things:

Complete RPE for every training session daily, complete the "Recovery self-monitoring system" questionnaire during the week, write the STEMS on a weekly basis, complete the HIMS on a weekly basis, and write the RESTQ-76-Sport once every month. The monitoring will continue until the end of your rugby season, which is end of October.

RPE

The RPE is a self-report measure of your perceived exertion during the whole training session. It uses a scale from 0 ("rest") to 10 ("maximal effort"). The data from RPE will be used to calculate the training load, monotony and stress. Thus indicating the amount of stress the body goes through during training.

STEMS

The Stellenbosch Mood Scale is a Likert-type scale ranging from 0 ("not at all") to 4 ("extremely"). One of the advantages of the STEMS is its brevity, consisting out of 24 items. The STEMS is developed for and with athletes and is a very reliable test and has shown acceptable psychometric properties and that it could be a suitable measure of mood states for use by Afrikaans and English speakers.

RESTQ-76-Sport

Kellman and Kallus (2001) developed the 76-item Recovery-Stress Questionnaire for Athletes (RESTQ-76-Sport) to measure the recovery-stress states of athletes. A scale measures the extent to which the athlete took part in different activities within the previous three days or nights. A Likert-type scale is used with values ranging from 0 ("never") to 6 ("always"). The RESTQ-76-Sport consists of 12 general stress and recovery scales, as well as seven sport-specific stress and recovery scales.

HIMS

The HIMS (Heart rate Interval-Monitoring test) monitor and predict chronic fatigue in players. The test lasts for 12 minutes, requires little equipment apart from heart rate monitors and an audio pacing tape. It measures heart rate recovery which is a sensitive marker of training status. The HIMS consists of 4 running stages (8.4 km/h, 9.6 km/h, 10.8 km/h, 12.0 km/h). Each running stage lasts two minutes and is separated by a one minute recovery period.

Recovery self-monitoring system

All participants act as their own controls. The questionnaires will not take longer than 30min to complete, the HIMS test is conducted over an hour. Participation will be required from March to October 2010. The "Recovery self-monitoring system", RPE, STEMS, and HIMS are conducted weekly, whereas the RESTQ-76-Sport is conducted monthly. The "Recovery self-monitoring system", RPE, and STEMS will be conducted at Huis Neethling, which is the place of residence for the WPRI. The HIMS and RESTQ-76-Sport will be conducted at the Sport Science Department of Stellenbosch University.

3. POTENTIAL RISKS AND DISCOMFORTS

Self-report measures have the advantages of being efficient, inexpensive, and non-invasive. Participation is voluntary and if any of the subjects feel uncomfortable completing one of the questionnaires, the researcher cannot force them to complete it.

4. POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

So far the monitoring of athletes only looked at self-report measures of training distress, disturbances in mood and perceived stress and comparing it to overtraining. By using self-report measures i.e. RPE, STEMS and combining it with the RESTQ-76-Sport and the HIMS, we would like to identify one or two non-invasive tools to measure recovery status. The monitoring of athletes can only benefit the individual/team and is an easy method of feedback to the coach or conditioning specialist to adapt the training load accordingly in order to prevent the overtraining syndrome.

Identification of one or two non-invasive tools can enable any coach and any team or individual athlete to monitor their training status without having to spend a lot of money or time on the monitoring process.

5. PAYMENT FOR PARTICIPATION

This study will form part of the monitoring of the rugby players playing for the WPRI. As participation is voluntary, no remuneration will be offered to participants.

6. CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by the researcher by safeguarding all information and data. Paper copies will be kept in a locked room to which only the researcher and the study leader will have access to. Electronic copies will be kept on a personal computer, which is password protected, and another copy on an external memory device. Certain information will be shared with the coach, as per his request, because it is part of the monitoring for the WPRI. To maintain confidentiality statistical analysis will be done anonymously, where each player will be assigned a specific number or code. In the event of publishing results or data, the coding will be used to identify the subjects to maintain the level of confidentiality.

7. PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise which warrant doing so. If the participant is not with the WPRI for the whole season, then the researcher can withdraw him from the study without any notice.

8. IDENTIFICATION OF INVESTIGATORS

If you have any questions or concerns about the research, please feel free to contact:

Trudine Nel

14619083@sun.ac.za

078 642 5557

East Lynne 30, Stellenbosch

9. RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact Ms Maléne Fouché [mfouche@sun.ac.za; 021-8084622] at the Unit for Research Development.

SIGNATURE OF RESEARCH SUBJECT OR LEGAL REPRESENTATIVE

The information above was described to ____ by Trudine Nel in [*Afrikaans/English]* and I am in command of this language or it was satisfactorily translated to me. I was given the opportunity to ask questions and these questions were answered to my satisfaction.

I hereby consent voluntarily to participate in this study. I have been given a copy of this form.

____

Name of Subject/Participant

______________________________________ _____________

Signature of Subject/Participant **Date**

SIGNATURE OF INVESTIGATOR

I declare that I explained the information given in this document to ____________________. He was encouraged and given ample time to ask me any questions. This conversation was conducted in [Afrikaans/English] and no translator was used.

______________________________________ _____________

Signature of Investigator **Date**

APPENDIX I

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P O Box 3050
Matieland, 7602
Tel/Fax: 021-886 4673

To whom it may concern

Regarding: WPRI Monitoring results

Hereby, we as WPRI management give Trudine Nel permission to use our 2010 monitoring results in completion of her Master's degree. She is also allowed to conduct extra tests if the need arises.

If you have any further questions, please don't hesitate to contact me.

Kind regards,

Steph Nel

Program Director WPRI