

**THE RELATIONSHIP BETWEEN PSYCHOLOGICAL WELLBEING AND
HEALTH-RELATED PHYSICAL FITNESS IN PROFESSIONAL RUGBY PLAYERS**

by

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ABSTRACT

Rugby Union is a popular sport both internationally and nationally. The sport has seen a rise in high-intensity activity and is more physically demanding on players since turning professional in 1995. Over the past decade, professional rugby players have made frequent appearances in the media due to lapses in psychological, physical, and social wellbeing, suggesting professional rugby players may experience compromised health. Research has largely ignored rugby players' health when health is defined beyond injury.

The present study aimed to provide insight into the health of professional rugby players by investigating two components of health, namely psychological and physical wellbeing and the relationship between these facets. Two hundred and thirty-eight (238) professional male rugby union players, situated at the Investec Rugby Academy participated in the study. Psychological wellbeing (PW) was measured by the State Trait Personality Inventory (form Y) (STPI-Y) and the Sport Competitive Anxiety Test (adult form) (SCAT-A). Physical wellbeing was defined as health-related physical fitness (HRPF). HRPF was assessed by measurements of the rugby players' body composition, physical fitness, and heart health. Pearson's correlation co-efficient was calculated between the variables used to measure HRPF and PW.

The results showed the rugby players experience average levels of competitive anxiety, above average levels of anger, anxiety, and depression and a relatively high level of curiosity. The rugby players had a high level of HRPF, with the exception of body composition (particularly BMI), cardiovascular endurance, muscle strength and endurance, and heart health (when measured according to the CSI), which indicate a moderate risk to the players' health. Furthermore, the results show significant correlations between variables of HRPF and PW in the rugby players. The findings that indicate professional rugby players do not experience optimal PW and HRPF, as well as the significant correlations found between the variables of the rugby players PW and HRPF, suggest these players may be in a state of overtraining or experiencing overtraining syndrome.

Key Words: Professional rugby union players, psychological wellbeing, health-related physical fitness, overtraining, health.

CHAPTER 1: INTRODUCTION

1.1. Introduction

For centuries philosophers have debated the mind-body relationship (Taylor, 2003). The twentieth century saw an end to the argument for separation between the mind and the body. This was evidenced by the profound impact the physical state of the body has on the mental state of a person, and the fact that the mental state of a person can create new physical states or change existing ones amassed (Forshaw, 2002; Marks, Murray, Evans, & Vida Estacio, 2011). Today, the mind and the body are accepted as two aspects of the whole person that work together as an overall system (Taylor, 2012a). This shift in perspective on the mind-body relationship naturally meant a change in the view on health. The World Health Organization's widely accepted definition of health, where health is defined as "a complete state of physical, mental and social well-being and not merely the absence of disease or infirmity" illustrates this change (Taylor, 2012b. p. 3; World Health Organization, 1948). Beyond illuminating the holistic nature of health and rejecting the dualistic view, this definition also denotes that health is no longer viewed as merely the absence of disease, but rather as a state to be achieved. This allows attention to be focused on the factors that enable people to stay well, rather than solely on what makes them ill (Brannon & Fiest, 2010; Marks et al., 2011).

People's behaviour, in the form of health habits, is accepted to have profound impacts on health (Brannon & Fiest, 2010). Health behaviour, which is behaviour executed by people without the presence of disease, may promote, preserve, and protect good health (Last, 2007; Steptoe, Garden, & Wardle, 2010). Regular physical activity has been characterised as positive health behaviour, providing both physiological and psychological benefits (Brannon & Fiest, 2010; Marks et al., 2011; Steptoe et al., 2010; Warburton, Nicol, & Bredin, 2006). Physical activity, however, is a broad concept encompassing hobbies or activities involved in daily living to structural exercise and competitive sport; not all of which are automatically beneficial to health (Biddle & Ekkekakis, 2005). Thus, the health benefits of physical activity are heavily dependent on the type of activity.

Rugby Union (hereinafter referred to as rugby) has been recently defined as a “physically intense intermittent sport coupled with high force collisions between players” (Lindsay, Draper, Lewis, Gieseg, & Gill, 2015, p. 480). Rugby became a professional sport in 1995, and has grown to be a popular sport, both nationally and internationally. The International Rugby Board, World Rugby, announced on their website (www.worldrugby.com) in their official 2014 review of international rugby that there are 7,23 million rugby players in the world. The site also stated that in 2015, the total number of registered rugby players increased from 2,56 million to 2,82 million, while the total number of non-registered rugby players rose from 4,47 million to 4,91 million. In South Africa, rugby is the second most popular sport with a following of over 10 million people (Potgieter et al., 2014).

Since professionalism, rugby saw numerous rule changes in order to become more attractive to spectators and for the sport to stand up against other football codes (Austin, Gabette, & Jenkins, 2011). This transformed the nature of demands facing rugby players (Lindsay et al., 2015). An increase in total duration and speed of gameplay has meant the game of modern rugby has seen a rise in high-intensity activity and is more physically demanding on players (Austin et al., 2011; Sedeaud et al., 2011). Advent to professionalism, rugby saw a dramatic increase in player injuries (Garraway, Lee, Hutton, Russell, & McLeod, 2000). Today, rugby has one of the highest incidents of game play injuries of all professional team sports (Brooks & Kemp, 2008; Heffernan, Kilduff, Day, Pitsiladis, & Williams, 2015). It is estimated that injury incidence is as high as 81 per 1000 gameplay hours, with approximately twenty days of rest to recover for each injury (Williams, Trewartha, Kemp, & Stokes, 2013).

A result of the high prevalence and severity of rugby injuries sees rugby related injury as the main focus of rugby research with hundreds of studies on the topic (Martin, Olmo, Chiroso, Carreras, & Sola, 2013). The focus of rugby-health research on other dimensions of rugby players’ health is limited. There may, however, be cause for concern over the impact of rugby on players’ health, beyond only the heightened risk of injuries, as professional rugby players are frequently cited in the media for negative health behaviours and deleterious health outcomes. Media reports have shown numerous professional rugby players displaying aggressive behaviour (such as physical and verbal assaults of other players and the referee during official rugby games, domestic violence, and murder); engaging in excess alcohol

consumption; suffering from mental health disorders, and attempted and successful suicides (“Depression and despair rule Kiwis,” 2013; Finan, 2016; “Hawkes Bay player facing assault charges,” 2007; Hayhurst, 2016; King, 2015; “Mathieu Bastareaud reveals how alcohol and depression led to attempted suicide,” 2015; “Paul Mulvihill appeals against conviction and sentence for murder,” 2016; Mairs, 2012). There has also been an influx of media reports in recent years of retired professional rugby players announcing their struggle with depression during their professional rugby career (Brown, 2012; “Cathal Sheridan opens up about dealing with depression as a pro rugby player,” 2016; Drew, 2014; Williams, 2012).

Given that professional rugby is only two decades old, the opportunity to study the effects of partaking in professional rugby for a decade or more has only recently become available. Recent research looking at retired professional rugby players has found a heightened rate of depression and anxiety among the players (Decq et al., 2016; Gouttebauge, Kerkhoffs, & Lambert, 2015). These research results coupled with the negative attention in the media for compromised psychological wellbeing may suggest the physical and psychological demands faced by professional rugby players during their careers could have deleterious consequences for their health.

1.2. Problem Statement

The majority of research investigating rugby players has focused on physical injuries and/or has been for the purposes of performance enhancement (Martin et al., 2013). However, as health is recognised as a holistic concept and as a state of wellbeing, the psychological and physical wellbeing of rugby players is of importance. The interaction between these spheres needs to be investigated to gain insight into the relation between rugby and health.

To the researcher’s knowledge, there are no studies assessing professional rugby players’ health, when health is defined beyond rugby-induced injuries or disease. There is a paucity of literature documenting aspects of rugby players’ psychological wellbeing (e.g. mood states) and physical wellbeing (e.g. body composition). A limited number of studies have explored aspects of both rugby players’ psychological and physical wellbeing. These studies were mostly concerned with emotion triggered by rugby competition and with only a single emotional indicator of rugby players’ psychological wellbeing (e.g. anxiety) and the physiological changes that accompanied the emotional experience (e.g. changes in cortisol

levels). Results from existing research suggest that firstly, persons participating in rugby may not experience all the health benefits associated with other forms of physical activity. Secondly, participating in professional rugby may trigger indicators of poor psychological and physical wellbeing for players. Lastly, the interaction between the psychological and physical impact of partaking in rugby is complex. Thus, the impact that rugby has on health cannot be deduced from previous findings on the impact of physical activity on health as well as the relationship between physical and psychological wellbeing. The present study attempts to address the lack of information on the relation between rugby and health and to monitor the psychological and physical wellbeing of South African professional rugby players. The study chose to focus on health-related physical fitness (HRPF) in assessing physical wellbeing as HRPF reflects the physical state necessary for improved health.

Research has suggested rugby has different psychological and physiological impacts on participants compared to other sports (Duthie, Pyne, & Hooper, 2003; Kerr & Syebak, 1994; Maxwell, 2004). This designates rugby players as a unique sample. By looking at the relationship between the psychological and physiological domains of unique samples, an opportunity for new knowledge on the mind-body relationship is created. For this reason, the present research adds to the knowledge field of the mind-body relationship.

1.3. Research Aim and Objectives

The primary aim of this study will be to investigate the correlation between the HRPF and psychological wellbeing (PW) of rugby players.

To reach the aim of the study, the following objectives were formulated:

- To investigate the HRPF of professional rugby players.
- To determine the PW of professional rugby players.
- To measure whether there is a relationship between the HRPF and the PW of professional rugby players as well as the strength and direction of this relationship.

The hypotheses set for the study are as follows:

H₀: There is no statistically significant relationship between HRPF and PW of professional rugby players.

H₁: There is a statistically significant relationship between HRPF and PW of professional rugby players.

1.4. Outline of the Dissertation

The remainder of the dissertation consists of:

- Chapter 2, which contains a review of the literature relating to the relationship between psychological and physical wellbeing. The chapter will also focus on the impact of partaking in rugby on players' psychological and physical wellbeing. The chapter finishes with a detail of research looking at the interaction between rugby players' psychological and physical wellbeing.
- Chapter 3, which describes the research methodology used as well as the ethical considerations of this study.
- Chapter 4, which consists of a presentation of the research results.
- Chapter 5, which contains a discussion of the research results, along with the limitations of the study and future recommendations for research.

1.5. Conclusion

The impact of rugby on players' health is unclear. This is a result of a lack of available research focused on how rugby impacts players' health, when health is measured in a holistic sense of physical and psychological variables. Beyond placing players at a heightened risk for physical injury, whether playing rugby can be considered a positive health behaviour is largely unresolved. Therefore, the proposed research will explore the impact that rugby has on health by correlating the relationship between the HRPF and the PW of rugby players who play at a professional level.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

The view of health held by academics and health professionals has changed over the years. The traditional dualistic perspective of health that sees disease as a failure within the body and health as the absence of disease has been replaced by a more holistic understanding (Taylor, 2012a). Health is now seen as the result of the interaction between the mind and body (Alonso, 2004; Taylor, 2012a). Contemporary views on health recognise health and illness as running along a single continuum, with disease at the one end and optimal wellbeing at the other (Forshaw, 2002; Sarafino, 1994). This shift in perspective has redirected research interest from disease, towards psychological and physical wellbeing.

Much research has been dedicated to examining the relationship between aspects of physical and psychological wellbeing (Diener & Chan, 2011; Hamed & Ameri, 2013). Insight into the impact that psychological wellbeing has on physical wellbeing is provided by a multitude of research studies investigating the physiological response and health outcomes associated with acute and chronic emotions (Diener & Chan, 2011). Obtaining evidence of the impact that physical wellbeing has on psychological wellbeing is complex. Studies looking at the psychological response to physical disease provide insight into how compromised physical health can impact psychological wellbeing. To gain an understanding of how improved physical wellbeing influences psychological wellbeing, it is useful to study behaviours that promote good health in the absence of disease (positive health behaviour) (Brannon & Fiest, 2010).

Physical activity is acknowledged as a positive health behaviour as it has been shown to have both physiological and psychological benefits (Brannon & Fiest, 2010). Physical activity is a broad concept encompassing many forms of activity, from leisurely hobbies to competitive sport. The impact that physical activity has on the psychological and physical wellbeing of an individual is dependent on the type of physical activity. Rugby is an extremely popular form of physical activity, both internationally and nationally. Due to its popularity, the sport enjoys much media coverage. As mentioned in Chapter 1, it has become apparent in the media that many professional rugby players struggle to maintain their psychological wellbeing and suffer from a multitude of adverse health outcomes.

Understanding the relationship between rugby and health is limited, as research on the health of rugby players is insufficient when health is defined in a holistic manner and not purely as the absence of disease or injury.

The onset of this chapter focuses on creating a picture of the interactional relationship between psychological and physical wellbeing as well as the impact of this relationship for health. For this to be achieved, psychological and physical wellbeing will be clearly defined. Subsequently, a summary of research findings of the impact of psychological wellbeing on physical wellbeing, and the reverse relationship follows. To achieve a better understanding of the impact that physical wellbeing has on psychological wellbeing, research focussed on the impact of the health behaviour of physical activity on psychological and physical wellbeing is highlighted. The latter section of the chapter focuses on the physical activity of rugby. Research documenting rugby players' psychological and physical wellbeing is detailed. Thereafter, studies on the relationship between the psychological and physical impact of rugby on players are discussed. The chapter concludes with a consideration of research findings of rugby players' psychological and physical wellbeing viewed in the context of the established mind-body relationship.

2.2. Defining Psychological Wellbeing

The term psychological wellbeing (PW) refers to the overall psychological condition of a person, which includes cognitive, emotional, and behavioural repercussions and characteristics (Bar-On, 1988). Emotions have been argued to be the essential signs of PW as they have been shown to motivate behaviour, impact on PW, and influence health (Spielberger & Reheiser, 2009; Spielberger, Ritterband, Sydeman, Reheiser, & Unger, 1975). Emotions can be either state or trait in nature. State emotion is transitory and is typically prompted by a particular stimulus, while trait emotion describes a general tendency of a person to experience a particular emotion (Gallo, Ghead, & Bracken, 2004). Spielberger and Reheiser (2003, 2009) claim that anxiety, anger, depression, and curiosity are critical emotional signs of PW.

2.2.1. Anxiety

Anxiety can be defined as a negative mood that includes feelings of worry and apprehension due to the anticipation of a real or imagined threat to the self. Physical tension

also forms part of anxiety (Barlow, 2005; Kaplan & Saccuzzo, 2013; Silverman & Treffers, 2001; Spielberger & Reheiser, 2009). Anxiety has gained much attention in psychological research. It has become accepted as a fundamental human emotion that, when properly managed, has an adaptive function as it warns the individual of danger, stimulates the individual to prepare, and helps them to perform (Sadock & Sadock, 2007; Sue, Sue, & Sue, 2006). However, anxiety that persists and is severe is considered harmful or debilitating as it can interfere with daily functioning and result in suffering (Sadock & Sadock, 2007).

2.2.2. Anger

Anger, like anxiety, is suggested to be an adaptive, problem-solving response (Spielberger & Reheiser, 2009). Anger ranges in intensity from feeling mildly irritated or annoyed to intense rage and fury (Hamdan-Mansour, Dardas, Nawafleh, & Abu-Asba, 2012). Definitions of anger, aggression, and hostility are often ambiguous. Spielberger and Reheiser (2009) define anger as a negative emotional state associated with activation of the autonomic nervous system. Hostility encompasses a complex set of attitudes and behaviours including contemptuous, malicious, and cruel behaviour charged by strong anger feelings. Aggression is a behaviour carried out with the intent to deliver destruction to other people or objects in the environment (Spielberger & Reheiser, 2009). State anger has been shown to be isolated from aggression in psychological studies of emotional states, but trait anger has been strongly correlated with aggression (Potegal & Stemmler, 2010).

2.2.3. Depression

Like anger and anxiety, depressive symptoms can vary in severity from the feeling of sadness to feelings of deep despondency and dejection, as well as range in duration from a short period to persistent depression (Spielberger & Reheiser, 2009). Depression is characterised by a persistent feeling of sadness and loss of interest or pleasure in activities that affect a person's thoughts, behaviours, feelings, and sense of wellbeing (American Psychiatric Association, 2013). A person who is depressed usually experiences several of the following symptoms: (a) feelings of sadness, (b) hopelessness and/or pessimism, (c) lowered self-esteem, (d) heightened self-depreciation, (e) decrease or loss of ability to take pleasure in ordinary activities, (f) reduced energy and vitality, (g) decreased concentration, (h) changes in appetite, (i) weight loss or weight gain, (j) insomnia or hypersomnia, (k) loss of

motivation, and (l) recurrent thoughts of suicide (Colman, 2006; American Psychiatric Association, 2013; Sue et al., 2006).

2.2.4. Curiosity

Unlike anger, anxiety, and depression, which are typically found in emotional disorders and warn of lapses in wellbeing, curiosity is considered a positive emotional indicator (Seligman et al., 2013 Spielberger & Reheiser, 2003, 2009). Curiosity indicates how people direct attention to novel or valued environmental stimuli and is defined in ways that are similar to constructs such as interest, openness to experience, and novelty-seeking behaviour (Bowler, 2010; Kashdan et al., 2009; Olver & Mooradian, 2003). Curiosity can be defined as the recognition, embracement and seeking out of knowledge and new experiences (Gallagher & Lopez, 2007; Kashdan et al., 2009). As suggested in the latter definition, curiosity is considered an influential motivator of human behaviour, which encourages a person to embrace exploration, build knowledge, and acquire new abilities (Litman, 2005; Spielberger & Reheiser, 2009; Von Stumm, Hell, & Chamorro-Premuzic, 2011). Furthermore, curiosity may enable individuals to adapt successfully to circumstances, solve problems, and handle distress (Hulme, Green, & Ladd, 2013; Kashdan et al., 2009; Kashdan et al., 2013). Research on the benefits of curiosity has found that it plays a role in the development of intelligence, wisdom, happiness, meaning in life, and satisfying and engaging social relationships (Kashdan et al., 2009). Furthermore, curiosity has been found to have inverse correlations with anxiety, anger, and depression (Spielberger & Reheiser, 2003).

2.3. Defining Physical Wellbeing as Health-Related Physical

Fitness

"Physical fitness refers to a physiological state of wellbeing that allows one to meet the demands of daily living or that provides the basis for sport performance, or both" (Warburton et al., 2006, p. 804). Definitions of physical fitness have also focused on the manner in which the demands of daily living are met. For example, Caspersen, Powell, and Christenson (1985) define physical fitness as "the ability to carry out daily tasks with vigour and alertness, without undue fatigue and with ample energy to enjoy pursuits and to meet unforeseen emergencies" (p.128). A number of measurable components contribute to

physical fitness. These fall into two groups where one is related to health and the other related to skills pertaining more to athletic ability (American College of Sports Medicine, 2014). Health-related physical fitness (HRPF) involves the components of physical fitness related to health status, including cardiovascular endurance, muscle endurance, muscle strength, body composition, and flexibility (American College of Sports Medicine, 2014; Caspersen et al., 1985; Singh, 2013).

2.3.1. Cardiovascular Endurance

Cardiovascular endurance relates to the ability of the circulatory and respiratory system to supply energy during sustained physical activity and to eliminate fatigue products after supplying energy (Caspersen et al., 1985; Singh, 2013). Persons with cardiovascular endurance have improved cardiovascular fitness as they have an increased amount of blood pumped with each heartbeat, which results in a lowering of both their resting heart rate and blood pressure, and an increase in the efficacy with which their cardiovascular system works (Brannon & Feist, 2010). Cardiovascular fitness is advantageous as it is believed to protect people from heart disease and a variety of other conditions (Brannon & Feist, 2010; Murphy, Nevill, Murtagh, & Holders, 2007).

2.3.2. Muscle Strength and Endurance

Muscle strength relates to the ability of a muscle group to exert an external force (Brannon & Feist, 2010; Caspersen et al., 1985; Singh, 2013). Muscular strength is beneficial to a person in that it improves overall health status and reduces the risk of chronic disease, disability, and injury (Garber et al., 2011; Warburton et al., 2006). Muscle endurance relates to a muscle group's ability to continually perform exertion of external force (Brannon & Feist, 2010; Caspersen et al., 1985; Singh, 2013). Endurance-trained muscles become provided with more blood capillaries (Spurway, 2003). Spurway (2003) suggests endurance trained muscles are two-to-three times more numerous in muscle fibres than untrained or differently trained muscles. There are numerous health benefits of muscular endurance such as stronger connective tissue, bones, tendons, and ligaments; decreased risk of cardiovascular disease and injury; and improved body composition (Garber et al., 2011).

2.3.3. Body Composition

Body composition is the ratio of fat-free mass (muscle, bone, blood, organs, and fluids) to fat mass (adipose tissue deposited under the skin and around organs) (Caspersen et al., 1985; Jennet, 2003; Singh, 2013). Lean tissue such as skeletal muscle contributes to the production of power output, while excess fat deposits lead to becoming overweight, and a continuation of this trend leads towards obesity (Carling, Reily, & Williams, 2008). Weight gain above the statistically healthy norm is widely acknowledged as a health risk, as the links between obesity, liability to ill health, and earlier death are well established (Jennet, 2003). The appropriate ranges for body weight related to sex, age, and height have been derived from healthy population samples. The body mass index (BMI) is defined as the body mass (measured in kilograms (kg)) divided by the square of the body height (measured in meters (m)). BMI is expressed in units of kg/m^2 . BMI is assessed to measure the amount of tissue mass (muscle, fat, and bone) in an individual, and then categorise that individual as underweight, normal weight, overweight, or obese (Jennet, 2003). Fat is commonly estimated indirectly from skin-fold thicknesses: At several specified sites, a fold of skin and its underlying fatty layer is lifted and its double thickness measured with graduated calipers (Jennet, 2003). The scientific steering groups of the British Olympic Association recommend five anatomical sites. These are biceps, triceps, subscapula, supra-iliac, and anterior thigh. Using these sites and referring to the age of the individual, the percentage of the body weight in the form of fat can be estimated (Carling et al., 2008). Waist-to-hip ratio (WHR) may offer additional insights into the body composition of a person. Pischon et al. (2008) showed that measurement of both general and centralised adiposity provides a better assessment of the risk of death- particularly among those with a lower BMI. Studies have also shown that centralised adiposity as measured by WHR may be a more accurate predictor of cardiovascular risk than BMI (Bellocco et al., 2010; Yusuf et al., 2005).

2.3.4. Flexibility

Flexibility relates to the range of motion capacity available of a joint (Brannon & Feist, 2010; Caspersen et al., 1985; Singh, 2013). Flexibility is established by the state of the joint structure, the condition of ligaments and fascia that are around the joint, and the amount a muscle can extend (Kent, 2007). Flexibility is advantageous to health as it is seen to

improve range of motion, postural stability, and balance. Flexibility has also been suggested to prevent injuries and relieve neuromuscular tension (especially back pain), although there does not appear to be consistent research linking flexibility to these health benefits (Garber et al., 2011).

2.3.5. Physical Fitness and Heart Health

Physical wellbeing will be defined as health-related physical fitness (HRPF) in this study. HRPF (for the purposes of this research) will include the above components of HRPF as well as physical fitness and heart health. Heart health concerns the functioning of the heart. Healthy functioning of the heart is vital for physical fitness and health as it is the key stakeholder in the circulation of blood and the maintenance of the blood pressure (Miller, 2003). Physical fitness, which is deemed optimal for good health, is a complex condition that requires each of the HRPF components to be achieved. This is accomplished by partaking in a combination of different types of exercise (isometric, isotonic, isokinetic, anaerobic, and aerobic) as each contributes to physical fitness, but no single type fulfils all the requirements (Brannon & Feist, 2010). Physical fitness is also dependent on the duration and intensity of the exercise performed (Brannon & Feist, 2010). A high level of HRPF is essential to health; this is shown in the compelling evidence of a 50% reduction in mortality among highly fit people compared to unfit people (Warburton et al., 2006).

2.4. The Impact of PW on HRPF

There is considerable evidence that acute feelings (state emotions) and chronic emotional dispositions (trait emotions) are associated with physiological responses, as well as general health outcomes (Diener & Chan, 2011). Historically, emotion-health research has concentrated on testing the notion that emotions directly contribute to disease aetiology (Diener & Chan, 2011). Research at this level has focused on trait negative emotions. Because of this interest, there exists convincing literature indicating negative emotions as a risk factor for chronic illness and mortality (Diener & Chan, 2011). The best evidence to date supports the association between trait negative emotions (namely anger, anxiety, and depression) and cardiovascular disease (CVD) (DeSteno, Gross, & Kubzansky, 2013). Several meta-analyses and reviews demonstrate the association between trait manifestations

of anxiety, depression, and anger and the development of various forms of CVD (Chida & Steptoe, 2009; Gallo et al., 2004; Hemingway & Marmo, 1999; Roest, Martens, de Jonge, & Denollet, 2010; Rugulies, 2002; Siegman & Smith, 2013; Smith, Glazer, Ruiz, & Gallo, 2004; Suls, 2013; Suls & Bunde, 2005). Furthermore, trait levels of these same negative emotions have been associated with specific physiological health changes that are consistent with the long-term damage that accompanies CVD (Brannon & Feist, 2010; Consedine & Moskowitz, 2007). Examples of the latter physiological changes are artery wall thickness (Howell, Kern, & Lyubomirsky, 2007; Ohira et al., 2012; Paterniti et al., 2001), arterial stiffness (Seldenrijk et al., 2011), artery damage (Baum & Pozluszny, 1999; Tomfohr, Martin, & Miller, 2008; Williams et al., 2000), and reduced heart rate variability (Carney et al., 2001; Hughes & Stoney, 2000; Suls, 2013; Watkins, Grossman, Krishana, & Sherwood, 1988). Furthermore, anger has been associated with chronic heightened blood pressure, platelet aggregation, and inflammation (Suls, 2013). Depression has also been linked to platelet aggregation and inflammation (Laghrissi-Thode, Wager, Polloci, Johnson, & Finkel, 1997; Musselman et al., 2000).

There is reasonable evidence that these negative emotions may play a role in the development of a variety of other chronic illnesses (DeSteno et al., 2013). For instance, trait depression, anxiety, and anger have been associated with an increased risk of arthritis (Karakus & Patton, 2011; Strahl, Kleinknecht, & Dinnel, 2000; Uskul & Horn, 2015), cancer (Spiegel & Giese-Davis, 2003; Uskul & Horn, 2015), and infectious diseases (Cohen, Tyrrell, & Smith, 1993). Depression and chronic stress have been connected to the risk of diabetes (Karakus & Patton, 2011; Mezuk, Eaton, Albrecht, & Golden, 2008; Sapolsky, 2005), and trait anxiety has been linked to greater risk of asthma (Rimington, Davies, Lowe, & Pearson, 2001).

Investigations into the physiological consequences of state level emotions provide insight into the mechanisms that underlie the health outcomes of trait emotions, and give an indication of the direct impact of PW on HRPF (Diener & Chan, 2011). State manifestations of negative emotions have been associated with a myriad of physiological changes in cardiovascular activity and immune functioning that, when experienced on a chronic basis, could lead to deleterious health outcomes (Diener & Chan, 2011; Herbert & Cohen, 1993a; Herbert & Cohen, 1993b). For example, anger, anxiety, and depression have been linked to biomedical markers (such as C-reactive protein, fibrinogen, cortisol, and interleukin-6),

which are known to signal suppressed immune functioning and are indicated in many adverse health outcomes such as CVD, osteoporosis, arthritis, type 2 diabetes, cancer, Alzheimer's disease, and periodontal disease (Brummett, Boyle, Kuhn, Siegler, & Williams, 2009; Cohen & Herbert, 1996; Consedine & Moskowitz, 2007; Herbert & Cohen, 1993a; Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002; Kubzansky, 2007; Rozanski, Blumenthal, Davidson, Saad, & Kubzansky, 2005; Suinn, 2001). In a meta-analysis of wellbeing and objective health outcomes, Howell, Kern, and Lyubomirsky (2007) found that experimentally induced negative emotional states of anger, anxiety, stress, and depression led to physiological changes indicative of compromised health functioning (measured in terms of heart rate, blood pressure, cortisol levels, and immune response). Ambulatory studies conducted in a natural setting have demonstrated that the physiological changes resulting from emotional states are, in turn, related to changes in health (Diener & Chan, 2011). For example, Rozanski, Blumenthal, and Kaplan (1999) found that mental states, such as stress induced in a laboratory, resulted in ischemia, and those experiencing ischemia in the laboratory were more likely to manifest it during the ECG monitoring of daily life events. Furthermore, Cohen et al. (1993) suggest that the changes in immune parameters caused by induced levels of state depression increase a person's susceptibility to infectious disease.

Positive emotions have received considerably less attention in research than negative emotions. This is likely a consequence of the traditional view of health focusing on disease (Kiecolt-Glaser et al., 2002). Determining positive emotions' contribution to the impact of PW on HRPF is complicated by literature failing to distinguish discrete positive emotions (Pressman & Cohen, 2005). Studies concerned with curiosity and the physical component of health are limited (Consedine & Moskowitz, 2007). Richman et al. (2005) suggested that curiosity plays a protective role against disease after finding trait curiosity was associated with lower levels of hypertension and diabetes mellitus. Research has found that older adults who display curious engagement with their environment live longer and are less likely to develop degenerative diseases of the central nervous system (Silvia, 2001). For example, Swan and Carmelli (1996) found that older adults who were more curious had a 30% decreased risk of dying during the five-year study period than their less curious counterparts.

Research with varying definitions of positive emotions (at both trait and state level) may provide additional insight into the impact of PW on HRPF, as researchers have found the

experience of positive emotions to overlap (Steptoe, Wardle, & Marmot, 2005). Trait manifestations of positive emotions (referring to a wide range of positive emotions such as joy, happiness, vigour, and interest) have been associated with a reduced risk of mortality, CVD, other chronic illnesses, and the common cold (Boehm & Kubzansky, 2012; Chida & Steptoe, 2008; Cohen, Doyle, Turner, Alper, & Skoner, 2003; Davidson, Mostofsky, & Wang, 2010; Ostir, Markides, Peek, & Goodwin, 2001). Conducting a meta-analysis of state level positive emotions, Lyubomirsky, King, and Diener (2005) found that experimentally induced positive emotion and physiological outcomes, such as immune function and cardiovascular reactivity, were significantly associated. A review of experimental and naturalistic ambulatory evidence by Pressman and Cohen (2005) found that positive emotions were related to the improvement of immune, endocrine, and cardiovascular functioning. Some of the physiological changes linked to positive emotions are a healthier profile of heart rate variability (Bhattacharyya, Whitehead, Rakhit, & Steptoe, 2008; Kok et al., 2013), more rapid blood pressure recovery following standard laboratory stress challenges (Steptoe, Gibson, Hamer, & Wardle, 2007), and an accelerated cardiovascular recovery profile after the experience of negative emotions (Tugade & Fredrickson, 2004). Additionally, positive emotion has been associated with decreased inflammatory activity (Chida & Steptoe, 2008), as well as lower levels of norepinephrine (Brummett et al., 2009). Findings from research by Cohen, Alpher, Doyle, Treanor, and Turner (2006) suggested that the physiological changes that experimentally induced positive emotions invoke, relate to changes in health. In a study conducted by Cohen et al. (2006), participants were exposed to infectious organisms such as the rhinovirus (common cold) and influenza virus. Responses to these viruses in relation to induced emotional state were analysed. It was found that participants who experienced more emotion that is positive had a reduced risk of developing upper respiratory illness (Cohen et al., 2006). Studies indicate that the relationship between positive emotion and improved physical changes is independent of negative emotion (Diener & Chan, 2011). Subsequently, researchers have suggested positive emotions may have distinctive biological correlates that could benefit health (Davidson et al., 2010; Marsland et al., 2008; Segerstrom & Sephton, 2010; Steptoe, Dockray, & Marmot, 2009).

2.5. The Impact of HRPF on PW

Knowledge of the direct impact of HRPF on PW is limited. Insight into the relationship between HRPF and PW can be deduced from studies assessing PW in persons with either compromised physical health or improved physical wellbeing. Studies have found that persons who experience compromised physical health are more likely to experience lapses in PW (Barley, Murray, Walters, & Tylee, 2011; Chapman, Perry, & Strine, 2005; Hamed & Ameri, 2013; Moussavi et al., 2007; Spiegel & Davis, 2003). Spiegel and Giese-Davis (2003) found that one-third of inpatients with compromised physical health reported mild or moderate symptoms of depression and up to one-quarter suffered from major depressive disorder or a depressive syndrome. The literature indicates that chronic physical illness is associated with the presence of depression, anxiety, and anger (Barley et al., 2011; Chapman et al., 2005; Hamed & Ameri, 2013). For example, The World Health Organization (WHO) World Health Survey – an extensive survey of 245404 adults aged 18 years and older, from 60 countries worldwide – found that on average, between 9% and 23% of participants with one or more chronic physical disease had suffered from comorbid depression (Moussavi et al., 2007). This result was significantly higher than the likelihood of suffering from depression in the absence of chronic physical disease (Moussavi et al., 2007).

Research focused on the emotional impact of particular chronic physical illnesses also provides insight into the influence of physical health on PW. Studies of this nature have shown that patients suffering from cardiovascular disease have heightened levels of depression, anger, anxiety, and stress (Goldston & Baillie, 2008; Hamed & Ameri, 2013; Kemp & Quintana, 2013; Moussavi et al., 2007; Smith, 2001). The degree of cardiovascular disease or coronary disability is suggested to be related to the degree of emotional disturbance in heart disease patients (Smith, 2001). This notion transpired after a study found that anxiety and depression were reliably related to the degree of obstruction of the coronary vessels (Smith, 2001). In a review of literature, Gallo et al. (2004) found that approximately 16% to 34% of coronary heart disease (CHD) patients experience major depression, and about two-thirds experience elevated depressive symptoms. CHD patients also have a higher prevalence of anxiety and anger (de Leon, 1992; Goldston & Baillie, 2008; Smith, 2001). Several studies have found an association between people living with angina (the most common form of CHD) and an increased risk of anxiety and depression (Marks et al, 2011;

Moussavi et al., 2007; Taylor, 2012a). Heart failure patients have been shown to have an 11% to 25% prevalence rate of depression for outpatients, and 35% to 70% for inpatients; a substantially higher rate than the general public (Joynt, Whellan, & O'Connor, 2004; Rutledge, Ries, Linke, Greenberg, & Mills, 2006). Ziegelstein (2001) found that roughly one in six persons who have experienced a myocardial infarction suffer from major depression, and at least twice that many experience significant depressive symptoms. Hypertensive patients have been shown to experience elevated levels of anger and depression (Tel, 2013).

Although the research is not as extensive as that for heart disease, there is evidence for the impact of other chronic physical illnesses on psychological wellbeing. Asthma patients commonly experience anxiety and depressive symptoms as well as mood disorders (Chapman et al., 2005; Moussavi et al., 2007; Nejtek et al., 2001). It has been suggested that approximately 50% of asthma patients may suffer from depressive symptoms (Mancuso, Peterson, & Charlson, 2000) and 18% may suffer from a clinically significant depressive disorder (Moussavi et al., 2007). Depression is the most commonly reported concern by persons with arthritis, likely occurring in 13% to 42% of arthritic patients (Bruce, 2008; Chapman et al., 2005). Hamed and Ameri (2013) found that stress levels and trait anger are higher in diabetic patients than healthy persons. Systematic reviews and meta-analyses show that diabetes is associated with an increased likelihood of having anxiety disorders and elevated anxiety symptoms (Grigsby, Anderson, Freedland, Clouse, & Lustman, 2002; Smith et al., 2013). A meta-analysis of the prevalence of comorbid depression in adults with diabetes found that depression is twice as prevalent among persons with diabetes as those without (Anderson, Freedland, Clouse, & Lustman, 2001). Cancer patients also suffer from depression and anxiety (Chapman et al., 2005; Uskul & Horn, 2015). Up to one-third of cancer patients show a clinically significant disordered mood (Mitchell et al., 2011). Turner and Kelly (2000) note that depression rates can exceed 30% among cancer patients compared to a prevalence of depression in the community of about 4% to 8%. Anxiety is common among patients with diverse forms of dementia such as Alzheimer's disease, frontotemporal dementia, and vascular dementia (Porter et al., 2003). Parkinson's disease patients are at an increased risk of developing anxiety (Stein, Heuser, Juncos, & Uhde, 1990) and depression (Allain, Schuck, & Mauduit, 2000). Stress levels, anger, anxiety, and depression are higher in persons who experience migraines than healthy individuals (Hamed & Ameri, 2013; Perozzo et al., 2005). Significant, positive correlations have been reported between high BMI or

obesity and depressive symptoms (Johnston, Johnson, McLeod, & Johnston, 2004). High WHR has been associated with an increased prevalence of depressive symptoms in men (Rosmond & Bjorntorp, 2000).

These studies do not create a clear picture of the impact that compromised HRPF may have on PW, as knowledge of the participants' PW before they became chronically ill is often unknown. Thus, it could be their poor PW that resulted in their poor HRPF, not the reverse. Additionally, many of the symptoms of the chronic physical disease overlap those of emotional disorders, such as fatigue or loss of appetite. Research investigating the impact of improved HRPF on PW has provided more compelling insight into how HRPF influences PW (Biddle, 2010). Studies have focused on behaviours that improve HRPF, and how this enhanced physical state influences PW. Of these behaviours, physical activity has gained much attention in the literature.

2.6. The Impact of Physical Activity on HRPF

Physical activity (PA) describes any bodily movement produced by the skeletal muscle system that results in energy expenditure above that of resting level (Biddle, 2010; Bouchard, Blair, & Haskell, 2012; Marks et al., 2011; Singh, 2013). A large body of evidence demonstrates that regular PA increases HRPF (Bouchard et al., 2012; Garber et al., 2011; Powell, Paluch, & Blair, 2011; Warburton et al., 2006). PA performed on a regular basis has been associated with increased cardiorespiratory endurance, musculoskeletal fitness and flexibility, improved body composition (e.g., through reduced abdominal adiposity and improved weight control), and a decrease in blood pressure (Bouchard et al., 2012; Brannon & Feist, 2010; Garber et al., 2011; Warburton et al., 2006). Furthermore, regular PA increases cardiac function, decreases blood coagulation, improves coronary blood flow, enhances lipoprotein profiles (C-reactive protein and other CHD biomarkers), improves endothelial function and autonomic tone, betters glucose homeostasis and insulin sensitivity, increases bone strength, and reduces systemic inflammation (Bouchard et al., 2012; Brannon & Feist, 2010; Garber et al., 2011; Miles, 2007; Warburton et al., 2006). The beneficial impact of PA for HRPF is confirmed by research linking PA to a decreased risk of premature death and several chronic diseases such as cardiovascular disease, diabetes, cancer,

hypertension, obesity, depression, and osteoporosis (Brannon & Feist, 2010; Garber et al., 2011; Powell et al., 2011; Warburton et al., 2006).

PA can, however, also threaten HRPF. Highly active people may suffer from exercise related injuries, where musculoskeletal is the most common (Brannon & Feist, 2010). The type and intensity of PA have been suggested as the most important factors in the incidence of injury (Garber et al., 2011). PA performed at a high intensity, and competitive sports have been associated with an increased risk of injury (Garber et al., 2011). PA performed too intensively (beyond one's threshold), at a high volume, and without including adequate rest (or overtraining) is associated with physiological stress. Some of the effects of overtraining are temporary impairments in immune functioning (Cunniffe et al., 2010; Gleeson, 2007), reduced maximal heart rate (Halson & Jeukendrup, 2004), higher resting heart rate, changes in normal blood pressure, decreased testosterone, increased cortisol levels, and weight loss (Johnson & Thiese, 1992). Although rare, acute myocardial infarction and sudden cardiac death can be triggered by partaking in PA. In these cases, the person is typically unaccustomed to PA, the exercise is vigorous and leads to physical exertion, the Person performing the PA often suffers from a physical illness, and/or there is exposure to superimposed environmental stressors (Garber et al., 2011).

2.7. The Impact of PA on PW

The link between PA and psychological functioning is less clearly established than that between PA and HRPF. However, there is substantial evidence to suggest that PA promotes PW (Biddle & Ekkekakis, 2005; Brannon & Feist, 2010; Buckworth, Dishman, O'Connor, & Tomporowski, 2013; Weinberg & Gould, 2010). A substantial review of literature indicated that PA performed regularly on a long-term basis is associated with a reduction in trait anxiety and depression, as well as improved mood states (Biddle & Ekkekakis, 2005; Miles, 2007; Mutrie & Faulkner, 2004; Weinberg & Gould, 2010). There is also evidence that regular PA is associated with decreases in anger, cynical distrust, and stress (Hassemen, Nathalie, & Uutela, 2000), as well as an improved self-concept and self-esteem (Buckworth et al., 2013). Single bouts of PA have been associated with reductions in state anxiety, and improvements in various mood states such as decreases in depression and tension, as well as increases in vigour (Biddle & Ekkekakis, 2005). Meta-analyses of the

effect of PA on depression have found that PA is related to moderate to large reductions in depression (Craft & Landers, 1998; Lawlor & Hopker, 2001), small to moderate reductions in state and trait anxiety (Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991; Wipfli, Rethorst, & Landers, 2008), and small improvements in general mood (reduction of negative moods in addition to the enhancement of positive mood states) (Arent, Landers, & Etnier, 2000).

PA has also been associated with compromised PW. Performing physical activity at an overly high intensity and overtraining has been associated with mood disturbances such as depression, anger, emotional lability, fatigue, and decreased vigour (Peluso & Andrade, 2005; Weinberg & Gould, 2015). Mood disturbances occur after a single bout of high-intensity exercise as well as after a prolonged period of high-intensity exercise and may last for 10 days to a few weeks (Peluso & Andrade, 2005). Researchers have suggested that mood state disturbances increase as the PA intensity increases in a dose-response manner: the more intensive the PA, the greater the mood disturbance (Weinberg & Gould, 2015). The incidence of mood disturbances attributable to high-intensity training is estimated to be between 7% and 20% per PA session, and this prevalence is believed to be even higher among elite athletes due to their extensive training program (Peluso & Andrade, 2005).

Determining the implications of PA for health is complicated by PA being an overarching concept that includes anything from competitive sport and structural exercise to hobbies or activities involved in daily living (Biddle & Ekkekakis, 2005; Miles, 2007). Sport is PA that is rule-governed, structured, and competitive and involves gross motor movement characterised by physical strategy, ability, and chance (Brannon & Feist, 2010). The impact that sport has on health is dependent on its type (Biddle & Ekkekakis, 2005). Rugby is a field-based team sport that elicits a variety of responses in players as a result of intermittently high- and low-intensity physical effort and a high frequency of contact (Duthie et al., 2003; Roberts, Trewaratha, Higgitt, El-Abd, & Strokes, 2008; Sedeaud et al., 2011). The psychological and physiological demands of rugby are proven to be more complex when compared with individual sports and other team sports of a less antagonistic level (Duthie et al., 2003; Kerr & Syebak, 1994; Maxwell, 2004).

2.8. The Impact of Rugby on Players' HRPF

The rugby game is played over two 40-minute halves divided by a break no longer than 10 minutes. There are no stoppages, apart from the occurrence of an injury (Duthie et al., 2003). During a rugby competition, 85% of the game time is typically spent in low-intensity activities and 15% in high-intensity activities. The high-intensity activities are comprised of 6% running and 9% tackling, pushing, and competing for the ball (Duthie et al., 2003). Rugby is mostly anaerobic, but the aerobic system is also needed. The high-intensity activities undertaken place significant stress on players' anaerobic energy sources while the aerobic system is necessary to provide energy during repeated efforts as well as for recovery (Duthie et al., 2003). Professional rugby has been identified as a severely intensive sport (Lindsay, Draper, Lewis, Giesege, & Gill, 2015). Evidence suggests a game of professional rugby induces significant physiological stress for players (Cunniffe et al., 2010; Lindsay, Lewis, Gill, Giesege, & Draper, 2015).

Since the professionalism of rugby in 1995, research has focused on factors that have an effect on rugby players' performance (Martin et al., 2013). Due to the high-intensity and high-collision nature of the sport, rugby players' physique is critical for competitive success. As such, much research has been dedicated to recording the anthropometric and physiological measurements of rugby players (Duthie et al., 2003; Higham, Pyne, Anson, Dziedzic & Slater, 2014; Lindsay, Draper et al., 2015). The level of play (e.g. amateur or professional) and the number of years participating in rugby professionally have shown to contribute to anthropometrical characteristics of rugby players (Smart, Hopkins, & Gill, 2013). The measurement of rugby players' anthropometrical characteristics has also highlighted position-specific attributes (Smart et al., 2013). Anthropometrical and physiological studies of rugby players provide insight into their HRPF. HRPF in rugby could be understood in terms of body composition, muscle strength, muscle endurance, and cardiovascular endurance. Rugby players' incident of disease may also provide insight into their HRPF.

2.8.1. Body Composition of Rugby Players

Studies have shown that rugby players participating at all levels of play (professional, semi-professional, and amateur) have a higher body mass than the average population and other team sport professional athletes (Duthie et al., 2003; Elloumi et al., 2009; Potgieter et

al., 2014; Smart et al., 2013). The body mass of rugby players is position- and level-of-play-specific (Quarrie et al., 1995; Smart et al., 2013). For instance, rugby players playing in a forward position typically have a higher body mass than those playing in a back position. Professional rugby players are commonly heavier than players competing at an amateur level (Quarrie et al., 1995; Smart et al., 2013). Crewther, Lowe, Weatherby, Gill, and Keogh (2009) found that professional rugby forwards from New Zealand, Australia, and South Africa have an average body mass of 110,6 kg. This discovery is within the range found by other researchers for South African (102,4 kg to 118,4 kg), New Zealand (110 kg) and English (111,7 kg) professional rugby forwards (Higham et al., 2014; Potgieter et al., 2014). Potgieter et al. (2014) and Kruger, Booysen, and Spamer (2010) found the average weight of semi-professional South African rugby forwards was 107 kg and 103 kg, respectively. This is within the recommended range for South African semi-professional and professional forwards, but below findings of Crewther et al. (2009) for international professional forwards (110,6 kg). Both Crewther et al. (2009) and Potgieter et al.'s (2014) findings of body weight for South African professional and semi-professional males are well above the average weight of other South African professional field team athletes (such as cricketers) (77,8 kg) and healthy active South African males (74,8 kg) (Micklesfield, Gray & Taliep, 2012). Potgieter et al. (2014) found South African semi-professional rugby forward players have a BMI of 32,5 kg/m², which is above the recommended BMI for South African semi-professional and professional forwards (18,5 kg/m² to 24,9 kg/m²) (Potgieter et al., 2014), but similar to the BMI of professional English forwards (30,9 kg/m²) (Fuller, Taylor, Brooks, & Kemp, 2013). According to WHO's standards for healthy weight, the latter findings of the BMI of South African rugby players would class these athletes as obese (Potgieter et al., 2014).

Authors have cautioned against BMI applicability to elite athlete participants in field games as they claim the BMI calculation fails to distinguish between muscle and fat as constituents of body mass (Carling et al., 2008; Potgieter et al., 2014). Carling et al. (2008) suggest that body composition in athletes is more accurately determined by measuring skin-fold thickness. Using seven skin-fold sites, Crewther et al. (2009) calculated that professional rugby forwards from New Zealand, South Africa, and Australia have a total body fat of 14,4% . This body fat percentage is within the national (14% - 20%) and international (8% - 17%) recommendations for professional rugby forwards (Potgieter et al., 2014), and below

the average for males in their mid-twenties (Carling et al., 2008). It has been observed that with a decrease of playing level, rugby players have a higher skin-fold thickness and percentage of body fat (Duthie et al., 2003; Smart et al., 2013). Potgieter et al. (2014) found semi-professional rugby forwards' body fat percentage was slightly above national and international recommendations for professional forwards, a difference of 2% and 5% respectively. Another study found that South African semi-professional forwards' body fat percentage was within the national normative range, but slightly above international recommendations for professional forwards (Kruger et al., 2010). Potgieter et al. (2014) showed that South African semi-professional rugby players have a mean body fat of 18,2% , which is 2,2% above the recommendation for the average male of their age (Carling et al., 2008).

In addition to fat mass, body composition includes the proportion of fat-free mass of a person (Caspersen et al., 1985; Jennet, 2003). Elloumi et al. (2009) found that professional rugby players have a higher lean body mass than a healthy population sample. Duthie, Pyne, Hopkins, Livingstone, and Hooper (2006) discovered that the lean body mass of a population of professional rugby players decreased over a four-year period of partaking in competitive rugby. The lean body mass of professional rugby players at the onset of the study was a mean of 58,8% for forwards and 52,4% for backs (Duthie et al., 2006).

The fat-free mass of a person includes their bone mass density (BMD), and professional rugby players have been suggested to have a higher BMD than the average healthy male (Elloumi et al., 2009). There is evidence that suggests the BMD of rugby players is higher than other professional athletes (Nevill, Holder, & Stewart, 2004). Nevill et al. (2004) examined 15 non-exercising participants and 106 male athletes from nine sports and found rugby players' BMD was the greatest of all sports groups, and was higher than the non-exercising participants. Higham et al. (2014) found that professional rugby forwards have a bone mass of 12% to 26%.

2.8.2. Muscle Strength of Rugby Players

The HRPF component of muscle strength has gained attention in rugby research, as rugby team success requires high levels of muscular strength from players (Duthie et al., 2006). Muscle strength has been proven to increase with a higher level of play (Smart et al.,

2013). Smart et al. (2011) found that backline players show lower maximal strength compared to forwards in terms of bench press (difference of approximately 11 kg), back squat (difference of approximately 18 kg), and power clean (difference of approximately 9 kg). Studies have shown that the muscle strength of rugby players is dependent on the player's position of play (Heffernan et al., 2015; Smart et al., 2011). Crewther et al. (2009) examined the muscle strength of 42 professional male rugby players and found a significant difference between the upper body strength of forwards and backs, where total bench press weight of forwards was 167,4 kg and backs was 129,0 kg. Professional rugby players' muscle strength is higher than the average healthy male. Elloumi et al. (2009) found the mean hand grip strength of professional rugby players was 15,4% and 34,5% respectively higher in back and forward players than healthy male controls. Rugby players have a large amount of fast twitch fibres; this is significant because the amount of fast twitch fibres is indicative of muscle strength (Duthie et al., 2003). A study reported that both professional forward and back players had 56% fast twitch fibres in the vastus lateralis muscle (Duthie et al., 2003). This is a similar amount of fast twitch fibres found in professional ice-hockey players and sprinters. Professional soccer players have percentages of fast twitch fibres below those of rugby players, ranging from 40% to 51% (Duthie et al., 2003). Jardine, Wiggins, Myburgh, and Noakes (1988) found that both professional South African backs and forwards had a preponderance of fast-twitch muscle fibres (57% and 53%, respectively).

2.8.3. Muscle Endurance of Rugby Players

In comparison to muscle strength, muscle endurance of rugby players has gained less attention in research. Studies have found that rugby players competing at a higher competitive level have a greater degree of muscle endurance than those competing at a lower level (Quarrie et al., 1995; Smart et al., 2013). Rigg and Rielly (1987) found that elite rugby players completed significantly more push-ups than amateur players did. In a review of literature, Duthie et al. (2003) found a discrepancy between findings on differences between positional groups of rugby players' muscle endurance. Duthie et al. (2003) noted that one study found abdominal endurance was superior in forwards (approximately 52 sit-up repetitions per minute) compared to backs (approximately 48 repetitions per minute), while another study observed that backs' muscle endurance was superior (a total of about 92 sit-up repetitions) to forwards (71 total repetitions). Quarrie et al.'s (1995) findings support the

evidence that there are differences between positional groups of rugby players regarding upper body muscular endurance. Quarrie et al.'s (1995) study found that professional rugby forwards performed, on average, 25,6 push-ups, and backs completed an average of 32,3 push-ups.

2.8.4. Flexibility of Rugby Players

Information on the muscle flexibility of rugby players is limited. Poor muscle flexibility of rugby players is believed to place players at a higher risk of common musculoskeletal injuries such as hamstring injuries (Brooks, Fuller, Kemp, & Reddin, 2005). Brooks et al. (2005) found that improving muscle flexibility through stretching exercises on its own did not reduce hamstring injuries of rugby players, but improving both strength and flexibility of muscles was effective. Van Gent and Spamer (2005) looked at adolescent amateur and semi-professional South African rugby players of differing ages (namely, under-13, 16, 18, and 19) and did not find a linear relationship between the increase in age of players (or level of play) and muscle flexibility. Another study addressing young South African professional rugby players' muscle flexibility using the sit-and-reach test, found that South African under-18 players had a considerably higher degree of muscle flexibility (13,03 cm) than their English counterparts (6,64 cm) (Plotz & Spamer, 2006). Using an adapted version of the sit-and-reach test, Van Gent and Spamer (2005) found that amateur under-19 South African rugby players' muscle flexibility differed between position groups. For example, tight forwards and backlines obtained a mean score of 4,75 cm and 5 cm respectively, while half-backs scored a 3 cm mean.

2.8.5. Cardiovascular Endurance of Rugby Players

The cardiovascular endurance of rugby players is a critical component of players' HRRPF as it indicates the strength of a players' heart. Unlike cardiovascular fitness (which is argued by some researchers to be important for competitive success), the cardiovascular endurance of rugby players has gained little attention in research. Rugby players competing at a higher level have a greater degree of cardiovascular endurance than those at a lower level (Quarrie et al., 1995; Smart et al., 2013). The cardiovascular endurance of rugby players is also dependent on a player's position of play. It has been observed that backs typically possess greater levels of cardiovascular endurance fitness than forwards (Duthie et al., 2003).

A player's resting heart rate (RHR) indicates cardiovascular endurance. A study conducted by Aubert, Beckers, and Ramaekers (2000) found that the RHR of professional rugby players (aged 18 to 35 years) is lower than sedentary controls of the same age.

2.8.6. Disease in Rugby Players

2.8.6.1. *Temporary immune suppressant effects of partaking in rugby*

There is evidence that partaking in a rugby game can have immune suppressant effects for players and increase players' susceptibility to post-game infection (Lindsay, Draper et al., 2015). Lindsay, Draper et al. (2015) found that professional rugby players experience a significant change in salivary cortisol, salivary immunoglobulin A (sIgA), and total urinary neopterin (NP) post-game. These immunological changes in professional rugby players have also been observed in other studies (Cunniffe et al., 2010; Lindsay, Lewis et al., 2015). Studies have shown that the disturbances in professional rugby players' immunity elicited by partaking in competition are temporary, as they last only up to 38 hours post-match (Cunniffe et al., 2010).

2.8.6.2. *Chronic physical illness in veteran rugby players*

A study investigating the incidence of chronic physical illness in veteran rugby players may provide additional insight into the impact of rugby on the HRPF of players. Climstein et al. (2011) found that veteran rugby players have a heightened risk of hypertension. They propose that veteran rugby players' higher incidence of hypertension is due to their high body weight and BMI. This suggestion emerged as Climstein et al.'s (2011) study also found that veteran rugby players had an increased risk of other mass-related disorders such as arthritis, sleep apnoea, and diabetes (all types). As a result, rugby players could be perceived as a risk population for heart disease due to their body mass and BMI increasing at a rate faster than the average population (Olds, 2001). However, Climstein et al.'s (2011) findings do not support the latter since they suggest that veteran rugby players have a lower incidence of coronary artery disease and angina than the average population.

2.9. The Impact of Rugby on Players' PW

Studies have shown that rugby elicits emotions associated with poor PW (Grobbelaar, Malan, Steyn, & Ellis, 2010; Kerr & Syebak, 1994; Nicholls, Backhouse, Polman, & McKenna, 2009; Nicholls, Jones, Polman, & Borkoles, 2009). Kerr and Syebak (1994) found that participating in rugby training decreased pleasant moods and increased unpleasant emotions such as anger, humiliation, sullenness, and shame. Persons involved in rugby also experienced significantly more stress than those partaking in less antagonistic sports, such as basketball and low intensity running (Kerr & Syebak, 1994). There is evidence that the intensity to which rugby players experience negative moods is associated with the players' level of play (Grobbelaar et al., 2010; Nicholls, Backhouse, et al., 2009; Nicholls, Jones, et al., 2009). For example, Grobbelaar et al. (2010) studied South African university rugby players over a five-month period and showed that highly experienced rugby players (played for the first team for three or more years) demonstrate a significantly greater total mood disturbance score and negative mood state scores of tension, depression, anger, fatigue, and confusion than their lesser experienced counterparts (players with one or two years experience at this level). Additionally, novice rugby players (players in their first season at this level) showed a slightly higher score for the positive mood state of vigour than both experienced rugby player groups (Grobbelaar et al., 2010).

Nicholls, Jones et al. (2009) looked at the emotional experience of professional rugby players over a 31-day period and found that the negative feelings of anxiety and anger were the most frequently cited emotions. Anxiety was the most frequently reported emotion during training days and anger was most reported during match days. The mean intensity of both anxiety and anger experienced by these professional rugby players was higher during match days than training days (Nicholls, Jones, et al., 2009). Other studies have also found rugby players experience anger and anxiety on both training and match days (Kerr & Syebak, 1994; Robazza & Bortoli, 2007).

Rugby players' experience of anger and anxiety has been the focus of several scientific investigations. This is unsurprising as coaches, as well as rugby players, stress the need for rugby players to be aggressive, tense, and angry to gain competitive success (D'Urso, Petrosso & Robazza, 2002). Additionally, the primary focus of research on rugby has been improving players' performance (Martin et al., 2013). Research has shown rugby

players display more aggression than other sportspeople do. For example, Maxwell (2004) assessed aggression experienced by 305 male and female competitive athletes, between the ages of 18 and 32 years, who represented several team and individual sports. Rugby players had the highest score on the aggression scale compared to all the other individual and team sports (Maxwell, 2004). The aggression scale used in this study consisted of four questions about the expression of aggressive acts in sport and one question on the experience of aggressive acts. Studies have examined rugby players' experience of both state and trait manifestations of anger. Pesce et al. (2013) studied anger expression in amateur rugby players 72 hours and two hours before official rugby games. Results suggested that rugby players experience state anger prior to a rugby game (Pesce et al., 2013). Robazza and Bortoli (2007) studied the trait anger displayed by professional and amateur rugby players using the State-Trait Anger Expression Inventory (STAXI) and found both levels of players had a general tendency to experience a moderate degree of trait anger. There is evidence that rugby players (irrespective of the players' competitive standard) perceive their experience of anger as facilitative to their performance (Robazza & Bortoli's, 2007). D' Urso et al. (2002) found that professional rugby players perceive the aggression they feel before and during a match as beneficial to their performance and that some players report this felt aggression as a pleasant experience.

In addition to investigating anger in rugby players, research also focuses on rugby players' competitive anxiety. This can be expected, given the improved player performance objectives of rugby research and the common view that competitive anxiety is detrimental to an athlete's performance (Weinberg & Gould, 2010). The Competitive State Anxiety Inventory-2 (CSAI-2) has mostly been utilised when studying rugby players' experience of anxiety. The CSAI-2 measures somatic state anxiety and cognitive state anxiety (Andrew, Grobbelaar, & Potgieter, 2007; Neil, Mellalieu, & Hanton, 2006). Andrew et al. (2007) used this scale to compare amateur South African rugby players competing at a higher level with amateur players competing at a lower level. Their sample had a mean age of 18,7 years. They found significant differences with small effect sizes for both cognitive and somatic state anxiety. The players competing at a higher level had a higher level of both somatic and cognitive state anxiety than players competing at a lower level (Andrew et al., 2007).

Robazza and Bortoli (2007) used the Competitive Trait Anxiety Inventory-2 (CTAI-2), a modified version of the CSAI-2 which measures the usual intensity of competitive

anxiety and somatic anxiety in sport, to assess the competitive trait anxiety of professional and amateur rugby players. They discovered that professional rugby players reported lower levels of competitive cognitive trait anxiety and similar levels of competitive somatic trait anxiety to their amateur counterparts (Robazza & Bortoli, 2007). The researchers included a direction scale for each item of the CTAI-2, to enable the rugby player to rate the degree to which the experienced intensity of each anxiety symptom was either facilitative or debilitating to their competitive performance. Findings revealed that professional rugby players experienced their competitive somatic trait anxiety as more facilitative than their amateur counterparts (Robazza & Bortoli, 2007). Niel, Mellalieu, and Hanton (2006) also investigated the competitive trait anxiety of professional and amateur rugby players. One hundred and fifteen professional and amateur rugby players between the ages of 18 and 36 years were included in this study. Dissimilar to the findings of Robazza and Bortoli (2007), Niel et al. (2006) noted that professional rugby players experienced a higher intensity of competitive somatic trait anxiety and a similar degree of intensity of competitive cognitive trait anxiety to the amateur rugby players. Niel et al. (2006), like Robazza and Bortoli (2007), assessed the direction of players' perception of their competitive trait anxiety. Findings revealed that professional players experienced their competitive somatic anxiety as facilitative while amateur players did not (Niel et al., 2006). In accordance with the Robazza and Bortoli (2007) study, both professional and amateur rugby players interpreted competitive cognitive anxiety as debilitating. However, in Niel et al.'s (2006) study, professional rugby players' experienced competitive cognitive anxiety as significantly less debilitating than amateur players. Niel et al. (2006) found that due to their facilitative perception of competitive trait anxiety, professional rugby players (unlike their amateur counterparts) maintain their levels of pre-game anxiety rather than attempt to reduce them. D'Urso et al. (2002) observed that professional rugby players interpreted a low intensity of cognitive anxiety experienced before and during competition as facilitative to performance while a high intensity of cognitive anxiety was considered debilitating. Additional to pre-competition anxiety, D'Urso et al.'s (2002) study looked at professional rugby players' experience of a variety of other pre-competition emotions. In D'Urso et al.'s (2002) study, rugby players were requested to identify emotions experienced before a rugby game that they found to be either facilitating or inhibiting to their performance from a 64-item list. This list of emotions had been established by previous studies, consisting of the most predominant

pre-competition emotions experienced by athletes. The rugby players were permitted to generate new items if they felt the emotions on the provided list were not indicative of meaningful emotional experiences before the competition. D'Urso et al. (2002) noticed that professional rugby players reported an interpretation of the experience of 'charm' and 'tranquillity' before a rugby competition as inhibiting their performance. In light of the discussion above, it is posited that studies thus far provide a limited understanding of professional rugby players' experience of anxiety as players' experience and perception of anxiety in a competitive situation are highlighted, but their trait and state anxiety in non-competitive situations are largely ignored. Anxiety experienced in any context is necessary to take into account as anxiety that is severe and/or persists can be damaging to rugby players' PW (Sadock & Sadock, 2007).

A small number of studies that have investigated aspects of veteran and retired rugby players' mental health may provide insight into the impact of rugby on players' PW. A recent study looked at 295 retired professional rugby players (mean age of 38 years) from France, Ireland, and South Africa (Gouttebauge, Kerkhoffs, & Lambert, 2015). This study established that there is a 28% prevalence rate of depression and/or anxiety disorder among retired professional rugby players (Gouttebauge, Kerkhoffs et al., 2015). This is lower than the 35% to 39% prevalence rate of retired professional football players (Gouttebauge, Aoki, & Kerkhoffs, 2015; Gouttebauge, Frings-Dresen, & Sluiter, 2015). However, it is higher than the 13% to 19% prevalent among the general Australian population (Gouttebauge, Kerkhoffs et al., 2015). Decq et al. (2016) studied the rate of depression in a total of 239 retired rugby players and 138 other retired sportsmen (with a mean age of 52), all of which had competed at a professional level (Decq et al., 2016). Findings showed a higher rate of major depressive disorder among retired rugby players (9%) compared to other retired sportsmen (6%) (Decq et al., 2016).

It may be concluded from the studies on rugby players' PW that participating in professional rugby has been associated with signs of poor PW, specifically anger, anxiety, and disturbed mood. Furthermore, professional rugby players perceive the experience of these negative emotional indicators (e.g. anger and anxiety) before and during a competition to be facilitative to their performance. The following section will focus on how the emotions interpreted by rugby players impact on their physical health and how the physiological experience of playing rugby may impact on rugby players PW.

2.10. The Interaction between the Physical and Psychological Impacts of Rugby

Studies have investigated the stress experienced by professional rugby players and found these players experience both physiological and psychological manifestations of stress (Nicholls, Backhouse, et al., 2009; Lindsay, Draper et al., 2015; Lindsay, Lewis, Gill et al., 2015; Lindsay, Lewis, Scarrott, Gill, Gieseg, & Draper, 2015). Nicholls, Backhouse et al. (2009) studied professional rugby players over a prolonged period and found these players report experiencing physiological and psychological sports-related and non-sports-related stressors on training days and match days. For example, on training days professional rugby players reported being more argumentative, bad-tempered, and less interested. They also felt “worse than normal” in terms of their physical symptoms on these days (Nicholls, Backhouse, et al., 2009, p.122). Nicholls, Backhouse et al. (2009) interpreted these findings as an indication that the professional rugby players assessed in the study were perhaps overtraining. Nicholls, Backhouse et al. (2009) suggested the results of their study are an indication of the interaction between the mind and body of professional rugby players. However, this study was reliant on rugby players' self-reported perceptions of their moods and physiological wellbeing, rather than reliable objective measures of these constructs.

The stress experienced by professional rugby players regarding competition has recently gained more research attention, especially in terms of psychophysiological studies (Lindsay, Draper et al., 2015; Lindsay, Lewis, Gill et al., 2015; Lindsay, Lewis, Scarrott, et al., 2015). Psychophysiological studies are concerned with the physiological bases of psychological processes (Andreassi, 2000). Several studies have investigated the psychophysiological stress responses of professional rugby players partaking in an official rugby game by assessing changes in biochemical indicators of stress such as NP, salivary cortisol, salivary sIgA, and myoglobin (Lindsay, Draper et al., 2015; Lindsay, Lewis, Gill et al., 2015; Lindsay, Lewis, Scarrott, et al., 2015). Myoglobin and NP together provide a snapshot of the physiological stress induced by rugby. Myoglobin indicates muscle damage severity, while NP signifies immune system activation and is a ratio indicator of physiological stress. SIgA is a biomarker of immune system status, and cortisol is a measure of both physiological and psychological stress (Lindsay, Lewis, Gill et al., 2015; Cunniffe et al., 2010). Lindsay, Draper et al. (2015) propose these biochemical markers measure not only

metabolic stress or emotional stress but also a combination of both. This notion arose after Lindsay, Draper et al. (2015) found that the psychophysiological stress experienced by professional rugby players during a game was not dependent on a players position of play (forward or back). However, the physical demands of the match (distance covered and number of impacts per minute of game time) were significantly position dependent (Lindsay, Draper et al., 2015). There is evidence that participating in an official rugby game results in relatively immediate increases in post-game concentrations of cortisol, total NP, myoglobin, and a decrease in sIgA (Cunniffe et al., 2010; Lindsay, Lewis, Gill et al., 2015; Lindsay, Lewis, Scarrott, et al., 2015). The latter shows that there is an association between professional rugby competition and psychophysiological stress experienced by rugby players (Cunniffe et al., 2010; Lindsay, Draper et al., 2015; Lindsay, Lewis, Gill et al., 2015). Lindsay, Lewis, Gill et al. (2015) found the psychophysiological stress triggered by a rugby game was transient, as findings from their study revealed professional rugby players had a temporary increase in cortisol levels post rugby game. In their study, professional rugby players' cortisol levels increased directly post-game, but 36 hours later the players' cortisol levels returned to pre-game levels. These studies contribute to the understanding of the psychophysiological stress responses of professional rugby players to competition by providing evidence of players' somatic experiences of stress. However, professional rugby players' cognitive experiences of stress as a result of partaking in a rugby game is not measured. In order to gain a true understanding of rugby players' experiences of stress, cognitive and somatic manifestations of stress need to be investigated concurrently.

Research that is both physiological and psychological in nature provides a better understanding of the interaction between the physical and psychological impacts of rugby on players. One such study examined the recovery of professional rugby players after a competitive game and found players experienced temporary physiological and psychological changes after the game (West et al., 2013). In this study, professional rugby players were assessed in the 12, 36, and 60 hours post-game for neuromuscular function, hormonal changes in testosterone and cortisol, as well as mood disturbance (West et al., 2013). Decreased levels of testosterone and increased levels of cortisol are thought to signify disturbances in the overall anabolic-catabolic balance of the body (Cunniffe et al., 2010). Results from this study showed that for 36 hours the neuromuscular function, testosterone, and the testosterone to cortisol [T/C] ratio of the rugby players were reduced while cortisol

levels were elevated. These changes returned to baseline level at 60 hours post-game (West et al., 2013). Moreover, players displayed an increased mood disturbance of tension, depression, anger, fatigue, and confusion at 12 hours post-game only. Mood had completely recovered by 36 and 60 hours post-game (West et al., 2013). West et al.'s (2013) finding that increased cortisol levels dissipate in professional rugby players by 60 hours after the game is similar to the findings of Lindsay, Lewis, Gill et al. (2015), who noted a transient increase in post-game cortisol levels. West et al.'s (2013) study reveals how participating in rugby may affect players psychologically and physically. This provides insight into the relationship between the psychological and physiological impacts of rugby on players. However, to gain an understanding of how the interaction between the physical and psychological impacts that rugby may have on the PW and HRPF of rugby players, it is necessary that research focus on both the PW and HRPF of rugby players.

Unfortunately, to the author's knowledge, research that focuses on both the PW and HRPF of rugby players does not exist. However, insight into the relationship between the impact of rugby on the PW and HRPF of rugby players can be deduced from a small number of psychophysiological studies that have examined the impact of a single component of PW (for instance anger or anxiety) on rugby players' physiology at a particular moment in time. Such studies have mainly focused on rugby player's pre-competition psychological and physiological state.

Pesce et al. (2013) studied anger and immune system activation in amateur rugby players (average age of 27,2 years) before three competitive rugby games. The psychological assessment (STAXI-2) was administered at the same time blood samples were taken. The STAXI-2 measures anger in terms of state anger, trait anger, and expression anger index (Pesce et al., 2013). Blood samples were taken to investigate the variations of gene expression. Findings revealed that during the two hours before each game, amateur rugby players experienced a significant increase in state anger compared to the score obtained 72 hours before the game. An increased expression of 11 genes of known immune enhancing functions at two hours compared to 72 hours before a rugby game was also found (Pesce et al., 2013). The results of this study suggest that the nearing of a rugby match can trigger anger state feelings and immune system activation (specifically, a non-pathologic activation in the peripheral blood mononuclear cells).

A recent psychophysiological study investigated professional rugby players' experience of anxiety before an official game by assessing changes in pre-competition hormonal and psychological states (Cunniffe et al., 2015). Pre-competition psychological state anxiety was assessed using the CSAI-2 (Cunniffe et al., 2015). Saliva samples were taken on a control day and 90 minutes before four official games played consecutively, to determine players' testosterone and cortisol levels. Findings revealed higher scores for pre-game testosterone and cortisol as well as cognitive and somatic state anxiety before all official games than on the baseline control day (Cunniffe et al., 2015). Thus, Cunniffe et al.'s (2015) findings show an anticipatory rise in psychophysiological variables of professional rugby players before rugby competition, similarly to Pesce et al. (2013). Pesce et al. (2013) found that during the two hours before a rugby game, amateur rugby players experience an increase in state anger and immune functioning.

Jooste (2011), like Cunniffe et al. (2015), conducted a psychophysiological study on the pre-competition anxiety of rugby players. Jooste (2011) investigated South African high school rugby players' experience of anxiety using the Sport Competitive Anxiety Test (SCAT) (to measure sport competition anxiety levels), the State-Trait Personality Inventory (STPI) (to assess state and trait anxiety), and players' cortisol levels. The study involved a group of rugby players and a group of individuals not participating in any sport. Participants were assessed one week before, the day of, and one week after a major rugby game. Participants' assessment on the day of the rugby game was in the morning, and the rugby game took place in the afternoon. Jooste (2011) found the South African high school rugby players experienced similar levels of trait anxiety to the non-sport partaking sample. However, the rugby players experienced a greater level of both state anxiety and sport competition anxiety on the day of an important rugby game than the non-sport partaking group. Scores for state anxiety and competitive anxiety were highest for rugby players on the day of an important game in comparison to the week before and the week after the game. There were no significant changes in the rugby players' cortisol levels on the game day. Consequently, Jooste (2011) suggests that high school rugby players experience the cognitive subcomponent of anxiety, but not the somatic (physical) subcomponent pre-competition.

Jooste's (2011) finding that high school rugby players perceive more anxiety on game days than on any other day is in line with the findings of Nicolls, Jones et al. (2009). Nicolls, Jones et al. (2009) found that professional rugby players report the mean intensity of their

experienced anxiety to be highest on game days than any other day. Furthermore, Jooste discovering that high school rugby players have a perceived increase in pre-game anxiety is similar to findings from Cunniffe et al.'s (2015) study. Cunniffe et al. (2015) assessed changes in pre-competition hormonal and psychological states of professional rugby players. Their findings revealed an increase in cognitive state anxiety and cortisol levels (somatic anxiety) for professional rugby players before games. Although Cunniffe et al. (2015) and Jooste (2011) both found that rugby players experience an increase in cognitive anxiety, unlike Cunniffe et al. (2015), Jooste (2011) did not find an increase in rugby players' cortisol levels (somatic anxiety). When comparing the results produced by Jooste (2011) and Cunniffe et al. (2015), it is important to note that there is a vast discrepancy between the ages, years of play, and experience level of participants of each study. The participants in Jooste's (2011) study were high school rugby players Cunniffe et al.'s (2015) participants were professionals. This discrepancy between the demographics of participants could explain the contradiction in results for somatic anxiety experienced by rugby players on game days. This is suggested as studies have revealed that more experienced rugby players experience a higher degree of state cognitive anxiety and perceived state somatic anxiety than less experienced players (Andrew et al., 2007; Niel et al., 2006). Andrew et al. (2007) found that rugby players competing at a higher level had a greater amount of both somatic and cognitive state anxiety before a rugby game than rugby players competing at a lower level (Andrew et al., 2007). Additionally, Niel et al. (2006) found that professional rugby players experienced a higher intensity of perceived competitive somatic trait anxiety and a similar degree of intensity of competitive cognitive trait anxiety to amateur rugby players. Despite the differing demographics of participants, Jooste's (2011) finding that rugby player's heightened score for game day anxiety dissipated by a week after the game is in line with results from West et al.'s (2013) study. West et al. (2013) found that the mood disturbance experienced by professional rugby players after a game dissipates by 36 and 60 hours post-game. These similar finding by Jooste (2011) and West et al. (2013) may suggest that the cognitive anxiety induced by participating in a rugby game experienced by rugby players participating at a wide range of ages, years of experience, and professional level is temporary.

In light of the preceding discussion of studies on aspects of rugby players PW and HPRF, to the researcher's knowledge, Pesce et al. (2013) and Jooste (2011) are the only researchers who have assessed both state and trait manifestations of an emotion indicative of

PW in addition to an aspect of rugby players' physiology. Three deductions can be made from the findings of these two studies. Firstly, amateur and young rugby players do not experience significantly high levels of trait negative emotions (anger and anxiety, respectively). Secondly, non-professional and young rugby players experience state manifestations of anger and anxiety, respectively, before an important rugby game. Lastly, these rugby players experience emotions indicative of poor PW (such as anger and anxiety), but this experience does not seem to affect their physiological wellbeing negatively.

2.11. Conclusion

The interactional relationship between the mind and body is clear. Lapses in PW are associated with a myriad of physiological changes and deleterious physical outcomes, while compromised HRPF is linked to adverse PW outcomes. PA is proven to typically preserve and promote good PW and HRPF. PA research indicates that improved HRPF is associated with increased PW. The relationship between the PW and HRPF of rugby players appears to be complex. Research suggests that participating in rugby may not provide the same PW and HRPF benefits as partaking in other forms of PA. Studies have suggested that conventionally classified negative or unpleasant emotions (such as anxiety and anger) are experienced by rugby players as pleasant and facilitative to their performance, are embraced, and may not have the expected pathological physical impact (D'Urso et al., 2002; Jooste, 2011; Pesce et al., 2013; Robazza & Bortoli, 2007).

CHAPTER 3: METHODOLOGY

3.1. Introduction

Evidence of the relationship between the psychological and physical wellbeing of a person was provided in Chapter 2. Additionally, Chapter 2 included a review of scientific investigations into the popular sport of Rugby Union. This review showed firstly, that participating in rugby may not have all the health-related benefits associated with other forms of physical activity. Secondly, a limited number of studies exist on the psychological and physical wellbeing of rugby players. The outcome of the review of the existing literature in Chapter 2 paved the way for the current study's research question: What is the relationship between the psychological wellbeing and physical wellbeing (hereafter referred to as health-related physical fitness) of professional male rugby union players?

Polit and Beck (2004) suggest the nature of the research question determines the methodology decisions to be made for a research study. A research methodology is the broad research strategy that delineates the way in which research is to be carried out (Howell, 2013). The techniques used to structure a study and gather and analyse the data in the course of the research investigation are included in the research methodology (Polit, Beck & Hulger, 2001).

This chapter will hence discuss the chosen methodology used to investigate the relationship between the psychological wellbeing (PW) and health-related physical fitness (HRPF) of rugby players. The chapter begins with a review of the aim and hypotheses of the study; the paradigmatic departure is then discussed and the research design described. Subsequently, the research sample is described along with the measurement instruments, data collection procedure and the methodology used to analyse the data. This chapter concludes with a discussion of the ethical considerations of the study.

3.2. Brief Review of Aim and Hypotheses

Based on the research problem statement (see Chapter 1, section 1.2) the primary aim of this study is to investigate the correlation between the HRPF and PW of professional rugby players.

H₀: There is no statistically significant relationship between HRPF and PW of professional rugby players.

H₁: There is a statistically significant relationship between HRPF and PW of professional rugby players.

3.3. Paradigmatic Point of Departure

The paradigmatic point of departure chosen for the current study is the biopsychosocial model. The model has gained recognition in several academic and institutional fields, such as health psychology, health education, and in public health (Alonso, 2004). The biopsychosocial model was developed by Engel in 1977 as a reaction to the traditional medical model (Forshaw, 2002; Marks et al., 2011). The medical model attributes health to the absence of disease and terms disease as caused by biological factors only (Taylor, 2012a). Engel saw the medical model (which he termed the biomedical model) as a reductionist and dualistic model (Havelka, Lučanin, & Lučanin, 2009). He considered it reductionistic since it is based on the philosophical principle that complex problems are as a result of simple primary principles; dualistic in terms of separating the mental from the physical processes (Havelka, Lučanin, & Lučanin, 2009).

The biopsychosocial model counters the biomedical model as it recognises health as a state of achievement rather than a lack of disease or a neutral state (Taylor, 2012a). The biopsychosocial approach moves away from the reductionist view as it recognises that health may be most usefully understood at the more complex levels of the natural systems continuum (Pilgrim, 2002; Taylor, 2012a). Additionally, the biopsychosocial model rejects dualistic ideas of health and rather advocates a holistic perspective, where health is seen as a result of the interaction between the psychological, physical, and social aspects of a person (Rohleder, 2012).

Engel draws on the systems theory of Weiss and von Bertalanffy to explain the interaction between the components of health, namely psychological, social, and physical (Pilgrim, 2002; Taylor, 2012a). Weiss and von Bertalanffy's systems theory denotes the following assumptions that are adopted by Engel: Disease and health become apparent within

individuals who are part of a whole system: This whole system has components, which are both sub-personal and supra-personal. The sub-personal includes the processes within a person (e.g. the nervous system containing organs, tissue, and cells, which in turn include molecules). The supra-personal includes people existing in a psychosocial context of mounting complexity (e.g. interpersonal relationships, community, culture, society, and biosphere) (Pilgrim, 2002). Weis and von Bertalanffy noted that the components of the whole system can be theorised as an organised systems hierarchy (Pilgrim, 2002). According to this hierarchy, lower levels of the organisation (or micro-level processes) are required for higher ones (macro-level processes) to subsist, but they are not adequate to describe or give an explanation of the nature of higher levels of the system. Additionally, unique characteristics emerge with the appearance of each higher level of organisation, which are not present at lower levels (Pilgrim, 2002).

Within the sub-personal processes of a person, an interaction happens between both macro-level processes (e.g. depression) and micro-level processes (e.g. cellular changes) (Taylor, 2012a). An interaction also happens between the supra-personal processes of an individual. According to the biomedical model, the sub-personal aspects of a person such as psychological wellbeing (e.g. emotions) and physical wellbeing (e.g. physical fitness) form part of the micro-level of the whole system. These sub-personal aspects interact with the supra-personal processes, such as social systems (e.g. mass media) which form part of the macro-level processes of the whole system (Taylor, 2012a). The interactions that happen between micro and macro levels within the whole system result in a change in one domain (e.g. psychological) necessarily causing changes in other domains (e.g. physical) (Suls, Lager, & Martin, 2011; Taylor, 2012a). Through this complex interaction between the micro and macro levels and thus the physical, psychological, and social domain of a person, a state of health is produced (Taylor, 2003).

The current study embodies the biopsychosocial model in that the study (like the model) recognises the mind and body are imperative to health and illness (Marks et al., 2011). Secondly, the study and the biopsychosocial model both acknowledge and place emphasis on the interconnectedness and the complexity of the relationship between psychological and physical aspects of health (Borrell-Carrió, Suchman, & Epstein, 2004). According to the biopsychosocial model, the health of a person is determined by the assessment of a person's physical, psychological, and social wellbeing (Brannon & Feist,

2010). This study chose to focus on two aspects of participants' health namely, their psychological and physical wellbeing. Participants' social wellbeing was excluded in the current study due to the complexity of their social domain. The social domain or supra-personal processes of the chosen participants of the present study (rugby players at the Investec Rugby Academy) would include the rugby players relationship to other members of his rugby team, the team as a whole, the coaches, medical staff, and club management. This would also include the impact that being a rugby player has on participants' family and social relationships. The cultural norms around being a rugby player and societal pressures communicated in mass media and through spectators (both internationally and nationally) would also need to be considered. Additionally, participants' experience at the Investec Rugby Academy is necessary to include. During a rugby player's visit to the Investec Rugby Academy, they are exposed to many familiar and unfamiliar players and coaches from both international and national clubs. This experience for participants would need to be assessed.

The researcher recognises the social domain is an essential component in determining participants' health. However, the study did not look to prove causation between professional rugby and health but rather aimed to provide insight into this relationship. By excluding the complex social domain, an in-depth analysis of the relationship between the remaining two domains (namely, psychological and physiological wellbeing) of participants' health was facilitated.

3.4. Research Design

This study employed a correlational research design. This research design is a quantitative method of research used to measure and define the direction and strength of the relationship between two or more variables from the same group of participants (Brannon & Feist, 2010; Gravetter & Forzano, 2012; Struwig & Stead, 2010).

To assess the degree of relationship or correlation between variables, the variables are measured in a group of participants, and then the correlation coefficient (r) between these measures is calculated (Brannon & Feist, 2010). The correlation coefficient (r) represents the strength of the relationship between the variables by means of a number that can range from -1.00 to 1.00 (Durrheim & Painter, 2006; Hoyle, Harris, & Judd, 2002). Positive correlations happen when there is a joint increase or decrease of variables. Negative correlations occur

when one of the variables increase as the other decreases. Correlations that are nearer to 1.00 (either positive or negative) signify stronger relationships than correlations that are closer to 0.00 (Brannon & Feist, 2010). A strong correlation between variables means that they are related but does not indicate that the one variable causes change in the other variable (Durrheim & Painter, 2006). This is because a correlational research design does not allow for determination of a causal relationship but rather knowledge on the degree of relationship between factors (Brannon & Feist, 2010).

A correlational research design was applicable to the present study as it allowed for statistical comparisons between the variables of PW and HRPF of professional rugby players (Brannon & Feist, 2010). Thus, the aim of the study was reached, which was to investigate the relationship between the variables of PW and HRPF in a population of rugby players.

3.5. Sample

3.5.1. Sampling Method

This study made use of purposive sampling. Purposive sampling involves intentionally selecting specific cases that manifest certain characteristics of interest to the researcher and will afford the most information for the question under study (Kemper, Springfield, & Teddie, 2003; Struwig & Stead, 2010). When developing a purposive sample participants are not randomly selected, rather researchers use their knowledge or expertise about a group to select participants who represent this population (Struwig & Stead, 2010). This sampling method is dependent on the availability and willingness of participants (Durrheim & Painter, 2006).

The inclusion criteria for research participants in the current study were as follows: (a) currently enrolled male subjects at the Investec Rugby Academy; (b) participants who were proficient in the English language; (c) participants who agreed to accurately complete the necessary questionnaires and partake in the assortment of testing procedures; and (d) participants who correctly and precisely read, understood, and signed the related informed consent documents. Research participants were screened at a preliminary introduction session to ensure they fulfilled all the necessary aforementioned inclusion criteria.

The exclusion criteria were as follows: (a) the presence of any respiratory, cardiovascular, or muscular disorder; (b) participants who were removed, dismissed or who resigned from Investec Rugby Academy; (c) participants who were unwilling to participate and/or complete the necessary testing procedures and sign the informed consent documents; and (d) participants who incompletely and/or inaccurately completed the necessary informed consent documents. Research participants were medically cleared by the medical team at Investec Rugby Academy before testing to ensure the exclusion criteria were met.

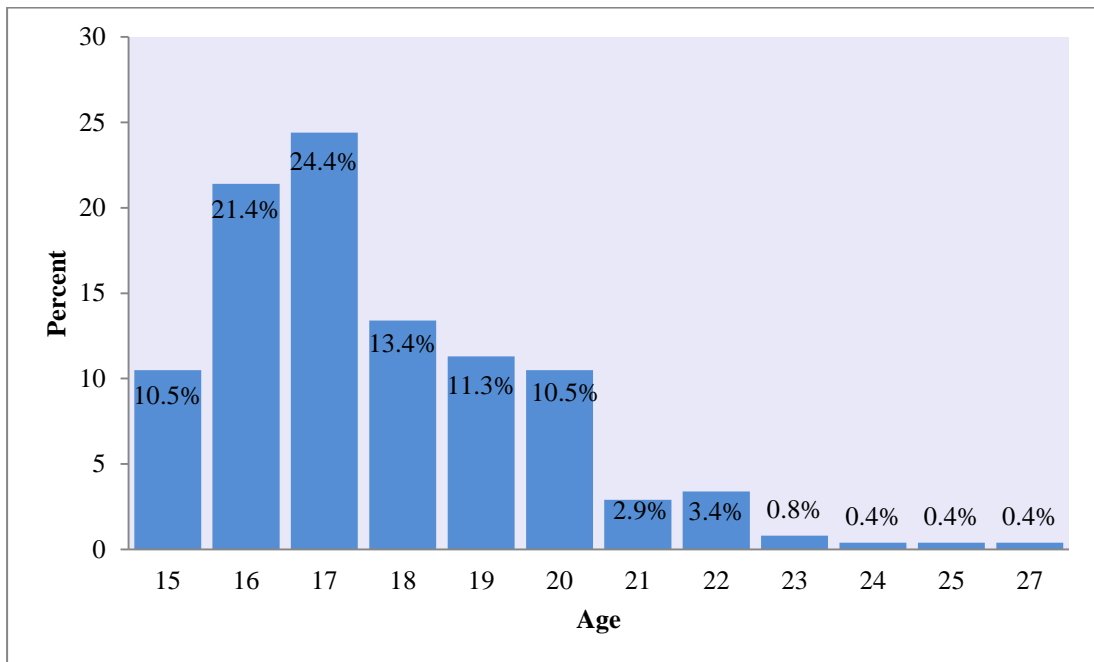
Each of the participants included in the sample was sufficiently enlightened on the design of the study and the procedures of the testing, and were subsequently requested to volunteer as participants in this research study.

3.5.2. Sample Obtained

Two hundred and thirty-eight ($n=238$) male rugby players at the Investec Rugby Academy were recruited as subjects in a study on high-level performance at the request of the Academy. The Investec Rugby Academy gave permission for the data of the study to be used. A copy of the permission letter from the Investec Rugby Academy to the principle researcher, Professor Du Toit is attached (see Appendix A). Investec Rugby Academy trains aspiring professional rugby players that partake at a national and international level of competition. This study was coordinated by the Department of Physiology at the University of Pretoria.

Research participants fell in age ranges of between 15 and 27 years of age. Graph 3.1 provides information on the age of the sample population.

Graph 3.1: Age of sample population



Graph 3.1 shows that the participants in the current study fall between the age range of 15 to 27 years. It can be seen in Graph 3.1 that a majority of the sample population are 16 and 17 years of age (21.4% of the sample population are 16 years of age and 24.4 % are 17 years of age). Much of the sample population are 18 (13.4 %), 19 (11.3 %), 20 (10.5 %), and 15 (10.5 %) years of age. A smaller percent of the sample population fall between 22 and 27 years of age (3.4 % are 22 years of age, 0.8 % are 23 years of age, and 0.4% are 24, 25 and 27 years of age).

3.6. Measurement Instruments

Both psychological and physiological measures were used to address the PW and HRPF of the sample population of rugby players. The following measurements were used:

- Bibliographical questionnaire
- Psychological measures:
 - State-Trait Personality Inventory Form (Y) by Spielberger and associates (1975)
 - Sport Competitive Anxiety Test by Martens, Vealey, and Burton (1990)
- Physiological measures:
 - Various physiological measures assessing heart health, body composition, and aspects of physical fitness.

3.6.1. Biographical Questionnaire

The biographical questionnaire documented participants' demographic information such as their name, contact details, gender, age, date of birth, race, dominant hand, and position of play. An example of the biographical questionnaire is attached (see Appendix B).

3.6.2. Psychological Measures

3.6.2.1. State-Trait Personality Inventory Form (Y)

The State-Trait Personality Inventory Form (Y) (STPI-Y) was used to measure the psychological wellbeing of the participants. The STPI-Y was developed by Charles Spielberger and his associates in 1975 (Coetzee, 2005). It is an 80-item self-report questionnaire that consists of eight 10-item scales for assessing anxiety, anger, depression, and curiosity as emotional states and personality traits (Spielberger et al., 1975; Spielberger & Reheiser, 2009). An emotional state is the intensity of the emotion as experienced at a particular time, whilst an emotional trait is how prone a person is to experience an emotion. Trait emotion is reflected in the frequency of which the emotion has been experienced in the past and is foreseen to occur in the future (Spielberger & Reheiser, 2009).

In responding to the STPI-Y state items, participants indicate how they are feeling at that particular moment on a four-point Likert scale: 1 = Not at all; 2 = Somewhat; 3 = Moderately so; or 4 = Very much. The STPI-Y trait items call for participants to indicate how they generally feel by also rating themselves on a four-point Likert scale (1= Almost never; 2 = Sometimes; 3 = Often; and 4 = Almost always) (Spielberger & Reheiser, 2009). This questionnaire has a no time limit and can be administered both individually and in groups (Spielberger & Reheiser, 2003).

3.6.2.2. Psychometric properties of the STPI-Y

Spielberger et al. (1975) performed much research on the STPI-Y to establish its reliability and validity. The STPI-Y is a valid instrument as it meets requirements set for construct validity, content validity, and predictive validity (Coetzee, 2005; Spielberger & Reheiser, 2009). The information on the reliability of the STPI as provided in the Preliminary Manual for the STPI is shown in Table 3.1 (Coetzee, 2005; Spielberger et al., 1975).

Table 3.1: Means (*M*), standard deviations (*SD*) and alpha coefficients calculated for the STPI

Age	18-22		23-32		33+	
	<u>Gender</u>		<u>Gender</u>		<u>Gender</u>	
	Females (n=180)	Males (n=112)	Females (n=189)	Males (n=138)	Females (n=129)	Males (n=128)
Trait Anxiety:						
<i>M</i>	19,40	19,13	17,99	18,08	17,98	16,27
<i>SD</i>	5,33	4,73	5,03	4,77	5,45	4,70
Alpha coeff.	0,92	0,91	0,91	0,91	0,92	0,88
State Anxiety:						
<i>M</i>	18,42	18,80	18,64	18,68	18,17	16,89
<i>SD</i>	6,26	5,65	6,84	5,49	5,75	5,57
Alpha coeff.	0,93	0,91	0,94	0,91	0,93	0,92
Trait Curiosity:						
<i>M</i>	27,59	26,72	29,00	28,50	28,86	30,45
<i>SD</i>	5,16	5,29	5,79	5,12	5,73	5,64
Alpha coeff.	0,96	0,96	0,95	0,96	0,95	0,93
State Curiosity:						
<i>M</i>	25,54	25,01	26,36	27,44	27,59	29,30
<i>SD</i>	6,51	6,34	6,59	6,30	6,73	6,23
Alpha coeff.	0,94	0,94	0,92	0,94	0,93	0,91
Trait Anger:						
<i>M</i>	20,19	20,33	18,45	18,49	18,13	17,41
<i>SD</i>	5,21	5,09	4,51	4,98	4,82	5,19
Alpha coeff.	0,91	0,92	0,89	0,91	0,90	0,88
State Anger:						
<i>M</i>	13,41	14,79	13,71	14,28	13,67	13,29
<i>SD</i>	5,25	5,91	5,72	6,03	5,24	4,93
Alpha coeff.	0,94	0,94	0,93	0,94	0,93	

Note Alpha coeff. = Alpha coefficient

Information on the reliability of the scales for Trait and State Depression did not feature in the Preliminary Manual. Later research, however, showed an alpha coefficient of $\alpha = .90$ for males and females on both scales (Coetzee, 2005; Spielberger & Reheiser, 2003; Spielberger & Reheiser, 2009).

The internal consistency reliability of the STPI-Y for the South African population has been found by Du Plessis (2013) to range from satisfactory (above $\alpha = .7$) to good (above .8). Du Plessis (2013) assessed the internal consistency reliability of the STPI-Y with Cronbach's Alpha. The internal consistency reliability was calculated for the total sample as well as four ethnic groups and two gender groups. Du Plessis' (2013) findings for the internal consistency reliability for the South African population are shown in Table 3.2.

Table 3.2: Cronbach's Alpha reliability calculated for the SPTI-Y in a South African population

STPI-Y Subscales	Total Group	Ethnic groups				Gender	
		African	Indian/ Asian	Coloured	White	Male	Female
State-Anxiety	.84	.82	.83	.82	.87	.85	.84
State-Anger	.90	.90	.90	.92	.91	.91	.90
State-Depression	.84	.83	.84	.82	.86	.84	.84
State-Curiosity	.76	.72	.72	.77	.80	.75	.76
Trait-Anxiety	.80	.80	.81	.75	.84	.81	.81
Trait-Anger	.82	.80	.85	.80	.85	.82	.82
Trait-Depression	.87	.86	.88	.79	.90	.87	.87
Trait-Curiosity	.78	.72	.78	.73	.83	.78	.78

In the current study, the internal consistency reliability of the STPI-Y subscales for the research sample population was assessed with Cronbach's Alpha. The Cronbach Alpha coefficients were found to range between $\alpha = .63$ and $\alpha = .87$. According to Bryman and Bell (2007), Cronbach Alpha values of $\alpha = .7$ and above are typically considered an indication of a good level of internal consistency reliability (Bryman & Bell, 2007). Values between $\alpha = .50$ and $\alpha = .69$ denote an acceptable level of reliability (Bryman & Bell, 2007). Therefore, according to Bryman and Bell (2007), the findings for the internal consistency reliability of

the STPI-Y subscales for the current studies sample population range from acceptable to good. These findings are shown in Table 3.3.

Table 3.3: Cronbach's Alpha reliability calculated for the SPTI-Y in the current studies sample population

STPI-Y Subscales	Sample population
State-Anxiety	.75
State-Anger	.87
State-Depression	.75
State-Curiosity	.63
Trait-Anxiety	.65
Trait-Anger	.73
Trait-Depression	.71
Trait-Curiosity	.67

3.6.3. Sport Competitive Anxiety Test

The Sport Competitive Anxiety Scale (SCAT) was used to measure the research participants' level of anxiety caused by participating in rugby competitions. The SCAT was developed by Martens, Vealey, and Burton (1990) to measure Competitive Trait Anxiety (A-trait) in Sport (Potgieter, 2009; Smith & Smoll, 1990). Competitive A-trait is a person's likelihood to view competitive situations as threatening, and the level of State Anxiety (A-state) with which they respond to such situations (Martens et al., 1990). A-state is the presented or immediate emotional experience characterised by apprehension and tension (Martens et al., 1990). Although the STPI-Y and SCAT both measure A-trait and A-state anxiety, the SCAT looks at anxiety experienced specifically in relation to sport, while STPI-Y looks at participants' experience of anxiety in all contexts.

The SCAT Adult Form (SCAT-A) was used for this research as it is valid for persons aged 15 and older. The SCAT-A is a self-administered paper-and-pencil questionnaire. It is a 10-item scale with each item specific to sport competition. The scale calls for participants to answer each item according to how they usually feel in competitive sport situations on a three-point Likert-scale categorised as hardly ever, sometimes, and often (Kar, 2013). This

SCAT-A scale generates a one-dimensional score of competitive trait anxiety. Competitive trait anxiety raw scores range from 10 (low competitive trait anxiety) to 30 (high competitive trait anxiety). There is no time-limit in which to complete the questionnaire, though on average less than five minutes is required.

3.6.3.1. Psychometric properties of the SCAT-A

The SCAT-A has been shown by various studies to be reliable and valid (Martens, 1982; Martens et al., 1990). Bias is avoided in the SCAT-A by the exclusion of any reference to the word or concept of anxiety within its statements. The SCAT-A also includes five spurious items that are not marked. The inclusion of these five spurious or false items is intended to increase the face validity and prevent response bias. Reliability of the SCAT-A has been assessed by test-retest and analysis of variance (ANOVA) techniques (Martens et al., 1990).

The test-retest of the SCAT-A is adequate as it has shown to range from $\alpha = .57$ to $\alpha = .93$ with a mean of $\alpha = .77$ (Potgieter, 2009). Martens et al., (1990) found the SCAT-A's ANOVA reliability coefficient's mean was $\alpha = .81$ and the SCAT-A had a high degree of internal consistency. Findings for the reliability and validity of the SCAT-A as reported by Jooste (2011) are provided in Table 3.4.

Table 3.4: Psychometric properties as calculated for the SCAT-A

	Coefficient	Mean
Internal consistency		
Cronbach alpha coefficient	.83	
Item-to-total correlations	From .78 to .98	
Test-retest reliability	.68 to .93	.82
ANOVA (reliability)	From .68 to .94	.85
KR-2	From .95 to .97	

As seen in the table above, according to Jooste (2011) the SCAT-A has good internal consistency, with a Cronbach alpha coefficient reported of $\alpha = .83$. In the current study, the Cronbach alpha coefficient was found to be satisfactory at $\alpha = .78$. Using a large sample group

over an extended period of time (15 years), Potgieter (2009) has established SCAT-A South African norms for rugby players.

3.6.4. Physiological Measures

HRPF was assessed by measuring heart health, body composition, and physical fitness. Firstly, heart health was looked at in terms of cardio stress index (CSI), heart rhythm, heart rate (HR), duration of vascular excitation (QRSd) and blood pressure (systolic pressure and diastolic pressure). The battery-operated Viport (Energy Lab Techniques GmbH) was used to assess all the measures of heart health with exception of blood pressure. Blood pressure was assessed using a mercury sphygmomanometer and stethoscope. Body composition was evaluated in terms of body mass index (BMI), body fat percentage and waist-to-hip ratio (WHR). BMI was determined by using a calibrated weight scale and tape measure. Body fat percentage was assessed with a Harpenden six-skin fold calliper. The Harpenden six-skin fold calliper consists of six tests on six skin folds in different areas of participants' bodies (the abdominal, thigh, triceps, calf, suprailiac, and subscapular). WHR was measured using a tape measure. Participants' physical fitness was measured according to the completion of four separate physical fitness tests. The physical fitness tests consisted of: (a) a one-minute sit-up test and one-minute push-up test, both of which needed a stopwatch and a floor mat (in the case of hard surfaces); (b) three minute step test, which required a step which rose approximately 40 cm above the ground and a stopwatch; (c) and finally, a sit-and-reach test. The purpose of the one-minute sit-up test and one-minute push-up test is to evaluate muscle strength and endurance, while the purpose of the three-minute step test is to evaluate cardiovascular endurance. The purpose of the sit-and-reach test is to assess the level of hamstring and lower back flexibility.

3.7. Data Collection

The biographical questionnaire and the psychological questionnaires (STPI-Y and SCAT-A) were administered simultaneously to participants as a group. Thereafter, the HRPF (physiological) components were measured. The questionnaires and HRPF components were administered in a hall at the Investec Rugby Academy training camps in Durban and Cape Town. All data was collected by the University of Pretoria's Sport Physiology and Sport

Science students. Since the STPI-Y and SCAT-A are only psychological questionnaires and not classified tests, they need not be administered by psychologists. Dr Nicoleen Coetzee of the University of Pretoria's Psychology Department, however, trained the data collectors to administer these two questionnaires. The physiological tests were administered under the supervision of Professor Peet du Toit of the University of Pretoria's Physiology Department. All the testing took place on the same day. The standard operating procedures formulated by the principal researcher Professor Peet du Toit that were followed to obtain the physiological measures are attached (see Appendix C).

3.8. Data Analysis

Correlation coefficients were determined between the PW and HRPF of participants. The correlation coefficients were calculated between the variables used to measure HRPF and those used to measure PW. The variables used to measure HRPF were heart health, body composition, and physical fitness. The variables that determined heart health was CSI, heart rhythm, HR, QRSd, systolic pressure, and diastolic pressure. Body composition was assessed with the variables body mass index (BMI), body fat percentage (assessed according to skin fold thickness), and WHR. Physical fitness was determined by the following four physical fitness tests: (a) a one-minute sit-up test; (b) a one-minute push-up test; (c) a three-minute step test; (d) and a sit-and-reach test. The variables used to measure PW were state and trait anxiety, depression, anger, curiosity, as well as competitive trait anxiety. IBM Statistical Package for the Social Sciences (SPSS) Statistics 23® was used to analyse the data. All results obtained were recorded and conclusions, confirming or rejecting the set hypotheses, were made.

3.9. Ethical Considerations

Prior to the commencement of the study, the principle researcher Professor Du Toit submitted the research protocol of the high-performance study to the Ethics Committee of the Faculty of Health Science at the University of Pretoria for approval. Ethical approval for the study on high performance was obtained successfully (See Appendix D for proof of ethical clearance for the high-performance study). Ethical approval was obtained by the researcher

for the current study from the Ethics Committee of the Faculty of Humanities at the University of Pretoria.

3.9.1. Voluntary Participation and Informed Consent

Potential participants were screened at a preliminary introduction session to ensure that all research participants fulfilled all the necessary aforementioned inclusion criteria. At this preliminary introduction session, the participants also received comprehensive information regarding their rights as participants, ethical approval, informed consent, confidentiality, possible risks and benefits associated with participation, as well as withdrawal procedures from the research study. Each participant was appropriately informed on the design of the study, rationale, and the procedures of the proposed research. Furthermore, it was stressed to the participants that the assessments conducted in this research study function as a health and lifestyle assessment and do not qualify as or substitute medical advice or treatment. Potential participants were also told that the measures would not be used for diagnostic purposes and that any medical concerns, health risks, and conditions they may have required the attention of a health care provider or medical physician. Participants were also informed that they would participate in the research at their own risk and that they could withdraw from the research at any point without any negative consequences. Time was then provided for participants who required further or additional clarification of any matters to ask questions. The participants who met all necessary criteria were invited to volunteer as research participants in the study. For those who agreed to volunteer, informed consent was attained in each participant's language of preference in which they are fluent and comprehensive. An example of the informed consent document given to participants is attached (see Appendix E). The consent form informed participants that the data and results of the study would be used for future research and guaranteed confidentiality to participants.

3.9.2. Confidentiality

Participants were assured in the consent document and verbally during the introductory sessions that any information gathered during the research study that could be tied to their identity would remain confidential and would not be disclosed to any other party outside of Investec Rugby Academy without their consent, or outside the requirements of the

law. Participants agreed in the informed consent document to the data being used for research purposes.

The confidentiality of participants and their responses was ensured through a numbering system in which each participant was given a number by which they were referred to throughout the study. The participants' names were recorded on their consent forms and answer sheets, which could only be linked to their results by the principle researcher, Professor Peet du Toit of the University of Pretoria's Physiology Department.

3.9.3. Data Storage

The data obtained for this study is stored at the University of Pretoria's Department of Psychology and Department of Physiology and will remain so for a minimum of 15 years.

3.9.4. Risks and Possible Disadvantages to the Participants

The nature of the research is such that participants were not and will not be in danger of physical or psychological harm as a direct or indirect result of the research process. A medical doctor was made available at the Investec Rugby Academy to participants at the time of testing in case they needed medical advice or care.

3.10. Conclusion

This chapter discussed the methodology that was used to investigate the relationship between psychological wellbeing and HRPF of professional rugby players at Investec Rugby Academy. The biopsychosocial model was selected in accordance with the aim of the study. A correlational research design was utilised in which participants were recruited through purposive sampling. The data was collected by University of Pretoria Physiology students under the supervision of the principal supervisor, Professor Du Toit of the University of Pretoria's Department of Physiology. The data was analysed according to the research design using the SPSS Statistics 23®. Care was taken to address the ethical concerns of the study. The following chapter will discuss the results of the data analysis.

CHAPTER 4: RESULTS

4.1. Introduction

The previous chapter discussed the methodology that was employed for this study. The present chapter focuses on the statistical analysis conducted on the sample population. The results of the descriptive statistics and the statistical analysis used to accomplish the research objectives and achieve the research aim are presented. As mentioned in Chapter 1, section 1.3 and Chapter 3, section 3.2, the aim of this study was to investigate the correlation between the psychological wellbeing (PW) and health-related physical fitness (HRPF) of rugby players. To reach this aim, the following three objectives were formulated:

- To investigate the HRPF of professional rugby players;
- To determine the PW of professional rugby players;
- To measure whether there is a relationship between the HRPF and the PW of professional rugby players as well as the strength and direction of this relationship.

4.2. Descriptive Statistics

Descriptive statistics provide statistical summaries of data for the purpose of facilitating an understanding of the focal characteristics of a data set (Struwig & Stead, 2010). The descriptive statistics that follow thus aim to describe the attributes of the variables under investigation. The descriptive statistics for the biographical questionnaire variables ethnicity and position of play are not included in the present study as there were too many missing values in the dataset. The data summary for the psychological measures (State-Trait Personality Inventory Form Y (STPI-Y) and Sport Competitive Anxiety Test (SCAT-A) and various physiological measures follow.

4.2.1. Psychological Measures Descriptive Statistics

4.2.1.1. *STPI-Y descriptive statistics*

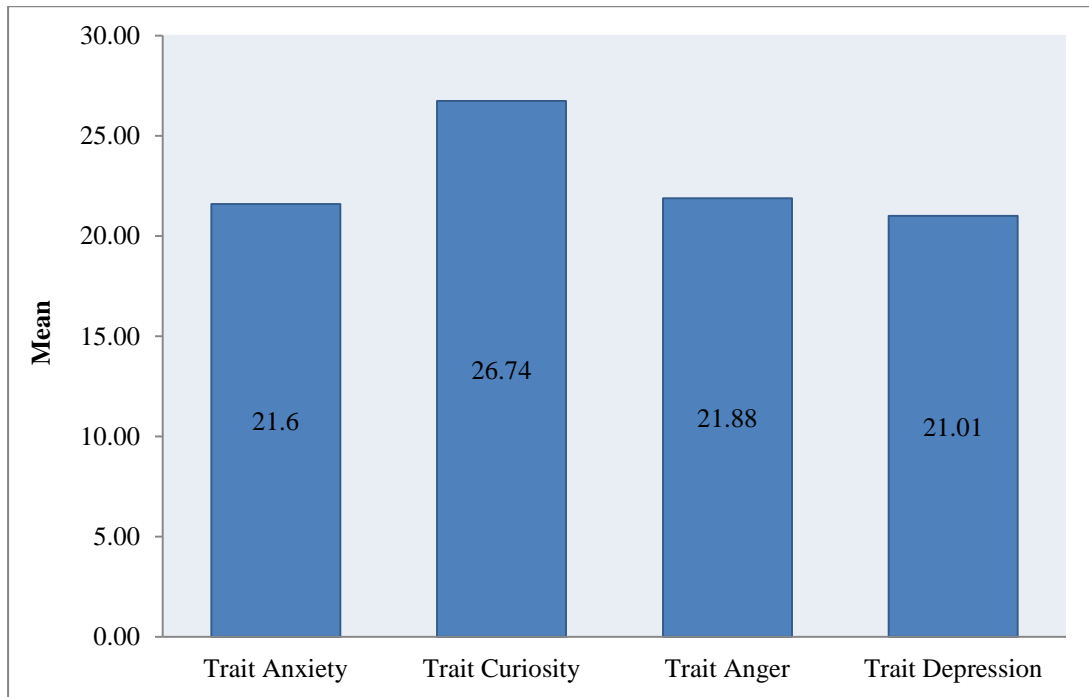
The descriptive statistics in Table 4.1 show the STPI-Y subscales (state anxiety, state curiosity, state anger, state depression, trait anxiety, trait anger, trait curiosity, and trait depression) central tendencies and variation for the sample population.

Table 4.1: Descriptive statistics of sample population (n=238) in relation to STPI-Y subscales

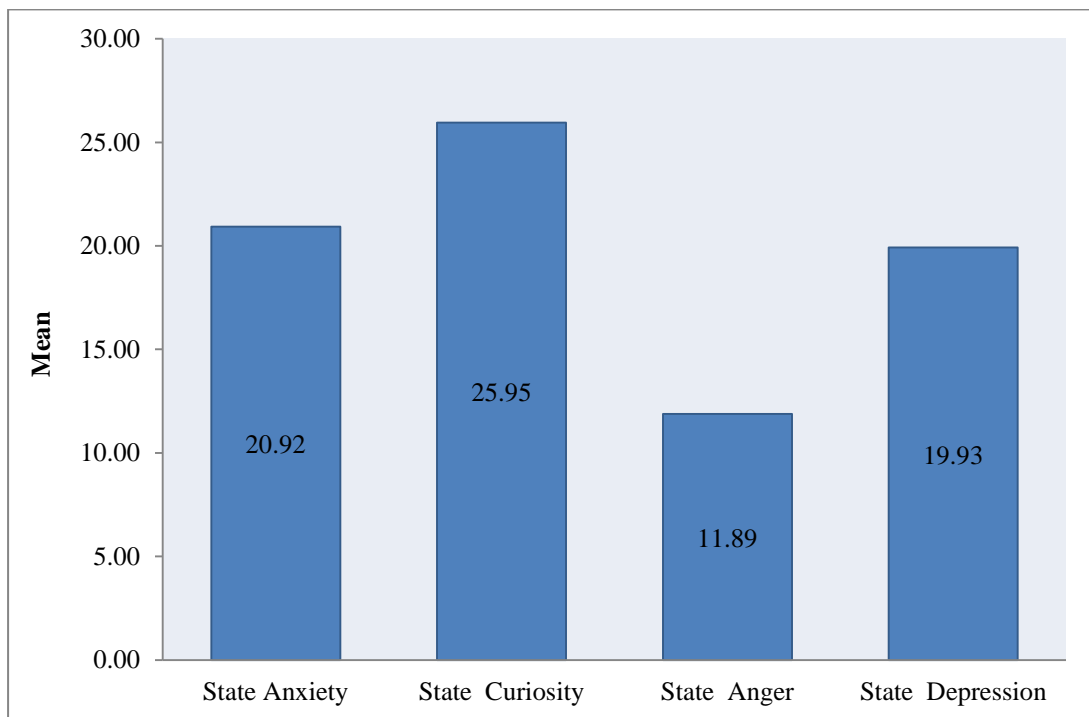
	Sample size	Mean	Standard Deviation	Minimum	Maximum
State Anxiety	234	20.92	4.23	11	35
State Curiosity	223	25.95	4.05	15	37
State Anger	232	11.89	3.53	10	40
State Depression	235	19.93	4.72	10	34
Trait Anxiety	225	21.60	4.47	11	32
Trait Curiosity	228	26.74	3.94	18	40
Trait Anger	230	21.88	5.22	10	39
Trait Depression	233	21.01	5.40	10	32

The descriptive statistics in Graph 4.1 display the STPI-Y trait subscales (trait anxiety, trait anger, trait curiosity, and trait depression) and Graph 4.2 shows the STPI-Y state subscales (state anxiety, state curiosity, state anger, and state depression) sample statistics.

Graph 4.1: Descriptive statistics of sample population (n=238) in relation to STPI-Y trait subscales



Graph 4.2: Descriptive statistics of sample population (n=238) in relation to STPI-Y state subscales



4.2.1.2. SCAT-A descriptive statistics

The descriptive statistics in Table 4.2 show the SCAT-A central tendencies and variation for the sample population.

Table 4.2: Descriptive statistics of sample population (n=237) in relation to SCAT-A

	Sample size	Mean	Standard Deviation	Minimum	Maximum
Total SCAT-A	237	19.92	2.98	10	26

4.2.2. Physiological Measures Descriptive Statistics

As mentioned in Chapter 3, section 3.6.4 and 3.8, the HRPF of the sample population was assessed by measuring heart health, body composition, and physical fitness. Firstly, heart health was examined in terms of a cardio stress index (CSI), heart rhythm, heart rate (HR), QRS duration (QRSd), and blood pressure. Blood pressure was recorded as systolic pressure and diastolic pressure. Body composition was assessed in terms of body mass index (BMI), body fat percentage and waist-to-hip ratio (WHR). Physical fitness was determined by the completion of four separate tests namely: (a) a sit-and-reach test, (b) a one-minute push-up test, (c) a three-minute step test, and (d) a one-minute sit-up test.

The results from the physiological measures used to determine the HRPF of the sample population were categorised into health risk and performance level ordinal scales. The health risk categories are based on international norms for each of the physiological measures. Scores for body composition and heart health are placed into one of three health risk groups, namely high, moderate, or low health risk. The fitness tests fall in one of three performance groups: high, moderate, or low performance. A low-performance fitness level has a high risk of affecting health; a moderate performance level has a moderate risk of affecting health; while a high-performance level has a low risk of affecting health. The descriptive statistics for each of the physiological measures follows.

4.2.2.1. *Body composition descriptive statistics*

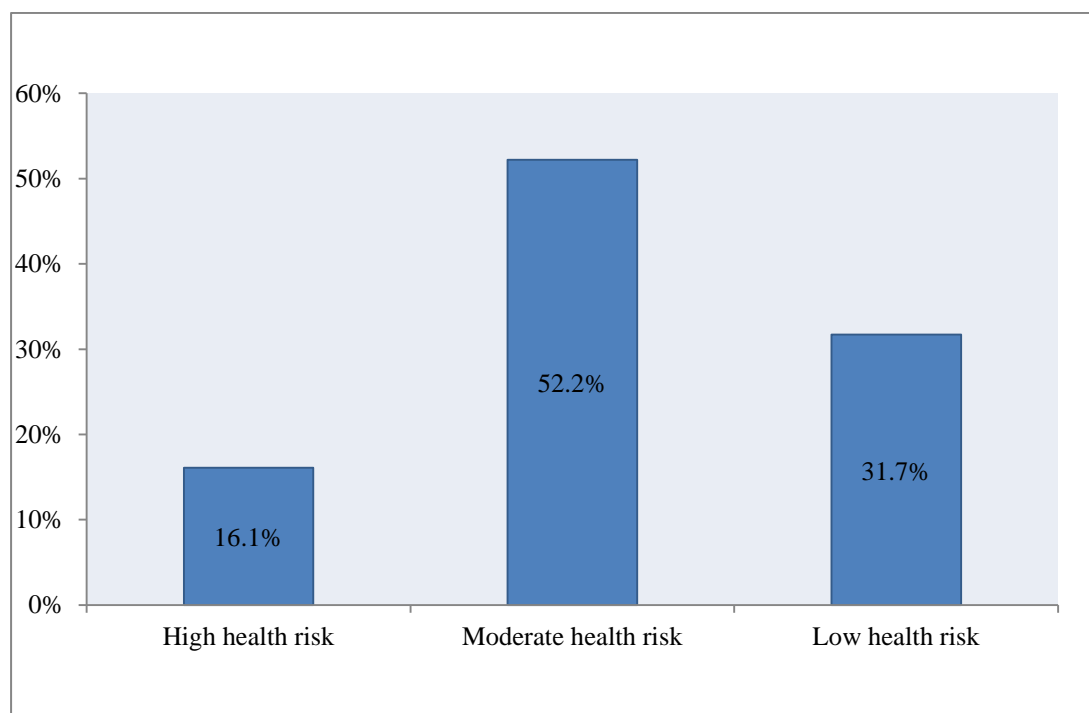
Body composition was measured by determining the BMI, WHR, and body fat percentage of the sample population of rugby players (see Chapter 3, sections 3.6.4 and 3.8; and Chapter 4, section 4.2.3). The descriptive statistics in Table 4.3 show the BMI, WHR, and body fat percentage central tendencies and variation for the sample population.

Table 4.3: Descriptive statistics of sample population in relation to BMI, WHR and body fat percentage

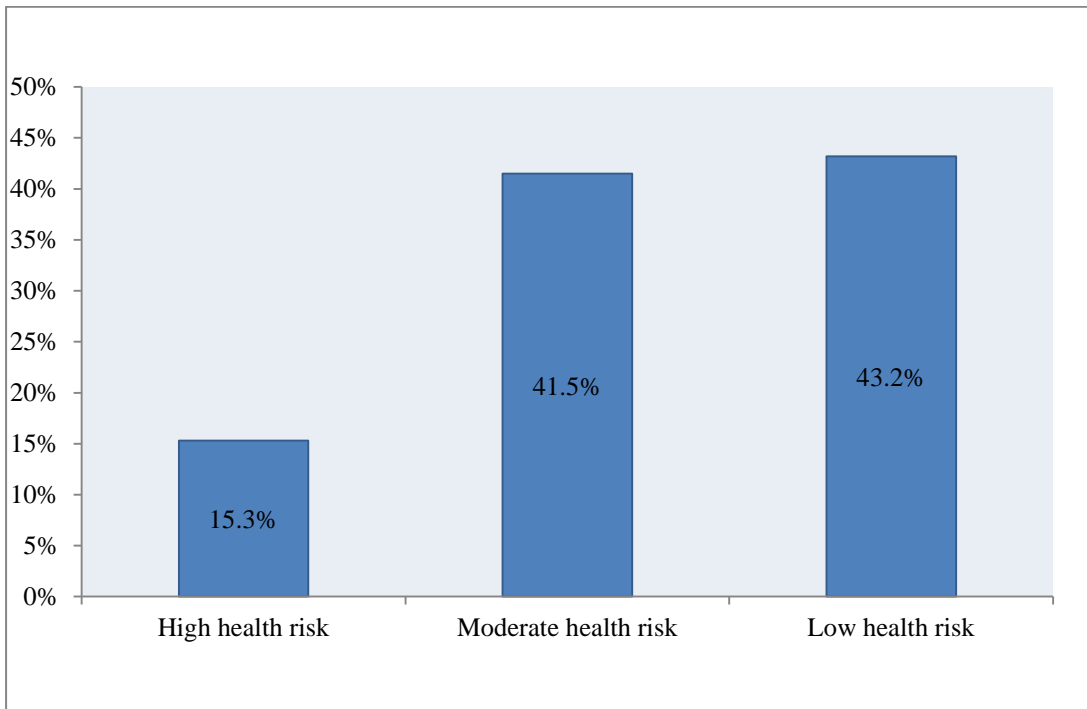
	Sample size	Mean	Standard Deviation	Minimum	Maximum
BMI	237	26.31	5.96	20.91	40.26
Body fat percentage	237	11.89	3.63	6.16	24.34
WHR	236	.67	.30	.23	1.12

The descriptive statistics in Graph 4.3, Graph 4.4, and Graph 4.5 display the BMI, WHR, and body fat percentage frequencies in the health risk categories for the sample population, respectively.

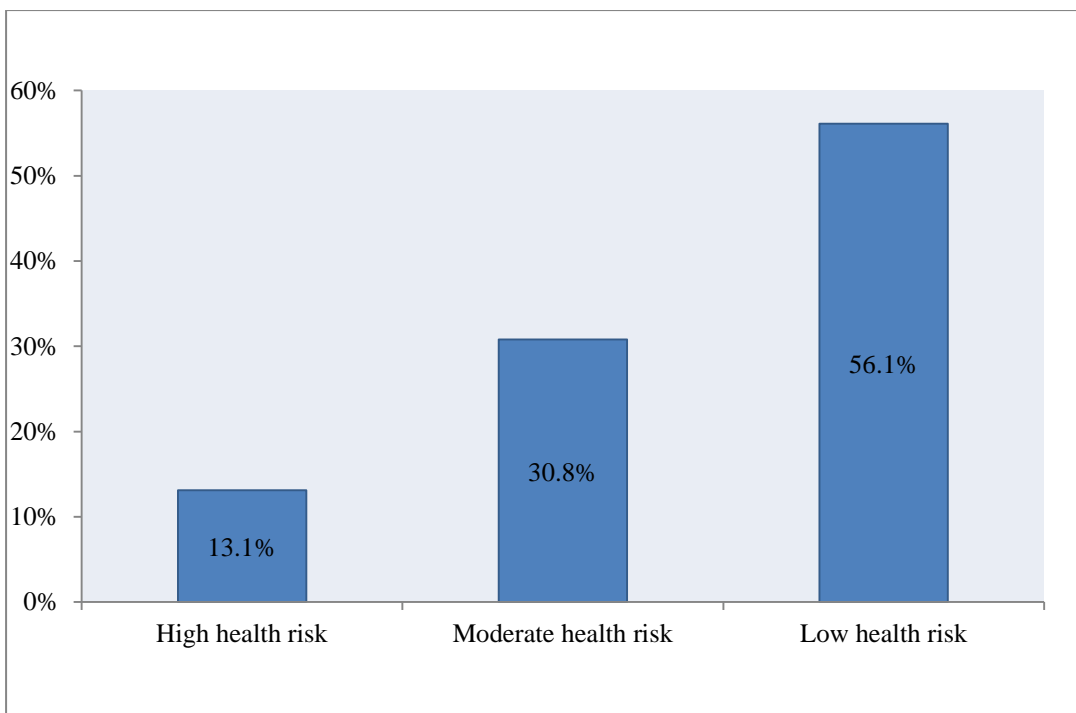
Graph 4.3: Descriptive statistics of sample population (n=237) in relation to BMI



Graph 4.4: Descriptive statistics of sample population (n=236) in relation to WHR



Graph 4.5: Descriptive statistics of sample population (n=237) in relation to body fat percentage



4.2.2.2. *Heart health descriptive statistics*

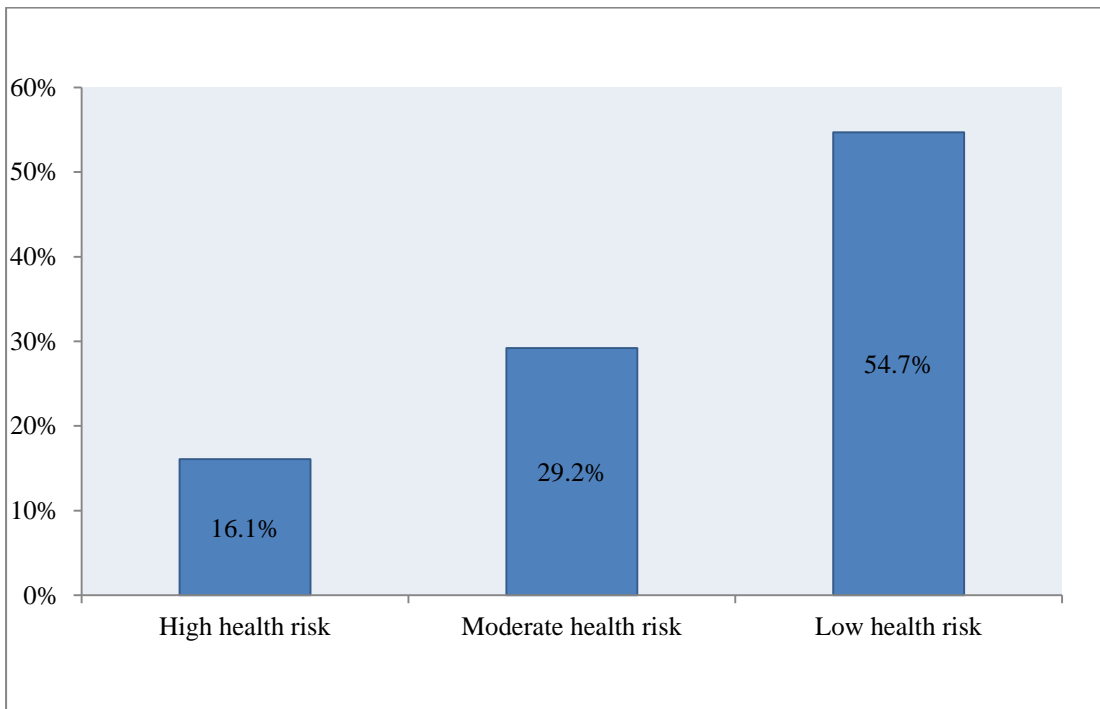
Heart health was assessed by a CSI, HR, heart rhythm, QRSd, and blood pressure (systolic and diastolic pressure) (see Chapter 3, sections 3.6.4 and 3.8; and Chapter 4, section 4.2.3). The descriptive statistics in Table 4.4 show CSI, HR, heart rhythm, QRSd, systolic pressure, and diastolic pressure central tendencies and variation for the sample population.

Table 4.4: Descriptive statistics of sample population (n=236) in relation to CSI, HR, heart rhythm, QRSd, systolic pressure, and diastolic pressure

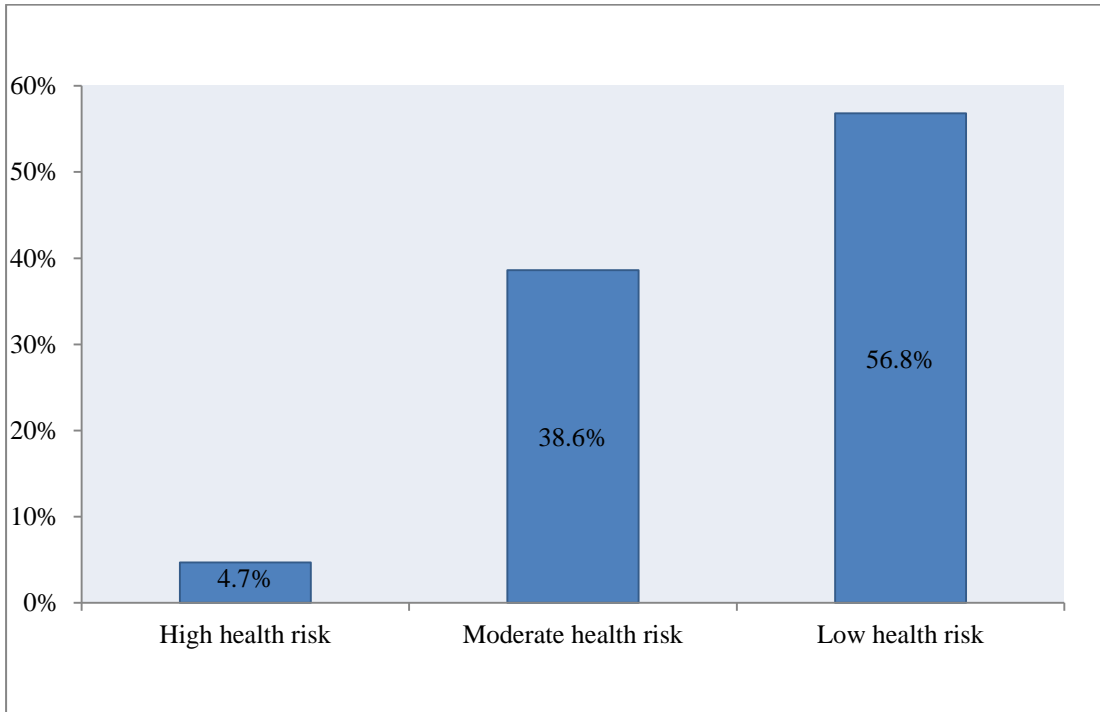
	Sample size	Mean	Standard Deviation	Minimum	Maximum
CSI	236	28.47	20.30	9	100
HR	236	78.76	12.08	28	109
Heart rhythm	236	.99	.09	.0	1
QRSd	236	88.20	10.06	54	119
Systolic pressure	234	129.95	13.01	100	172
Diastolic pressure	234	76.45	7.51	52	101

The descriptive statistics in Graph 4.6, 4.7, 4.8, 4.9, 4.10, and 4.11 display the CSI, HR, heart rhythm, QRSd, systolic pressure, and diastolic pressure frequencies in the health risk categories for the sample population.

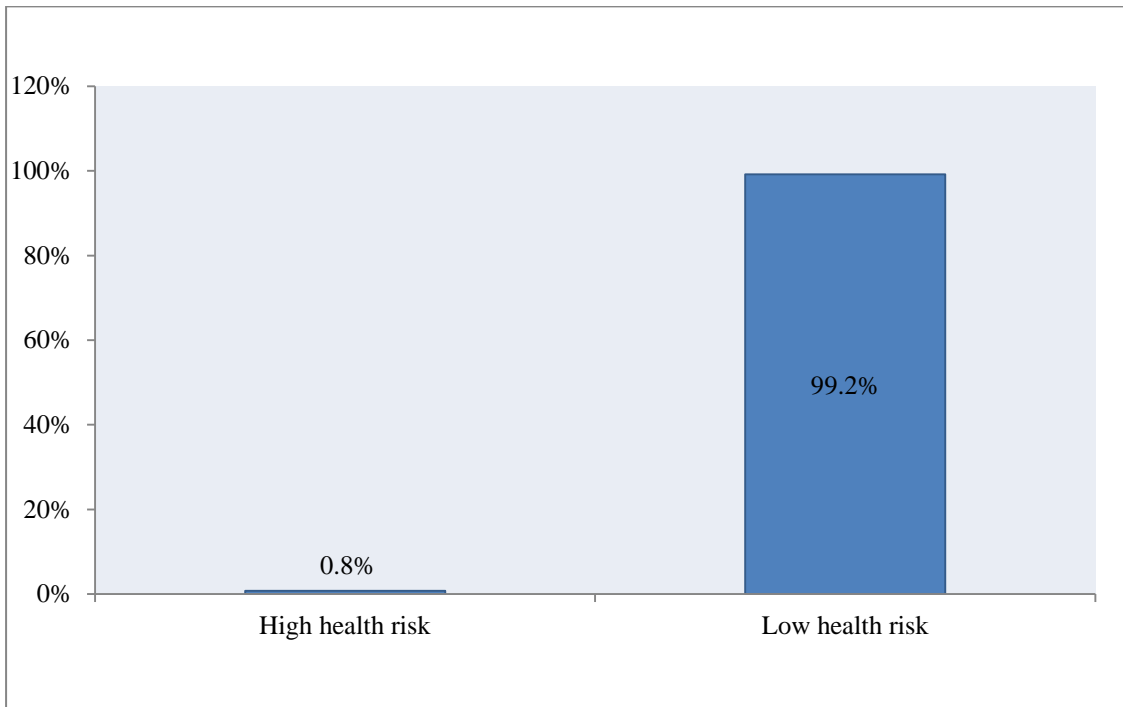
Graph 4.6: Descriptive statistics of sample population (n=236) in relation to CSI



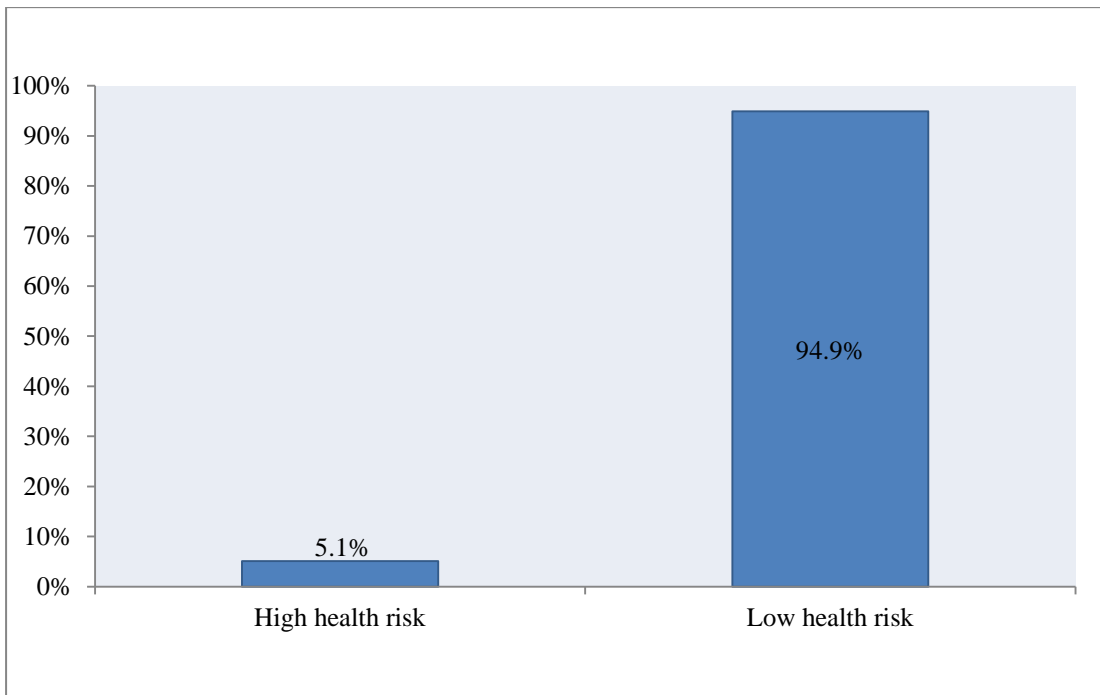
Graph 4.7: Descriptive statistics of sample population (n=236) in relation to HR



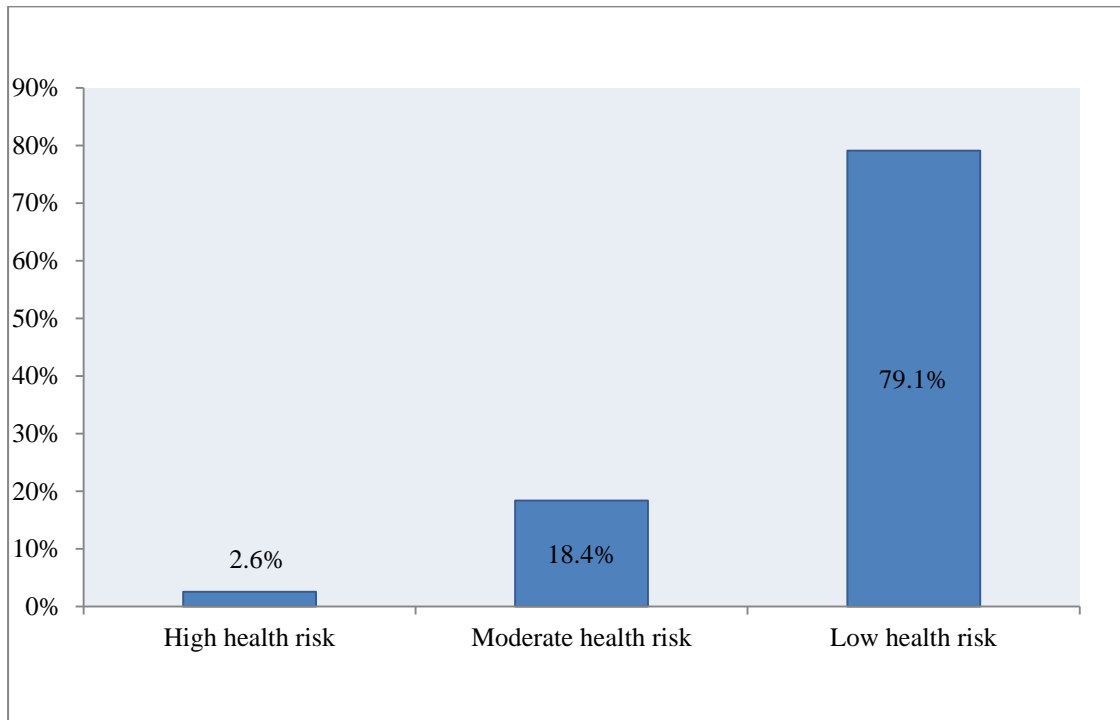
Graph 4.8: Descriptive statistics of sample population (n=236) in relation to heart rhythm.



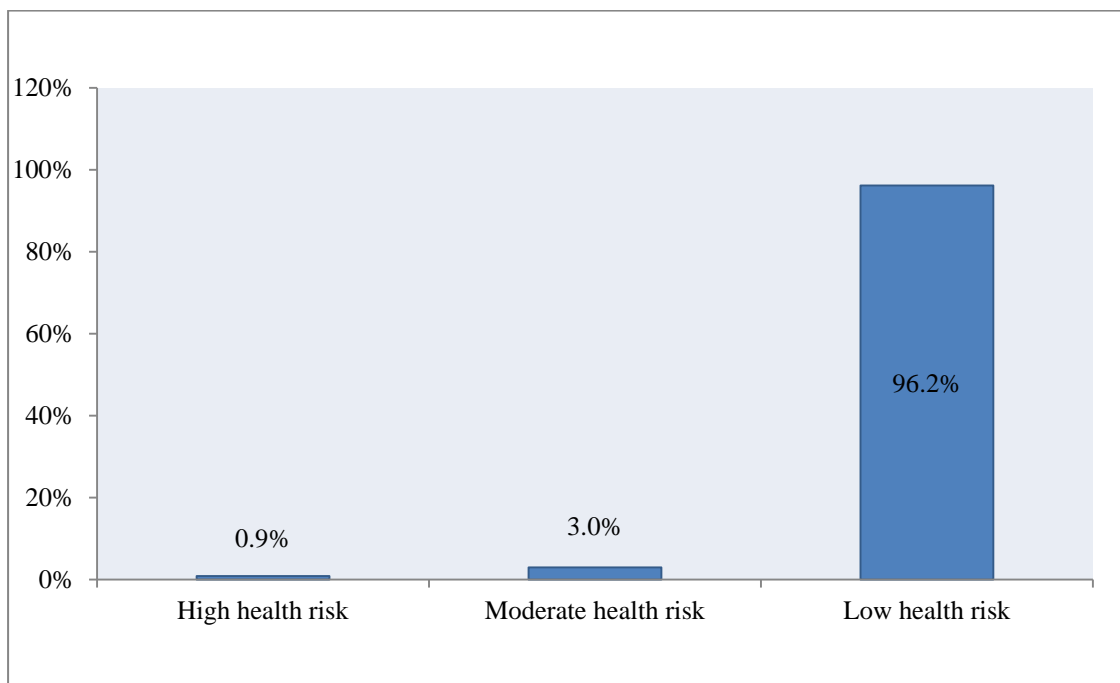
Graph 4.9: Descriptive statistics of sample population (n=236) in relation to QRSd



Graph 4.10: Descriptive statistics of sample population (n=234) in relation to systolic pressure



Graph 4.11: Descriptive statistics of sample population (n=234) in relation to diastolic pressure



4.2.2.3. *Physical fitness descriptive statistics*

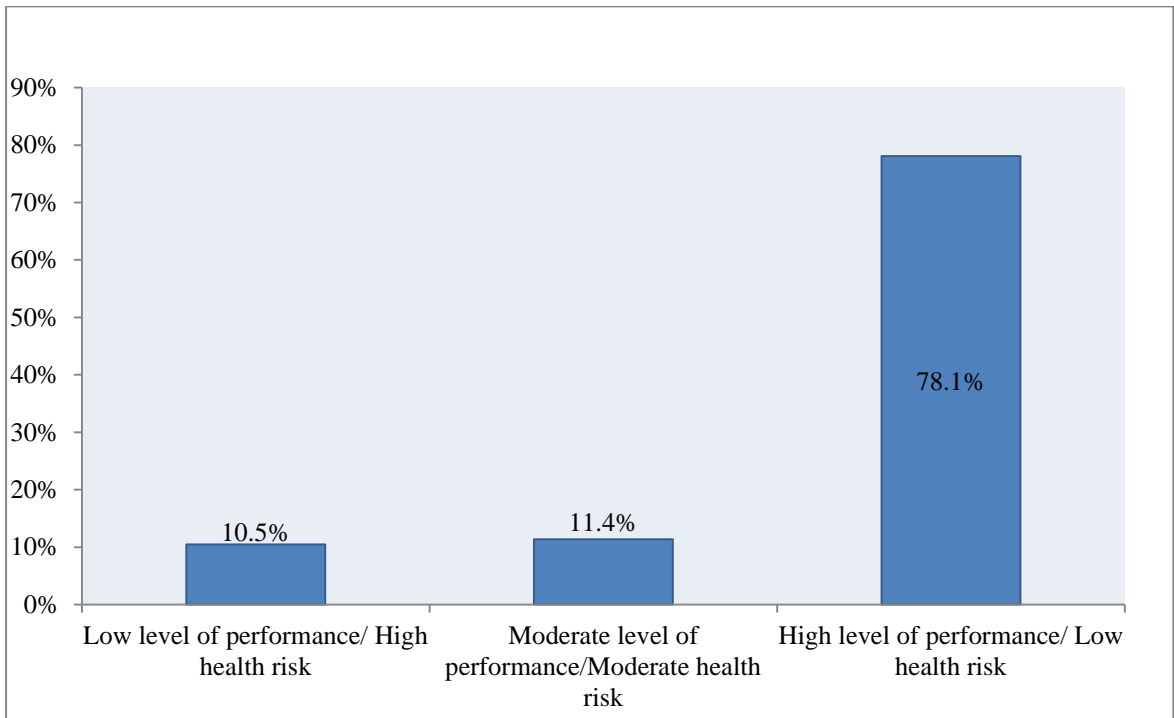
As stated in Chapter 3, sections 3.6.4 and 3.8, and Chapter 4, section 4.2.3, the physical fitness component of HRPF was assessed according to four separate fitness tests namely a one-minute sit-up test, one-minute push-up test, three-minute step test and finally, a sit-and-reach test. The descriptive statistics in Table 4.5 show the central tendencies and variation for the sample population for each fitness test.

Table 4.5: Descriptive statistics of sample population in relation the fitness tests

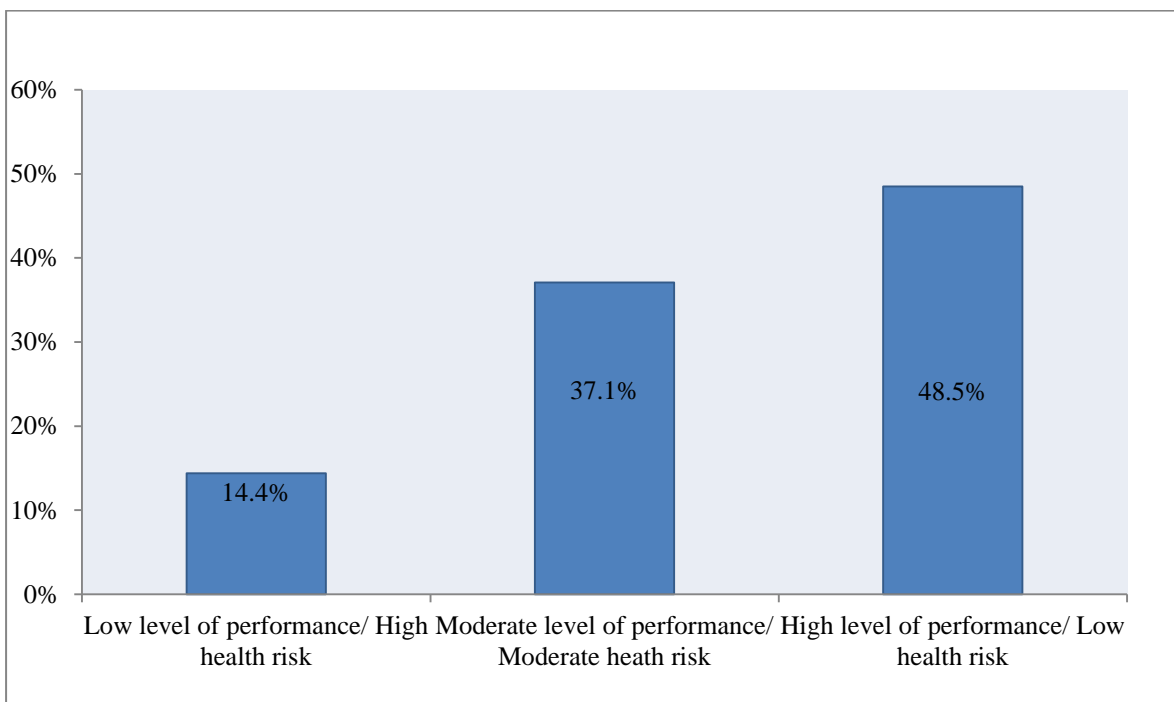
	Sample	Standard			
	size	Mean	Deviation	Minimum	Maximum
Sit-and-reach test	237	29.26	9.13	5	50
One-minute push-up test	229	56.39	14.97	16	105
One-minute sit-up test	230	52.11	11.54	27	89
Three-minute step test	191	143.04	27.23	80	240

The descriptive statistics in Graph 4.12, 4.13, 4.14, and 4.15 display the frequencies in the performance categories of the sample population in relation to the sit-and-reach test, one-minute push-up test, one-minute sit-up test, and three-minute step test, respectively.

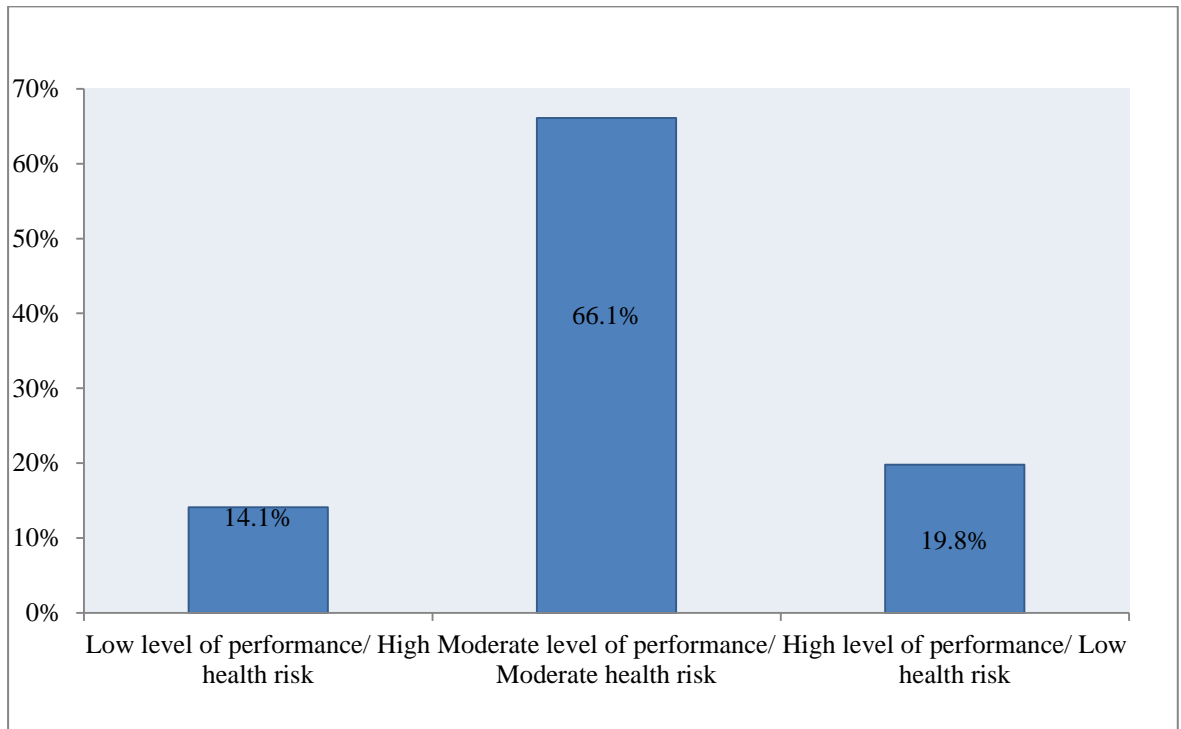
Graph 4.12: Descriptive statistics of sample population (n=237) in relation to sit-and-reach test



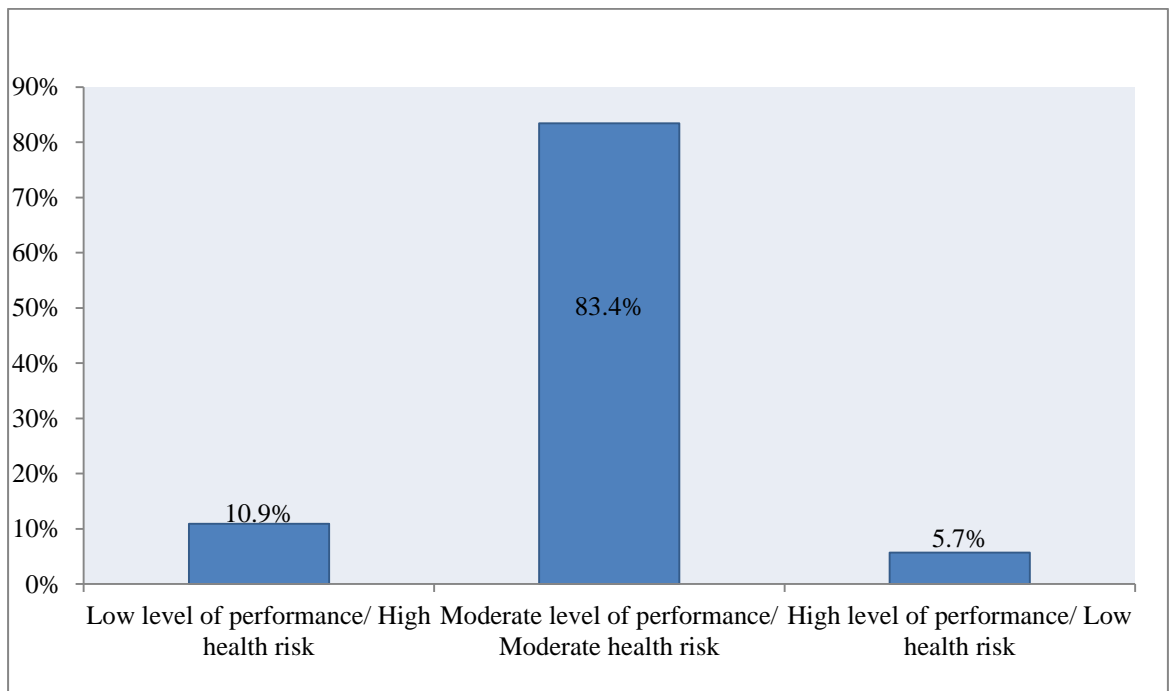
Graph 4.13: Descriptive statistics of sample population (n=229) in relation to one-minute push-up test



Graph 4.14: Descriptive statistics of sample population (n=230) in relation to one-minute sit-up test



Graph 4.15: Descriptive statistics of sample population (n=191) in relation to three-minute step test



4.3. Statistical Analyses used to reach the Research Aim and Test Hypotheses

The current study made use of parametric techniques. The large sample size, symmetric distribution of scores as well as interval measurement scale enabled the current study to meet the assumptions required to employ parametric techniques (Blaikie, 2003; Struwig & Stead, 2010).

4.3.1. Correlation between the HRPF and PW of the Sample Population

As mentioned in Chapter 1, section 1.2, 3.2, and Chapter 4, section 4.1, the primary aim of this study was to investigate the correlation between the HRPF and PW of rugby players. This aim was formalised in the following null and alternative hypotheses.

- H_0 : There is no statistically significant relationship between HRPF and PW of professional rugby players.
- H_1 : There is a statistically significant relationship between HRPF and PW of professional rugby players.

The Pearson product-moment correlation (Pearson's r) test was used to test these hypotheses. The Pearson's r test is used when there is a need to determine the relationship between variables or the degree to which "variation in one continuous variable explains variation in another continuous variable" (Struwig & Stead, 2010, p. 160). The Pearson's r test produces a Pearson Correlation Coefficient (r), which is a numerical value that measures and describes the relationship between variables (Gravetter & Forzano, 2012; Pallant, 2010). The sign of the correlation (positive/negative) indicates the direction of the relationship (Gravetter & Forzano, 2012). A positive correlation indicates that as one variable increases, so too does the other, while a negative correlation shows that as one variable increases, the other decreases (Pallant, 2010). The numerical value of r indicates the strength of the relationship between variables (Gravetter & Forzano, 2012). This can range from -1.00 to 1.00 . A perfect correlation of 1 or -1 indicates that the value of one variable can be determined exactly by knowing the value of the other variable, while a correlation of 0 represents no relationship between variables (Pallant, 2010). Perfect relationships such as this are uncommon; coefficients preceded by decimals are more regular (Struwig & Stead, 2010).

Gravetter and Forzano (2012) as well as Pallant (2010) reference Cohen's (1988) guidelines for interpreting the strength of the relationship between variables. According to Cohen (1988), values of r between .10 and .29 signify a small correlation; a medium correlation is assumed if r falls between .30 and .49, and a large correlation can be assumed if r equals a value between .50 and 1.0 (Gravetter & Forzano, 2012; Pallant; 2010).

All results obtained by statistical methods bear the disadvantage that they might have been caused by statistical chance. The level of statistical significance (p) is an approximation of the likelihood that a result has occurred by chance. Hence, a small value of p represents a large level of statistical significance and vice versa (Gravetter & Forzano, 2012). It is practice to define a level of significance at which a correlation will be considered to be proven. An accepted level at which the threshold of p is set is .01, which signifies there is a 1% chance that the result was produced by random variation. The significance of such a result would then be indicated by the statement $p \leq .01$. Typically, a lower level of statistical significant such as $p \leq .05$ is set. This means that there is a one in twenty chance that the result was produced by random variation. If the p -value is sufficiently extreme, it is deemed unlikely to be the result of chance. In such a case, the null hypothesis is rejected and the alternative hypothesis accepted (Gravetter & Forzano, 2012). In statistical significance testing, a two-tailed test assesses the possibility of an effect in two directions, both positive and negative.

The Pearson's r was employed to determine the relationship between variables of HRPF and PW in the sample population of rugby players. A two-tailed test was used to compute the level of statistical significance. Values for Pearson's product-moment correlations and level of statistical significance were calculated for all the pairs of variables that determine PW and HRPF. The level of significance at which the correlation of the variables of PW and HRPF are considered proven are $p \leq .01$ and $p \leq .05$. The results are displayed according to the components of HRPF namely, body composition, heart health, and physical fitness.

4.3.1.1. Correlation between PW and body composition of the sample population

As mentioned in Chapter 3, section 3.8, PW was measured according to several variables namely, state and trait anxiety, anger, depression and curiosity, as well as competitive trait anxiety. The body composition component of HRPF was determined by the

variables of BMI, body fat percentage and WHR (see Chapter 3, section 3.8 and Chapter 4, section 4.2.3). Table 4.6 shows the Pearson product-moment correlations and level of statistical significance (p) between the variables that measure PW and body composition.

Table 4.6: Pearson product-moment correlations between PW and body composition

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Com T_Anx		.23**	----	----	----	.36**	----	.17**	.13*	----	----	----
2. S_Anx			-.25**	.40**	.59**	.52**	-.21**	.19**	.40**	----	----	-.16*
3. S_Cur				-.15*	-.55**	-.18**	.70**	.20**	-.40**	----	----	.49**
4. S_Ang					.41**	.25**	----	.27**	----	----	----	.14*
5. S_Dep						.42**	-.43**	----	.65**	.17**	.24**	-.58**
6. T_Anx							-.18**	.40**	.63**	----	----	-.20**
7. T_Cur								.13*	-.35**	----	-.14*	.40**
8. T_Ang									----	----	----	.23**
9. T_Dep										.13*	.20**	-.62**
10. BMI											.50**	-.15*
11. BF												-.26**
12. WHR												

Notes. For all scales, higher scores are indicative of more extreme responding in the direction of the construct assessed. Com T_Anx= competitive trait anxiety; S_Anx = state anxiety; S_Cur = state curiosity; S_Ang= state anger; S_Dep= state depression; T_Anx = trait anxiety; T_Cur = trait curiosity; T_Ang= trait anger; T_Dep= trait depression; BF = body fat percentage. ^a n = 237 for variables 2 to 11 and n= 236 for variables 1 and 12. *. $p \leq .05$, two tailed. **. $p \leq .01$, two tailed.

There is a positive correlation between the PW variables of state and trait depression and the HRF variables of BMI and body fat percentage. Table 4.6 shows a small positive correlation between state depression and BMI ($r = .17$; $p = .01$; $p \leq .01$); between trait depression and BMI ($r = .13$; $p = .05$; $p \leq .05$); between state depression and body fat percentage ($r = .24$; $p = .00$; $p \leq .01$) and between trait depression and body fat percentage ($r = .20$; $p = .00$; $p \leq .01$). There is also a positive correlation between the PW variables of state and trait curiosity as well as anger and the HRF variable of WHR. Table 4.6 displays a medium positive correlation between state curiosity and WHR ($r = .49$; $p \leq .01$) as well as trait curiosity and WHR ($r = .40$; $p \leq .01$). A small positive correlation was obtained between state anger and WHR ($r = .14$; $p \leq .05$) and trait anger and WHR ($r = .23$; $p \leq .01$).

Negative correlations were obtained between body fat percentage and trait curiosity ($r = -.14$; $p \leq .05$). WHR correlated negatively with state and trait anxiety as well as state and trait depression. Table 4.6 shows a small negative correlation between state anxiety and WHR ($r = -.16$; $p \leq .05$) and trait anxiety and WHR ($r = -.20$; $p \leq .01$). A large negative correlation was found between state depression and WHR ($r = -.58$; $p \leq .01$) and between trait depression and WHR ($r = -.62$; $p \leq .01$).

No significant correlations are evident between the components of body composition and competitive trait anxiety. Additionally, the BMI and body fat percentage of the participants were not significantly related to state and trait anxiety, state and trait anger, as well as state depression. There was also no significant correlation between trait curiosity and BMI.

4.3.1.2. Correlation between PW and heart health of the sample population

As mentioned in Chapter 3, section 3.8, and Chapter 4, section 4.2.3, the heart health component of HRPF consists of the following variables; cardiovascular stress index (CSI), heart rate (HR), heart rhythm, QRSd, systolic blood pressure, and diastolic blood pressure. Table 4.7 shows the Pearson product-moment correlations (r) and level of statistical significance between the variables of PW (see Chapter 3, section 3.8 and Chapter 4, section 4.3.1.1) and heart health for the sample population.

Table 4.7: Pearson product-moment correlations between PW and heart health

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Com T_Anxiety		.23**	----	----	----	.36**	----	.17**	.13*	----	----	----	----	----	----
2. S_Anxiety			-.25**	.40**	.59**	.52**	-.21**	.19**	.40**	----	----	----	----	----	----
3. S_Curiosity				-.15*	-.55**	-.18**	.70**	.20**	-.40**	----	.20**	----	----	----	----
4. S_Anger					.41**	.25**	----	.27**	----	----	----	----	----	----	----
5. S_Depression						.42**	-.43**	----	.65**	----	-.19**	----	----	----	----
6. T_Anxiety							-.18**	.40**	.63**	----	----	----	----	----	----
7. T_Curiosity								.13*	-.35**	----	----	----	----	----	----
8. T_Anger									----	----	----	.-----	----	----	.15*
9. T_Depression										----	-.16*	----	----	----	----
10. CSI											.25**	-.17**	----	----	----
11. HR												----	----	----	----
12. HRhythm													----	----	----
13. QRSd														----	----
14. SP															.28**
15. DP															

Notes. For variables 1 through to 11 higher scores are indicative of more extreme responding in the direction of the construct assessed. For variables 12 and 13 scores outside of a set range are indicative of irregular heart functioning. Com T_Anxiety= competitive trait anxiety; S_Anxiety = state anxiety; S_Curiosity = state curiosity; S_Anger= state anger; S_Depression= state depression; T_Anxiety = trait anxiety; T_Curiosity = trait curiosity; T_Anger= trait anger; T_Depression= trait depression; heart rhythm= HRhythm; SP = systolic pressure; DP = diastolic pressure. ^a n's range from 191 to 236 due to occasional missing data *. $p \leq .05$, two tailed. **. $p \leq .01$, two tailed.

As seen in Table 4.7 there is a small positive correlation between state curiosity and the HRPF variable of heart rate ($r = .20$; $p \leq .01$). There is a small positive correlation between trait anger and the blood pressure component, diastolic pressure ($r = .15$; $p = .02$; $p \leq .05$). Negative correlations were obtained for state and trait depression and heart rate. There is a small negative correlation between heart rate and state depression ($r = -.19$; $p \leq .01$) as well as heart rate and trait depression ($r = -.16$; $p \leq .05$).

There are no significant correlations between the PW variables and the heart health components of CSI, QRSd, and systolic pressure. There are also no significant correlations between the PW variables of competitive anxiety, state and trait anxiety, state anger, trait curiosity, and any of the heart health components. All the heart health components were not significantly correlated to trait anger beyond diastolic pressure. Diastolic pressure was not significantly correlated to any of the heart rate variables beyond trait anger. Heart rhythm was not significantly correlated with state and trait depression.

4.3.1.3. Correlation between PW and physical fitness of the sample population

The physical fitness component of HRPF was measured according to a fitness index which consisted of four separate fitness tests. These fitness tests were: sit-and-reach test, one-minute push-up test, one-minute sit-up test, and three-minute step test (see Chapter 3, section 3.8 and Chapter 4, section 4.2.3.3). Table 4.8 shows the Pearson product-moment correlations (r) and level of statistical significance (p) between the variables of PW (see Chapter 3, section 3.8 and Chapter 4, section 4.3.1.1) and physical fitness for the sample population.

Table 4.8: Pearson product-moment correlations between PW and physical fitness

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Com T_Anx		.23**	----	----	----	.36**	----	.17**	.13*	----	----	----	.17*
2. S_An timer			-.25**	.40**	.59**	.52**	-.21**	.19**	.40**	----	----	-.16*	----
3. S_Cur				-.15*	-.55**	-.18**	.70**	.20**	-.40**	----	.17**	.35**	----
4. S_Ang					.41**	.25**	----	.27**	----	----	----	----	----
5. S_Dep						.42**	-.43**	----	.65**	----	----	-.30**	----
6. T_An timer							-.18**	.40**	.63**	----	----	----	----
7. T_Cur								.13*	-.35**	----	----	.30**	----
8. T_Ang									----	----	.15*	----	----
9. T_Dep										----	----	-.28**	----
10. S&R											.16*	----	----
11. PushUp												.33**	-.18**
12. SitUp													----
13. Step													----

Notes. For all scales, higher scores are indicative of more extreme responding in the direction of the construct assessed. Com T_An timer = competitive trait anxiety; S_An timer = state anxiety; S_Cur = state curiosity; S_Ang = state anger; S_Dep = state depression; T_An timer = trait anxiety; T_Cur = trait curiosity; T_Ang = trait anger; T_Dep = trait depression; S&R = sit-and-reach test; PushUp = minute push-up test; SitUp = one-minute sit-up test; Step = three-minute step test.^a n's range from 191 to 236 due to occasional missing data *. p ≤ .05, two tailed. **. p ≤ .01, two tailed.

Positive medium correlations are evident between the one minute sit-up test and state curiosity ($r = .35$; $p \leq .01$) as well as the one-minute sit-up test and trait curiosity ($r = .30$; $p \leq .01$). There is a small positive correlation between state curiosity and the one-minute push-up test ($r = .17$; $p \leq .01$) as well as between trait anger and the one-minute push-up test ($r = .15$; $p \leq .05$). A small positive correlation was also obtained between competitive trait anxiety and the three-minute step test ($r = .17$; $p \leq .01$).

A medium negative correlation was obtained between state depression and the one-minute sit-up test ($r = -.30$; $p \leq .01$). There is also a small negative correlation between trait depression and the one-minute sit-up test ($r = -.28$; $p \leq .01$), as well as state anxiety and the one-minute sit-up test ($r = -.16$; $p \leq .05$).

There are no significant correlations between the PW variables and the physical fitness variable of sit-and-reach test. The PW variables do not correlate significantly with the one-minute step test beyond competitive trait anxiety (see Table 4.8). Competitive trait anxiety, trait anxiety, and state anxiety are not significantly correlated with the one-minute push-up test and the one-minute sit-up test. State anxiety, trait curiosity, and trait depression are not significantly related to the one-minute push-up test, while trait anger is not significantly related to the one-minute sit-up test.

4.4. Conclusion

This chapter provided the descriptive statistics and statistical analyses of the data. The Pearson's r was employed to meet the research aim and investigate the hypotheses. Results showed that some correlations between pairs of PW and HRPF variables reached statistical significance while others did not. The following chapter provides detailed interpretations and discussions of these results.

CHAPTER 5: DISCUSSION AND CONCLUSION

5.1. Introduction

The previous chapter presented the results from the statistical analysis conducted on the sample used to accomplish the research objectives and achieve the research aim. The present chapter will provide a discussion of these results in relation to the research objectives, aim, and hypotheses. The limitations of the current study, recommendations for future research, and a study conclusion will follow.

5.2. Brief Overview of the Aim and Objectives of the Study

The fundamental aim of the study was to investigate the correlation between the psychological wellbeing (PW) and health-related physical fitness (HRPF) of professional rugby players (see Chapter 1, section 1.3; Chapter 3, section 3.2; and Chapter 4, section 4.1). In order to reach this aim three objectives were set:

- To determine the PW of professional rugby players,
- To investigate the HRPF of professional rugby players and
- To measure whether there is a relationship between the HRPF and the PW of rugby players as well as the strength and direction of this relationship.

The first two objectives, namely to determine the PW and HRPF of professional rugby players, are deduced from the descriptive statistics presented in Chapter 4, section 4.2. The third objective is met by discussing the results of the Pearson product-moment correlation (Pearson's r) test presented in Chapter 4, section 4.3.

5.3. Discussion of the Descriptive Statistics Obtained in the Study

The mean and standard deviation were calculated for all PW and HRPF variables in the current study (Gravetter & Forzano, 2012; Struwig & Stead, 2010). The physiological

measures used to determine the HRPF of the rugby players were categorised into health risk categories. The frequencies to which the research samples' (hereinafter referred to as the rugby players) scores fall within the different health risk categories are presented in Graphs 4.3 - 4.15

5.3.1. The PW of Professional Rugby Players

PW refers to the overall psychological condition of the rugby players, including cognitive, emotional, and behavioural repercussions and characteristics (Bar-On, 1988). Emotions have been argued to be the critical signs of PW, especially anxiety, anger, depression, and curiosity (Spielberger & Reheiser, 2009; Spielberger et al., 1975). Emotions can be state and trait in nature. State emotion is transitory and is typically prompted by a particular stimulus (Gallo et al., 2004). On the other hand, trait emotion assesses the more stable differences in tendencies of individuals to experience an emotion (Spielberger & Reheiser, 2009).

PW was measured in accordance with the STPI-Y and SCAT-A (see Chapter 3, section 3.6.2). Descriptive statistics have been calculated for each construct that forms part of PW and are shown in Table 4.1, 4.2, Graph 4.1 and 4.2. Since the maximum score on any of the STPI-Y scales is 40 (see Chapter 3, section 3.6.2.1), a decision was made to use the midpoint of 20 to indicate if a score could be perceived as above or below average.

5.3.1.1. The PW of rugby players and their STPI-Y scores

When revisiting the rugby players' PW in terms of the STPI-Y, it was found that the variables for the four trait subscales were above the midpoint of 20. The rugby players' state scores for curiosity and anger were above the midpoint while their state scores for anger and depression fell below the midpoint.

5.3.1.1.1. Curiosity

The rugby players' mean score for curiosity was higher than the mean scores they obtained for anger, anxiety, and depression (Spielberger & Reheiser, 2003, 2009). While the latter emotions warn of lapses in PW, curiosity is considered a positive emotional indicator of PW (Seligman et al., 2013; Spielberger & Reheiser, 2003, 2009). The rugby players achieved a relatively high mean score for state curiosity ($M = 25.95$; $SD = 4.05$) and trait curiosity (M

= 26.74; $SD = 3.94$), five and six points above the midpoint (see Table 4.1). This finding suggests that many of the rugby players possess PW as they experience positive emotions more frequently, in more situations, and for a longer duration than they do any one negative emotion. This is in accordance with research on the impact of physical activity (PA) on participants' PW. Research indicates that persons who regularly participate in PA (as is the case with the rugby players) generally experience more positive emotions and less negative emotions (Arent et al., 2000). However, the finding that rugby players experience more curiosity than depression, anxiety, or anger is not in accordance with results of studies investigating aspects of rugby players' PW. For example, Nicholls, Jones et al. (2009) looked at the emotional experience of professional rugby players over a 31-day period and found that the negative emotions of anxiety and anger were most frequently cited. This difference in findings may be explained by the discrepancy between the ages of the samples. The sample of rugby players used in Nicholls, Jones et al.'s (2009) study were older than the rugby players in the present study and were consequently more likely to have additional playing experience. This is significant as there is evidence that the intensity to which rugby players experience negative emotions is associated with players' years of playing experience (Grobbelaar et al., 2010). Grobbelaar et al. (2010) assessed student rugby players playing at the highest level of South African university rugby competition over a 5-month period. They found that rugby players with more years of playing experience at this level of competition had a higher degree of negative emotions and lower degree of positive emotions than players with fewer years of experience at this level. The players with more years of playing experience were significantly older than the players with fewer years of experience. In addition to a heightened level of negative emotions, Grobbelaar et al. (2010) found that the players with more years of playing experience were more physically and/or mentally stressed, less capable of using individual strategies for recovery, and had a higher number of key characteristics of burnout. These include, for example, a reduced sense of accomplishment and a higher level of emotional/physical exhaustion than the players with fewer years of playing experience. Grobbelaar et al. (2010) deduced from their findings that the experience level of rugby players participating at a high level of competition influences their chances of experiencing overtraining, overtraining syndrome, and burnout. According to Grobbelaar (2015), the term overtraining refers to the process during which a rugby player is overloaded or stressed due to an increase in volume and intensity of physical training in order to bring

about an “overreached state, which, coupled with sufficient recovery and rest should result in positive physiological and psychological adaptations” (p. 2). The term overtraining syndrome refers to the negative consequences of this process (both physiological and psychological) brought about by too much training and not enough recovery. The term burnout in relation to rugby players is an “enduring psycho-social syndrome characterised by a reduced sense of accomplishment, sport devaluation and emotional and physical exhaustion” (Grobbelaar et al. 2009, p. 45).

5.3.1.1.2. Anger

The rugby players’ mean score for state anger was relatively low ($M = 11.89$; $SD = 3.53$). This suggests the players did not experience intense feelings of anger on the day of testing. The rugby players’ mean score for trait anger was 21.88 ($SD = 5.22$). Additionally, several players acquired extremely high scores for state and trait anger (see Table 4.1). Rugby players high in trait anger would most likely interpret a broad range of circumstances as anger-provoking and as a consequence experience state anger more regularly (Spielberger & Reheiser, 2009). State anger ranges in intensity from feeling mildly irritated or annoyed to intense rage and fury (Hamdan-Mansour et al., 2012). State anger is suggested to be an adaptive, problem-solving response, however, when felt at extreme intensity and over a prolonged period, can have a deleterious impact on PW (Spielberger & Reheiser, 2009). According to Spielberger et al. (1975, p. 46) “the maladaptive effects of anger are important contributors to the aetiology of depression, the psychoneuroses, and schizophrenia”.

The rugby players’ elevated experience of anger is in accordance with several studies investigating the PW of rugby players. A study by Nicholls, Jones, et al. (2009) on emotions experienced by professional rugby players over a prolonged period found anger was one of the most frequently cited emotions of professional rugby players over a prolonged period (Nicholls, Jones, et al. 2009). Maxwell (2004) found rugby players scored higher for aggression than a large number of athletes between the ages of 18 and 32 years, who represented several team and individual sports. Trait anger has been strongly correlated with aggression (Potegal & Stemmler, 2010). Some contradictory findings have, however, been made by Robazza and Bortoli (2007) for both professional and amateur Italian rugby players. Robazza and Bortoli (2007) found that both levels of rugby players’ trait anger mean score was below the midpoint of 20 (17.92 and 17.74, respectively). The difference in scores may

be due to cultural differences between the samples as studies have found that aggression is experienced differently by athletes from different cultures (Weinberg & Gould, 2010).

5.3.1.1.3. *Anxiety*

Similarly to trait anger, the rugby players' mean score for trait anxiety was just over one point higher than the midpoint ($M = 21.60$; $SD = 4.47$). The players' mean score for state anxiety was similar ($M = 20.92$; $SD = 4.23$) to their trait anxiety score. State anxiety is characterised by an experience of physical tension and feelings of apprehension due to the anticipation of a real or imagined threat to self (Barlow, 2005; Kaplan & Saccuzzo, 2013; Silverman & Treffers, 2001; Spielberger & Reheiser, 2009). Anxiety, like anger, has become accepted as a fundamental human emotion that when properly managed, has an adaptive function as it warns the individual of danger, stimulates the individual to prepare, and helps them to perform (Sadock & Sadock, 2007; Sue et al., 2006). However, anxiety that persists and is severe is considered harmful to PW (Sadock & Sadock, 2007). The rugby players' mean score for state anxiety suggests that at the time of testing the rugby players experienced feelings of anxiety at an intensity that was slightly above what would be considered conducive to their PW. The elevated state anxiety score suggests that the rugby players' feelings were influenced by the test being administered. The rugby players may have interpreted the test as threatening or the results from the assessment as placing them in danger. Alternatively, the rugby players may have had thoughts relating to past traumatic events associated with testing situations (Spielberger & Reheiser, 2009).

A rugby player who is high in trait anxiety is likely to find a wide range of circumstances anxiety-provoking and subsequently experience state anxiety more frequently (Spielberger & Reheiser, 2009). The rugby players' trait anxiety mean score was higher than Jooste's (2011) findings for South African first team high school rugby players. Jooste (2011) measured trait anxiety according to the STPI-Y trait subscale over three time periods (one week before, the day of, and one week after a major rugby game). Jooste's (2011) findings revealed that high school rugby players obtained a mean trait anxiety score below the midpoint on the two non-official game days ($M = 18.80$; $SD = 4.24$ and $M = 19.00$; $SD = 3.30$) and slightly above the midpoint on the game day ($M = 20.33$; $SD = 4.06$). The difference in scores found in the current study and Jooste's (2011) study could be explained by the research sample's difference in level of play (professional vs. amateur) and probable

years of experience. The current study's sample participating in professional rugby means they have years of playing experience at a level of competition that Jooste's (2010) sample do not. Grobbelaar et al. (2010) found South African rugby players who have more years of experience playing at a high level of competition demonstrate a significantly greater negative mood state score of tension than their lesser experienced counterparts.

5.3.1.1.4. Depression

The rugby players' mean score for state depression fell slightly below the midpoint ($M = 19.93$; $SD = 4.72$), while their trait depression score fell one point above it ($M = 21.01$; $SD = 5.40$). These findings suggest that the average professional rugby player did not experience feelings of depression on the day of testing that was harmful to their PW. They may, however, suffer from episodes of depression-related cognitions and feelings more frequently than is optimal for their PW (Spielberger & Reheiser, 2009). The latter finding that professional rugby players have an elevated level of trait depression is in accordance with other studies that have investigated the PW of rugby players. Kerr and Syebak (1994) found that participating in rugby training increased emotions indicative of depression such as humiliation, sullenness, and shame. Grobbelaar et al. (2010) found an increase in state depression in more experienced South African university rugby players than less experienced players.

In light of the discussion above on the descriptive statistics concerning rugby players' PW, it is posited that the average professional rugby player experiences the positive emotion of curiosity more frequently and intensely than the negative emotions of anger, depression, and anxiety. This finding is supported by studies demonstrating the positive relationship between PA and positive emotions. Meta-analyses of the effect of PA on general mood have found small improvements in overall mood (reduction of negative moods in addition to the enhancement of positive mood states) (Arent et al., 2000). The descriptive statistics further indicate that the average professional rugby player may interpret more situations as anxiety and anger provoking and may experience more intense and frequent feelings of anger, depression, and anxiety than is beneficial for their PW. The rugby players' heightened experience of emotions indicative of poor PW is confirmed by various studies on the PW of rugby players (Grobbelaar et al., 2010; Kerr & Syebak, 1994; Nicholls, Backhouse et al., 2009; Nicholls, Jones et al., 2009). Examining the rugby players' extreme scores indicates

that some professional rugby players may experience severe lapses in PW due to anger. This is cause for concern as these rugby players' health may be compromised. The findings are further indicative of overtraining and overtraining syndrome that might have occurred in the rugby players (Grobbelaar, 2009; Weinberg & Gould, 2015).

Together with the STPI-Y, the SCAT-A was administered to assess anxiety experienced by rugby players. The rugby players' SCAT-A scores were interpreted according to international norms, which allows for the rugby players SCAT-A mean score to be classed as either a low, average, or high level of competitive trait anxiety.

5.3.1.2. The PW of rugby players and their SCAT-A scores

The current study's finding for professional rugby players' competitive trait anxiety mean score suggests that many of the professional rugby players experience an average level of competitive trait anxiety. Competitive trait anxiety is a rugby players' likelihood to view competing in a rugby game as threatening, and the level of state anxiety with which the player responds to rugby games (Martens et al., 1990). The present study's sample of professional rugby players' mean score for competitive trait anxiety ($M = 19.92$; $SD = 2.98$) was below Jooste's (2011) findings for first team high school rugby players' level of competitive trait anxiety. Jooste (2011) found that high school rugby players' competitive trait anxiety mean score was 20.60 ($SD = 2.50$) and 20.70 ($SD = 2.27$) on days the players were not participating in an official game and 26.70 ($SD = 1.49$) on the day of an official game. The differences in findings for competitive trait anxiety for professional and amateur (high school) rugby players is supported by a study comparing competitive anxiety in amateur rugby. Andrew et al. (2007) compared amateur South African rugby players competing at a high level with amateur players competing at a low level. Their sample had a similar mean age to the present studies' rugby players. Andrew et al. (2007) found that players competing at a higher level had a more elevated level of both somatic and cognitive competitive state anxiety than players competing at a lower level (Andrew et al., 2007). Further support is provided by a finding by Niel et al. (2006) in their study on the competitive trait anxiety of professional and amateur rugby players. Niel et al. (2006) found that professional rugby players experienced a higher intensity of competitive somatic trait anxiety than amateur rugby players.

The next section will provide a discussion on the descriptive statistics of the rugby player's HRPF (see Tables 4.3 - 4.5; Graphs 4.3- 4.15).

5.3.2. The HRPF of Professional Rugby Players

HRPF refers to the components of physical fitness directly related to good health. These components are body composition, flexibility, muscular strength, muscular endurance, and cardiovascular endurance (American College of Sports Medicine, 2014; Caspersen et al., 1985; Singh, 2013). The present study added heart health when defining HRPF of the rugby players (see Chapter 2, section 2.3.5). As mentioned in Chapter 3, section 3.6.4, 3.8, and Chapter 4, section 4.2.3, the rugby players' HRPF was measured according to the variables of body composition, heart health, and physical fitness.

5.3.2.1. *Body Composition*

Body composition is the ratio of fat-free mass to fat mass (Caspersen et al., 1985; Jennet, 2003; Singh, 2013). Lean tissue such as skeletal muscle contributes to the production of power output, while excess fat deposits lead to becoming overweight, and a continuation of this trend leads towards obesity (Carling et al., 2008). Weight gain above the statistically healthy norm is widely acknowledged as a health risk (Jennet, 2003). The conventional measurements of body composition used in the current study to determine the rugby players body composition were BMI, WHR, and body fat percentage (see Chapter 3, sections 3.6.4 and 3.8; Chapter 4, sections 4.2.3 and 4.2.3.1; and Chapter 5, section 5.2). BMI is assessed to measure the amount of tissue mass (muscle, fat, and bone) in an individual, and then categorise that individual within a weight category (Jennet, 2003). A BMI score of between 18.5 to 24.90 kg/m² is classified as normal weight. Any scores above or below this range are considered either under or over the ideal weight. The rugby players' mean BMI score ($M = 26.31$ kg/m²; $SD = 5.96$) would class the rugby players as overweight. The descriptive statistics in Graph 4.3 show that a majority of the rugby players (52.2%) are at a moderate health risk due to their BMI. The finding that the rugby players have a higher BMI than would be considered healthy for the average population confirms Potgieter et al.'s (2014) findings. He found that South African semi-professional rugby players playing in a forward position have a BMI of 32.5 kg/m², which according to WHO's standards for healthy weight would class these athletes as obese (Potgieter et al., 2014). Researchers have cautioned

against BMI applicability to elite athlete participants in field games as they claim the BMI calculation fails to distinguish between muscle and fat as constituents of body mass (Carling et al., 2008; Potgieter et al., 2014).

Body fat percentage is the measure of subcutaneous fat in various areas of the body (Carling et al., 2008). Recommended body fat percentage for young male adults is 8% to 19%. The rugby players' mean score for body fat percentage ($M = 11.89\%$; $SD = 3.63$) is considered to be within the recommended range. The descriptive statistics in Graph 4.5 show that a majority of the rugby players' (56.1%) body fat percentage scores fell in the low health risk category. This finding is confirmed by Potgieter et al.'s (2014) study which found South African semi-professional rugby players' mean body fat score fell in the recommended range. However, Potgieter et al.'s (2014) semi-professional rugby players mean score for body fat ($M = 18.2\%$) was higher than the present study's rugby players' mean body fat percentage score. This difference in body fat percentage could be explained by the discrepancy between the rugby players' level of play (professional vs. semi-professional), as studies have found that with a decrease of playing level, rugby players have a higher percentage of body fat (Duthie et al., 2003; Smart et al., 2013).

Beyond BMI and body fat percentage, WHR offers additional insights into the body composition of rugby players. The rugby players' WHR mean score ($M = 0.67$; $SD = 0.30$) classes the players as being at a low health risk. The descriptive statistics displayed in Graph 4.4 show that the highest percentage of players' WHR scores were in the low health risk category (43.2%). However, a large percentage of players (41.5 %) fell in the moderate health risk category. The latter is not in accordance with research on the influence of PA on body composition as research has shown that PA performed on a regular basis at a high intensity is linked to reduced abdominal adiposity and WHR (Ekelund et al. 2011; Warburton et al., 2006). Tremblay et al. (1990) found decreases in WHR were directly proportional to the intensity to which exercise is performed; more intense exercise resulted in a greater decrease in WHR.

5.3.2.2. *Physical fitness*

Physical fitness is a state of good physical condition and is principally a product of exercise (Du Toit et al., 2012). Physical fitness has numerous health benefits and is a vital factor in promoting wellbeing and prevention of disease (Warburton et al., 2006). As stated in

Chapter 3, sections 3.6.4 and 3.8, and Chapter 4, section 4.2.3, the physical fitness component of HRPF was assessed according to four separate fitness tests. These included a one-minute sit-up test, a one-minute push-up test, a three-minute step test and finally, a sit-and-reach test. These selected tests measure components of physical fitness related to good health.

The sit-and-reach test assessed the rugby players' flexibility. Flexibility relates to the range of motion capacity available to a joint (Brannon & Feist, 2010; Caspersen et al., 1985; Singh, 2013). The majority of the rugby players' scores for the sit-and-reach test (78.1%) indicated a high level of performance and consequently a low level of health risk. The current study's sample of rugby players' high performance for flexibility is in concurrence with research showing that participating in regular PA improves flexibility (Garber et al., 2011). The rugby players' mean score for the sit-and-reach test ($M = 29.26$ cm; $SD = 9.13$) was not in accordance with findings from another study on rugby players' flexibility. The sit-and-reach scores Plotz and Spamer (2006) recorded for South African rugby players competing at high school level ($M = 13.03$ cm) were considerably lower than the current study's findings for professional rugby players (Plotz & Spamer, 2006). The discrepancy in scores may be due to the differences in the level of play between the samples (amateur vs. professional).

The one-minute sit-up test and one-minute push-up test measure muscle strength and endurance. Muscle strength relates to the ability of a muscle group to exert an external force, while muscle endurance is the muscle groups' ability to continually perform exertion of external force (Brannon & Feist, 2010; Caspersen et al., 1985; Singh, 2013). The rugby players' scores for the one-minute sit-up test and one minute push-up test indicate that most of the players have a moderate to high level of muscle strength and endurance. Furthermore, the rugby players' scores show that their muscle strength and endurance place them at a moderate to low health risk. The aforementioned findings are supported by Elloumi et al. (2009) who found that professional rugby players' muscle strength is higher than the average healthy male (Elloumi et al. 2009). The rugby players' mean score for the one-minute sit-up test ($M = 52.11$; $SD = 11.54$) was in alignment with an older study that found a similar mean score for amateur rugby players (Maud, 1983). Maud (1983) assessed a small sample ($n = 15$) of American amateur club rugby players with the mean age of 29 years and found these players had a mean score of 50 for the one-minute sit-up test. The current study's samples' mean score for the one-minute push-up test ($M = 56.39$; $SD = 14.97$) was, however, not in

alignment with Quarrie et al.'s (1995) findings. Quarrie et al. (1995) found that professional rugby forwards performed, on average, 25.6 push-ups, and backs completed an average of 32.3 push-ups per minute. This is a substantively lower amount of push-ups performed in one minute than the rugby players in the current study. This discrepancy in findings could suggest that professional rugby players' muscle strength and endurance has increased over the past decade. The latter notion is supported by research suggesting the physiological characteristics of rugby players have changed over the years due to the increased physical demands placed on players since professionalism of the sport in 1995 (Austin et al., 2011; Lindsay, Draper et al., 2015; Sedeaud et al., 2011).

The final component of the rugby players' physical fitness assessed was cardiovascular endurance. Cardiovascular endurance relates to the ability of the circulatory and respiratory system to supply energy during sustained physical activity and to eliminate fatigue products after supplying energy (Caspersen et al., 1985; Singh, 2013). The three-minute step test was used to assess the cardiovascular endurance of the rugby players. Most (83.4%) of the rugby players' scores for the three-minute step test fall within the moderate performance level. This suggests that a majority of the rugby players' cardiovascular endurance is not ideal for optimal health. This finding is not in line with studies that show PA performed at a medium and high intensity on a regular basis is associated with improved cardiovascular endurance (Garber et al., 2011).

Cardiovascular endurance is also indicated by measuring resting heart rate (HR) and blood pressure, as persons with cardiovascular endurance have an increased amount of blood pumped with each heartbeat, resulting in a lowering of both their resting HR and blood pressure (Brannon & Feist, 2010). The rugby players' HR and blood pressure were measured as part of the HRPF component heart health. The descriptive statistics for the rugby players' HR and blood pressure are shown in Table 4.3; Graph 4.7; Graph 4.10 and Graph 4.11. The blood pressure score results indicate that most (71.9%) of the rugby players have a good level of cardiovascular endurance (at a low health risk). This does not confirm the three-minute step test finding suggesting that the rugby players' health is at a moderate risk due to their cardiovascular endurance. The results for HR show a majority of the rugby players' (56.8%) HR scores fell in the low health risk category and a number of the rugby players' (38.6%) HR scores fell in the moderate health risk category. Thus, the rugby players' performances on the three-minute step test as well as their scores for HR indicate that many of the players' level of

cardiovascular endurance are not ideal for optimal health. A better understanding of the health risk for the rugby players due to their heart health is presented in the next section.

5.3.2.3. *Heart health*

According to the WHO's (1948) definition of health, heart health can be defined as the functioning of the cardiovascular system within its expected normal limits and the absence of any cardiovascular disease. In the current study, heart health was assessed by a cardio stress index (CSI), heart rhythm, HR, the duration of vascular excitation (QRS duration) and blood pressure (see Chapter 3, sections 3.6.4 and 3.8, and Chapter 4, sections 4.2.3 and 4.2.3.1). The descriptive statistics for the heart health measures are shown in Table 4.4 as well as Graph 4.6, 4.7, 4.8, and 4.9. A CSI reading of 25% or less is optimal for heart health (Du Toit, 2012). An HR of between 60-80 beats per minute (bpm) is considered normal, and QRS duration should lie between 60-110 milliseconds (ms) (Du Toit et al., 2012). The expected range for systolic blood pressure is 100-139 mmHg and diastolic blood pressure should be 60-85 mmHg. Heart rhythm is either considered normal or abnormal. Deviations in cardiovascular system functioning from these established normal limits can be considered a health risk factor.

The rugby players' mean score for HR ($M = 78.76$; $SD = 12.08$), QRS duration ($M = 88.20$; $SD = 10.06$), blood pressure, both systolic pressure ($M = 129.95$; $SD = 13.01$) and diastolic pressure ($M = 76.44$; $SD = 7.51$), as well as heart rhythm fell within the normal limits for healthy heart functioning. However, the rugby players' mean score for CSI fell outside of the expected limitations for healthy heart functioning. The rugby players' mean score for CSI was 28.44 % ($SD = 20.30$). CSI is an indicator of stress loading on the heart and is considered analogous to heart rate variability (HRV) (Du Toit, 2012). Low HRV suggests a lethargic heart that does not respond flexibility to received stimuli and could be vulnerable to health impairments (Du Toit, 2012). High CSI readings, ranging above 25% (as the case with the rugby players' mean score) indicates a lowered HRV measurement (Du Toit, 2013; Energy-Lab Technologies, 2005). The descriptive statistics in Graph 4.6 show that almost half of the rugby players' CSI scores fell in the moderate (29.2% of participants) and high health risk range (16.1% of participants). As such, the rugby players' elevated CSI score suggests that professional rugby players may be vulnerable to health problems due to an overload of stress on their heart. The rugby players' CSI mean score is supported by a study

that found rugby players do not have a better HRV measurement than non-athletes (Aubert et al, 2000). Aubert et al. (2000) conducted a study that looked at HRV of rugby players and athletes from other sports and found only aerobic athletes have a better HRV measurement than a sedentary control group.

Low levels of HRV have been linked to overtraining and overtraining syndrome (Hottenrott, Hoos, & Esperer, 2006). Thus, the increased CSI score for the rugby players suggests that many of the rugby players are overtraining and may experience overtraining syndrome. This would not be unlikely as professional rugby has been identified as a severely intensive sport which induces significant physiological stress for players (Cunniffe et al., 2010; Lindsay, Draper, et al., 2015; Lindsay, Lewis et al., 2015). Additionally, several studies have suggested that South African rugby players experience overtraining and overtraining syndrome relatively often (Grobbelaar, 2009; Van Zyl & Lombard, 2003). These findings corroborate the findings of PW that was obtained by the STPI-Y (see section 5.3.1.1).

The above discussion on the descriptive statistics of the HRPF of the rugby players indicates that the rugby players' body composition, muscle strength and endurance, cardiovascular endurance, and heart health (as measured by the CSI) might not be optimal for players' health. These variables of the rugby players HRPF place the players at an increased health risk. The finding that the rugby players do not have optimal HRPF is not aligned with research that shows PA performed on a regular basis increases HRPF (Bouchard et al., 2012; Garber et al., 2011; Powell, Paluch, & Blair, 2011; Warburton et al., 2006). It is suggested that rugby has unique impacts on the body composition of players, as other studies have confirmed rugby players do not have optimal body composition (Potgieter et al. 2014). Furthermore, many of the rugby players may be overtraining, experiencing overtraining syndrome, or both, as this would explain their lack of performance on the physical fitness measures as well as increased CSI (Grobbelaar, 2009; Hottenrott et al. 2006).

5.4. Discussion of the Statistical Analyses used to reach the Research Aim and Test Hypotheses

The research aim of investigating the correlation between the PW and HRPF of professional rugby players was formalised in the following null and alternative hypotheses (see Chapter 1, section 1.2; Chapter 3, section 3.2; and Chapter 4, sections 4.1 and 4.3.1):

- H_0 : There is no statistically significant relationship between HRPF and PW of professional rugby players.
- H_1 : There is a statistically significant relationship between HRPF and PW of professional rugby players.

As mentioned earlier in this chapter, the third objective of this study allowed for the above hypotheses to be tested. To reach the third objective the Pearson's r test was performed between the variables of PW and HRPF; the results are presented in Chapter 4, section 4.3. A discussion of the results of the statistical analysis used to reach the third objective is presented below.

5.4.1. The Relationship between the HRPF and the PW of Professional Rugby Players and the Relationship's Strength and Direction

5.4.1.1. Relationship between PW and the HRPF component of body composition

There were relationships found between variables of PW and the HRPF component of body composition. Significant correlations between the body composition measurement of WHR and all the critical emotional signs of PW were found, suggesting a relationship between abdominal obesity and PW in professional rugby players (see Table 4.6). The strongest relationship found was between depression and WHR. The findings indicate a large inverse relationship between state ($r = -.58$; $p \leq .01$) and trait depression ($r = -.62$; $p \leq .01$) and WHR. A small, inverse relationship was found between state anxiety ($r = -.16$; $p \leq .05$) and trait anxiety ($r = -.20$; $p \leq .01$) and WHR. It is therefore suggested that the higher the frequency and intensity to which rugby players experience depressive and anxiety feelings and cognitions, the lower their WHR. This finding is supported by Sadock and Sadock (2010), who indicate weight loss as a common symptom of mood and anxiety disorders. Additionally, studies have indicated depression, anxiety, and weight loss as signs and symptoms of overtraining and overtraining syndrome (Grobelaar, 2009).

In contrast to these inverse correlations between negative emotions and WHR, a medium, positive correlation was found between the positive emotions of state curiosity ($r = .49$; $p \leq .01$) and trait curiosity ($r = .40$; $p \leq .01$) and WHR. To the researcher's knowledge,

there are no studies on the relationship between curiosity and body composition and further research on the matter is necessary. The correlations found between curiosity and WHR suggest that the less frequently and intensely the rugby players experience curiosity, the lower their WHR. This finding is supported by the inverse relationship found between curiosity and depression (Spielberger & Reheiser, 2009), as weight loss is a symptom of depression (Sadock & Sadock, 2010). Therefore, like the relationship found between depression and WHR, the relationship between curiosity and WHR is supported by research on overtraining and overtraining syndrome in athletes (Grobbelaar, 2009).

Differently to the inverse relationships found between WHR and depression and WHR and anxiety, as well as the positive relationship between WHR and curiosity, there were small, positive correlations found between WHR and state anger ($r = .14$; $p \leq .05$) as well as WHR and trait anger ($r = .23$; $p \leq .01$). These findings are in accordance with studies on the relationship between anger and WHR in non-rugby players. Goldbacher and Matthews (2007) reviewed literature on the association between anger and WHR. They note several studies such as Nelson, Palmer, Pedersen, and Miles (1999) and Wing, Matthews, Kuller, Meilahn, and Planting (1991) that found a positive relationship between anger and WHR.

Significant relationships between the body composition measurement of body fat percentage as well as BMI and depression were found. A small, positive correlation was found between body fat percentage and state depression ($r = .24$; $p \leq .01$) and trait depression ($r = .20$; $p \leq .01$), as well as BMI and state depression ($r = .17$; $p \leq .01$) and trait depression ($r = .13$; $p \leq .05$). These correlations are supported by a study on non-rugby players that shows significant positive associations between depressive symptoms and BMI as well as depression and obesity (Johnston et al., 2004). Johnston et al. (2004) established a relationship between BMI and the risk of depression in a randomly selected large sample ($n = 2,482$) aged 18 and over. They studied depression as measured by the Centre for Epidemiological Studies Depression Scale (CES-D). The CES-D measures current levels of depressive symptoms and emotional distress as assessed by the frequency or duration of depressive symptoms experienced in the previous week. BMIs were categorised according to international standards. Results of a logistic regression indicated that BMI risk categories ($p < 0.05$) were significantly related to an increased risk of depression. When weight was categorised as obese or not (using a BMI cut-off of 30) and depressive symptoms as

indicating at risk or not (using a CES-D cut-off of 16), obese subjects were significantly more likely to be at risk of depression.

5.4.1.2. Relationship between PW and the HRPF component of physical fitness

A relationship between PW (as measured by the STPI-Y and SCAT-A) and muscle strength and endurance (as measured by the one-minute sit-up test and one-minute push-up test) was found. There was a medium, positive correlation between the variables of the one-minute sit-up test and state curiosity ($r = .35$; $p \leq .01$) as well as the one-minute sit-up test and trait curiosity ($r = .30$; $p \leq .01$), with high levels of curiosity associated with higher levels of performance on the one-minute sit-up test. There was a small, positive correlation between the one-minute push-up test and state curiosity ($r = .17$; $p \leq .01$), with high levels of curiosity associated with higher levels of performance on the one-minute push-up test. As mentioned in section 5.3.2.2, the one-minute sit-up test and one-minute push-up test assess muscle strength and endurance. This suggests that high levels of curiosity are associated with higher levels of muscle strength and endurance. There is a lack of research on curiosity and muscle strength and endurance, and further research on this topic is hence necessary.

The relationship between the positive emotions of curiosity and muscle strength is in accordance with a study by Tolea et al. (2012), which assessed the relationship between positive emotions and muscle strength. Tolea et al. (2012) conducted a study on knee muscle strength and personality traits. The sample was large ($n = 1220$), consisting of community-dwelling volunteers, age ranging from 20 to 94 years ($M = 58$ years; $SD = 16$ years), who were on average overweight. Tolea et al. (2012) found the positive-emotion extraversion personality trait was positively correlated with knee muscle strength; this relationship was independent of gender, race, age, and BMI (Tolea et al., 2012).

A small, positive relationship was found between the one-minute push-up test and trait anger in the present study ($r = .15$; $p \leq .05$). This positive relationship found between trait anger and muscle strength is contrary to another finding of the study conducted by Tolea et al. (2012). In addition to the personality trait of extraversion, Tolea et al. (2012) assessed the relationship between neuroticism and knee muscle strength in the large community-dwelling sample. Tolea et al. (2012) found neuroticism and most of its facets, including 'angry hostility', to be inversely correlated with muscle strength, independent of gender, race, age, and weight (p. 5). This suggests that the physical experience of anger is different for

professional rugby players. The notion that rugby players have an unconventional experience of anger is supported by studies that have shown rugby players perceive their experience of anger as facilitative to their performance and that some players report aggression as a pleasant experience (D' Urso et al. 2002; Robazza & Bortoli, 2007). There is not enough research on the relationship between anger and muscle strength in professional rugby players and further research on the topic is therefore necessary.

There was a medium, negative correlation between the variables of the one-minute sit-up test and state depression ($r = -.30$; $p \leq .01$) and a small, inverse correlation between the variables of the one-minute sit-up test and state anxiety ($r = -.16$; $p \leq .05$). High levels of state depression and anxiety were associated with lower levels of performance on the one-minute sit-up test. This finding suggests that feelings of anxiety, depression, or both for professional rugby players' negatively affects their ability to perform tasks that require muscle strength and endurance. This inverse relationship found between negative state emotions and physical fitness (muscle strength and endurance) is supported by research that suggests negative mood states are associated with decreased athletic performance (Beedie et al., 2000; Davis, Woodman, & Callow, 2010; Leunes & Burger, 2000). Furthermore, research has shown that negative mood states such as depression and anxiety as well as decreased physical fitness are symptoms of overtraining and overtraining syndrome in athletes (Grobelaar, 2009).

A small, negative correlation was found between trait depression and the one-minute sit-up test ($r = -.28$; $p \leq .01$), with high levels of trait depression associated with lower levels of performance on the one-minute sit-up test. As the one-minute sit-up test measures muscle strength, this relationship is supported by Tolea et al.'s (2012) finding for non-rugby players. Tolea et al. (2012) found the personality trait of depression was inversely correlated to muscle strength, irrespective of the participant's age, gender, race, or BMI. This implies depression experienced by professional rugby players over a pro-longed period might result in decreased muscle strength for these players. This may also indicate overtraining syndrome in professional rugby players, as depression and decreased physical fitness are both symptoms of the syndrome.

A small, positive correlation was found between competitive trait anxiety and the three-minute step test ($r = .17$; $p \leq .01$), with higher levels of competitive trait anxiety

associated with higher levels of performance on the three-minute step test. As stated in section 5.3.2.2, the three-minute step test assesses cardiovascular endurance. There is a lack of research on competitive anxiety and cardiovascular endurance, and hence more research on this topic is necessary. The positive relationship between competitive trait anxiety and cardiovascular endurance of the rugby players might be explained by research that has shown decreased physical fitness and decreased motivation for sports competition as symptoms of overtraining syndrome (Grobbelaar, 2009).

5.4.1.3. *The relationship between PW and the HRPF component of heart health*

As seen in Table 4.7, there was a small, positive correlation found between the PW variable of state curiosity and the HRPF variable of HR ($r = .20$; $p \leq .01$). This finding is not supported by research, which has found positive moods are inversely related to HR (Diener & Chan, 2011; Mathew & Paulose, 2011). There was a small, negative correlation found between state depression and HR ($r = -.19$; $p \leq .01$) as well as trait depression and HR ($r = -.16$; $p \leq .05$). This finding is contradictory to existing research that found a positive association between depression and elevated HR (Howell, Kern, & Lyubomirsky, 2007). Overtraining may explain these relationships as depression is associated with overtraining, and high-intensity PA performed on a regular basis is associated with lower HR (Grobbelaar, 2009; Warburton et al., 2006). Thus, although the rugby players are experiencing the psychological maladaptations of depressive feelings and cognitions due to overtraining, they are also experiencing the long-term benefits of increased PA such as lowered HR.

There was also a small, positive correlation found between trait anger and the blood pressure component, diastolic pressure ($r = .15$; $p \leq .05$), with higher levels of trait anger associated with higher levels of diastolic pressure. This finding is supported by research that has shown a relationship between anger and heightened blood pressure (Suls, 2013). The significant relationship found between diastolic pressure and anger and not systolic pressure and anger might be due to the age of the research sample, as diastolic pressure is generally thought to be the best predictor of health risk in persons younger than 50 years of age (Pickering et al., 2005).

The above discussion indicates that statistically significant relationships exist between facets of the rugby players' HRPF and PW. Thus, the null hypothesis which states that there is no statistically significant relationship between HRPF and PW of rugby players is rejected.

Examining several of the significant correlations found between variables of the rugby players PW and HRPF, there are chances that the rugby players are in a state of overtraining, experiencing overtraining syndrome, or both. Several studies have suggested that professional rugby players experience overtraining and overtraining syndrome (Nicholls, Backhouse et al., 2009; Grobbelaar, 2009; Van Zyl & Lombard, 2003). For example, Nicholls, Backhouse et al., (2009) studied professional rugby players over a prolonged period and found these players reported experiencing physiological and psychological sports-related and non-sports-related stressors on training days and match days. Nicholls, Backhouse et al., (2009) interpreted these findings as an indication that the professional rugby players assessed in the study were overtraining.

5.5. Limitations of the Study

As is the case with all research, this study also presented with limitations. The first limitation is associated with the way the current study defined professional rugby players. Rugby players enrolled at the Investec Rugby Academy are at the highest level of play for the sport and range from a high school age to an age suited to play for the national team. This hence implies that there was a difference in the competitive levels at which the rugby players played. The rugby players included in the sample were also predominantly at the high school age of 16 and 17 years. The definition of professional rugby players in most research studies is players who are over 21 years of age and are primarily playing professional rugby. Thus, the research sample may be better defined as aspiring professional rugby players or young professional rugby players.

The second limitation has to do with the position of play. Due to a lack of data, the researcher could not control for position of play. Research has shown significant differences between rugby players' body composition (Quarrie et al., 1995; Smart et al., 2013), muscle strength (Heffernan et al., 2015; Smart et al., 2011), muscle endurance (Duthie et al., 2003; Quarrie et al., 1995), flexibility (Van Gent & Spamer, 2005), and cardiovascular endurance (Duthie et al., 2003), dependent on their position of play.

The third limitation of this study is the measurement instruments used to assess the psychological wellbeing of the sample. The State-Trait Personality Inventory Form (Y) by Spielberger and associates (1975) as well as the Sport Competitive Anxiety Test by Martens

et al., (1990) were chosen by the principle researcher to assess the sample population's psychological wellbeing. This study utilised the data gathered by the principle researcher and as such the author of this study did not have control over which measurement instruments were used. A more recent measurement of psychological wellbeing may be more accurate in determining the psychological wellbeing of the sample population.

Another limitation of the study is the researchers' lack of information about the time-period between when the research sample engaged in a rugby game and when data collection took place. Research has shown that professional rugby players experience temporary psychological and physiological disturbances (possibly up to 36 hours) after participating in a rugby game (West et al. 2013). As such, the research sample engaging in a rugby game the day before testing might have affected the results of the current study.

The last limitation of the study has to do with the fact that only one professional club was included in the sample. Findings cannot thus be generalised to other rugby clubs and should be interpreted with caution.

5.6. Recommendations for Future Research

There is a lack of research focusing on the psychological and physiological wellbeing of rugby players. Although this study attempts to address this gap in the literature, future research extending this topic is encouraged. Specifically, it is recommended that future research:

- Reassess the relationship between the HRPF and PW of professional rugby players and control for the rugby players' position of play. Such research should employ partial correlation during statistical analysis (Pallant, 2010). Partial correlation is similar to Pearson's product-moment correlation used in the current study except that it allows the researcher to control for an additional variable (such as the position of play) (Pallant, 2010). Another variable that should be controlled for is professional rugby players' years of experience, as the number of years participating in rugby professionally has shown to contribute to physiological and psychological characteristics of rugby players (Grobbelaar et al., 2010; Smart et al., 2013).

- Investigate anger experienced by professional rugby players. It has been suggested that rugby players experience anger differently than non-rugby players. Thus, a psychophysiological study on rugby players' experience of anger might provide additional insight into their physiological processes of anger.
- Explore the correlations found in the current study between variables of the rugby player's HRPF and PW. The present study was able to establish that a relationship exists between some sets of variables and provide a description of these relationships. However, due to the nature of a correlation research design, a clear and unambiguous explanation for the relationship between the variables is not possible (Pallant, 2010).
- Investigate the social wellbeing of rugby players in addition to the physical and psychological wellbeing. According to the biopsychosocial model, investigating all three of these dimensions will enable research to produce a more holistic picture of the rugby players' health (Brannon & Fieist, 2010). There is a gap in research on the health status of rugby players and the impact of rugby on health.
- Investigate overtraining and overtraining syndrome in rugby players. Such research should include coping mechanisms for preventing overtraining syndrome in rugby players.
- Include more professional rugby players from clubs around South Africa in future studies.

5.7. Conclusion

The current study investigated the relationship between the PW and HRPF of professional rugby players. From the discussion presented in this chapter, it is clear that there are significant relationships between some variables of professional rugby players' PW and HRPF. Furthermore, it is suggested that professional rugby players do not experience optimal PW as they experience negative emotions at a rate and intensity that is slightly above average. However, it is suggested that professional rugby players experience a relatively high level of curiosity, which indicates these players do not suffer from poor PW in totality. The HRPF of professional rugby players is high with the exception of body composition (particularly BMI), cardiovascular endurance, muscle strength and endurance, and heart

health (when measured according to the CSI), which indicate a moderate risk to the players' health.

The findings that indicate that professional rugby players do not experience optimal PW and HRPF as well as several of the significant correlations found between the variables of the rugby players' PW and HRPF suggest the rugby players might be in a state of overtraining or experiencing overtraining syndrome. Professional rugby players experiencing overtraining or overtraining syndrome is not an unlikely suggestion, as the game of rugby has been shown to impose immense physiological and psychological demands on players (Lindsay, Draper et al. 2015). Since the sport became professional in 1995, the increase in training volume and the number of games per season have led to an increase in psychological and physiological demands on players and a decrease in the time players have to fully rest and recover (Austin et al., 2011; Grobbelaar, 2009; Sedeaud et al., 2011). The result of these escalating difficulties facing professional rugby players is that the players are becoming increasingly vulnerable to experiencing overtraining and overtraining syndrome. As such, it is suggested that professional rugby players are at risk for overtraining and overtraining syndrome. It is advisable that rugby players, coaches, health professionals, and family of rugby player should be educated on overtraining syndrome. Such education may include signs and symptoms, health risks, prevention tactics, as well as coping strategies of overtraining syndrome.

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APPENDIX A: DATA COLLECTION PERMISSION LETTER



Prime Human
Performance
Centre

Shop 2/3
Moses
Mabhida
Stadium

44 Isaiah
Ntshangase
Road

Durban

4001

Telephone:
+27861 Rugby
Academy

Telephone:
+2731 940
5565

Facsimile +27
86 296 6615

Date: 23 April 2013

To whom it may concern

Invitation to do testing and compile data

We, the Investec International Rugby Academy hereby invite Dr Peet du Toit and his staff to conduct tests on our course applicants during course time and also request them to compile this data into statistics.

Should you need any additional information please do not hesitate to contact me on 083 556 5404

Yours sincerely

Ruan Fourie

Director



APPENDIX B: DEMOGRAPHIC QUESTIONNAIRE



Questionnaire



BIOGRAPHICAL INFORMATION

Initials: Name: Surname:

ID number: Contact number:

Email address: Gender: Male Female

Age: Date of birth: Dominant hand:

Ethnicity: Black Coloured Indian Asian White Other

Please note, ethnicity is solely required for research purposes, and not intended to be discriminative in any way or form.

POSITION/S IN RUGBY

Choose the three most regular positions

- | | | |
|--|---|---|
| <input type="checkbox"/> 1. Loosehead prop | <input type="checkbox"/> 2. Hooker | <input type="checkbox"/> 3. Tighthead prop |
| <input type="checkbox"/> 4. Number 4 lock | <input type="checkbox"/> 5. Number 5 lock | <input type="checkbox"/> 6. Blindside-flanker |
| <input type="checkbox"/> 7. Openside flanker | <input type="checkbox"/> 8. Number-8 | <input type="checkbox"/> 9. Scrum-half |
| <input type="checkbox"/> 10. Fly-half | <input type="checkbox"/> 11. Left-wing | <input type="checkbox"/> 12. Inside-centre |
| <input type="checkbox"/> 13. Outside-centre | <input type="checkbox"/> 14. Right-wing | <input type="checkbox"/> 15. Fullback |

APPENDIX C: STANDARD OPERATING PROCEDURES FOR DATA COLLECTION

Standard operating procedures formulated by Professor Peet du Toit.

Heart health components of HRPF

Heart health: Cardio Stress Index (CSI), Heart Rhythm, Heart Rate (HR) and QRS duration.

- 1) Participants were requested to sit comfortably in an upright position.
- 2) To prevent electrode signaling interference, participants were requested to remove all jewelry.
- 3) Conduction gel e.g. Ten20, was applied to the electrodes of the Viport to provide moisture.
- 4) It was necessary to position the top two electrodes of the Viport on the first intercostal space on the participant, ensuring that all three electrodes were touching the skin.
- 5) The Viport was then able to be turned on.
- 6) Once the initial beeping sounds occurred the Viport was able to start its measure which took two minutes to formulate. While the measurement was taking place, participants were requested to remain silent, be still, avoid sudden movements and maintain regular, natural breathing.
- 7) Once the final, longer beep sounds had commenced the Viport had completed the measurement and results were then recorded. The Viport measurement was repeated three times and the average result was utilized.

Blood Pressure (BP)

- 1) Participants were requested to sit comfortably in an upright, relaxed position while auscultatory systolic and diastolic pressures were measured at Korotocoff sounds I and IV.
- 2) The BP cuff was placed around the left arm slightly above the brachial artery.
- 3) Subsequently the stethoscope was placed above the brachial artery position.

- 4) The bulb of the sphygmomanometer was then pumped repeatedly to restrict the blood flow through the artery.
- 5) Steadily the valve on the bulb was unfastened to release the cuff pressure.
- 6) When the first audible sound is heard by means of the stethoscope which will sound like a clear ‘thud’, at that position the systolic pressure will be recorded.
- 7) The repetitive heart beat sounds become unclear and muffled and at that position of disappearance the diastolic pressure was recorded.
- 8) The measurement was repeated three times and was recorded as systolic/diastolic millimeters of mercury (mmHg). The average was used.
- 9) Measurements were separated by at least one minute but should be separated by as much time as reasonably practicable.

Body composition component of HRPF

Body composition

Body Mass Index (BMI)

- 1) The participant’s height was measured in meters.
- 2) The participant’s weight was measured in kilograms.
- 3) The results were recorded by $\text{WEIGHT [KG]} / (\text{HEIGHT [M]})^2$ (height squared)

Subcutaneous body fat percentage

By utilizing the Harpenden Skinfold Caliper, the following areas of the body were measured:

- 1) Abdominal – vertical fold measured 2cm to the right of the umbilicus.
- 2) Thigh – vertical fold measured on the anterior midline of the thigh, midway between the proximal border of the patella and the hip.
- 3) Triceps – vertical fold measured on the posterior midline of the upper arm (halfway between the elbow and the shoulder).
- 4) Calf – vertical fold measured at the maximum circumference of the calf (on the midline of the medial border).
- 5) Suprailiac – diagonal fold measured in the line with the natural angle of the iliac crest.

- 6) Subscapular – diagonal fold (at a 45degree angle), measure 1- 2cm below the inferior angle of the scapula.

The measures were synthesized by MALES: SUM OF SIX SKINFOLDS X 0.1051 + 2.585.

Waist-to-hip ratio (WHR)

- 1) The tester instructed the participant to stand comfortably, with their arms hanging loosely at their sides, ever slightly raised to accommodate for the acquisition of measurements.
- 2) The tester then proceeded to measure the circumference of the smallest section of the waist. Should there have been a lack of natural form to the waist; the tester would have then record the circumference at the position of the participant's naval.
- 3) The tester then measured and recorded the circumference of the largest part of the hip section.
- 4) The tester measured by wrapping the tape measure in a horizontal fashion around each of the indicated circumferences so that it fits comfortably, without indenting the skin.
- 5) The tester then repeated the assessment three times, utilizing the average of the results and recording the measurement in centimeters to the closest millimeter (i.e. decimal point).

The WHR was then determined by means of the following equation: waist measurement (cm) / hip measurement (cm).

Physical fitness component of HRPF

One-minute sit-up test

- 1) The tester instructed participant to lie on their back on the field/floor mat with his arms crossed, hands lying comfortably on the chest with fingertips lying slightly atop the shoulders.
- 2) The tester instructed the participant to bend their knees to a 90 degree angle with his feet flat on the surface about 30-45cm away from the buttocks.
- 3) The tester then instructed the participant to raise his shoulders and back off the floor towards their knees, keeping his back straight throughout the motion.

- 4) The sit-up was counted once the participant's elbows came into contact with his knees, after which the participant needed to lower himself back to the floor before he could repeat the movement.
- 5) The tester then signaled the participant to commence with the measurement, and the participant then had to complete as many sit-ups as possible in a 60 second time period.
- 6) The one-minute sit-up test was then repeated twice and the average of the results utilized.

One-minute push-up test

- 1) The tester instructed the participant to situate his hands directly beneath his shoulders, with the option of widening the breadth between the hands to ensure that emphasis is placed on the chest.
- 2) The tester then instructed the participant to position the finger-tips in a forward direction.
- 3) The participant was then instructed to maintain a straight position in the legs and torso.
- 4) The participant was instructed to lower his body to the floor until his arms are bent at a 90 degree angle to the body. Additionally, he needed to breathe out on descent and breathe in on ascent, while ensuring his head remained in line with the spine.
- 5) The tester then signaled the participant to commence with the evaluation and record the amount of times the participant could complete a push up in 60 seconds.
- 6) The test was repeated twice and the average of the results utilized.

Three-minute step test

The tester instructed the participant to practice stepping beforehand by stepping onto the step and off of the step to an Up-Up Down-Down motion.

- 1) The participant was instructed to begin the test and maintain the explained pace for the duration of three minutes.
- 2) Once the three minutes had ceased, the participant was stopped and instructed to measure his carotid pulse for a measure of 15 seconds.

- 3) Once the tester had indicated that the 15 seconds were complete, the participant provided the tester with his result and the tester then multiplied that value by 4. This end value represented the estimation of the heart rate per minute.

Sit-and-reach test

- 1) The tester instructed the participant to remove his shoes and sit with his legs together and extended with his back against the wall.
- 2) The participant was then instructed to reach towards his toes as far forward as possible, while still keeping his knees fully extended and arms evenly stretched with his palms facing the floor.
- 3) The stretch position needed to be maintained for at least two seconds, after which the distance of how far down the legs the fingertips can touch was measured.
- 4) The sit and reach test was repeated and recorded twice in centimeters with the average of the results utilized.



APPENDIX D: ETHICAL CLEARANCE

The Research Ethics Committee, Faculty Health Sciences, University of Pretoria complies with ICH-GCP guidelines and has US Federal wide Assurance.

- FWA 00002567, Approved dd 22 May 2002 and Expires 20 Oct 2016.
- IRB 0000 2235 IORG0001762 Approved dd 22/04/2014 and Expires 22/04/2017.



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Health Sciences Research Ethics Committee

13/05/2014

Approval Certificate
New Application

Ethics Reference No.: 126/2014

Title: The importance of anthropometry, physical and motor skills, sports specific testing and sports vision techniques in the evaluation of male rugby players of different ages.

Dear Ms Alida Stephani Le Roux

The **New Application** as supported by documents specified in your cover letter for your research received on the 4/04/2014, was approved, by the Faculty of Health Sciences Research Ethics Committee on the 13/05/2014.

Please note the following about your ethics approval:

- Ethics Approval is valid for 2 years
- Please remember to use your protocol number (126/2014) on any documents or correspondence with the Research Ethics Committee regarding your research.
- Please note that the Research Ethics Committee may ask further questions, seek additional information, require further modification, or monitor the conduct of your research.

Ethics approval is subject to the following:

- The ethics approval is conditional on the receipt of 6 monthly written Progress Reports, and
- The ethics approval is conditional on the research being conducted as stipulated by the details of all documents submitted to the Committee. In the event that a further need arises to change who the investigators are, the methods or any other aspect, such changes must be submitted as an Amendment for approval by the Committee.

We wish you the best with your research.

Yours sincerely

Dr R Sommers; MBChB; MMed (Int); MPharMed.
Deputy Chairperson of the Faculty of Health Sciences Research Ethics Committee, University of Pretoria

The Faculty of Health Sciences Research Ethics Committee complies with the SA National Act 61 of 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 and 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health).

◆ Tel: 012-3541330 ◆ Fax: 012-3541367 Fax2Email: 0866515924 ◆ E-Mail: fnsethics@up.ac.za
◆ Web: <http://www.healthethics-up.co.za> ◆ H W Snyman Bld (South) Level 2-34 ◆ Private Bag x 323, Arcadia, Pta, S.A., 0007



APPENDIX E: INFORMED CONSENT



Informed Consent and Indemnity



INFORMED CONSENT AND INDEMNITY – PERFORMANCE EVALUATION

As part of the Investec Rugby Academy Course you will partake in a performance evaluation conducted by a research team from the Department of Physiology, University of Pretoria, headed by Prof Peet du Toit.

Participation will include blood lactate determination, urine sample analysis, the completion of various health and lifestyle related questionnaires and you will undergo Sports Vision, fitness evaluations as described during the information session presented by Prof du Toit.

Any information gathered during the performance evaluation that can be linked to you will remain confidential and won't be disclosed to any party other than the Investec Rugby Academy without permission or outside requirements of the law. By signing this document you will give permission to use the information obtained for any and all research purposes.

I participate in the performance assessment at my own risk. I understand that the material and content contained in this survey intends to assess my health and lifestyle and does not substitute any professional medical advice, diagnosis or treatment. All my medical conditions or health risks should still primarily be presented to my health care provider or physician.

I understand that the report that follows the completion of this assessment depends on the accuracy and honesty of my responses. Neither the University of Pretoria nor any other party involved in creating, producing or delivering this report can be held liable in any manner whatsoever for any decision made, action or non-action taken by me in reliance upon the information provided through this report. I also give my full consent to share my personal report and/or health data with other stakeholders, including but not limited to research institutions in actions that will support sports development.

I hereby consent to the terms and conditions of the performance assessment.

I grant permission to share my health data for research purposes.

Participant name (please print): _____

Date:

DD	MM	YEAR
----	----	------

 Participant Signature: _____

GAURDIAN or INVESTEC RUGBY ACADEMY if participant is under the age of 18 years:

I hereby give consent to the terms and conditions of study.

Consenter's name (please print): _____

Date:

DD	MM	YEAR
----	----	------

 Consenter Signature: _____



Informed Consent and Indemnity



Witness's name (please print): _____

Date:

DD	MM	YEAR
----	----	------

 Witness Signature: _____

I Prof Peet du Toit herewith confirm that the above participant has been informed fully about the nature, conduct and risks of the above trail.

Investigator's name (please print): _____ Peet du Toit

Date:

--	--	--

 Investigator Signature: _____