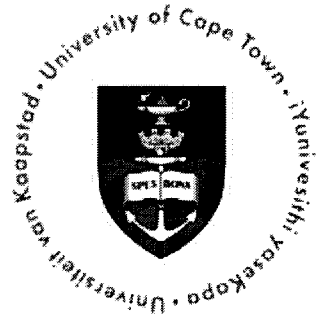

Psychological correlates of injury, illness and performance in Ironman Triathletes

A dissertation prepared by Daniel Hugo (HGXDAN002) in partial fulfilment of the requirements for the Master of Philosophy degree in Sports Medicine (MPhil Sports Medicine) from the University of Cape Town

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Declaration

I, Daniel Hugo, hereby declare that the work on which this dissertation is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

Signed by candidate

Signature removed

20 November 2008

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Abbreviations

BMI	body mass index
CD-RISC	Connor-Davidson Resilience Scale
CHD	coronary heart disease
Cm	Centimetre
EAMC	exercise associated muscle cramps
EI	emotional intelligence
HA	harm avoidance
Kg	Kilogram
kg/m^2	kilogram per metre squared
Km	Kilometre
K10	Kessler 10 psychological distress test
MCS	mental component summary scale
Min	Minute
NS	novelty seeking
RD	reward dependence
TCI	temperament and character inventory
TPQ	Tri-dimensional personality questionnaire

Abstract

Background: The association of psychological factors with athletic performance and proneness to injury and illness has been widely recognised as an integral part of athletic preparation, treatment and rehabilitation. The exact nature of this association is still not clear, but it can be hypothesised that better mental health leads to better performance, less injuries and illness and more rapid recovery. Psychological distress is a strong predictor of injury, illness and poor performance, but inherent personality traits have failed to show a constant association with these parameters. Advances in validated psychometric instruments of personality and resilience show promise in their application to further the understanding of the psyche in athletes.

Objective: The aim of this study was to evaluate the predictive value of personality traits (novelty seeking, harm avoidance and reward dependence), resilience and general psychological distress in terms of injury, illness and performance in a group of triathletes competing in the 2007 Ironman Triathlon.

Methods: For this descriptive cross-sectional study, 166 entrants in the 2007 Ironman Triathlon were recruited. Each subject completed a detailed, previously validated set of questionnaires during registration prior to the event. Contained in the questionnaire were sections on general demographic information, detailed previous and current medical conditions and injuries, and psychometric instruments (TPQ – a measure of personality, CD-RISC – a measure of resilience, K10). After the event, the official overall finishing times, as well as the split times for the swimming, cycling and running legs, were obtained from the race organisers.

Results: Higher NS and RD scores were predictors for faster predicted performance times and higher psychological distress scores was a predictor for slower actual

times (r=0.160, P=0.053) and particularly predicted slower cycling times (r=0.026, P=0.002). Higher K10 scores significantly predicted the presence of flu-like symptoms (P=0.019) and higher HA scores significantly predicted nervous system symptoms during exercise (P=0.035). Higher RD scores predicted the absence of nervous system symptoms (P=0.075). Higher K10 scores (P=0.093) and HA scores (P=0.070) were associated with medication use prior to and during the event. Higher resilience scores predicted the occurrence of exercise associated collapse (P=0.081) and absence of EAMC (P=0.075). Higher HA scores predicted GIT symptoms during exercise (P=0.091). Higher reward dependence predicted the presence of tendon / ligament injuries (P=0.039) and genital injuries were associated with lower resilience (P=0.098) and higher HA scores (P=0.065).

Conclusion: Generally, the results showed only a few consistent findings in terms of identifying predictors, although interesting correlations and trends were observed. Studies on different athletic populations and on a larger scale are needed. Physicians should be aware of the cardinal importance of mental well-being, as this is as vital in the preventative and curative management of the injured, ill or poor performing athlete as optimal physical conditioning.

Keywords: psychological factors, personality, resilience, general distress, performance, injury, illness

Chapter 1

Introduction and scope of the thesis

In keeping with the competitive nature of sport, athletes have and always will strive towards greater achievements than those before them. This has been the driving force behind the advancement in the fields of Exercise Science, Sports Medicine, and also Sports Psychology. Since the late 19th century, research was focused on the influence of psychological factors on health and illness, and later, on injuries and athletic performance. These findings challenged the traditional view of a body and a mind that functioned separately. Today it is widely recognised that mental well-being is not only paramount to physical well-being, but also an integral part of the formula for successful athletic performance. The available body of literature dealing with psychological and personality traits and their relationship to health/illness, injury and athletic performance in reviewed in Chapter 2.

The Ironman Triathlon is an ultra-endurance event that challenges participants on many levels. The South African Ironman which formed part of this investigation was held in Port Elizabeth during March 2007. This race consists of a 3.8km surf swim, a 180km cycle and a 42.2km road run (to be completed within a cut-off time of seventeen hours). To master this race requires not only strenuous, time-consuming mental and physical preparation, but a monumental human effort on the day.
Due to the extreme nature of an ultra-endurance event like the Ironman, it provides an excellent opportunity to study the psychological profiles of endurance athletes. In addition, the relationship of specific aspects of triathletes' psychological profiles with

the occurrence of injuries and illnesses, as well as their athletic performance, can also be investigated.

The details and findings of a descriptive cross-sectional study investigating the relationship of general psychological distress, resilience and personality (temperament traits; namely, harm avoidance, reward dependence and novelty seeking), with the injury/illness and performance profiles of a sample of triathletes who completed the 2007 Ironman Triathlon are presented and discussed in Chapter 3 of this dissertation.

The Kessler Psychological Distress Scale (K10), the Connor-Davidson Resilience Scale (CD-RISC) and the Tri-dimensional Personality Questionnaire (TPQ) are validated psychometric instruments and were selected for this study on the basis of their psychometric properties.

In Chapter 4 of this dissertation, the body of evidence, the findings of the study together with the relevant clinical applications, and future directions of study are summarised.

Chapter 2

The psychology of injury, illness and performance in athletes: A review

Despite the advances in the field of sports medicine, the refinement of technology, the creation of specialist sports and rehabilitation equipment and the development of coaching techniques, social and psychological factors continue to be major factors that influence athletes' performance[1].

Being able to exercise in the heat for prolonged periods of time is an adaptation that enabled early hominids to hunt during the day, when animals normally seek the coolness of the shade[2]. As the understanding of the human body during endurance exercise is furthered, researchers are discovering increasing evidence of the existence of central governing strategies in determining athletic performance[3]. Recent evidence supports the hypothesis that fatigue is regulated by the central nervous system[3]. It seems as though understanding the human brain during exercise could represent the next frontier in understanding the exercising human body.

Psychological factors are not only important with respect to human performance, but also vital to further the understanding of the psyche of the exercising human being[4]. The steady improvement in the predictive value of psychometric instruments has enabled researchers to make more valid and reliable findings when studying the relationship of psychological factors to athletic performance[4;5].

This chapter will, after placing this field in its historical context (Section 2.1), review the body of knowledge available to understand the psychological factors, particularly personality characteristics, life-stress and coping mechanisms, that impact on an athlete's susceptibility to injury (Section 2.2) and illness (Section 2.3), as well as performance (Section 2.4). Although not the focus of this dissertation the relatively novel concept of emotional intelligence will be briefly reviewed in Section 2.5. Finally, the three psychological factors, namely, personality traits, resilience and general psychological distress, investigated in this dissertation will be reviewed in Section 2.6 of this review.

2.1. Historical overview

2.1.1. Psychology of health and disease

Early investigation of the psychological disposition of patients led to the acknowledgement of an interaction between human biology and psychology[6]. Since the first part of the 20th century, the biomedical community has increasingly recognised the importance of psychological factors in the origin and discourse of infection, disease and rehabilitation from illness[7;8]. Recently, it has become almost common knowledge that there is a delicate clinical and scientific relationship between psychology and illness (or health)[8-11]. In fact, psychology is embedded in biology and has a definite biochemical basis. Emerging only in the past 25 years as a distinct discipline, the notion of psychosocial and behavioural factors affecting health and

disease processes, has evolved into the field that is currently known as "Health Psychology"[8-10 11].

2.1.2. Psychology of sports injury

A variety of factors, including biological, physiological, psychological and psychosocial precedents, have to be taken into account when considering athletic injury[12-16]. The notion that psychological factors could influence the risk of injury in athletes was first investigated in the mid-1960s [10]. It was clear from this research that life-changing events, such as marriage, divorce, abuse and the death of a family member or a friend, that become major stressors, increased the prevalence and duration of injuries. Anxiety, as a general state or as an inherent trait, was also identified as a major risk factor for sport injuries[17]. Several models of the interaction of life events, altered mental state and injuries have consequently been developed, such as the model by Andersen and Williams[18;19] that will be discussed in Section 2.2.1 of this review.

2.1.3. Psychology of sports performance

The history of psychological factors influencing sports performance has been extensively reviewed by Raglin[4]. According to Raglin's review, Dudley wrote in 1888 in the Harvard Alumni Magazine: "in all success in athletes the mental qualities figure largely". The initial focus of research in the psychology of sports performance, which peaked in the 1960s, was directed at the influence of personality traits on sports performance. The significance of personality traits with regard to performance

was subsequently questioned throughout the 1970s. The development of more accurate psychometric tools enabled researchers to correct many of the methodological flaws of earlier studies that failed to connect personality with athletic performance. More recent studies have consistently shown that better mental health is associated with greater success amongst athletes, but the association of personality remained unclear [4].

Today there is consensus amongst sports psychologists that both internal and external psychological stressors, together with physical stressors, are important determinants of injury, illness and performance in athletes. Arguably, the most extreme manifestation of this interaction occurs during an event that leads to a loss of playing time and decreased performance[20].

2.2. Psychological factors influencing injury

While physiological factors are definitely the primary causes of injuries, Nor[13] has suggested that psychological factors are the most important aspect when studying the incidence of sports injuries. Some researchers suggest that psychological precedents can even cause certain athletes to be more prone to injuries than others[21;22].

The stress response, personality, life events and daily hassles, potentially stressful situations, or low coping resources are examples of factors that may predispose athletes to injury [21;23]. The relationship of each of these psychological factors with sport injuries will be reviewed in the following sections.

2.2.1. Stress and injury

Although "stress" is a widely used term both in daily life and in the scientific literature, it is rarely adequately defined. "Stress" is defined by the Oxford Dictionary as "pressure or tension exerted on a material object" and pertaining to humans as "demand on physical or mental energy". Hans Selye[24], regarded by many as the father of stress research, defined stress simply as: "a non-specific response to a demand".

According to Weinberg and Gould[25] previous research has shown that the relationship between athletic injuries and psychological factors is essentially a relationship between stress and injuries. In this sense, stress is predicted to produce an increased state of anxiety which causes alterations in the focus of attention and muscular tension.

Andersen and Williams[19] developed a model (Figure 2.1) illustrating the psychological factors involved in athletic injury. This model offers both a basis for measuring risk of injury as well as recommended interventions for reducing the probability of injury. This model proposes that injury occurs either as a result of diminished flexibility through stress-related muscle-tension or as a result of decreased attention capacity. It was further hypothesised by Andersen and Williams [18;19] that injury is caused by the interaction between personality factors (e.g. locus of control, anxiety), history of stressors (e.g. life events, daily hassles), coping resources (e.g. stress management skills), and potentially stressful situations[12;26].

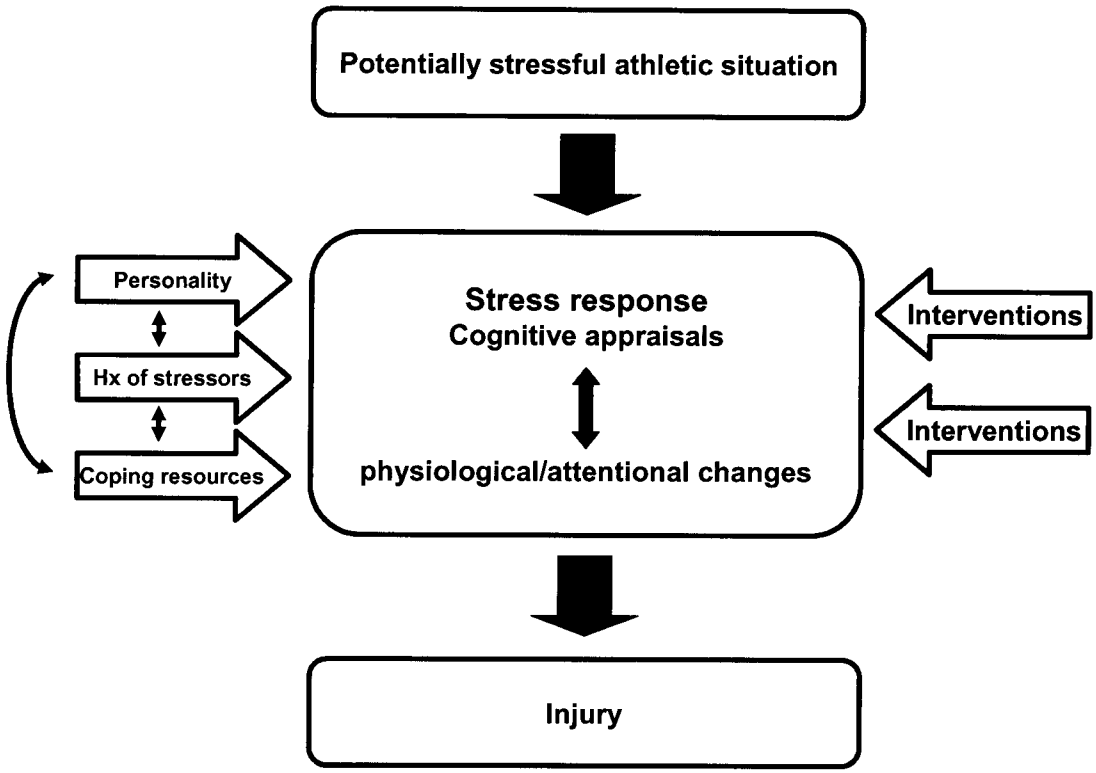

Figure 2.1: The Andersen and Williams Stress and Injury Model (Adapted from [19]).

Maddison[27] tested the Andersen and Williams model[18;19] and found a positive correlation between life-stresses and the number of injuries, and playing time lost due to injuries in a group of 470 rugby players. In a follow-up study, he randomised the players from the initial study with the highest risk of injury, which was defined as (1) history of previous injury, (2) recent major life-stresses, (3) high competitive anxiety and (4) poor coping skills, into two groups. One group was subjected to an ongoing stress management program and the other served as a control. Maddison[27] found a significant decrease in playing time lost due to injury, but no change in the number of injuries in the intervention group after one year. It seems therefore that proper management of stressors reduces not so much the occurrence of injuries, but significantly reduces the severity and the recovery time of athletic injuries.

2.2.2. Personality and injury

A number of personality variables (Type A behaviour, external locus of control, competitiveness) have been identified as being important in the stress-illness relationship[22]. Personality characteristics may dispose individuals to be more or less susceptible to the effects of stressors, such as major life events or the hassles of daily life. Johnson[21] has reported the existence of several studies documenting relationships between injury outcome and risk factors, such as an internal or external locus of control, competitive trait anxiety, and low self-esteem. Research has shown that athletes with an internal locus of control and lower competitive trait anxiety to be less likely to sustain injuries[28].

2.2.3. A history of stressors

Adverse or major life events (marriage, death of a friend or family member, abuse, loss of a job) and daily hassles are included in this category. In one of the earliest studies of its kind, Bramwell[29] found a positive correlation between major life events and injury in football players. Subsequently, researchers found that an increase in the level of life event stress directly increased the risk of being injured[28]. Johnson[21] also indicated that major life changes can affect concentration, thereby increasing the likelihood of injury in athletes.

Research has indicated that a history of a previous injury is a strong risk factor for future injury. Situations leading to injury in the past can create tension and anxiety

which, in turn, may predispose the athlete to injury by virtue of physical and/or attention deficits[13].

2.2.4. Coping resources

The influence of coping skills and social support has frequently been studied in connection with life events[30]. The assumption is that sufficient resources in adaptive coping strategies should reduce the effect of life events on the risk of injury[17]. Several studies support the link between coping resources and athletic injury[21]. In one study[31], high sensation-seeking was suggested as a protective factor against life stressors.

As summarised in Tables 2.1 and 2.2 below, studies investigating the relationship between sports injuries and psychological factors have used different methods, making it difficult to compare the results of these studies. Another limitation is that these studies focused primarily on the influence of life events or personal characteristics on the risk of injury, leaving many other areas unexplored.

Table 2.1: Summary of studies, reviewed by Junge, examining the relationship between personality traits and sports injuries.

Author (number of subjects)	Type of sport	Personality trait of injured players compared with uninjured players
Brown (186)	Football	no difference
Lysens (185)	physical education	lack of caution, emotional lability
Garcia & Argues (149)	Football	very high + very low anxiety
Jackson et al (110)	Football	tough minded
Taimela et al (37)	Football	adventurous, forthright
Hamilton (29)	Ballet	Enterprising
Valliant (21)	Running	no significant difference

Adapted from 'The Influence of Psychological Factors on Sports Injuries' (Junge 2000)

Table 2.2: Summary of studies, reviewed by Junge, examining the relationship between anxiety and sports injuries.

Author (number of subjects)	Type of sport	Result
Lysens (185)	physical education	curvilinear relationship
Hanson et al (181)	track & field	effect on severity of injury
Petrie (158)	American football	effect on absence from sport
Kolt & Kirkby (115)	gymnastics	effect on frequency of injury
Blackwell & McCullagh (105)	American football	difference in group extremes
Passer & Seese (104)	American football	no modulating effect
Kerr & Minden (41)	gymnastics	no effect

Adapted from 'The Influence of Psychological Factors on Sports Injuries' (Junge 2000)

In reviewing the literature on sport injuries, Junge[17] found that psychosocial stressors, coping resources, and situation-dependent emotional states have an effect on an athlete's risk injury. Life events are the most frequently investigated and verified of these factors, and social support appears to buffer the effect of these life events on injury risks. Personality traits appear to have no influence on the risk of injury, and no typical personality profile exists for an injury-prone athlete, but an inclination towards taking risks was noted.

Physical and psychological stressors can have a potentiating, as well as a cumulative effect, and because of this, an elite athlete in the overreaching phase of training can be at significantly increased risk of sustaining an injury. Intense competition can create similar effects on injury risk[32].

It is vital for any team physician to be aware of all the areas (as discussed in the text) where early intervention can prevent an excessive stress response and possible injury.

2.2.5. Summary

Research has clearly shown that a prominent stress response increases the risk of athletic injury. The stress response and the cognitive appraisal thereof are thought to lead to altered muscle tension and focus, which predisposes the athlete to injury.

Factors such as personality, a history of stressors, coping resources (personal, coach, family, friends) and interventions (psychological) strongly influence the stress response and subsequently the occurrence of an injury.

2.3. The psychology of illness

In addition to their effects on susceptibility to injury, medical practitioners, scientists and psychologists alike increasingly advocate that positive psychological states can enhance bodily health and well-being[10;11;33;34]. Similarly, the chronic existence of distress symptoms, such as depression and anxiety, are being highlighted for their detrimental effects on the development and discourse of illnesses and diseases in certain individuals[9;35-37].

Research in this field has moved away from the traditional biomedical model of describing disease only, in terms of an underlying antigen or organism[38], and is now attributing the functioning of humans in relation to their own health to a combination of biological, cognitive, emotive, behavioural and social factors[39-42].

Within this context, the key variables that are commonly ascribed as influencing illness and disease are stress, depression, anxiety, social support, personality and self-belief[37;39;43-45]. These factors will be reviewed in the following sections.

2.3.1. Stress and illness

Various studies have reported that individuals with greater psychological stress express more symptoms, signs and severity of diseases and infectious illnesses than those with less stress[7;43;46]. These reports show a particular relationship between

stress and illnesses related to the respiratory system, cardiovascular disease, cancer, pregnancy complications and immune system-mediated diseases[8;35-37;39;46].

Cohen and Williamson[43] explain this relationship in that a particular stressful life event or array of events affects the course of physical illness by creating negative emotional states. These directly influence biological processes by attacking the immune system either directly through the central nervous system or through the release of hormones in the body. The weakened defence mechanisms (barrier function and early response to pathogens) increase the body's exposure to pathogens and a resultant proneness to contract disease[8;45]. In vulnerable personality types these stressful events can influence the limbic system which leads to a neurophysiologic response from the hypothalamus. This immuno-endocrine-autonomic response is central in the development and maintenance of so-called "psychosomatic disease"[47].

2.3.2. Anxiety, depression and illness

It is commonly documented in psychological and psychiatric literature that psychiatric symptoms, including anxiety and depression, are significant risk factors to an individual's health, specifically in that these factors increase the individual's tendency to commit suicide or self-inflict injuries[48]. More recently, however, it has also come to light that depression and anxiety are important risk factors for cardiac illnesses and immune-deficient diseases[48-53].

2.3.3. Social support

Although studies have not always been consistent, and more research is required in this field, it has been found that a sense of personal control and perceived social support does have an influence on mental as well as physical health, both directly and as a buffer to stress. Social support has been found to be negatively linked with cardiovascular death and to safeguarding against recurrence of disease and death among persons diagnosed with disease[54;55].

2.3.4. Personality and illness

The idea of a link between personality and health has been studied since the time of ancient Greece. However, empirical research started only in the mid-20th century, with the emergence of the idea that Type A behaviour is a risk for coronary heart disease (CHD)[56]. In recent times, research has been expanded to include more characteristics, with links to other diseases. Poor coping skills, unhealthy behaviour and physiological reactivity are included as mediating factors of personality-caused illness. Specific disease-prone traits that have been studied include extroversion, neuroticism, hostility, depression, conscientiousness, impulsivity, repression, and lack of disclosure[57].

Research indicates that Type A individuals (i.e. people who are competitive, achievement-oriented, easily annoyed, and time-urgent) may be at risk for a poor health-related quality of life, including chest pain, general health problems, and

injuries[7]. Furthermore, Type A characteristics, including hostility, anger, and anger expression, have repeatedly been linked to coronary heart disease (CHD)[56]. Other characteristics associated with CHD are the need for approval, competitiveness, impatience and irritability, and the inability to stop working[7;56].

A study by Friedman and Booth-Kewley[56] found that traits traditionally linked with neuroticism (chronic anxiety, long periods of sadness and pessimism, unremitting tension, incessant hostility) could be associated with asthma, headaches, peptic ulcers and heart disease.

In a recent study[58] researchers found that, in elite collegiate athletes from Stanford University, personality factors (such as, self-esteem, mindfulness and low distress) were greater predictors of happiness than external factors (game time during the season and a scholarship).

2.3.5. Self-belief

Psychologists have suggested that positive self-beliefs can be associated with psychological health[37;59]. Optimism, a sense of personal control, and the ability to find meaning in one's life experiences are valuable psychological assets which can have a beneficial influence on physical health[37].

2.3.6. Coping strategies

The response to negative life events can influence the development of illness. More resilient female athletes (less occurrence of illness in response to high levels of life stress) use adaptive or problem-focussed stress coping mechanisms, whereas the less resilient females use maladaptive coping mechanisms, like avoidance and blaming others. These findings suggest healthier coping mechanisms in certain people, for life-stress can be protective against illness[60].

2.3.7. Summary

The application of a wide variety of psychological intervention techniques with regard to health and illness[61] now makes it possible to predict, manage and even prevent social and psychological distress symptoms. It is apparent that there is a resultant effect on an individual's ability to resist infection or diseases[39]. Major sporting events and cycles of overreaching during training can be a prominent stressor that leads to psychological distress and an increased risk of illness.

2.4. Psychology of performance

In earlier sections of this review the relationship between psychological factors and injury and illness in athletes is discussed. Injury and illness have a detrimental effect on performance, directly and indirectly due to the negative psychological sequelae. It is widely recognised that elite sporting performance is also directly influenced by

psychological factors, including personality and general mental well-being. In competitive situations the winner is often the person who is mentally stronger on the day[4;5].

2.4.1. Mental well-being and performance

According to the Mental Health Model of Sport Performance[4;62], a relationship exists between mental health and sporting achievement. The model hypothesises a positive correlation between an athlete's performance and the state of his/her psyche[63]. Similarly, the mood states of athletes, which is a combination of environmental and personality factors, have also been described to affect the outcome of performance positively[63;64;64-66]. Indeed, successful athletes prove to experience lower levels of undesirable mood states (e.g. fatigue, depression, anger) and higher levels of desirable mood states (e.g. vigour). This has been termed the Iceberg Profile[63].

2.4.2. Personality and performance

Many personality traits have been shown to have a direct correlation with athletic performance[4;5;63;67]. Anxiety, as both a mental disposition and personality trait, has specifically been reported to negatively influence athletic performance[4;63]. Performance is reportedly affected by two types of anxiety, namely, state anxiety (intensity of anxiety experienced at a given moment that can change in a few seconds) and trait anxiety (stable factor as part of personality, reflecting the tendency to experience increases in state anxiety in response to stressors, such as sport competition)[63].

Studies have shown strong relationships between high levels of extroversion, low anxiety and low levels of neuroticism with successful performance[67-69]. Han et al[5], utilising a Korean version of Cloninger's Temperament and Character Inventory[70;71], reported that temperamental traits of harm avoidance, novelty seeking, reward dependence and persistence impact on the outcome of sports performance in a variety of codes including swimming and long-distance running in high school boys[5]. In this study, 277 athletes and 152 non-athletes were compared according to temperamental traits and anxiety. Between and within-group comparisons were also performed on the athletes according to different sport codes and according to differentiation into winners and non-winners. The athletes' group scored higher than the non-athletes' group with respect to harm avoidance. This result was consistent with Cooper's 1969 report[72], where athletes displayed a higher degree of emotional stability and seemed more socially adjusted than non-athletes. Further results revealed long-distance runners to have the lowest persistence and highest novelty seeking scores. This finding is in contrast to other studies[67;73;74] that depicted endurance athletes as socially extroverted, controlled and optimistic. Results also showed higher persistence and reward dependence in the winner group (athletes who had experience as the first of final winners). The research report concluded that persistence was the strongest predictor item for the winning experience[5].

2.4.3. Summary

Mental well-being, mental strength and problem-focused stress coping strategies have a protective effect with regards to illness and injury in athletes which in itself

enables athletes to perform at their optimal level[19;20]. Psychological health and mental toughness, as well as certain personality traits, have been positively correlated with a variety sport codes and enhanced athletic performance[5].

2.5. Emotional intelligence (EI)

Emotional intelligence is a fairly novel concept that is increasingly being used in the psychometric testing of subjects, especially in the corporate context, to predict success in the workplace. Salovey and Mayer[75] were the first authors to link emotion and intelligence, and described emotional intelligence as "a type of social intelligence that involves the ability to monitor one's own and other people's emotions, to discriminate among them, and to use the information to guide one's thinking and actions". Mayer and Salovey[76] felt that emotionality, emotion management and neurological substrates may be mechanisms involved with EI.

Goleman[77] described five critical pillars for EI, namely: self-awareness, self-regulation, self-motivation, social awareness, and social skills. These traits or competencies imply awareness of one's emotions and the constant monitoring and regulation thereof, the awareness of the feelings and needs of those around you and the ability to drive oneself to reaching goals[78]. This contribution of emotional intelligence in the achievement of an individual's goals has increasingly been studied in the fields of sports practice and sport psychology. Meyer and Zizzi[79] state that sports leaders (coaches, captains, senior players) with higher EI abilities may be better equipped to help athletes and teammates to recognise and manage their

emotions. Effective management of emotion is a necessary component of athletic success.

However, Sevdalis et al. [80] found that higher emotional intelligence can be associated with a decline in positiveness of mood in individuals after they have relived disappointing situations that have had profound effects on their lives. The influence of emotional intelligence on athletic performance has not been studied to the same extent as other psychological traits reviewed in this study, but some of the results that do exist have shown potential for emotional intelligence to become an integral part of the psychological profiling of athletes[78].

Although emotional intelligence was not examined as a parameter in this study (Chapter 3), it is an entity that needs to be taken into account when dealing with the psychological realm of sport.

2.6. Description of personality and other psychological factors

The three psychological factors selected for this study (Chapter 3) are personality (novelty seeking or NS, harm avoidance or HA, reward dependence or RD)[71;81;82], resilience[83] and general psychological distress[84-86]. These factors were selected because they can be measured by specific, validated psychometric instruments, and because of their potential association with athletic injury, illness and performance. As discussed above, some of these factors (personality traits: NS, HA, RD) have been studied previously in athletic populations[5]. These factors will be reviewed in the following sections.

2.6.1. Personality

Personality is defined as "deep seated, long-standing traits and behavioural patterns that become evident in one's interpersonal relationships; observation and thinking concerning the environment and self"[87]. The Diagnostic and Statistical Manual (DSM-IV) defines personality as the persistent pattern of observation of a person regarding himself or herself, other people and the environment[88]. Cloninger et al. [71] define personality as "the dynamic organisation within an individual of the psychobiological systems that modulate adaptation to a changing environment". The systems that are referred to, include those regulating cognition, emotion, mood, impulse control and social relations.

Personality comprises of specific temperament and character traits. Temperament describes those components of personality that are inherent and mostly stable throughout life, whilst character refers to traits that develop in infancy and mature throughout life (self-object relations)[82].

Cloninger et al.[71;81;82] described a model of personality using four temperament and three character traits. The four temperament dimensions are novelty seeking, harm avoidance, reward dependence and persistence. The three character dimensions are self-directedness, cooperativeness and transcendence.

Cloninger[81] developed a hypothesis where the three basic temperament dimensions were linked to specific neural pathways and neurotransmitters, thus viewing

personality as having an underlying biological basis. According to this hypothesis, novelty seeking is associated with dopaminergic pathways, harm avoidance is associated with serotonergic pathways, and reward dependence is associated with noradrenergic pathways. His hypothesis has been tested by several studies with varying results. The authors of a recent study[89] proposed a modified hypothesis that novelty seeking, harm avoidance and reward dependence would have the greatest total variance for dopamine, serotonin and noradrenaline genes respectively. Their study only partially supported the Cloninger model[81], and the modified hypothesis proposed only found a clear association between RD and noradrenaline. A third hypothesis, that several groups of genes play a role in most of the personality traits with positive and negative correlations, provided the best explanation for their findings[89]. Thus personality is determined by a complicated interplay of genetic and neural factors.

The seven personality traits[71] are summarised in Tables 2.3 and 2.4.

Table 2.3: Personality characteristics of subjects scoring high and low on the four temperament dimensions.

Dimension	High	Low
Harm avoidance	fearful	optimistic
	pessimistic	daring
	fatigable	energetic
	Shy	Outgoing
Novelty seeking	impulsive	rigid
	exploratory	reserved
	irritable	stoical
	Extravagant	Frugal
Persistence	determined	spoiled
	industrious	lazy
	perfectionist	pragmatist
	Ambitious	underachiever
Reward dependence	open	aloof
	sentimental	critical
	sympathetic	independent
	Warm	Detached

Adapted from Cloninger et al. (1997)

Table 2.4: Personality characteristics of subjects scoring high and low on the three character dimensions.

Dimension	High	Low
Cooperativeness	helpful	hostile
	principled	opportunistic
	tender-hearted	intolerant
	empathic	insensitive
	Compassionate	Revengeful
Self-transcendence	spiritual	materialistic
	idealistic	practical
	self-forgetful	unimaginative
	enlightened	possessive
	Transpersonal	Controlling
Self-directedness	resourceful	inept
	disciplined	undisciplined
	self-accepting	vain
	purposeful	aimless
	Responsible	Blaming

Adapted from Cloninger et al.(1997)

Generally:

- Individuals high in harm avoidance are fearful and anxious about perceived danger, whereas those low in harm avoidance are positive and prone to risk-taking.

- Individuals high in novelty seeking are pleasure-seekers who will rarely hesitate to transgress the law to pursue the next thrill, and those low in novelty seeking are more reserved, content, and even stoic.
- Individuals high in persistence are ambitious over-achievers and those low in persistence are unmotivated under-achievers.
- Individuals high in reward dependence are socially conscious, open and warm, while those low in reward dependence are aloof and socially detached.
- Individuals high in cooperativeness are compassionate and principled, and those low in cooperativeness are opportunistic, vindictive and insensitive.
- Individuals high in self-transcendence are idealistic and serve the greater good, but those low in self-transcendence show materialistic self-centred behaviour.
- Individuals high in self-directedness are conscientious and focused, whereas those low in self-directedness are inept, aimless and generally incompetent.

These personality dimensions can be measured by the Temperament and Character Inventory (TCI, discussed in Section 2.6.4)[71]. As described above, an individual's high or low score predicts certain temperament and character traits.

2.6.2. Resilience

Resilience refers to the ability to cope with stress. A resilient person displays adaptive responses to highly stressful conditions as opposed to the maladaptive responses of the non-resilient. Research reveals that these adaptive responses are a result of better, more problem-focused coping strategies[60].

In competitive sport there are many adverse situations and with resilience being the ability to thrive under adversity[83], it might be of value to be able to predict the way that athletes are able to cope with the stress of injury, illness and the stressful demands of competitive sport in general.

2.6.3. General psychological distress

Psychological distress is generally accepted as the experience of anxiety and depression defined by a diverse set of cognitive, behavioural, emotional and psychophysiologically-associated symptoms[84-86]. It can be caused by a variety of stressors, including adverse life events and daily hassles[90]. These stressors also have a strong association with sports injuries[18;19] and this may be important in the prediction of athletic well-being and success.

2.6.4. Psychometric instruments

As stated in Section 2.6, each of the selected psychological factors is measured by a specific psychometrical instrument. These are: the Tri-dimensional Personality Questionnaire (TPQ) for personality[82], the Connor-Davidson Resilience Scale (CD-RISC) for resilience[83] and the Kessler 10 (K10) for general psychological distress[84;85]. The psychometric instruments used in this study (Chapter 3) have sound psychometrical properties[82;83;85]. The TPQ, CD-RISC and K10 are described in this section.

2.6.4.1. The Tri-dimensional Personality Questionnaire (TPQ) and the Temperament and Character Inventory (TCI)

The Temperament and Character Inventory (TCI) is a self-report psychometric diagnostic tool that measures and scores the seven traits of personality as described by Cloninger et al. [71]. The Tri-dimensional Personality Questionnaire (TPQ) is an earlier self-report true/false tool that measures three higher order personality dimensions, each with four lower order dimensions. Scores for novelty seeking, harm avoidance and reward dependence are given. The breakdown of scores is described in Table 2.5. Each of the dimensions is scored on a continuum with the respondent being high or low in each dimension.

Given the deep-seated nature of personality in the individual, the measurement of personality dimensions is of significant predictive value in terms of diagnosis, treatment and outcome. Several studies have used the TPQ and TCI to predict outcomes in the treatment of psychiatric conditions, including substance dependence[91], bipolar disorder[92], obsessive compulsive disorder[93] and compulsive gambling[94], but also in medical conditions, including ischemic heart disease[95], chronic pain[96] and psoriasis. It is also increasingly used to look at the personality traits of athletes. Han et al.[5] studied a group of Korean high school boys competing in a variety of sport codes using a Korean version of the TCI.

Table 2.5: Scales and subscales of the Tri-dimensional Personality Questionnaire.

Scale	Subscale
Harm avoidance (HA)	HA1: anticipatory worry vs. uninhibited optimism (10 items)
	HA2: fear of uncertainty vs. confidence (7 items)
	HA3: shyness with strangers vs. gregariousness (7 items)
	HA4: fatigability and asthenia vs. vigour (10 items)
Novelty seeking (NS)	NS1: exploratory excitability vs. stoic rigidity (9 items)
	NS2: impulsiveness vs. reflection (8 items)
	NS3: extravagance vs. reserve (7 items)
	NS4: disorderliness vs. regimentation (10 items)
Reward Dependence (RD)	RD1: sentimentality vs. insensitiveness (5 items)
	RD2: persistence vs. irresoluteness (9 items)
	RD3: attachment vs. detachment (11 items)
	RD4: dependence vs. independence (5 items)

Adapted from Cloninger et al (1991)

2.6.4.2. The Connor-Davidson Resilience Scale (CD-RISC)[83]

The CD-RISC is a relatively new scale for the measurement of resilience, comprising of 25 items that are rated on a nominal scale, with higher scores indicative of higher resilience. The test is concise, self-rated and psychometrically sound. Connor and Davidson showed that resilience can be improved and that this improvement can

contribute to general psychological well-being. Thus the CD-RISC has excellent clinical and research possibilities. To the author's knowledge, the CD-RISC has not been used to study athletic populations.

2.6.4.3. The Kessler Psychological Distress Scale (K10)

The K10 is a 10-question screening test that is used to identify trends of unspecified or general psychological distress on a large scale mostly in communities/populations. The test has been extensively validated to have strong psychometric properties and shows the ability to separate psychiatric (fulfil DSM-IV criteria) cases from non-cases[85]. The K6 is an abbreviated version of the K10 (only six questions), with the same accuracy. The accuracy and effectiveness of the K10 as a screening tool for psychological distress makes it suitable for research purposes[84;85]. To the author's knowledge, the CD-RISC has not been used to study athletic populations.

2.7 Conclusion

Empirical evidence and studies as far back as the late 19th century confirmed that psychological disposition is an important determining factor in the injury, disease and performance profiles of athletes. The relationship between biological measures and psychological assessments is still in need of more psychometrically sound evidence. Cloninger's work on personality assessments has shown promise towards facilitating a greater understanding of the interaction of the human psychosocial and physiological realms, but it also highlighted the challenges that await athletes,

coaches, sport scientists and physicians in their pursuit of going higher, further and faster.

From this review it should be clear that knowledge of the psychological profiles of athletes is invaluable to sports physicians and other practitioners involved with teams or individual athletes. Mental wellness is an integral part of the prevention, treatment and rehabilitation of injuries and illness, as well as the optimisation of performance in athletes. In order to initiate timely and appropriate interventions to facilitate optimal athletic performance, psychological profiling should provide psychological dimensions that have strong predictive values for factors that influence athletic success.

This study, as described in Chapter 3, aims to investigate the predictive value of personality, resilience and general psychological distress with regards to injury, illness and performance in Ironman triathletes.

Chapter 3

Psychological correlates of injury, illness and performance in Ironman Triathletes

3.1 Introduction

In ancient times when organised sport was first popularised, athletes and coaches alike have sought ways to improve performance and to go beyond what was achieved by others[97]. This trend has continued into modern times. The last century has seen vast improvements in coaching techniques, sport and safety equipment, injury prevention and management strategies, and our general understanding of the optimisation of athletic performance[1]. This apparent "physical evolution" has curiously not been mirrored by similar advances with regards to the "psychology" of the athlete.

Throughout the sporting fraternity the importance of attaining the optimal "mental approach" to sport is recognised[25]. Terms including *big match temperament, pressure player, cool under pressure, killer instinct, nerves of steel, tough as nails, winning habit, true competitor* and *team player* are commonly used to describe the personality traits in athletes and the traits that are believed to make them more likely to succeed. The integral role of the mind in reaching our goals is further illustrated by the well-known poem by Walter D. Wintle (The Man Who Thinks He Can*: "...Life's battles don't always go to the stronger or the faster man, but sooner or later, the man who wins is the man who thinks he can".).*

Our knowledge of human exercise physiology far exceeds our understanding of the complex nature of the human psyche with regards to exercise. Researchers in the field of sports psychology have failed to find a strong link between personality and performance or injury proneness[4]. However, the body of evidence has indicated that stress and stress coping mechanisms are indeed important determining factors in the success of the participating athlete[25].

As studies on the physical performance of the human body and its behaviour during strenuous exercise progress, it is becoming evident that similar to the days of the mighty Roman Empire: All roads lead to the *brain*[3]. It follows naturally that understanding the brain, and therefore the exercising mind, and its influence/control of the exercising body is the next frontier in the science of sport.

Ultra-endurance events like the Ironman Triathlon studied in this investigation provide an excellent opportunity for studying the body and mind of the competing athlete under extreme conditions. The South African Ironman Triathlon was held in Port Elizabeth in March 2007 and consisted of a 3,8km surf swim, a 180km road cycle followed by a 42,2km road run.

The demanding nature of the event not only challenges the athlete's toughness on the day, but also requires strenuous physical and mental preparation. Despite this, there are a fairly large number of entrants, ranging from recreational to elite triathletes.

Recent advancements in validated psychometric tools and an enhanced understanding of the relevant neurotransmitters have enabled researchers to study many psychiatric conditions like bipolar disorder[92], obsessive compulsive disorder[93] and gambling addiction[94]. These applications can bring sport scientists ever closer to identifying those psychological traits that can predict the performance, injury and illness profiles of athletes.

This study was prompted by the need for medical and paramedical professionals who are involved in sport to understand the psychological processes that influence the occurrence, treatment and rehabilitation of injuries and illnesses and the performance of athletes.

3.2 Objective

The objective of this study wass to measure the general distress, resilience and temperament traits (as part of the personality assessment) of a group of ultra-endurance athletes competing in the 2007 Ironman Triathlon and to assess the possible associations of these traits with their performance in the event and their injury and illness profiles.

3.3 Research methodology

3.3.1 Type of study

This study took the form of a descriptive cross-sectional research design. Descriptive cross-sectional studies deal with the description of phenomena *ex post facto* (retrospective) and describe the characteristics of these phenomena, as well as the associations between studied variables, thereby providing valuable information about the general traits of the population under study and their influencing factors[98].

3.3.2 Subjects

The subjects for this study were recruited from 1566 entrants for the 2007 South African Ironman Triathlon (only 1308 entrants crossed the finish line inside the cut-off time). The study protocol was approved by both the Research Ethics Committee of the University of Cape Town (reference REC 002/2007) (Appendix E) and the official organisers of the Port Elizabeth "Spec-Savers" South African Ironman Triathlon that included the general organising committee and the medical subcommittee. An email informing the triathletes about the study and inviting them to take part in it was distributed to all the entrants two months prior to the event. The research questionnaires were also available on the official Ironman website and at the research hub during the 3 registration days before the event. During recruitment and data collection 166 entrants consented to participate in the study and partially or completely filled in the Ironman medical and training questionnaires.

3.3.3 Data collection

The main research tool used to gather data for the study was a detailed and previously validated questionnaire. The document comprised of: information about the intended study and its protocols (Appendix A and Appendix B), an informed consent form (Appendix C) and the questionnaire (Appendix D) which requested personal details, medical history, history of injuries, recent or current symptoms of illness or injury, and three psychometric instruments namely, the Kessler Psychological Distress Scale (K10), the Connor-Davidson Resilience Scale (CD-RISC) and the Tri-dimensional Personality Questionnaire (TPQ). (The CD-RISC was used with permission from Dr JRT Davidson)

All three psychometric tools are self-report "paper-and-pencil"-based tests. The K10 is a 10-question screening tool that is used to detect trends of general distress in large groups, e.g. communities[85]. Each question is rated on a nominal scale consisting of the following options: (1) none of the time, (2) a little of the time, (3) some of the time, (4) most of the time, and (5) all of the time. The CD-RISC is a 25-question test with each question also rated on a nominal scale with a higher score indicative of increased resilience[83]. The nominal scale consists of the following five options (1) not true at all, (2) rarely true, (3) sometimes true, (4) often true, and (5) true nearly all of the time. For the K10 and CD-RISC questionnaires a score of 1 was given to each question answered with option 1, 2 for option 2, 3 for option 3, 4 for option 4 and 5 for option 5. Total scores ranging from 5 to 50 and 25 to 125 are therefore obtained from the K10 and the CD-RISC questionnaires respectively.

The TPQ is a 100-question test of which only 96 items were used in this study (Questions 40, 61, 71 and 79 were not included in the questionnaire of which Questions 61 and 71 are not used in calculating any of the three main temperaments). This test measures the three main temperament dimensions, namely, novelty seeking (NS), harm avoidance (HA), reward dependence (RD)[82]. Each question is answered either True or False, and scores 1 for a true answer and 0 for a false answer.

The following equations were used to calculate the four subscales (1 to 4) and scales for NS, HA and RD from the 96 questions[82]:

(1) NS1=Q2+Q4+(1-Q9)+(1-Q11)+Q43+(1-Q85)+(1-Q93)+(1-Q96)

(2) NS2=Q30+(1-Q46)+Q48+Q50+(1-Q55)+(1-Q56)+(1-Q81)+(1-Q99)

(3) NS3=(1-Q32)+(1-Q66)+Q70+Q72+(1-Q76)+(1-Q78)+(1-Q87)

(4) NS4=Q13+(1-Q16)+(1-Q21)+Q22+Q24+Q28+(1-Q35)+Q60+Q62+(1-Q65)

(5) NS=NS1+NS2+NS3+NS4

(6) HA1=(1-Q1)+Q5+(1-Q8)+Q10+Q14+(1-Q82)+(1-Q84)+(1-Q91)+(1-Q95)+(1-Q98)

(7) HA2=Q18+Q19+Q23+(1-Q26)+(1-Q29)+(1-Q47)+(1-Q51)

(8) HA3=Q33+Q37+Q38+(1-Q42)+(1-Q44)+(1-Q89)+(1-Q100)

(9) HA4=Q49+Q54+Q57+(1-Q59)+(1-Q63)+Q68+Q69+Q73+(1-Q75)+(1-Q80)

(10) HA=HA1+HA2+HA3+HA4

(11) RD1=Q27+Q31+Q34+Q83+Q94

(12) RD2=Q39+Q41+(1-Q45)+(1-Q52)+(1-Q53)+Q77+Q92+Q97

(13) RD3=Q3+Q6+Q7+(1-Q12)+(1-Q15)+Q64+Q67+Q74+(1-Q86)+(1-Q88)+(1-Q90)

(14) RD4=(1-Q17)+(1-Q20)+(1-Q25)+(1-Q36)+(1-Q58)

(15) RD=RD1+RD2+RD3+RD4

Where Q is the score (either 0 for false and 1 for true) for the specific questions on the questionnaire. Example Q1 is question1. NS – novelty seeking, HA – harm avoidance and RD – reward dependence. The subscales are explained in Table 2.5.

A dedicated data collection station was set up in the registration area. Here subjects could fill in or hand in completed questionnaires, or discuss the study with the researchers.

3.3.4 Data analysis

All the data was entered into an Excel spreadsheet (Microsoft 2003) and analysed using the Statistica 7.0 (Stat-soft Inc, Tulsa, Oklahoma, USA) and GraphPad InStat 2.05a (GraphPad Software, San Diego, California, USA) statistical programs. All normally distributed numerical data are represented by the mean ± standard deviation, with the number of subjects in parenthesis and a one-way analysis of variance (ANOVA) was used to determine any significant differences between groups. Categorical data were expressed as frequencies, and significant differences between groups were analysed using the Pearson's chi-square or Fisher's exact tests. Correlation coefficients (r) were used to determine relationships between pairs of numerical data. Statistical significance was accepted when $P<0.05$.

3.4 Results

3.4.1 Psychometric scores and subject characteristics

Of the 166 recruited subjects (10.6% of all entrants), the CD-RISC was completed by 159 (10.1%), the K10 was completed by 159 (10.1%) and the TPQ was completed by 120 (7.7%) triathletes. All in all, 163 (10.4%) entrants completed at least one of the psychometric tests and 116 completed all 3.

The general characteristics, actual performance times and the psychometric scores of the subjects are depicted in Table 3.1. These data indicate a clear male predominance (84%) and a range of overall finishing positions from 49 to 1301. Overall finishing times of the triathletes who participated in this study ranged from 617 minutes to 994 minutes which spanned the finishing times of the entire field of triathletes (Figure 3.1). The average overall finishing time of the triathletes was 792 ± 95 min, with the average swim, cycle and run times being 95 ± 16 min, 95 ± 16 min and 287 ± 51 min respectively. The average scores for the triathletes' psychometric measurements were 104.2 ± 11.6 for the CD-RISC, 16.8 ± 4.3 for the K10, 14.7 ± 5.7 for novelty seeking, 8.1 ± 5.5 for harm avoidance and 16.5 ± 4.6 for reward dependence.

Table 3.1: General characteristics, actual performance times and psychometric scores of the triathletes who participated in this study during the 2007 South African Ironman Triathlon.

	Ave ± Std Dev	N	Range
Age (years)	39.3 ± 8.6	145	21 - 69
Height (cm)	178.3 ± 8.2	152	152 - 196
Weight (kg)	75.6 ± 11.5	157	50 - 122
BMI (kg/m^2)	23.7 ± 2.8	149	18.0 - 36.4
Overall Position	700 ± 393	150	49 - 1301
Overall Time (min)	792 ± 95	150	617 - 994
Swim Time (min)	95 ± 16	150	65 - 136
Cycle Time (min)	392 ± 37	150	308 - 478
Run Time (min)	287 ± 51	150	199 - 426
RISC	104.2 ± 11.6	159	73 - 125
K10	16.8 ± 4.3	159	10 - 34
TPQ NS	14.7 ± 5.7	120	4 - 28
TPQ HA	8.1 ± 5.5	120	0 - 24
TPQ RD	16.5 ± 4.6	120	5 - 27

Abbreviations: cm - centimetre; kg - kilogram; kg/m^2 - kilogram per metre squared; min - minute; BMI - body mass index; Ave - average; Std Dev - standard deviation; N - number of subjects; RISC - resilience scale; K10 - Kessler 10; TPQ – Tri-dimensional Personality Questionnaire; NS - novelty seeking; HA - harm avoidance; RD - reward dependence

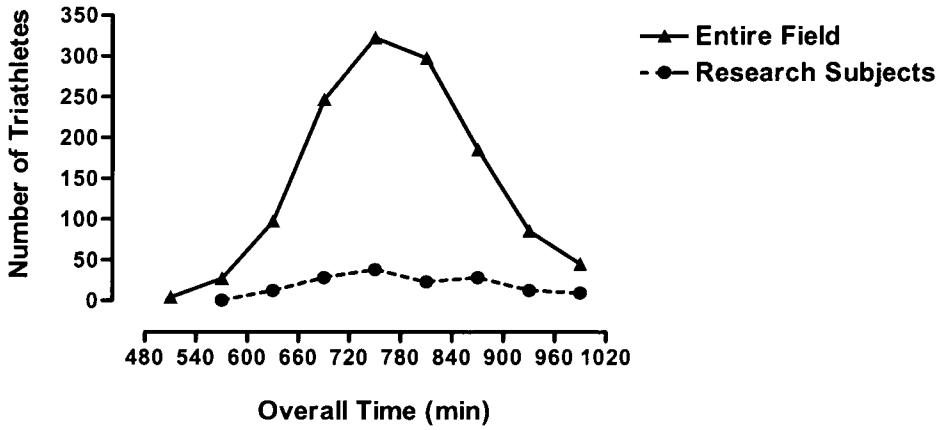

Figure 3.1: Comparison of the overall race time distributions of the entire field (solid triangles) of triathletes who completed the 2007 South African Ironman Triathlon and the triathletes who participated in this study (solid circles).

The correlations of the triathletes' general characteristics with the RISC, K10 and TPQ scores are shown in Table 3.2. The main findings indicated that age has a significant negative correlation with novelty seeking scores, indicating that as age increases, so novelty seeking scores decrease (Figure 3.2A). Novelty seeking scores were significantly positively correlated with both height (Figure 3.2B) and weight (Figure 3.2C), but not BMI (Figure 3.2.D), indicating that as weight and height increases so novelty seeking scores increases.

In addition, older athletes tended to show higher resilience scores (r=160, P=0.054, N=145). Height was significantly negatively correlated to harm avoidance scores (r=-0.168, P=0.04, N=149). Reward dependence tended to be negatively correlated with weight (r=-0.158, P=0.052, N=153), but was significantly negatively correlated with BMI (r=-0.211, P=0.011, N=146) (Table 3.2).

Table 3.2: Correlation of demographic and anthropometrical measurements with psychometric scores in a sample of triathletes who completed the 2007 SA Ironman Triathlon.

	RISC	K10	TPQ NS	TPQ HA	TPQ RD
Age (years)	0.160 (0.054) *	-0.126 (0.135)	-0.226 (0.007) **	-0.045 (0.593)	-0.124 (0.144)
Height (cm)	0.027 (0.744)	0.042 (0.608)	0.226 (0.006) **	-0.168 (0.040) **	-0.043 (0.603)
Weight (kg)	-0.014 (0.864)	0.024 (0.769)	0.240 (0.003) **	-0.092 (0.257)	-0.158 (0.052) *
BMI (kg/m^2)	-0.026 (0.757)	-0.014 (0.865)	0.114 (0.169)	0.023 (0.782)	-0.211 (0.011) **

Values are expressed as correlations (r) with P values in parenthesis; ** indicates significant differences (P<0.05) and ** indicates trends (P<,0.1).
Abbreviations: cm - centimetre; kg - kilogram; kg/m^2 - kilogram per metre squared; BMI - body mass index; RISC - resilience scale score; K10 - Kessler 10 score; TPQ – Tri-dimensional Personality Questionnaire; NS - Novelty Seeking; HA - Harm Avoidance; RD - Reward Dependence

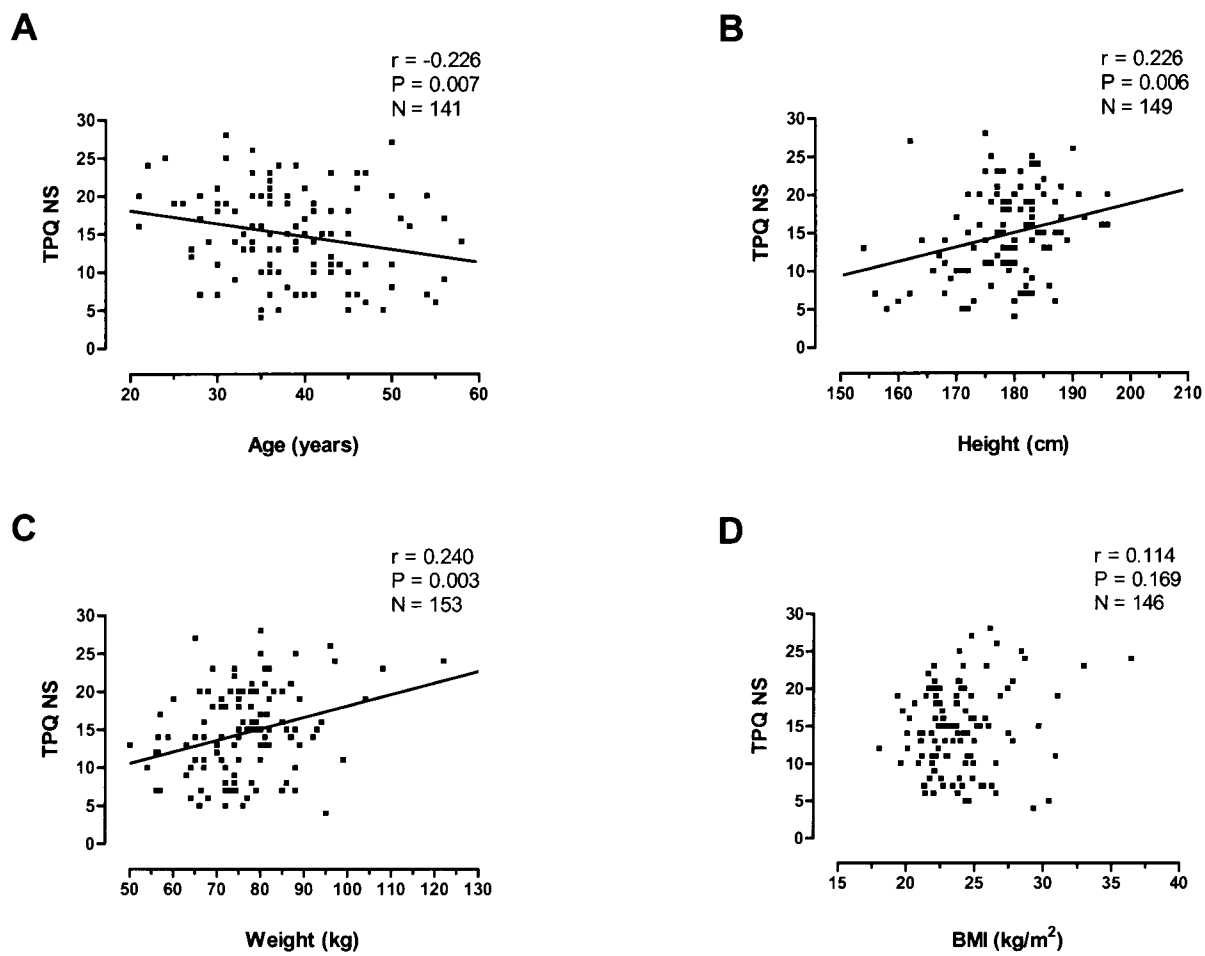

Figure 3.2: Correlations of general characteristics **(A)** age, **(B)** height, **(C)** weight, and **(D)** BMI with novelty seeking scores in the triathletes who completed the 2007 South African Ironman Triathlon.

The solid lines indicate significant correlations ($P<0.05$). Abbreviations: cm - centimetre; kg - kilogram; kg/m^2 - kilogram per metre squared; BMI - body mass index; TPQ – Tri-dimensional Personality Questionnaire; NS - Novelty Seeking

As shown in Table 3.3, female triathletes tended to score higher on the K10 questionnaire when compared to the male triathletes, which would indicate a trend towards greater general psychological distress in the female triathletes (P=0.077). However, there were no significant differences between male and female triathletes with respect to the other psychological measurement scores.

Table 3.3: The psychometric measurement scores of the male and female triathletes who completed the 2007 South African Ironman Triathlon.

	Male	Female	P Value
RISC	103.7 ± 11.5 (128)	106.9 ± 11.0 (23)	0.227
K10	16.6 ± 4.0 (129)	18 ± 4.0 (22)	0.077
TPQ NS	15.1 ± 5.6 (97)	13.5 ± 6.1 (17)	0.292
TPQ HA	7.9 ± 5.3 (97)	8.1 ± 5.2 (17)	0.868
TPQ RD	16.3 ± 4.9 (97)	17.5 ± 3.8 (17)	0.338

Values are expressed as average ± standard deviation, with the number of subjects (N) in parentheses. Abbreviations: RISC - resilience scale score; K10 - Kessler 10 score; TPQ – Tri-dimensional Personality Questionnaire; NS - Novelty Seeking; HA - Harm Avoidance; RD - Reward Dependence.

3.4.2 Psychometric scores and performance

The predicted, actual and relative times during the 2007 South African Ironman Triathlon and the relationship to the scores obtained from the psychometric instruments are shown in Table 3.4. There was a trend towards a negative correlation between the novelty seeking scores (Figure 3.3A) and reward

dependence scores (Figure 3.4A) and the predicted overall finishing times of the triathletes. This relationship was also apparent with respect to novelty seeking scores and predicted swim time (Figure 3.3C) but not for run time (Figure 3.3G). The triathletes novelty seeking scores were significantly negatively correlated with their predicted cycle times (Figure 3.3E). Similar trends for reward dependence scores were also observed with respect to the athletes' predicted swim- (Figure 3.4C), cycle- (Figure 3.4E) and run- (Figure 3.4G) times. Collectively, these findings suggest that athletes with a higher novelty seeking or reward dependence score predicted that they would complete the event and most of the individual legs in a faster time.

Despite athletes with higher novelty seeking and reward dependence scores predicting faster overall and most split times, there were no significant correlations between these psychological measurements and their actual overall finishing times (Figures 3.3B and 3.4B), as well as their cycle (Figures 3.3F and 3.4F) and run (Figures 3.3H and 3.4H) split times. There was, however, a tendency for a negative relationship between their actual swim time and novelty seeking score (Figure 3.3D), and a significant negative relationship between their actual swim time and reward dependence score (Figure 3.4D).

Table 3.4: The correlation of psychological variables with the predicted, actual and relative times for the overall event and the respective swim-, cycle- and run legs in the triathletes who completed the 2007 South African Ironman Triathlon.

	RISC	K10	TPQ NS	TPQ HA	TPQ RD
Predicted Times	N=153/154	N=153/154	N=117/119	N=117/119	N=117/119
Overall	-0.063 (0.437)	0.108 (0.185)	-0.174 (0.058) *	0.021 (0.822)	-0.173 (0.060) *
Swim	0.068 (0.402)	0.058 (0.474)	-0.163 (0.080) *	-0.051 (0.586)	-0.154 (0.097) *
Cycle	-0.059 (0.471)	0.130 (0.109)	-0.195 (0.035) **	0.095 (0.310)	-0.161 (0.082) *
Run	-0.045 (0.580)	0.087 (0.282)	-0.095 (0.294)	-0.011 (0.930)	-0.156 (0.093) *
Actual Times	N=146	N=146	N=110	N=110	N=110
Overall	-0.015 (0.854)	0.160 (0.053) *	-0.082 (0.394)	-0.052 (0.591)	-0.111 (0.247)
Swim	0.067 (0.421)	0.033 (0.689)	-0.171 (0.073) *	-0.046 (0.632)	-0.241 (0.012) **
Cycle	-0.040 (0.636)	0.216 (0.002) **	-0.103 (0.283)	0.011 (0.909)	-0.103 (0.284)
Run	-0.032 (0.700)	0.124 (0.136)	-0.014 (0.889)	-0.071 (0.458)	-0.057 (0.556)
Relative Times [a]	N=140/141	N=140/141	N=107/109	N=107/109	N=107/109
Overall	0.154 (0.070) *	<0.001 (0.996)	0.076 (0.435)	-0.124 (0.198)	0.106 (0.274)
Swim	0.069 (0.419)	-0.073 (0.390)	-0.030 (0.760)	-0.007 (0.946)	-0.054 (0.579)
Cycle	0.089 (0.291)	0.063 (0.459)	0.079 (0.418)	-0.183 (0.059) *	0.133 (0.172)
Run	0.054 (0.527)	0.014 (0.869)	0.103 (0.289)	-0.111 (0.253)	0.090 (0.354)

Values are expressed as correlations (r) with P values in parenthesis; ** indicates significant differences (P<0.05) and ** indicates trends (P<,0.1). [a] Relative time = Actual time / Predicted time. Abbreviations: RISC - resilience scale score; K10 - Kessler 10 score; TPQ – Tri-dimensional Personality Questionnaire; NS - Novelty Seeking; HA - Harm Avoidance; RD - Reward Dependence

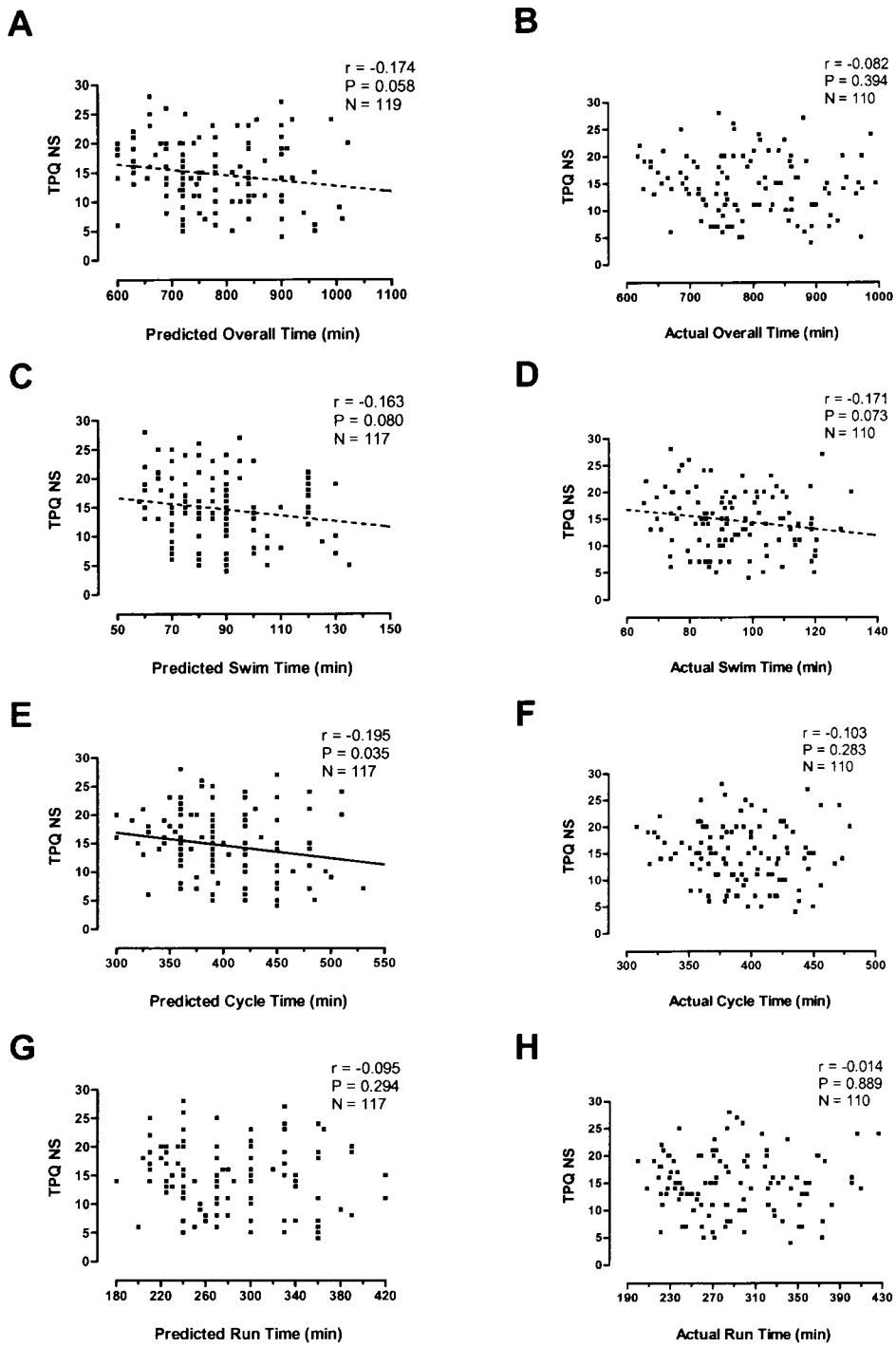

Figure 3.3: The relationship between novelty seeking scores with **(A)** predicted overall time, **(B)** actual overall time, **(C)** predicted swim time, **(D)** actual swim time, **(E)** predicted cycle time, **(F)** actual cycle time, **(G)** predicted run time, **(H)** actual run time.

The solid line indicates a significant correlation ($P<0.05$) while the dashed lines indicate trends ($P<0.1$)

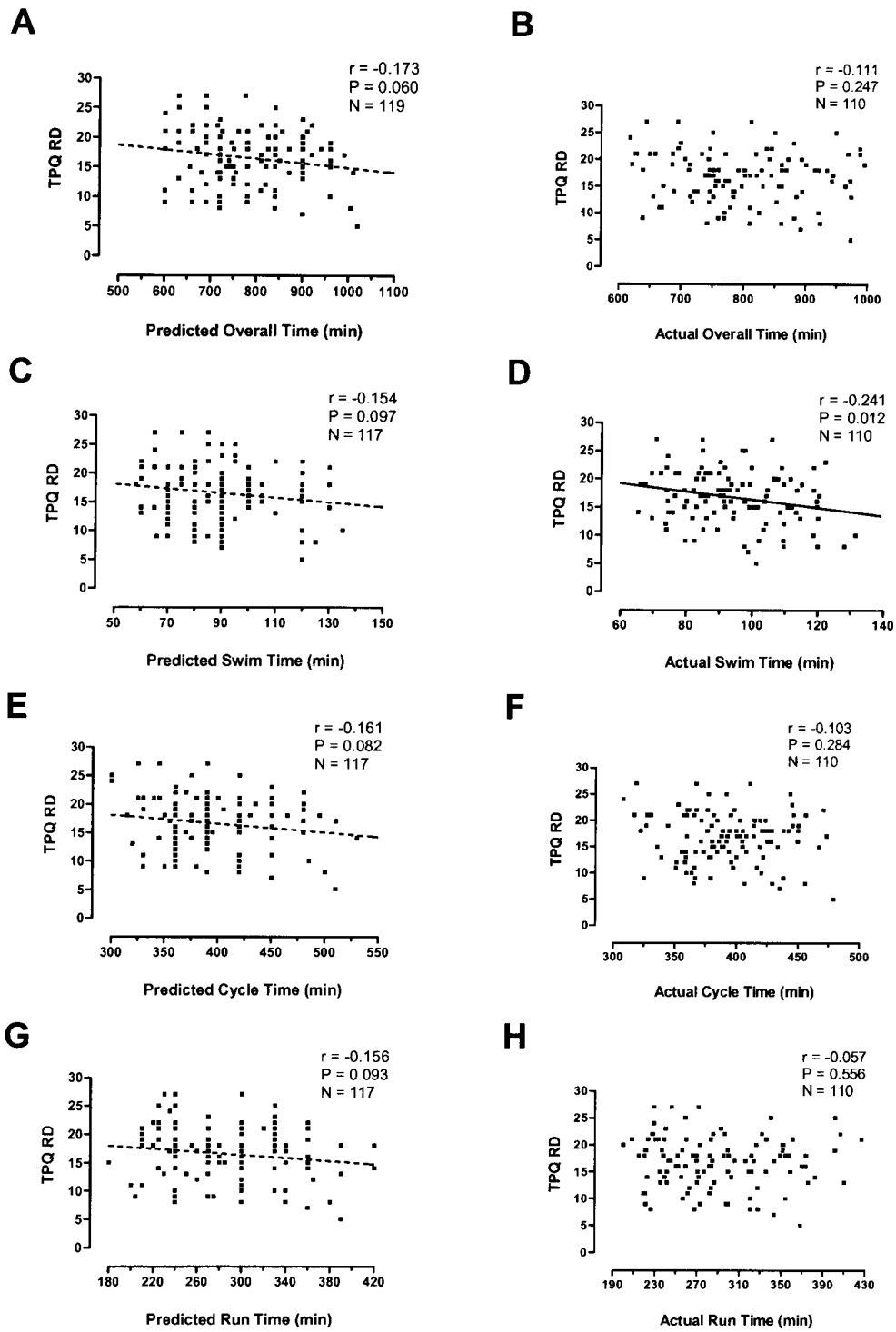

Figure 3.4: The relationship between reward dependence scores with **(A)** predicted overall time, **(B)** actual overall time, **(C)** predicted swim time, **(D)** actual swim time, **(E)** predicted cycle time, **(F)** actual cycle time, **(G)** predicted run time, **(H)** actual run time.

The solid line indicates a significant correlation ($P<0.05$) while the dashed lines indicate trends ($P<0.1$)

There was a significant positive correlation between the triathletes' K10 scores and actual cycle times (Figure 3.5C), but not their actual swim (Figure 3.5B) and run (Figure 3.5D) times. This finding indicates that triathletes with higher scores for general psychological distress (prior to the event) cycle slower. This was reflected in the tendency for a positive correlation between K10 scores and actual overall finishing times (Figure 3.5A). There was, however, no correlation between the triathletes' predicted cycle times and K10 scores (r=0.130, P=0.109) (Table 3.4).

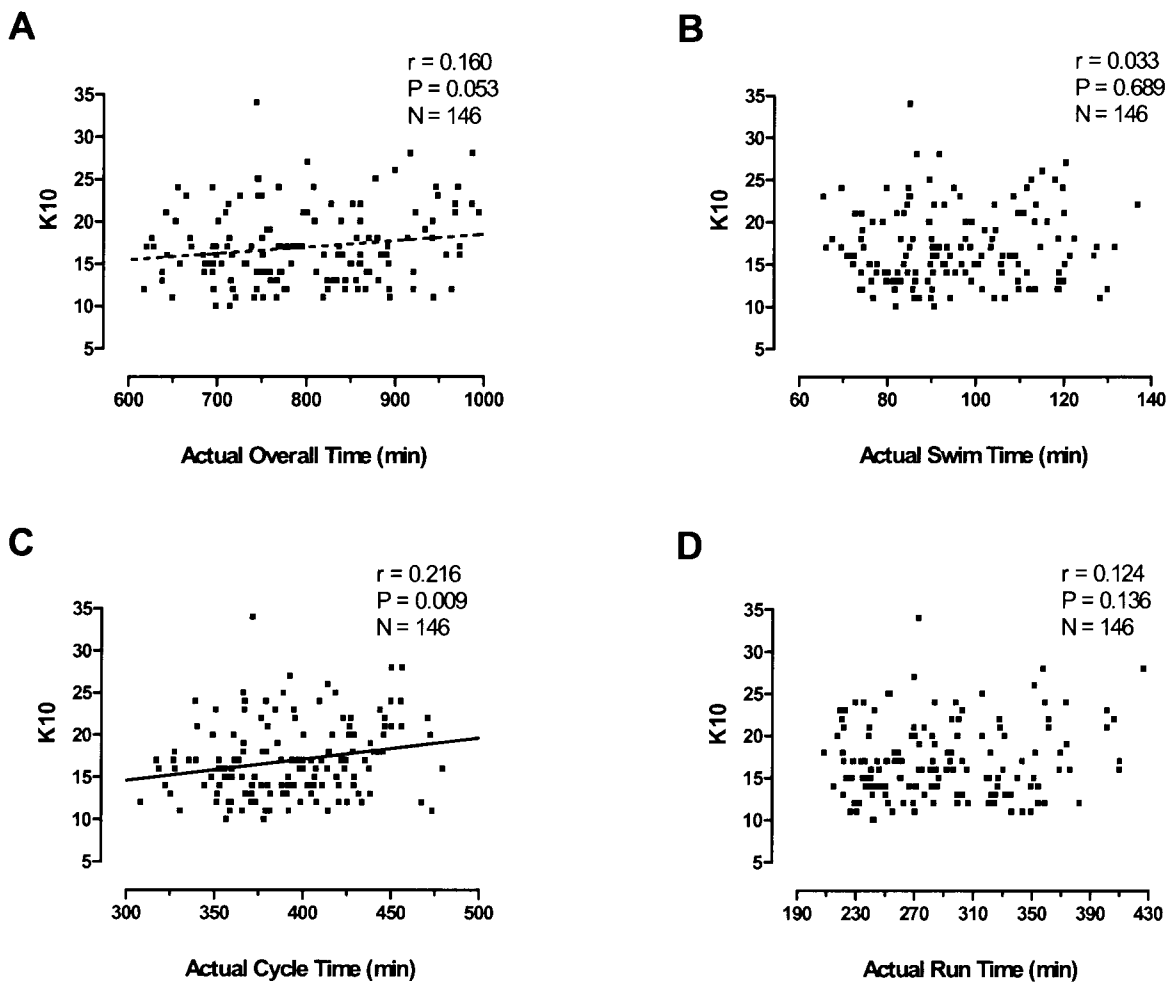

Figure 3.5: The relationship between the triathletes' K10 scores with **(A)** actual overall time, **(B)** actual swim time, **(C)** actual cycle time, **(D)** actual run time.

The solid line indicates a significant correlation (P<0.05) while the dashed line indicates a trend (P<0.1)

It is of interest to note that there were tendencies for harm avoidance (Figure 3.6A) and resilience (Figure 3.6B) scores to be negatively and positively related to the overall relative time respectively. This finding suggests that the less resilient triathletes, as well as those with a greater harm avoidance personality trait, are more likely to overpredict their overall finishing time.

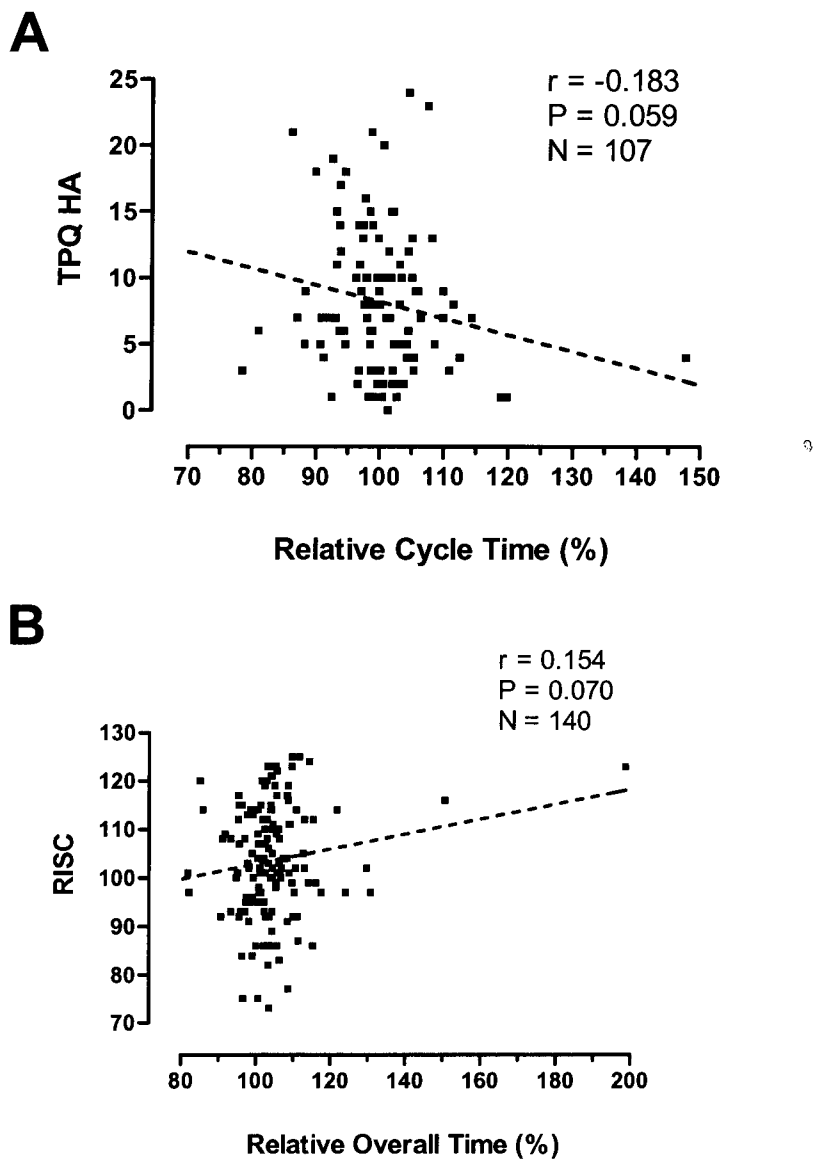

Figure 3.6: The relationship of **(A)** harm avoidance scores with relative cycle time and **(B)** resilience scores with relative overall time.

The dashed lines indicate trends (P<0.1). Relative time = Actual time / Predicted time

It is interesting to note that, with five exceptions, there were no significant correlations of any of the psychometric scores with any of either the frequency, distance and duration of swim, cycle or run training during the 15 weeks, as well as the 1 week, prior to the 2007 South African Ironman triathlon (results not shown). There was a significant positive correlation between the triathletes' reward dependence scores and the distance swum per week during 15 weeks prior to the event (r=0.284, P=0.018, N=69). This could be related to the reason why RD predicts faster swim times. There was also a significant negative correlation between their resilience score and the distance cycled during the week prior to the triathlon (r=-0.231, P=0.044, N=77). There was a tendency for a positive correlation between novelty seeking and the distance run per week during the 15 weeks (r=0.234, P=0.051, N=70) and 1 week (r=0.227, P=0.071, N=64) prior to the race. Finally, there was a tendency towards a negative correlation with the triathletes' K10 scores and hours run during the week prior to the race (r=-0.207, P=0.068, N=78).

3.4.3 Psychometric scores, injuries and illness

Triathletes were divided into those with, and without, self-reported specific illness or injury symptomatology and medication usage (Tables 3.5 to 3.9). Table 3.5 indicates that athletes who reported experiencing flu-like symptoms, such as fever, sore throat, blocked or runny nose, cough, wheeze, muscle aches and pains, during the 6-week period prior to the race had higher K10 scores compared to those without these symptoms (P=0.019). Furthermore, there was a tendency for the K10 scores to be higher in those triathletes who, during their entire careers, reported using medication to treat injuries in the week before or during a race when compared to those who did

not use medication (P=0.093). The medication included anti-inflammatory drugs, cortisone (pills or injection) and/or pain killers. The triathletes with or without flu-like symptoms or medication usage were, however, similarly matched for age, weight, height, BMI, gender and performance times (data not shown). There was no significant difference in the K10 scores of athletes with or without any other self-reported symptomatology.

Table 3.5: The K10 scores of the triathletes who completed the 2007 South African Ironman Triathlon with (Yes) and without (No) self-reported specific illness or injury symptomatology and medication usage.

	Yes	No	P value
Illness			
Flu-like Symptoms	17.6 ± 4.6 (78)	16.0 ± 3.9 (79)	0.019
EAMC	16.7 ± 4.3 (72)	16.9 ± 4.3 (86)	0.752
Collapse	16.0 ± 3.3 (12)	16.8 ± 4.4 (146)	0.521
Exercise Related GIT Symptoms	16.7 ± 3.7 (64)	16.8 ± 4.7 (94)	0.898
Nervous system Symptoms	17.1 ± 4.4 (29)	16.7 ± 4.3 (129)	0.649
Exercise Related Skin Disease	17.3 ± 4.3 (67)	16.4 ± 4.3 (91)	0.230
Exercise Related Sunburn	17.4 ± 4.4 (59)	16.4 ± 4.3 (99)	0.133
Allergy Symptoms	17.3 ± 5.0 (49)	16.5 ± 4.0 (108)	0.279
Asthma	14.9 ± 1.7 (9)	16.9 ± 4.4 (149)	0.179
Injury			
Current Symptoms of Injury	17.6 ± 3.7 (43)	16.4 ± 4.4 (114)	0.100
Surgery	16.7 ± 4.2 (96)	16.8 ± 4.5 (62)	0.907
Tendon or Ligament Injuries	16.8 ± 3.8 (62)	16.7 ± 4.6 (95)	0.958
Genital Injury	17.1 ± 4.1 (44)	16.7 ± 4.1 (114)	0.566
Medication Usage	17.6 ± 4.5 (51)	16.4 ± 4.2 (107)	0.093

Values are expressed as average ± standard deviation, with the number of subjects (N) in parentheses. Abbreviations: EAMC - exercise associated muscle cramps; GIT - gastrointestinal.

Although there were no significant differences with regard to the average novelty seeking scores between athletes with or without self-reported symptomatology (Table 3.6), the harm avoidance scores were significantly higher in triathletes who reported symptoms of the nervous system, including exercise-induced headaches, nerve tingling or loss of sensation, during their triathlon careers (P=0.035), and tended to be higher in athletes with a history of gastrointestinal symptoms during exercise, which included heartburn, nausea, vomiting, abdominal pain, urge to defecate (pass a stool), diarrhoea, and/or blood in the stools, (P=0.091), injury to the genital area during cycling, which included numbness, pain and/or swelling, (P=0.065) and medication use (P=0.07) (Table 3.7).

Table 3.8 shows that athletes with previous self-reported tendon and/or ligament injuries had significantly lower reward dependence scores than athletes without prior history of these injuries (P=0.039). Furthermore, there was a trend for the reward dependence scores to be lower in athletes with exercise-induced nervous system symptoms compared to those without symptoms (P=0.075). The triathletes with gastrointestinal symptoms during exercise were significantly younger (with 36.0 ± 7.7 years, N=45 vs. without 40.1 ± 7.6 years, N=63, P=0.007) and had a lower BMI (with 23.4 ± 2.4 $kg.m^{-2}$, N=49 vs. without 24.5 ± 3.2 $kg.m^{-2}$, N=62, P=0.038) than those without symptoms. In addition, significantly more female triathletes (58.8%, N=10) reported injury in the genital area during cycling than male triathletes (28.1%, N=27) (P=0.027). The triathletes with or without any of the other specific self-reported illness or injury symptomatology and medication usage were similarly matched for all the other physiological characteristics and performance times (data not shown).

Table 3.6: The novelty seeking (TPQ NS) scores of the triathletes who completed the 2007 South African Ironman Triathlon with (Yes) and without (No) self-reported specific illness or injury symptomatology and medication usage.

	Yes	No	P value
Illness			
Flu-like Symptoms	14.8 ± 5.7 (63)	14.4 ± 5.7 (56)	0.706
EAMC	14.8 ± 5.6 (53)	14.5 ± 5.8 (66)	0.744
Exercise Related GIT Symptoms	15.3 ± 5.9 (53)	14.1 ± 5.5 (66)	0.243
Nervous system Symptoms	13.1 ± 5.5 (25)	15.0 ± 5.7 (94)	0.134
Exercise Related Skin Disease	14.2 ± 5.7 (50)	14.9 ± 5.7 (69)	0.518
Exercise Related Sunburn	14.4 ± 5.7 (45)	14.8 ± 5.7 (74)	0.698
Allergy Symptoms	15.4 ± 5.6 (40)	14.1 ± 5.8 (78)	0.264
Asthma	16.4 ± 6.8 (10)	14.5 ± 5.6 (109)	0.309
Collapse	16.0 ± 2.9 (7)	14.6 ± 5.8 (112)	0.517
Injury			
Current Symptoms of Injury	15.6 ± 5.8 (36)	14.1 ± 5.6 (82)	0.206
Surgery	14.5 ± 5.9 (70)	14.9 ± 5.4 (49)	0.704
Tendon or Ligament Injuries	14.5 ± 5.7 (49)	14.6 ± 5.7 (69)	0.963
Genital Injury	15.1 ± 5.7 (38)	14.4 ± 5.7 (81)	0.589
Medication Usage	13.9 ± 5.6 (42)	15.01 ± 5.7 (77)	0.286

Values are expressed as average ± standard deviation, with the number of subjects (N) in parentheses. Abbreviations: EAMC - exercise associated muscle cramps; GIT - gastrointestinal

Table 3.7: The harm avoidance (TPQ HA) scores of the triathletes who completed the 2007 South African Ironman Triathlon with (Yes) and without (No) self-reported specific illness or injury symptomatology and medication usage.

	Yes	No	P value
Illness			
Flu-like Symptoms	8.0 ± 5.6 (49)	8.3 ± 5.4 (56)	0.766
EAMC	8.4 ± 5.1 (53)	8.0 ± 5.9 (66)	0.704
Exercise Related GIT Symptoms	9.1 ± 5.9 (53)	7.4 ± 5.1 (66)	0.091
Nervous system Symptoms	10.2 ± 6.3 (25)	7.6 ± 5.2 (94)	0.035
Exercise Related Skin Disease	8.4 ± 5.3 (50)	8.0 ± 5.7(69)	0.691
Exercise Related Sunburn	8.2 ± 5.4 (45)	8.1 ± 5.6 (74)	0.957
Allergy Symptoms	9.2 ± 6.6 (40)	7.7 ± 4.9 (78)	0.158
Asthma	9.4 ± 6.2 (10)	8.0 ± 5.5 (109)	0.453
Collapse	5.4 ± 3.4(7)	8.3± 5.6 (112)	0.180
Injury			
Current Symptoms of Injury	8.6 ± 5.6 (36)	8.0 ± 5.5 (82)	0.617
Surgery	8.1 ± 5.6 (70)	7.8 ± 5.4 (49)	0.523
Tendon or Ligament Injuries	8.5 ± 5.3 (49)	8.0 ± 5.7 (69)	0.617
Genital Injury	9.5 ± 6.5 (38)	7.5 ± 4.9 (81)	0.065
Medication Usage	9.4 ± 6.0 (42)	7.5 ± 5.2 (77)	0.070

Values are expressed as average ± standard deviation, with the number of subjects (N) in parentheses. Abbreviations: EAMC - exercise associated muscle cramps; GIT - gastrointestinal.

Table 3.8: The reward dependence (TPQ RD) scores of the triathletes who completed the 2007 South African Ironman Triathlon with (Yes) and without (No) self-reported specific illness or injury symptomatology and medication usage.

	Yes	No	P value
Illness			
Flu-like Symptoms	16.1 ± 4.5 (63)	16.8 ± 4.7 (56)	0.422
EAMC	16.5 ± 4.6 (53)	16.4 ± 4.6 (66)	0.923
Exercise Related GIT Symptoms	17.2 ± 4.5 (53)	15.9 ± 4.6 (66)	0.131
Nervous system Symptoms	15.0 ± 4.6 (25)	16.8 ± 4.5 (94)	0.075
Exercise Related Skin Disease	16.4 ± 4.9 (50)	16.4 ± 4.4 (69)	0.991
Exercise Related Sunburn	16.3 ± 4.9 (45)	16.5 ± 4.4 (74)	0.836
Allergy Symptoms	15.6 ± 5.2 (40)	16.9 ± 4.2 (78)	0.135
Asthma	15.7 ± 4.3 (10)	16.5 ± 4.6 (109)	0.592
Collapse	19.1 ± 1.3 (7)	16.3 ± 4.6 (112)	0.107
Injury			
Current Symptoms of Injury	15.9 ± 5.1 (36)	16.6 ± 4.3 (82)	0.442
Surgery	16.0 ± 4.4 (70)	17.1 ± 4.7 (49)	0.205
Tendon or Ligament Injuries	15.4 ± 4.5 (49)	17.2 ± 4.5 (69)	0.039
Genital Injury	16.1 ± 4.3 (38)	16.6 ± 4.7 (81)	0.580
Medication Usage	16.7 ± 4.0 (42)	16.3 ± 4.9 (77)	0.607

Values are expressed as average ± standard deviation, with the number of subjects (N) in parentheses. Abbreviations: EAMC - exercise associated muscle cramps; GIT - gastrointestinal

The resilience (RISC) scores in athletes with or without symptomatology are reported in Table 3.9. The RISC scores tended to be lower in those athletes with a self-reported history of both exercise associated muscle cramps during or immediately (within 6 hours) after exercise (P=0.075) and injury to the genital area during cycling (P=0.098). However, the RISC scores tended to be higher in athletes who reported a previous history of exercise associated collapse during the event, at the finish area, or after a race or training session which required medical attention (excluding collapses due to an accident) (P=0.081). The triathletes with a previous history of EAMC cycle (with 382 ± 38 min, N=66 vs. without 402 ± 34 min, N=78, P<0.001) and finished the entire 2007 Ironman Triathlon (with 772 ± 95 min, N=66 vs. without 814 ± 91 min, N=78, P=0.007) significantly faster than those without a history of EAMC. In addition, the triathletes with a previous history of exercise associated collapse (21.9 ± 2.2 $kg.m^{-2}$, N=10) had a significantly lower BMI than those without any history (23.9 ± 2.8 $kg.m^{-2}$, N=133, P=0.026). The triathletes with or without any of the other specific self-reported illness or injury symptomatology and medication usage were similarly matched for all the other physiological characteristics and performance times (data not shown).

Table 3.9: The resilience (RISC) scores of the triathletes who completed the 2007 South African Ironman Triathlon with (Yes) and without (No) self-reported specific illness or injury symptomatology and medication usage.

	Yes	No	P value
Illness			
Flu-like Symptoms	103.5 ± 12.5 (77)	104.9 ± 10.7 (79)	0.449
EAMC	102.5 ± 11.4 (72)	105.8± 11.6 (85)	0.075
Exercise Related GIT Symptoms	102.5 ± 11.5 (64)	105.5 ± 11.6 (93)	0.116
Nervous system Symptoms	105.4 ± 12.9 (29)	104.0 ± 11.4 (128)	0.579
Exercise Related Skin Disease	104.3 ± 10.4 (65)	104.3 ± 12.5 (65)	0.989
Exercise Related Sunburn	104.1 ± 10.3 (58)	104.4 ± 12.4 (99)	0.899
Allergy Symptoms	104.6 ± 13.4 (49)	104.1 ± 10.8 (107)	0.811
Asthma	103.8 ± 12.1 (11)	104.3 ± 11.6 (146)	0.889
Collapse	109.9 ± 10.5 (12)	103.8 ± 11.6 (145)	0.081
Injuries			
Current Symptoms of Injury	102.8 ± 12.3 (41)	104.8 ± 11.4 (115)	0.350
Surgery	104.4 ± 11.4 (95)	104.1 ± 12.0 (62)	0.854
Tendon or Ligament Injuries	103.2 ± 11.1 (61)	105.0 ± 12.0 (95)	0.347
Genital Injury	101.9 ± 13.1 (45)	105.3 ± 10.9 (112)	0.098
Medication Usage	104.3 ± 12.9 (52)	104.3 ± 11.0 (105)	0.968

Values are expressed as average ± standard deviation, with the number of subjects (n) in parentheses. Abbreviations: EAMC - exercise associated muscle cramps; GIT - gastrointestinal

3.5 Discussion

3.5.1 General discussion

The Ironman Triathlon is a particularly difficult event that places considerable physical and psychological strain on its participants. Several studies have investigated the physiological demands and effects of these ultra-endurance events on participants[99-101], but very little work has been conducted on the psychological aspects of the participating triathletes. The cohort of triathletes investigated in this study represented the entire spectrum of triathletes with respect to finishing times and gender.

The average resilience scores (CD-RISC) of the Ironman triathletes was 104.2 ± 11.6. In their study comparing the resilience scores of patients in different clinical categories, Connor and Davidson[83] found an average RISC score of 80.4 ± 12.8 in their general population group (N = 577). The scores gradually decreased from the general population to primary care patients to psychiatric outpatients. Indeed, patients suffering from general anxiety disorder and post-traumatic stress disorder had the lowest resilience scores of 62.4 ± 10.7 and 47.8 ± 19.5 respectively. This suggests that the triathletes competing in the South African Ironman Triathlon are on average more resilient than the general population, thus displaying more evolved adaptive responses to highly stressful situations [60]. It should be noted, however, that there was a tendency for the resilience scores of the triathletes to be correlated with age, so that the older triathletes tended to have higher resilience scores. Further

studies are therefore required to determine the resilience scores in a cohort of the appropriately matched, including age matched, general South African population. The triathletes' resilience scores were not associated with any of the predicted or actual performance times for the event. This may suggest that resilience plays a role in the choice of the ultra-endurance triathlon as a sport

The average K10 scores of the triathletes was 16.8 ± 4.3, with the female triathletes having a slightly higher K10 score than their male counterparts (P=0.077). Although there were no correlations of the K10 scores with the triathletes' predicted times, there was, however, a positive correlation of their K10 scores with their actual cycle times. Thus the triathletes with higher K10 scores had slower cycle times. This relationship was reflected in the overall finishing times. Andrews and Slade[84] found an average K10 score of 14.2 using comparative normative data from the Australian national survey (household survey, persons older than 18yrs), which was slightly lower than the average reported for the triathletes. Andrews and Slade also reported a higher score for females than males; 14.5 vs. 13.9 (P<0.001). Another recent Australian study[102],examining the occurrence of general psychological distress in a large, representative sample of employees (N=60 556) from public and private employers, found that 4,5% of employees have high psychological distress (K6 score > 13) with gender and age having no significant effects. It could be argued that the triathletes, in the 1- to 3 days before the event, and especially at registration, when the enormity of the event is realised, the triathletes are especially conscious of pre-race tension and anxiety, and this could influence the K10 scores. Further investigations are required to determine the possible effect of pre-race stress on athletic populations.

The triathletes' average novelty seeking, harm avoidance and reward dependence scores were 14.7 ± 5.7, 8.1 ± 5.5 and 16.5 ± 4.6 respectively. Slightly higher novelty seeking values of 16.5 ± 5.0 were reported in 4349 subjects of the general Finnish population[103]. This Finish study also reported higher harm avoidance scores of 13.1 ± 5.9 and reward dependence scores of 17.7 ± 3.9 respectively. The harm avoidance scores of the triathletes in our group were lower when compared to studies investigating personality traits of general populations[71;82]. Individuals who score low on harm avoidance are reported to be more daring and energetic, and this may be reflected in their choice of competing in a challenging ultra-endurance event like the Ironman. Han et al.[5] studied a group of adolescent male long-distance runners and also reported high average novelty seeking scores of 23.0 ± 3.7 and harm avoidance scores of 18.4 ± 5.3, but lower reward dependence scores of 13.7 ± 3.3 respectively. The long-distance runners had the highest novelty seeking scores when compared to athletes from other types of power sports (individual and combat) and team sport codes. Han et al. [5] suggested that the higher novelty seeking scores in their long-distance runner group, compared to other studies[67;74] could be due to a cohort effect, or differences of trait anxiety, or the environment. In our study, there was a significant negative correlation between the novelty scores of the triathletes and age, with the older athletes having lower novelty seeking scores. The mean age of the athletes in the Han et al. study was 17.4 ± 3.0 years, and this might also be a contributing factor to the discrepancy in novelty seeking scores. The significantly lower novelty seeking scores for the older triathletes indicate a tendency to be less adventurous and impulsive and a higher inclination towards being more reflective, rigid and stoic (Table 2.3)[81;82].

The taller and heavier athletes showed significantly higher novelty seeking scores; there was also a significant correlation of taller athletes with higher HA scores and an association of the heavier athletes with lower reward dependence scores. Whilst these relationships with the morphological characteristics are interesting, there is no apparent explanation for this and thus warrants further investigation.

Generally, athletes with higher novelty seeking or reward dependence scores predicted faster overall finishing and split times. However, these factors tended not to predict faster actual times, with the exception of the swim leg which happens to be the first leg of event. It is possible that the athletes who display this trend might set out too fast and have a less accurate pacing strategy.

In general, the psychological factors measured did not show consistent associations with regards to symptoms of illness or medical conditions. However, several associations were found. Most notably, triathletes who reported nervous system symptoms during exercise (headaches, tingling or loss of sensation in the hands) had significantly higher harm avoidance scores and tended to have lower reward dependence scores.

Higher resilience (higher RISC score) tended to predict the presence of previous episodes of exercise-associated collapse and the absence of episodes of exercise-associated muscle cramps (EAMC). Whilst the explanation for these associations remains obscure, the association with EAMC warrants further comment. According to Schwellnus[101], in a review of EAMC, the strongest risk factors for EAMC are a

previous history of EAMC, and exercise performed at an intensity or duration which is relatively higher than normal training. As previously stated, higher resilience implies the use of adaptive strategies in dealing with highly stressful situations. It could be argued that if the Ironman Triathlon represents a highly stressful situation, the response to it is represented by the pacing strategy of the triathlete during the race. An appropriate pacing strategy (as used in training) could be, in this case, an example of an adaptive response. Therefore it may be possible that higher resilience leads to a more appropriate pacing strategy, with less risk of exceeding the training pace or intensity, and this in turn could protect the triathlete against developing EAMC. This also warrants further investigation.

Higher general psychological distress, as manifested by a depressive mood and/or higher anxiety (higher K10 score), was significantly associated with the presence of flu-like symptoms (e.g. fever, rhinorrhoea, malaise, arthralgia). This finding is similar to the findings of other studies that investigated the relationship of psychological distress and upper respiratory tract infections, including colds and flu[104-106]. Faulkner and Smith[105] evaluated 21 patients with chronic fatigue syndrome (CFS) and 18 matched healthy control subjects for 15 weeks. They found significantly higher reported levels of stress in the weeks preceding the occurrence of URTI symptoms in the CFS group, but not in the healthy group. A plausible explanation is that chronic stress (of more than one month) is associated with an altered immune system function and hence an increased risk of developing viral URTI[107]. It may be that the months of preparation and the anticipation of major event (Ironman Triathlon) is the cause of chronic psychological stress for the triathletes in this study.

As with illness, certain psychological factors were associated with of a history of previous or current injury, but the relationships were inconsistent. Higher RD scores predicted the presence of tendon or ligament injuries, and the presence of genital injuries was predicted by the higher HA and lower RISC scores. The reasons for these associations are not clear and further investigation is needed. As is shown in the literature, trying to associate different personality traits with different general medical disorders has not yielded much of note.

The use of medication before and during the event was predicted by higher HA and K10 scores. Higher HA scores were significantly associated with the occurrence of nervous system symptoms, the most important of which is probably headaches, and higher K10 scores were significantly associated with the presence of flu-like or URTI symptoms. URTIs and headaches represent two conditions for which medication is both commonly used and readily available (over-the-counter). This could explain the association of HA and K10 scores with medication use before and during the event.

The only other noteworthy findings were an association of higher RD scores with the absence of nervous system symptoms, and the association of higher HA scores with the presence of GIT symptoms during exercise.

In general, all the measured psychological dimensions, except for novelty seeking, showed associations with subsets of injuries and illnesses in the subject group of Ironman triathletes.

A survey amongst the physician members of the American Orthopaedic Society for Sports Medicine, American College of Sports Medicine, American Medical Society for Sports Medicine and American Osteopathic Academy of Sports Medicine reiterated the relative ignorance toward the psychological well-being of injured, ill or poor performing athletes. In this survey, two-thirds of doctors indicated that they rarely or never refer athletes to a sports psychology professional for problems not related to injury, whereas three-quarters of the doctors surveyed rarely or never do so for athletes with problems related to injury[108].

Physicians and other members of the multidisciplinary team involved with athlete care should be aware of the cardinal importance and the different areas of intervention in achieving sound mental health, as this is as vital in the preventative and curative management of the injured, ill or poor performing athlete as optimal physical conditioning [20].

3.5.2 Limitations of this study

The focus of this study was on a very specific athletic discipline of an ultra-endurance event (Ironman Triathlon). Thus the results from this study cannot be extrapolated to general athletic populations before they have been duplicated in other sporting codes.

Although a fair sized subject sample was used (N=166), a larger sample is needed to determine if the trends found in this study are indeed an accurate reflection of our findings to date. A larger sample size might also be useful in overcoming the

limitations encountered when performing multiple analyses on many variables, and to identify other trends that could serve to paint a clearer picture of the influence and predictive value of psychological factors on performance and the injury/illness profiles of athletes. Furthermore, although attempts have been made to interpret these data from other published sources, appropriate culturally sensitive samples from the South African population would need to be recruited and studied.

This descriptive cross-sectional study provides only a "snap shot" of the dynamic human psychology and physiology. A prospective cohort study over a prolonged period could provide more accurate data.

3.5.3 Future directions

In order to determine psychological predictors pertaining to athletes, studies of this nature need to be undertaken on a larger scale and in different athletic populations. This will allow comparison between different sporting codes and populations (e.g. elite vs. recreational athletes; athletes vs. non-athletes).

An important and interesting area of present research is the neurohormonal-genetic link to psychological (and physiological) traits. As discussed in Chapter 2, recent studies support the idea that groups of genes coding for certain neurotransmitters and their receptors are associated with specific personality traits. Further research in this area will improve our understanding of the interaction between physiology and psychology.

3.6 Conclusion

In this study, certain personality characteristics were found to correlate significantly with physiological characteristics, specific types of injury, and illness amongst Ironman athletes. In addition, higher novelty seeking scores significantly correlated with younger age, greater height and weight, and the presence of nervous system symptoms. Higher reward dependence scores significantly correlated to faster actual swim times and the presence of previous or current tendon or ligament injuries. Higher K10 scores significantly correlated with slower actual cycling times and the presence of flu symptoms.

These findings indicate that certain of the personality and psychological dimensions included in this study may be predictive of injury, illness and performance in Ironman triathletes. However, extrapolations of these findings to other sports settings cannot be done at this stage and will need to be confirmed through further research.

Therefore the clinical application of the findings in this study lies not so much in the specific predictive values of the psychometric dimensions (as originally hypothesised), but rather in their integration into the total management, rehabilitation and performance-enhancing strategies of Ironman triathletes.

Chapter 4

Summary and conclusion

This descriptive cross-sectional study investigated the predictive value of psychological factors, specifically personality traits, resilience and general psychological distress, with regard to the prevalence of injuries and illnesses, and athletic performance in a group of triathletes competing in the South African Ironman event, held in Port Elizabeth in March 2007. The study sample comprised of 166 triathletes who completed the Ironman race (out of 1308 total finishers).

The results of this study revealed that psychometric scores showed associations with demographic characteristics, race performance times and the injury and illness profiles of the cohort of triathletes. Older triathletes had significantly higher NS scores, with a tendency towards higher resilience and lower RD scores. Taller athletes had significantly higher NS scores and lower HA scores and heavier athletes had significantly higher NS scores and a tendency towards lower RD scores. Furthermore, in terms of performance, athletes with higher NS and RD scores predicted faster finishing and split times, but lower K10 scores was a better predictor of faster actual times and significantly predicted faster cycling times. With regard to symptoms of illness, higher K10 scores significantly predicted the presence of flu-like symptoms. Symptoms of the nervous system during exercise were related to significantly higher HA scores and lower RD scores. Medication use prior to or during an event showed a relationship with higher HA and K10 scores. The association of K10 and HA scores with flu-like and nervous system symptoms

respectively could be the reason for its association with medication use. Higher RISC scores predicted exercise-associated collapse and an absence of exercise-associated muscle cramps. Resilience seems to have a protective effect against EAMC. Higher HA scores were associated with GIT symptoms during exercise. With regard to previous or current injuries, higher RD scores were significantly predictive of tendon and ligament injuries, and genital injuries were associated with higher HA and lower RISC scores.

In general, the results showed only a few consistent findings in terms of identifying predictors, but some interesting correlations and trends were observed. Prospective cohort studies with larger samples, over more prolonged periods, and in different athletic and sedentary populations, are needed to paint a clearer picture of the relationship between psychological factors to athletic injury, illness and performance. Also, in the South African setting, appropriate culturally sensitive samples from the South African population would need to be recruited and studied. The identification of psychological predictors and appropriate, accurate psychometric instruments will enable clinicians to optimise the mental well-being and ultimately the performance of athletes.

In their approach to athletes, all sports physicians should be mindful of the importance of the role of psychology in sport. The attainment of psychological and physiological harmony is paramount to athletic success.

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Appendices

Appendix A

Invitation to participate in the Medical Research at Ironman 2007

Once again, the medical research team will conduct studies at the 2007 Ironman in Port Elizabeth. We anticipate that the findings ultimately will assist you in improving your performance and improving the standard of your medical treatment at future triathlons and other endurance events:

Research results from Ironman 2006

Attached is a summary of the main results from the research we conducted last year at the Ironman 2006 (please download the attachment). A number of the research projects are ongoing, and the same or similar questions will again be examined this year.

What are the research questions the team wishes to answer?

The following research questions have been identified and will be investigated:

1. What is the best treatment of a collapsed triathlete?
2. Does training affect the risk of developing Exercise Associated Muscle Cramping in Ironman triathletes?
3. Why can Ironman triathletes cope so well with pain and discomfort during training and competition?
4. How does your genetic make-up affect your performance and possible medical complications during an Ironman triathlon?
5. Does your brain become exhausted during an Ironman event – what is the evidence?
6. What are the causes of gastro-intestinal (GIT) distress in Ironman triathletes ? (It was very evident from the research findings of 2006, that this is a very common problem)

How can you volunteer to participate in the research studies in 2007?

As a participant in the Port Elizabeth IRONMAN 2007 triathlon, you will be given the unique opportunity to participate in this research effort. The following are very important:

- Please understand that your participation is entirely voluntary
- You will be given the opportunity to participate in any number, or all components of the study
- Brief information of each component is given below, but more details of the research studies and precise instructions on how to participate in the research are attached
- Please download and read the following documents:
    1. Subject information sheet (this will give you detailed information about each component of the research)
    2. Informed consent form (If you wish to participate, this document needs to be signed in the presence of a member of the research team – at the time of registration in Port Elizabeth)
    3. Medical and training questionnaire (Please complete this questionnaire in the 2-3 weeks before registration, and bring it with you to the research stand at the registration area – this questionnaire can be completed even if you do not wish to participate in all the research studies)
- We acknowledge that the questionnaire is long, and we therefore suggest that you complete it over a few days and perhaps section by section. Your assistance is MUCH appreciated.

Brief information on each component of the research study

1. Treatment of the collapsed triathlete

In this study we wish to determine which of two commonly used forms of treatment (drinking fluids, or receiving fluids into you vein through a "drip") are most effective in the treatment of collapsed athletes.

Under the expert care of the medical team in the medical tent, you will be able to voluntarily participate in this study (either before, or on admission to the medical tent).

2. Exercise associated muscle cramping
In this study, we wish to determine whether there is a training-related factor that may play a role in the risk of developing cramping. Information for this study will be obtained by completing the medical questionnaire and by getting your "effort rating" during the race (this will be explained to you). Further information will also be obtained from those of you that have your own recording and down-loadable type heart rate monitor. If you are interested in participating in this study, please start (or continue if you already do this) monitor your heart rate during training in the 4-6 weeks before the race and during the race. It will be necessary to download the heart rate data and then to submit this to us via email, or you can bring the data on your flash-drive to registration. We could even get this information from you after the event!

3. Pain coping strategies in Ironman triathletes
As you are all well aware, intense training and competing in an extreme endurance event such as the Ironman is associated with discomfort and physical pain. In this study, we wish to identify strategies used by triathletes to cope with pain experienced during extreme physical exercise. This information will be obtained by a questionnaire (completed before the race), and by testing your level of concentration, heart rate variability and your pain threshold before the race (20-30 min test). This information will be determined 1-4 weeks before the race at a research centre in Cape Town or it can be done at registration before the race. Some of these tests will be repeated after the race.

4. Genetic make-up and performance, physiological responses and medical complications during an Ironman triathlon
In this study, we wish to determine whether genetic markers are associated with performance and medical complications during an Ironman triathlon. Information for this study will be obtained by completing a questionnaire. In addition, we will need volunteers to donate a small blood sample (1 teaspoon) from which your genetic material (DNA) will be extracted for the identification of gene variants. This information and the blood sample will be obtained at registration before the race.

5. Brain "exhaustion" after an Ironman Triathlon
In this study, we wish to measure the effect of the Ironman on brain and nerve processing and the nerve activity that, for instance, controls your heart rate. Using an electroencephalogram (EEG) machine (measured through a cap, similar to a swim cap, that has electrodes that only record nerve activity) we will be measuring brainwave patterns and heart rate variability during a simple mental test before and immediately after (within 60min of completing) the Ironman. This test is not painful, and takes about 20-30 min. It will be conducted 1-4 weeks before the race at the Sports Science Institute in Cape Town, or at the registration area before the race.

6. Possible causes of gastro-intestinal (GIT) distress in Ironman Triathletes
In this study we wish to find out why such a large percentage of triathletes suffer from stomach and other abdominal upsets during training and racing. Volunteers for this component of the study will be asked to complete the questionnaire. In addition, in a smaller group of volunteers, we wish to measure the blood flow to the intestines using an ultrasound machine (such as used in scans during pregnancy or when we scan the tendons) before the race (during registration in Port Elizabeth) and then again immediately after the race (particularly in those triathletes who regularly develop abdominal problems). This scan is not painful, and will take about 10 minutes.

A final word from the medical team and the research team

One of the main components of the projects is the completion of a detailed medical questionnaire. The information obtained form this questionnaire will be very useful for the medical team and can lead to improvements in medical care if you need it. We therefore encourage all of you to complete the questionnaire, and also consider participating in some (or all) of these other tests.

Medical Research Director	Chief Medical Officer	Race Director
Prof Martin Schwellnus	Dr Peter Schwartz	Mr Paul Wolff

Appendix B

SUBJECT INFORMATION SHEET

Dear Tri-athlete

We have the privilege to inform you that scientific research at the Port Elizabeth Spec-Savers Ironman South Africa triathlon has been planned in collaboration with the MRC/UCT Research Unit for Exercise Science and Sports Medicine based at the Sports Science Institute of South Africa. This will provide a unique opportunity for a research programme to address important medical and physiological problems associated with the Ironman triathlon. Each participant will be able to access a summary of the findings of the study, once it has been completed. The research study will concentrate on the following 6 main components that will ultimately lead to an **improvement in medical and physiological knowledge which may improve training strategies and medical treatment** at future triathlons and other endurance events:

- Management of the collapsed tri-athlete
- Causes of exercise associated muscle cramping (EAMC) in Ironman triathletes
- Pain coping strategies in Ironman Triathletes
- Genetic basis for performance, physiological responses and medical complications during an Ironman Triathlon
- Neural fatigue following an Ironman Triathlon

As a participant in the Port Elizabeth Spec-Savers Ironman South Africa triathlon, you will be given the choice to participate in this research effort. Your participation is entirely voluntary. Please read through the details of the following six components of the study. You will be given the opportunity to participate in one or more components of the study. The details of each component are explained in this document, and if you wish to participate in one or more components of the study, please read through and sign the INFORMED CONSENT FORMS that relate to each component of the study. Please feel free to contact members of the research team should you have any questions related to the study (or any component of the study). Contact details of the research team are as follows: Ironman@sports.uct.ac.za or (021) 650 4567

SUBJECT INFORMATION SHEET:

COMPONENTS OF THE RESEARCH STUDY TO BE CONDUCTED AT THE 2007 IRONMAN TRIATHLON IN PORT ELIZABETH

The research study at the 2007 Spec-Savers Ironman South Africa triathlon, comprise of six components. The detailed information on each of these components of the study is as follows:

Component 1: Management of the collapsed Tri-athlete

General information

The aim of this study is to evaluate the optimum treatment strategies for which to treat collapsed tri-athletes, after an Ironman race. Although intravenous (fluid that is infused through a needle into one of your veins – also referred to as IV fluid) fluid replacement is a common practice in the treatment of collapsed tri-athletes, medical personnel need to be advised of a treatment method that will prevent possible fluid overload, which can cause hyponatraemia. Hyponatraemia can be a very severe condition. Your participation in this trial will aid in the understanding and management of how best to correct any fluid imbalance following this race.

If you collapse during or after the Ironman Triathlon and are brought into the medical tent, you will be evaluated and treated according to the current best standard of care principles. Your legs will be elevated and your heart rate, blood pressure, mental status and serum sodium concentration will be measured. If you are confused and your sodium level is normal, other laboratory tests will be performed such as an evaluation of your body temperature and blood sugar levels. If your body temperature is normal and do not have evidence for another treatable medical condition, a small needle and tube will be placed into a vein in your arm. The appropriate fluid (into your vein or drinking normally by mouth) (ad libitum – you chose how much you wish to drink) – will be given to you until you recover and can leave the

medical tent without assistance. Your discharge will be at the discretion of the supervising medical officer. If your condition deteriorates at any time, you will be immediately removed from the trial, treated appropriately and transported to the nearest hospital. At all stages of the research study and medical care, the highest standard of safety and medical country as practised in this country will be adhered to.

The risk of adverse affects of placement of an intravenous line include: infection, delayed healing, bruising, physical pain, mental discomfort and possible injury to a nerve or vessel. The risk of these adverse effects are rare and every attempt to minimize these risks will be undertaken by the use of sterile technique and use of disposable, single use, material. Your blood will be used for evaluation of serum sodium or blood glucose concentration only. No other tests will be performed on your blood and your blood samples will be appropriately discarded after these tests are performed.

We will obey the strict practices of confidentiality and anonymity. Each subject's identity will be known only to the researchers and numbers will be assigned to each sample in lieu of names. No results will be publicly available and the scientific publication of results will never disclose subject identity. Upon specific request, data such as electrolyte analyses will be made available to subjects.

Potential risks of this component of the study

- The completion of personal details, racing, training, equipment use, medical, supplement use, fluid use and lifestyle history questionnaires are not associated with any risk. Completion of self-rated behavioural questionnaires has not previously been shown to be associated with risk. A potential risk is that people who have experienced significant past trauma will find questionnaires on this uncomfortable. The questions within the behavioural questionnaires are asking are about temperament and none of the scales are directed at picking up psychopathology. Questionnaire and other clinical data (paper and electronic) will be kept confidential, will be kept secure, and will not be made available to any party other than the research team without the consent of the individual subjects.
- The risks associated with participation in this component of the study do not exceed the risks associated with competing in the Ironman competition. The administration of fluid into your vein will involve an invasive placement of an intravenous line (a small needle and tube). The risks associated with the placement of an intravenous line include: infection, delayed healing, hematoma, physical pain, mental discomfort and injury to a nerve or vessel. These risks will be minimized by the use of trained phlebotomists, sterile technique and disposable, single use materials. If at any time the condition of a collapsed

Appendix D

Department of Human Biology

UCT/MRC RESEARCH UNIT FOR EXERCISE SCIENCE & SPORTS MEDICINE

Faculty of Health Sciences, University of Cape Town
Private Bag, Rondebosch 7700, South Africa
Tel: + 27 21 650 4561
Fax: + 27 21 686 7530

2006 IRONMAN – MEDICAL AND TRAINING QUESTIONNAIRES

These questionnaires have been constructed by the Medical Research team, in conjunction with the Medical Director of the Ironman 2006. The information obtained from these questionnaires is essential for the planning of medical care during events such as the Ironman 2006. We acknowledge that the questionnaires are long, but we are asking about 20 minutes of your valuable time to complete them. The completion of the questionnaires is voluntary, all the information will be kept confidential and will only be used for research and medical care planning purposes. We suggest that you consider completing this before the event, or at the time of registration.

Prof Martin Schwellnus (Chairman, Research Team)
Dr Peter Schwartz (Medical Director, Ironman 2006)

Instructions

You can either complete the questionnaires electronically using Microsoft word or print the questionnaires and complete them manually. Please answer each question by filling in the details in the allocated space or checking one or more of the option boxes.

If you complete the questionnaire electronically using Microsoft word, please e-mail the completed forms to ironman@sports.uct.ac.za and bring the signed consent form to the research table at race registration.

If you complete the questionnaire manually, please bring the completed forms together with the signed consent form to the research table at race registration.

Please complete sections A, B, C, D and E

Please complete only the relevant questions in the following section

published in journals on the condition that neither my name nor any other identifying information is used.

11. **Abdominal ultrasound to determine blood flow to the abdominal organs (only for the GIT component)**

    I agree to having a pre-and post-race abdominal ultrasound to measure the blood flow to my abdominal organs.

I have read the preceding subject information sheet and understand the testing procedures outlined therein. I understand any accompanying risks and discomforts. Knowing these risks and discomforts and having had the opportunity to pose questions answered to my satisfaction, I hereby consent to participate in this study. I understand that I may withdraw from this study at any time without further question. I have been informed that the individual data derived from my participation in these protocols will remain confidential. I understand that the medical staff and the research team have professional medical insurance.

Name of the tri-athlete: _____

Signature of tri-athlete _____

Date: _____

Name of investigator: Prof Martin Schwellnus

Signature of Investigator: _____

Date: _____

blood collection technique from the ante-cubital veins are: infection, delayed healing, haematoma, physical pain, mental discomfort and injury to a nerve or a vessel. These risks are small and will be minimized by the use of trained phlebotomists, use of sterile techniques and the use of disposable, single use materials. The risk of decreased performance as a result of blood collection will be reduced by not subjecting any participant to the collection of a blood volume exceeding 15 ml prior to the race.

The DNA will only be used for scientific research purposes relating to the genetic basis of (1) athletic ability, (2) physiological response to (3) medical complications during ultra-endurance events. I have also agreed to complete personal particulars, training, sporting, measures of behavioural endophenotypes and medical questionnaires and understand that all the information that is collected during the study will be treated with the strictest confidentiality and will only be used for scientific research purposes. Questionnaire and other clinical data (paper and electronic) will be kept confidential, will be kept secure, and will not be made available to any party other than the research team without the consent of the individual subjects. I also understand that all data will be analysed anonymously and my DNA sample will be destroyed on completion of the study.

I understand that some of the DNA extracted form the donated blood sample will be sent to the Cyprus Institute of Neurology and Genetics in Cyprus for analysis. I understand that the DNA samples will be shipped to and analysed in Cyprus anonymously. I understand that the DNA will be genotyped (analysed) for variations (polymorphisms) within genes relating to the genetic basis of athletic ability, tendon and ligament overuse injuries and dysnatraemia during ultra-endurance events only.

I understand that whilst there is no direct benefit to myself, if a genetic predisposition for (1) athletic ability, (2) physiological response to and (3) medical complications during ultra-endurance events can be established, then future generations will be able to establish their risk for this condition. This may allow better prevention and treatment options in the future. I understand that I will receive the overall results of the study.

I have read (or, where appropriate, have had read to me) and understood the information about this study, and any questions I have asked have been answered to my satisfaction. I agree to participate in the study, realising that I have the right to request that my DNA sample be destroyed at anytime. I agree that research data provided by me or with my permission during the project may be included in a thesis, presented at conferences and

this component of the study will involve contact with subjects during the race. There is a potential risk that in the process of data collection, the performance of subjects in the race will interfere with. This risk will be minimal, as the nature of the data collection is such that subjects will only be asked to shout out two numbers as they pass members of the research team at designated points in the race. However, should tri-athletes feel that this affects their performance during the race; they will be free to withdraw from this component of the study during the race. There will be no interference with other race participants during this data collection process.

7. **Recording of heart rate variability during stroop test: (only for the management of pain components)**

   The stroop test is a simple, computer based test. The mental concentration that is required for the test is relevant for the data collection and not the outcome of the test. There is no risk associated with the recording of the heart rate variability

8. **Pain threshold with a digital pain probe: (only for the management of pain components)**

   There is no risk associated with the assessment of the pain threshold with the digital pain probe. As the onset of pain is determined, the discomfort is minimal.

9. **Brain wave measurements: (only for the neural fatigue)**

   There are no potential risks associated with brain wave measurements, since we are merely recording the underlying electric activity generated by the brain and not stimulating the brain in any way. Similarly, there are also no potential risks associated with measuring the electrical activity generated by the heart. There may be some discomfort experienced by the EEG gel needed to increase the conductivity of the electric signal, but no more so than what would be experienced by applying hair gel to flatten your hair.

10. **Blood sample collection for genetic studies: (only for the genetics component)**

    At one of the pre-race facilities or at race registration, I have agreed to donate ten milliliters (2 teaspoons) of venous blood. The sample will be used for the extraction and analysis of genetic material (DNA).

    The potential risks to subjects of blood collection are minimal and are related to 1) blood sample collection technique, and 2) the volume of blood collected prior to racing and the potential risk of a decreased performance in the race. The potential risks associated with

potential risks associated with blood collection technique from the ante-cubital veins are: infection, delayed healing, haematoma, physical pain, mental discomfort and injury to a nerve or a vessel. These risks are small and will be minimized by the use of trained phlebotomists, use of sterile techniques and the use of disposable, single use materials. The risk of decreased performance as a result of blood collection will be reduced by not subjecting any participant to the collection of a blood volume exceeding 15 ml prior to the race.

Body weight will be measured on the morning before the start of the race and immediately after completing the race in the medical facility using a standard electronic scale, and there is no risk associated with this procedure.

4. **Measurement of heart rate data: (only for the cramps component)**
   This will be done with the subjects own heart rate monitor used during training and racing. The stored files will be emailed to the researcher at the Sports Science Institute, and will be kept confidential.

5. **Score of perceived exertion during the race: (only for the cramps and the management of pain components)**
   During the race researchers will be allocated to about 12 stages throughout the race. As you swim, run or cycle past these researchers they will hold up two boards with the scores for *"perception of effort rating".* You will be asked to shout out your respective scores as you go past them and they will record these scores against your race number. Data for this component of the study will involve contact with subjects during the race. There is a potential risk that in the process of data collection, the performance of subjects in the race will interfere with. This risk will be minimal, as the nature of the data collection is such that subjects will only be asked to shout out two numbers as they pass members of the research team at designated points in the race. However, should tri-athletes feel that this affects their performance during the race; they will be free to withdraw from this component of the study during the race. There will be no interference with other race participants during this data collection process.

6. **Pain during the race: (only for the management of pain components)**
   During the race researchers will be allocated to about 12 stages throughout the race. As you swim, run or cycle past these researchers they will hold up two boards with the scores for *"pain assessment".* You will be asked to shout out your respective scores as you go past them and they will record these scores against your race number. Data for

(DELETE THOSE COMPONENTS YOU DO NOT AGREE TO PARTICIPATE IN)

1. **Completion of a questionnaire: (all components)**

   The completion of personal details, racing, training, equipment use, medical, supplement use, fluid use and lifestyle history questionnaires are not associated with any risk. Completion of self-rated behavioural questionnaires has not previously been shown to be associated with risk. A potential risk is that people who have experienced significant past trauma will find questionnaires on this uncomfortable. The questions within the behavioural questionnaires are asking are about temperament and none of the scales are directed at picking up psychopathology. Any personal identification of subjects (names and surnames), questionnaire data and other clinical data (paper and electronic) will be kept confidential, will be kept secure, and will not be made available to any party other than the research team without the consent of the individual subjects.

   I agree that the all the questionnaire information, my performance during the Ironman triathlon, together with all the other data collected from the various components of this trial may be used to answer scientific questions about the medical conditions, physiological responses and measures of performance associated with the participation in and completion of an Ironman triathlon.

2. **Treatment if I collapse after the race: (only for the collapsed athlete component)**

   If I collapse during or after the race I might receive either fluid replacement directly into your vein or oral fluids ad libitum (as much as I want) but according to my post-race blood sodium level. Optimum care will be provided to me according to the current standard of care. Treatment will cease when my laboratory values have returned to normal and I am alert and oriented. I will be transported to the local hospital if my condition requires more urgent medical attention.

3. **Pre- and post-race serum electrolyte (salt) levels and weights (only for the collapsed athlete component)**

   I have agreed to donate 5 milliliters (1 teaspoons) of venous blood during registration and immediately after completing the race in the medical facility. The sample will be used to measure my serum electrolyte (blood salt) levels. The potential risks to subjects of blood collection ar I have agreed to donate ten milliliters (2 teaspoons) of venous blood. The sample will be used for the extraction and analysis of genetic material (DNA). mal and are related to 1) blood sample collection technique, and 2) the volume of blood collected prior to racing and the potential risk of a decreased performance in the race. The

Appendix C

INFORMED CONSENT FORM

I, _____, agree voluntarily to participate in the following components **(DELETE THOSE COMPONENTS YOU DO NOT AGREE TO PARTICIPATE IN)** of the UCT/MRC Research Unit for Exercise Science and Sports Medicine's, University of Cape Town, research project titled:-

1. "A study on the management of the collapsed tri-athlete",
2. "A study to determine the cause of Exercise Associated Muscle Cramping (EAMC)"
3. "A study on the management of pain in triathlon athletes",
4. "A study to determine the genetic basis for performance, physiological responses and medical complications during an Ironman Triathlon"
5. "A study to determine the extent of neural fatigue in athletes immediately post Ironman triathlon"
6. "Factors associated with gastro-intestinal (GIT) distress in Ironman triathletes"

I understand that my participation in this research project has no direct benefits to me during the Ironman 2007 competition. However, I understand that my participation in the research project will advance the medical and scientific knowledge related to endurance sports. Therefore, information gathered through my participation in this project could advance the future medical care, training advice and performance of endurance athletes.

I have read the subject information sheets and the following procedures and concepts have been explained to me in full:

pubic bone exposed). A gel will be applied to your skin, and the radiologist will move the scanning probe across the skin. This is not associated with any pain or discomfort and the procedure lasts about 5-10 minutes. Your heart rate and brachial artery blood pressure will be obtained at the same time as the ultrasound.

After the race you will be asked to have a repeat ultrasound, immediately on completing the event. Heart rate and brachial artery blood pressure will again be obtained at the same time as the ultrasound.

Stool samples will be obtained from you (should you agree to this part) after the race. This involves collecting a sample from you after the race, in a designated container, which you can hand to the research staff for analysis for traces of blood.

Potential risks of this component of the study

- The completion of the medical questionnaire is not associated with any risk. Questionnaire and other clinical data (paper and electronic) will be kept confidential, will be kept secure, and will not be made available to any party other than the research team without the consent of the individual subjects.
- Abdominal ultrasound: There are no known risks of an abdominal ultrasound in healthy individuals.

Potential benefits of this component of the study

- There is not direct benefit in participating in this component of the study. The long term anticipated benefits of this component of the research study are to identify factors that may cause gastrointestinal symptoms in triathletes. This information may lead to 1) lower risk of developing these symptoms and 2) improved medical care of triathletes that develop these symptoms.

stool). However, we do not yet know the precise causes of these symptoms It is believed that lower GIT symptoms could be related to a decrease in blood flow to the small and large bowel, because blood flow is diverted from the GIT to the working muscle during exercise. Furthermore, dehydration may add to this problem. Other possible mechanisms are dietary (increased fibre intake), psychological stress, mechanical movement of the bowel (mainly during running) and hormonal (increased secretion of hormones affecting gastro-intestinal motility). In this component of the research project, we wish to identify some of the possible mechanism for these symptoms, so that medical care can be improved.

The main aims of this component of the study are to identify possible aetiological factors that are associated with GIT complaints experienced by the triathletes. More specifically, the following will be measured:

- To establish an association between the development of GIT symptoms during the race and pre-race dietary habits, pre-race emotional stress factors and other medical conditions (past history of surgery, past history of GIT disease, age, gender, training etc.) (obtained through a pre-race questionnaire)
- To establish whether there is a significant difference in the blood flow to the small and large bowel (celiac artery and superior mesenteric artery blood flow immediately pre- and post-exercise and between triathletes who developed GIT symptoms and those who did not develop any GIT symptoms during the race
- To establish whether the athletes with GIT complaints during the race have a higher risk of blood in a post-race stool sample
- To ascertain whether GIT symptoms are associated with dehydration (as measured by changes in pre- post-race body weight)

This study involves the following. You will be contacted prior to the event via email or will be given information at the time of registration. Once you have volunteered, and have given consent to participate, you will be asked to complete a Medical Questionnaire (Appendix). You will also be contacted again two weeks after the race via email and asked to answer another brief medical questionnaire.

At either a designated research centre, or at registration in Port Elizabeth, you will have a Doppler abdominal ultrasound to determine blood flow in your celiac artery (CA) and superior mesenteric artery (SMA) (prior to the race during the registration). This procedure is similar to the ultrasound done in pregnant women to screen for abnormalities in the baby. You will be asked to lie on an examination couch on your back with the abdomen (rib cage to the

The anticipated benefits of this component of the study are that the results will further our understanding of the deterioration of neural processing in athletes completing extreme endurance exercise. If significant deterioration in brain processing is indeed found, strategies can be implemented to combat this, whether by dietary, training or psychological means.

Potential risks of this component of the study

- The completion of a questionnaire is not associated with any risk. Completion of self-rated behavioural questionnaires has not previously been shown to be associated with risk. A potential risk is that people who have experienced significant past trauma will find questionnaires on this uncomfortable. The questions within the behavioural questionnaires are asking are about temperament and none of the scales are directed at picking up psychopathology. Questionnaire and other clinical data (paper and electronic) will be kept confidential, will be kept secure, and will not be made available to any party other than the research team without the consent of the individual subjects.
- There is no risk associated with the recording of the heart rate variability.
- There is no risk associated with the recording of the Stroop test
- There is no risk associated with the recording of an EEG

Potential benefits of this component of the study

- There is not direct benefit in participating in this component of the study. The long term anticipated benefits of this component of the research study are to identify genetic factors that may predispose to 1) improved performance or 2) increased risk of medical consequences (such as abnormal electrolyte imbalances). This information will eventually assist tri-athletes in predicting and improving their performance, and decrease their risk of medical complications during participation in triathlon.

Component 6: Factors associated with gastro-intestinal (GIT) distress in Ironman triathletes

General information

It is well established that gastrointestinal (GIT) symptoms (nausea, vomiting, abdominal cramps, urge to defecate (passing a stool), diarrhoea or blood in the stool) are common amongst endurance athletes. In a study conducted by our Unit during the 2006 Ironman triathlon about 40% of athletes indicated that they suffered from GIT symptoms. Furthermore, most of the symptoms were lower GIT symptoms (urge to defecate, diarrhoea or blood in the

Potential benefits of this component of the study

- There is not direct benefit in participating in this component of the study. The long term anticipated benefits of this component of the research study are to identify genetic factors that may predispose to 1) improved performance or 2) increased risk of medical consequences (such as abnormal electrolyte imbalances). This information will eventually assist tri-athletes in predicting and improving their performance, and decrease their risk of medical complications during participation in triathlon.

Component 5: Neural fatigue following an Ironman Triathlon

General information

The aim of this study is to increase our understanding of the extent of neural processing slowdown/changes and arousal changes that occur in tri-athletes having just completed an exhaustive Ironman Triathlon. Since this component of the study requires completion of a familiarisation test 6 weeks prior to the event, in Newlands, Cape Town, only Cape Town based competitors will be considered for this component.

The way we will test for neural processing changes is by way of a repetitive reaction time cognitive test – a computer generated Stroop test – whereby participants have to respond to the colour of 4 different colour words presented in the centre of the laptop screen. The 4 colour words, red, blue, green and yellow will be presented on the screen in a different colour to what the word says, e.g. red written in blue ink, or green written in yellow. To ensure that participants read the words, 20% of the 4 colour words will be presented in grey – in this case participants have to respond to the word (i.e. not the colour).
Arousal changes will be determined from heart rate variability (HRV) and the electroencephalogram (EEG) power spectrum.

A familiarisation test will be conducted 6 weeks prior to the Ironman in the EEG room at the MRC/UCT Research Unit for Exercise Science and Sports Medicine, which is located at the Sports Science Institute of South Africa. A further pre-event test will be conducted the day before the Ironman during registration in a separate tent; and finally a post-event test will be done within 30 min of completing the Ironman in the same tent.

We will be using a portable Biopac MP150 W System to record the EEG and HRV data. The measurements are completely non-invasive and harmless and will be collected by way of a neoprene scull cap containing 20 electrodes for the EEG data and 3 electrodes attached to both wrists and the left ankle to record HRV data.

The DNA will only be used for scientific research purposes relating to the genetic basis of (1) athletic ability, (2) physiological response to and (3) medical complaints during ultra-endurance events. Personal particulars and sporting and medical questionnaires will have to be completed and this information will be treated with the strictest confidentiality and will only be used for scientific research purposes. All data will be analysed anonymously and DNA samples will be destroyed on completion of the study.

Part of the DNA extracted form the donated blood sample will be sent to the Cyprus Institute of Neurology and Genetics in Cyprus for analysis. DNA samples will be shipped to and analysed in Cyprus anonymously. DNA will be genotyped (analysed) for variations (polymorphisms) within genes relating to the genetic basis of athletic ability, physiological response to and (3) medical complaints during ultra-endurance events.

Potential risks of this component of the study

- The completion of personal details, racing, training, equipment use, medical, supplement use, fluid use and lifestyle history questionnaires are not associated with any risk. Completion of self-rated behavioural questionnaires has not previously been shown to be associated with risk. A potential risk is that people who have experienced significant past trauma will find questionnaires on this uncomfortable. The questions within the behavioural questionnaires are asking are about temperament and none of the scales are directed at picking up psychopathology. Questionnaire and other clinical data (paper and electronic) will be kept confidential, will be kept secure, and will not be made available to any party other than the research team without the consent of the individual subjects.
- The potential risks to you during blood collection are minimal and are related to 1) blood sample collection technique, and 2) the volume of blood collected prior to racing and the potential risk of a decreased performance in the race. The potential risks associated with blood collection technique from the ante-cubital veins are: infection, delayed healing, haematoma, physical pain, mental discomfort and injury to a nerve or a vessel. These risks are small and will be minimized by the use of trained phlebotomists, use of sterile techniques and the use of disposable, single use materials. The risk of decreased performance as a result of blood collection will be reduced by not subjecting any participant to the collection of a blood volume exceeding 15ml prior to the race.

- There is no risk associated with the recording of the heart rate variability.
- There is no risk associated with the assessment of the pain threshold with the digital pain probe. As the onset of pain is determined, the discomfort is minimal.
- During the race researchers will be allocated to about 12 stages throughout the race. As the athletes swim, run or cycle past these researchers they will hold up two boards with the scores for *"perception of effort rating"* and *"pain assessment".* The athletes will be asked to shout out their respective scores as they go past them and these scores will be recorded against the athlete's race number. Data for this component of the study will involve contact with subjects during the race. There is a potential risk that in the process of data collection, the performance of subjects in the race will interfere with. This risk will be minimal, as the nature of the data collection is such that subjects will only be asked to shout out two numbers as they pass members of the research team at designated points in the race. However, should tri-athletes feel that this affects their performance during the race; they will be free to withdraw from this component of the study. There will be no interference with other race participants during this data collection process.

Potential benefits of this component of the study

- The identification of coping strategies in athletes with regards to pain will help to teach similar coping strategies to patients with chronic pain conditions in order to improve their quality of life.

Component 4: Genetic basis for performance, physiological responses and medical complications during an Ironman Triathlon

General information

This study will be conducted by the UCT/MRC Research Unit for Exercise Science and Sports Medicine at the University of Cape Town in Cape Town, South Africa, in conjunction with the Molecular Genetics Department B and Laboratory of Forensic Genetics of the Cyprus Institute of Neurology and Genetics in Nicosia, Cyprus.

The study involves donate ten millilitres (2 teaspoons) of venous blood and this will be done at one of the pre-race facilities (either in Cape Town, Port Elisabeth, Durban, Bloemfontein or Johannesburg) or at race registration. The sample will be used for the extraction and analysis of genetic material (DNA).

- Before the race you will be required to visit a centre, designated to your area (either in Cape Town, Port Elisabeth, Durban, Bloemfontein or Johannesburg), where you will be asked to complete a questionnaire with personal details, training details, past injury, pain and medical details, details about family history and a psychological questionnaire. You will also be asked to perform a stroop test. The stroop test is a simple, computer based test. The mental concentration that is required for the test is relevant for the data collection and not the outcome of the test. During the test your heart rate variability will be recorded. This procedure entails wearing a heart rate monitor strapped around your chest. This procedure is not associated with any discomfort. While the EEG recordings themselves are completely painless, a slight (1) measure of discomfort may be experienced when the electro-cap is pulled (2) over the scalp - similar to pulling a swimming cap over the scalp. (3) When the electro gel is applied it may feel cold and sludgy - cleaning towels and water will be available to freshen up afterwards. In addition, your pain threshold will be assessed with a digital probe. As the onset of pain will be assessed, this procedure is associated with minimal discomfort. You will also be familiarised with the subjective scores for *"perception of effort rating" and "pain assessment"* before the race.
- During the three days of registration before the event and immediately after the event, the Stroop test and the concomitant recording of the heart rate variability will be repeated.
- The assessment of the pain threshold level will be repeated immediately before and after the race, together with a recording of the athletes' feelings/mood.
- During the race researchers will be allocated to about 12 stages throughout the race. As you swim, run or cycle past these researchers they will hold up two boards with the scores for *"perception of effort rating"* and *"pain assessment"*. You will be asked to shout out their respective scores as they go pass.

Potential risks of this component of the study

- The completion of personal details, racing, training, equipment use, medical, supplement use, fluid use and lifestyle history questionnaires are not associated with any risk. Completion of self-rated behavioural questionnaires has not previously been shown to be associated with risk. A potential risk is that people who have experienced significant past trauma will find questionnaires on this uncomfortable. The questions within the behavioural questionnaires are asking are about temperament and none of the scales are directed at picking up psychopathology. Questionnaire and other clinical data (paper and electronic) will be kept confidential, will be kept secure, and will not be made available to any party other than the research team without the consent of the individual subjects.

scores for "*perception of effort rating*". You will be asked to shout out your score as you go past them and they will record these scores against your race number.

Potential risks of this component of the study

- The completion of personal details, racing, training, equipment use, medical, supplement use, fluid use and lifestyle history questionnaires are not associated with any risk. Completion of self-rated behavioural questionnaires has not previously been shown to be associated with risk. A potential risk is that people who have experienced significant past trauma will find questionnaires on this uncomfortable. The questions within the behavioural questionnaires are asking are about temperament and none of the scales are directed at picking up psychopathology. Questionnaire and other clinical data (paper and electronic) will be kept confidential, will be kept secure, and will not be made available to any party other than the research team without the consent of the individual subjects.
- Data for this component of the study will involve contact with subjects during the race. There is a potential risk that in the process of data collection, the performance of subjects in the race will be interfered with. This risk will be minimal, as the nature of the data collection is such that subjects will only be asked to shout out a number as they pass members of the research team at designated points in the race. However, should tri-athletes feel that this affects their performance during the race, they will be free to withdraw from this component of the study during the race. There will be no interference with other race participants during this data collection process.

Potential benefits of this component of the study

- The anticipated benefits of this component of the study are that the results will further our understanding of the possible cause/s of EAMC in endurance athletes. In particular, once the aetiology of EAMC is better understood, this will improve our ability to prevent this condition.

Component 3: Pain coping strategies in Ironman Triathletes

General information

The purpose of this component of the research study is to determine if athletes participating in an endurance event (such as the Ironman) use a common coping strategy to endure pain that is related to exercise.

tri-athlete deteriorates, the most appropriate treatment will be initiated, the trial terminated and the patient will be transported to the local hospital if necessary. The support form the local hospital is part of the normal standard medical care associated with this event.

Potential benefits of this component of the study

- The data collected in this component of the study will aid in the development of optimal treatment strategies for collapsed tri-athletes. Although fluid replacement directly into your vein is a common practice in the treatment of collapsed tri-athletes, medical personnel need to be advised of a more judicious approach to treatment as to avoid the deleterious effects of fluid overload (hyponatraemia). This information will aid in the understanding and management of serum sodium disorders in collapsed tri-athletes by scientifically 1) evaluating the efficacy of fluid replacement directly into your vein versus oral rehydration and 2) assessing if the normalization of serum sodium levels are important in the recovery of collapsed tri-athletes.

Component 2: Causes of Exercise Associated Muscle Cramping (EAMC) in Ironman Triathletes

General information

The purpose of this component of the study is to determine the possible cause of exercise associated muscle cramping (EAMC) in endurance athletes. Tri-athletes will be contacted as soon as possible and given the opportunity to volunteer to participate in this component of the study. Anyone who owns a recording heart rate monitor will be eligible to participate.
Details of the study are as follows:

- A questionnaire detailing personal particulars, training and racing history, psychological and behavioural, medical information, and history of muscle cramping will be completed.
- Each triathlete will be asked to send a file via email to the Sports Science Institute of their weekly heart rate data as recorded during their training and racing using their personal recording heart rate monitors.
- You will be asked to complete a questionnaire on your training habits for swimming, cycling and running in preparation for the Ironman and your personal best times for the 3 disciplines.
- You will be familiarised with the subjective scores for *"perception of effort rating"* before the race. During the race researchers will be allocated to about 12 stages throughout the race. As you swim, run or cycle past these researchers they will hold up a board with the

Section A: Personal details			
2007 Ironman Race Number			
Surname			
First Name			
Postal Address		Postal/ Zip Code	
E-mail address		Phone (day time)	code number
Alternate E-mail address			
Date of birth	yyyy-mm-dd	Cell (Mobile)	
Height	cm	Gender	Male ☐ Female ☐
Weight	kg	Age (on race day)	yrs
Ethnic group (Only Required and Used for Research Purposes)	Black/African ☐ White ☐ Indian ☐ Mixed Ancestry (Coloured) ☐ Asian ☐ Other ☐		
Ancestry: Tribal or national background (eg Xhosa, Dutch, Zulu, German, Italian)	Father: Unknown ☐ Mother: Unknown ☐		
Country of Birth			
Dominant Hand	Left ☐ Right ☐ Both ☐	Dominant Leg	Left ☐ Right ☐ Both ☐
Occupation			
What **percentage** of your **working** day is spent in the following activities?	Sitting: ____ % Standing: ____ % Walking (Lower body activity) ____ % Manual Labour (upper and body activity) ____ %		
Did you participate in the research project conducted at the 2006 Ironman in Port Elizabeth			Yes ☐ No ☐

Section B. Racing and training history			
Type of triathlon	**Standard (1.6, 40, 10)**	**Ironman**	
Which triathlons have you **ever** participated in?	Yes ☐ No ☐	Yes ☐ No ☐	
Year of first event			
How many triathlon events have you **ever** participated in?			
How many triathlon races have you completed over the **past 2 years**?			
Personal best time **ever**	_____ hrs:min	_____ hrs:min	
What was your time for your last triathlon race during the **past 12 months**?	_____ hrs:min	_____ hrs:min	
Type of running event	**10 km**	**21.1 km**	**42.2 km**
Which road running races have you **ever** participated in?	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐
Year of first event			
How many events have you **ever** participated in?			
Personal best time **ever**	_____ min	_____ min	_____ min
What is your best time, in a running race, in the **last 15 weeks**?	_____ min	_____ min	_____ min
Type of event	**Two Oceans Marathon**	**Comrades Marathon**	
Which races have you **ever** participated in?	Yes ☐ No ☐	Yes ☐ No ☐	
Year of first event			
How many events have you **ever** participated in?			
Personal best time	_____ hrs:min	_____ hrs:min	
What is your personal best cycling time in a race between **80 to 120 km** in the **last 15 weeks**?	Time: _____ min Distance: _____ km		
South African Ironman Triathlon racing history Did you enter any of the South African Ironman Triathlons?			
2000 (Gordon's Bay)	Yes ☐ No ☐ Race No _____		
2001 (Gordon's Bay)	Yes ☐ No ☐ Race No _____		
2005 (Port Elizabeth)	Yes ☐ No ☐ Race No _____		
2006 (Port Elizabeth)	Yes ☐ No ☐ Race No _____		
What is your predicted time for the entire 2007 Ironman event and each of the three splits?	Entire event: _____ min Swim: _____ min Cycle: _____ min Run: _____ min		

Please answer the following questions, with your answers reflecting your average in the **most recent 15 weeks i.e. beginning December 2006 to 18th March, 2007.**	
Do you train with a heart rate monitor?	Yes ☐ No ☐
Do you race with a heart rate monitor?	Yes ☐ No ☐
Do you record, download and store your heart rate information?	Yes ☐ No ☐
Would you be willing to make your heart rate data available to the research team?	Yes ☐ No ☐
How many days a week did you train during the **last 15 weeks**?	days/week
What distances did you train in an average week during the **last 15 weeks**?	Swim: _____ km/week Cycle: _____ km/week Run: _____ km/week
How many hours a week did you **train** in an average week during the **last 15 weeks**?	Swim: _____ hrs/week Cycle: _____ hrs/week Run: _____ hrs/week
How many hours a week did you **work** in an average week during the **last 15 weeks**?	_____ hrs/week
What **distances** did you train in the week before the race?	Swim: _____ km Cycle: _____ km Run: _____ km
How many **hours** did you train in the **week before** the race?	Swim: _____ hours Cycle: _____ hours Run: _____ hours
How many fast/ hard sessions did you do per week in the **last 8 weeks**?	Swim: _____ Cycle: _____ Run: _____
Describe briefly the session, including distance, time and recovery interval (if applicable) e.g. 10 x 400m in 75 sec with 60 sec jog recovery between each	
What percentage of your weekly training distance was done at race speed or faster (for each discipline)?	Swim: _____ % Cycle: _____ % Run: _____ %
How many hours did you train 3 days before the race	Swim: _____ hours Cycle: _____ hours Run: _____ hours
How many hours did you train 2 days before the race	Swim: _____ hours Cycle: _____ hours Run: _____ hours
How many hours did you train the day before the race	Swim: _____ hours Cycle: _____ hours Run: _____ hours
How did your training commitment affect your social life?	☐ Not at all ☐ A fair amount ☐ A lot

Flexibility training history	
Do you perform flexibility training (regular stretching exercises)?	Yes ☐ No ☐
If YES, please complete the rest of the flexibility training history section below:- If NO, continue completing the questionnaire from the top of page 5 (Equipment use history).	
On average, how many days a week do you perform a stretching session?	days/week
On average, how times a day do you perform a stretching session?	times/day
Please tick which muscle groups do you include in your stretching session?	☐ Hamstrings ☐ Quadriceps ☐ Calf (gastrocnemius) ☐ Calf (soleus) ☐ Groin (inner thigh) ☐ Upper body limbs ☐ Other: _____
Please tick when you stretch? (before, during and/or after exercising. You can tick more than one box)	☐ Before Exercise ☐ During Exercise ☐ After Exercise
When you stretch an individual muscle group, on average, **how long do you hold the stretch** for?	seconds
When you stretch an individual muscle group, on average, **how many times do you stretch the muscle for**?	☐ Once ☐ Twice ☐ 3 times ☐ 4 times ☐ 5 times ☐ 6 or more times

Equipment use history			
Please indicate which type of **bicycle** you use?	☐ Kuota ☐ Aegis ☐ Felt ☐ Cervelo ☐ Elite ☐ Giant	☐ Kestrel ☐ Litespeed ☐ Quintana Roo ☐ Argon 18 ☐ Specialized ☐ Other: _____	☐ Trek ☐ Softride ☐ Javelin ☐ Scott ☐ Guru
Please indicate which type of **handle bars** you use?	☐ Bontrager ☐ Profile Design ☐ Deda ☐ Pedalsoft ☐ Other: _____	☐ HED ☐ Vision Tech ☐ Easton ☐ Kestrel	☐ Zipp ☐ Oval Concepts ☐ Syntace
Please indicate which type of **saddle** (Brand - model) you use?	☐ Selle San Marco- Azoto TriathGel ☐ Profile Design- Tri Stryke (with a groove) ☐ Selle San Marco- Rever Profil ☐ Fizik- Arione Tri ☐ Terry ☐ Koobi ☐ Other: _____		
Please indicate which brand of **helmet** you use?	☐ Trek ☐ MET	☐ Bell ☐ Other: _____	☐ Giro
Please indicate which type of **cycling shorts** you use?	☐ Thin lycra (no padding) ☐ Triathlon shorts with some padding ☐ Other: _____		☐ Padded cycling shorts ☐ Swimming costume
Do you normally wear **underwear** together with cycling shorts?		☐ Yes	☐ No
Please indicate which type of **cycling shoes** you use?	☐ Olympic ☐ Shimano ☐ Other: _____	☐ Nike ☐ Carnac	☐ Diadora ☐ Sidi
Please indicate which type of **kit** you use?	☐ Anatomic ☐ Howzit ☐ De Soto ☐ Zoot	☐ Nike ☐ Adidas ☐ Louis Garneau ☐ Other: _____	☐ Velo ☐ Orca ☐ Quintana Roo
Please indicate which **brand of running shoe** you use?	☐ Adidas ☐ New Balance ☐ Puma ☐ Other: _____	☐ Asics ☐ Nike ☐ Reebok	☐ Brooks ☐ Mizuno ☐ Saucony
Please indicate which **type of running shoe** you use?	☐ Soft neutral shoe ☐ Mild anti-pronation shoe ☐ Motion control shoe ☐ Light racing shoe ☐ Unknown or not sure ☐ Other: _____		

Section C. History of medication and supplement use			
What medication, if any, are you currently using? (please list)	Name of medication		Years taken
Do you use protective skin sunscreen during training session or when competing?	Yes ☐ No ☐	☐ Every session ☐ Some sessions	☐ Most sessions ☐ Very occasionally
Are you currently taking dietary supplements/vitamins?			Yes ☐ No ☐
If **yes** to the above question, please list names of dietary, sports or vitamin supplements.	Name of supplement		Years taken
	☐ Multi-vitamins		_____
	☐ Anti-oxidants		_____
	☐ Immune boosters		_____
	☐ Protein powders/supplements, Protein bars. BCAAs		_____
	☐ Creatine		_____
	☐ Caffeine		_____
	☐ Fat cutters		_____
	☐ Carbohydrate drinks/powders/gels		_____
	☐ Other: _____		_____
Have you ever used oral corticosteroids (cortisone tablets)? (If **yes**, how long ago?)	Yes ☐ No ☐	☐ 3 months ☐ 12 months	☐ 6 months ☐ 24 or more months
Have you ever been given an injection with corticosteroids? (If **yes**, how long ago?)	Yes ☐ No ☐	☐ 3 months ☐ 12 months	☐ 6 months ☐ 24 or more months
Have you ever been given an injection of corticosteroids in or around the **Achilles** tendon? (If **yes**, how many times?)	Yes ☐ No ☐	☐ Once ☐ 3 times	☐ Twice ☐ >3 times
Have you ever used fluoroquinoline antibiotics? (refer to the following list)	Yes ☐ No ☐	☐ 3 months ☐ 12 months	☐ 6 months ☐ 24 or more months

List of some fluoroquinoline antibiotics:		
ADCO-CIPRIN	CIPROBAY	SANDOZ CIPROFLOXACIN
AVELON	CIPROGEN	TAFLOC
BACTIDRON	CPL ALLIANCE CIPROFLOXACIN	TARIVID
CIFLOC	DYNAFLOC	TAVANIC
CIFRAN	FACTIVE	TEQUIN
CIPLA-CIPROFLOXACIN	FLOXIN	UNIQUIN
CIPLOXX	MAXAQUIN	UTIN-400
CIPRO-HEXAL	NOROXIN	ZANOCIN
	ORPIC	

Lifestyle and habits history			
Please indicate your smoking status	Current smoker ☐	Ex smoker ☐	Never smoked ☐
If you answered yes, (past or current smoker) please complete the section on the right	Number of years of smoking:	If stopped, how many years ago:	
	What is (was) the average number of cigarettes per day:		
On average, how much alcohol do you drink per week (tots, glasses) of spirits, wine or beer?	_____ glasses beer/cider per week _____ glasses wine per week _____ tots of spirits per week		

Fluid Intake					
How do you best describe your fluid intake during an Ironman triathlon race?	(a) I drink to thirst ☐ (b) I drink as much as tolerable ☐ (c) I drink according to a predetermined fluid intake schedule ☐ (d) I drink to prevent any weight loss during exercise ☐ (e) I combine (a) with (c) ☐ (f) I combine (b) with (c) ☐ (g) Other: _____ ☐				
What percentage of your fluid intake will consist of these beverages?	Water:	☐ 0-25%	☐ 26-50%	☐ 51-75%	☐ 76-100%
	Sports drink:	☐ 0-25%	☐ 26-50%	☐ 51-75%	☐ 76-100%
	Coke:	☐ 0-25%	☐ 26-51%	☐ 51-75%	☐ 76-100%
	Other:	☐ 0-25%	☐ 26-50%	☐ 51-75%	☐ 76-100%
	Specify other: _____				
What will be your estimated **total** fluid intake be **(if at all)** during the **swim**?	ml				
What will be your estimated **total** fluid intake be during the **cycle**?	ml				
What will be your estimated **total** fluid intake be during the **run**?	ml				
Rank the following sources of information on their importance in formulating your drinking strategy. (1 being most influential and the lowest number being least influential)	_____ Fellow triathletes _____ Coach / trainer _____ Magazines / books _____ Website (please specify: _____) _____ Drinking guidelines from sports associations _____ Adverts _____ Self-experimentation _____ Other: _____				

Section D. Psychological and Behavioural					
Connor-Davidson Resilience Scale (CD-RISC)					
Please indicate how much you agree with the following statements as they apply to you over the last **month**. If a particular situation has not occurred recently, answer according to how you think you would have felt.					
	not true at all	**rarely true**	**sometimes true**	**often true**	**true nearly all the time**
1. I am able to adapt when changes occur.					
2. I have at least one close and secure relationship which helps me when I am stressed.					
3. When there are no clear solutions to my problems, sometimes fate or God can help.					
4. I can deal with whatever comes my way.					
5. Past successes give me confidence in dealing with new challenges and difficulties.					
6. I try to see the humorous side of things when I am faced with problems.					
7. Having to cope with stress can make me stronger.					
8. I tend to bounce back after illness, injury, or other hardships.					
9. Good or bad, I believe that most things happen for a reason.					
10. I give my best effort, no matter what the outcome may be.					
11. I believe I can achieve my goals, even if there are obstacles.					
12. Even when things look hopeless, I don't give up.					
13. During times of stress/crisis, I know where to turn for help.					
14. Under pressure, I stay focused and think clearly.					
15. I prefer to take the lead in solving problems, rather than letting others make all the decisions.					
16. I am not easily discouraged by failure.					
17. I think of myself as a strong person when dealing with life's challenges and difficulties.					
18. I can make unpopular or difficult decisions that affect other people, if it is necessary.					
19. I am able to handle unpleasant or painful feelings like sadness, fear and anger.					
20. In dealing with life's problems, sometimes you have to act on a hunch, without knowing why.					
21. I have a strong sense of purpose in life.					
22. I feel in control of my life.					
23. I like challenges.					
24. I work to attain my goals, no matter what roadblocks I encounter along the way.					
25. I take pride in my achievements.					

TPQ / TCI (96 shared items)		
1. I usually am confident that everything will go ell, even in situations that worry most people.	True☐	False ☐
2. I often try new things just for fun or thrills, even if most people think it is a waste of time.	True☐	False ☐
3. I like to discuss my experiences and feelings openly with friends instead of keeping them to myself.	True☐	False ☐
4. When nothing new is happening, I usually start looking for something that is thrilling or exciting.	True☐	False ☐
5. Usually I am more worried about that most people that something might go wrong in the future.	True☐	False ☐
6. I don't mind discussing my personal problems with people whom I have known briefly or slightly.	True☐	False ☐
7. I would like to have warm and close friends with me most of the time.	True☐	False ☐
8. I nearly always stay relaxed and carefree even when nearly everyone else is fearful.	True☐	False ☐
9. I usually demand very good practical reasons before I am willing to change my old ways of doing things.	True☐	False ☐
10. I often have to stop what I am doing because I start worrying that something might go wrong.	True☐	False ☐
11. I hate to change the way I do things, even if many people tell me there is a new and better way to do it,	True☐	False ☐
12. My friends find it hard to know my feelings because I seldom tell them about my private thoughts.	True☐	False ☐
13. I like it when people can do exactly what they want without strict rules and regulations.	True☐	False ☐
14. I often stop what I am doing because I get worried, even when my friends tell me everything will go well.	True☐	False ☐
15. It wouldn't bother me to be alone all the time.	True☐	False ☐
16. I like to be very organized and set up rules for people whenever I can.	True☐	False ☐
17. I usually do things my own way, rather than giving in to the wishes of other people.	True☐	False ☐
18. I usually feel tense and worried when I have to do something new and unfamiliar.	True☐	False ☐
19. I often feel tense and worried in familiar situations, even when others feel there is little to worry about.	True☐	False ☐
20. Other people often think that I am too independent because I won't so what they want.	True☐	False ☐
21. Even when most people feel it is not important, I often insist on things being done in a strict and orderly way,	True☐	False ☐
22. I often do things based on how I feel at the moment, without thinking about how they are done in the past.	True☐	False ☐
23. I often feel tense and worried in unfamiliar situations, even when others feel there is no danger at all.	True☐	False ☐
24. I often brake rules and regulations when I think I can get away with it.	True☐	False ☐
25. I don't care very much whether other people like me or the way I do things.	True☐	False ☐
26. I usually stay calm and secure in situations that most people would find physically dangerous.	True☐	False ☐
27. I feel it is more important to be sympathetic and understanding of other people than to be practical and tough- minded.	True☐	False ☐
28. I lose my temper more quickly than most people.	True☐	False ☐
29. I am usually confident that I can easily do things that most people would consider dangerous (such as driving as automobile fast on a wet or icy road).	True☐	False ☐

30. I often react so strongly to unexpected news that I say or do things that I regret.	True☐	False ☐
31. People find it easy to come to me for help, sympathy, and warm understanding.	True☐	False ☐
32. I am much more reserved and controlled than most people.	True☐	False ☐
33. When I have to meet a group of strangers, I am more shy than most people.	True☐	False ☐
34. I am strongly moved by sentimental appeals (like when asked to helped crippled people).	True☐	False ☐
35. I almost never get so excited that I lose control of myself.	True☐	False ☐
36. I have a reputation as someone who is practical and does not act on emotion.	True☐	False ☐
37. I often avoid meeting strangers because I lack confidence with people I do not know.	True☐	False ☐
38. I usually stay away from social situations where I would have to meet strangers, even if I am assured that they will be friendly.	True☐	False ☐
39. I usually push myself harder than most people do because I want to do as well as I possibly can.	True☐	False ☐
40. I often push myself to the point of exhaustion or try to do more than I really can.	True☐	False ☐
41. I would probably stay relaxed and outgoing when meeting a group of strangers, even if I were told they were unfriendly.	True☐	False ☐
42. It is difficult for me to keep the same interests for a long time because my attention often shifts to something else.	True☐	False ☐
43. I think I would stay confident and relaxed when meeting strangers, even if I were told they are angry with me.	True☐	False ☐
44. I could probably accomplish more than I do, but I don't see the point of pushing myself harder than is necessary to get by.	True☐	False ☐
45. I like to think about things for a long time before I make a decision.	True☐	False ☐
46. Most of the time I would prefer to do something a little risky (like riding in an automobile over steep hills and sharp turns), rather than having to stay quiet and inactive for a few hours.	True☐	False ☐
47. I often follow my instincts, hunches, or intuition without thinking through all the details.	True☐	False ☐
48. I try to do as little work as possible, even when other people expect more of me.	True☐	False ☐
49. I often have to change my decisions because I had a wrong hunch or mistaken first impression.	True☐	False ☐
50. Most of the time I would prefer to so something risky (like hang-gliding or parachute jumping(, rather than having to stay quiet and inactive for a few hours.	True☐	False ☐
51. I am satisfied with my accomplishments and have little desire to do better.	True☐	False ☐
52. I see no point in continuing to work on something unless there is a good chance of success.	True☐	False ☐
53. I have less energy and get tired more quickly than most people.	True☐	False ☐
54. I usually think about all the facts in detail before I make a decision.	True☐	False ☐
55. I nearly always think about all the facts in detail before I make a decision, even when other people demand a quick decision.	True☐	False ☐
56. I often need naps or extra rest periods because I get tired so easily.	True☐	False ☐
57. I don't go out of my way to please other people.	True☐	False ☐
58. I am more energetic and tire less quickly than most people.	True☐	False ☐
59. I am usually able to get other people to believe me, even when I know that what I am saying is exaggerated or untrue.	True☐	False ☐
60. I can usually do a good job of stretching the truth to tell a funnier story or to play a joke on someone.	True☐	False ☐
61. I usually can stay "on the go" all day without having to push myself.	True☐	False ☐

62. I am usually more upset than most people by the loss of a close friend.	True ☐	False ☐
63. I have trouble telling a lie, even when it is meant to spare someone else's feelings.	True ☐	False ☐
64. I am better at saving money than most people.	True ☐	False ☐
65. Even after there are problems in a friendship, I nearly always try to keep it going anyway.	True ☐	False ☐
66. I recover more slowly than most people from minor illnesses or stress.	True ☐	False ☐
67. I need much extra rest, support, or reassurance to recover from minor illnesses or stress.	True ☐	False ☐
68. I often spend money until I run out of cash or get into debt from using too much credit.	True ☐	False ☐
69. Because I so often spend too much money on impulse, it is hard for me to save money, even for special plans like a vacation.	True ☐	False ☐
70. It is extremely difficult for me to adjust to changes in my usual way of doing things because I get so tense, tired or worried.	True ☐	False ☐
71. If I am feeling upset, I usually feel better around friends than when left alone.	True ☐	False ☐
72. I usually feel much more confident and energetic than most people, even after minor illnesses or stress.	True ☐	False ☐
73. Some people think I am too stingy or tight with my money.	True ☐	False ☐
74. I often keep trying the same thing over and over again, even when I have not had success in a long time.	True ☐	False ☐
75. It is hard for me to enjoy spending money on myself, even when I have saved plenty of money.	True ☐	False ☐
76. I recover more quickly than most people from minor illnesses or stress.	True ☐	False ☐
77. I hate to make decisions based only on my first impressions.	True ☐	False ☐
78. I think I will have very good luck in the future.	True ☐	False ☐
79. I am most often moved deeply by fine speech or poetry.	True ☐	False ☐
80. If I am embarassed or humiliated, I get over it very quickly.	True ☐	False ☐
81. I like old "tried and true" ways of doing things according to their priority of importance to me because of lack of time.	True ☐	False ☐
82. I like to keep my problems to myself.	True ☐	False ☐
83. I enjoy saving money more than spending it on entertainment or thrills.	True ☐	False ☐
84. Even when I am with friends, I prefer not to "open up" very much	True ☐	False ☐
85. I feel very confident and sure of myself in almost all social situations.	True ☐	False ☐
86. I usually like to stay cool and detached from other people.	True ☐	False ☐
87. I never worry about terrible things that might happen in the future.	True ☐	False ☐
88. I am more hard-working than most people.	True ☐	False ☐
89. In conversations I am much better as a listener than as a talker.	True ☐	False ☐
90. I like to please other people as much as I can.	True ☐	False ☐
91. Regardless of any temporary problem that I have to overcome, I always think it will turn out well.	True ☐	False ☐
92. I like to stay at home better than to travel and explore new places.	True ☐	False ☐
93. I am usually so determined that I continue to work long after other people have given up.	True ☐	False ☐
94. I usually have good luck in whatever I try to do.	True ☐	False ☐
95. I like to pay close attention to details in everything I do.	True ☐	False ☐
96. It is easy for me to organize my thoughts while talking to someone.	True ☐	False ☐

K10					
Instructions: The following questions ask about how you have been feeling during the **past four weeks**. For each question, please circle the number that best describes how often you have had this feeling. Your answers will be kept confidential.					
In the past four weeks:	**None of the time**	**A little of the time**	**Sometime of the time**	**Most of the time**	**All of the time**
1. About how often did you feel tired of for no good reason?	1	2	3	4	5
2. About how often did you feel nervous?	1	2	3	4	5
3.About how often did you feel so nervous that nothing could calm you down?	1	2	3	4	5
4. About how often did you feel hopeless?	1	2	3	4	5
5. About how often did you feel restless or fidgety?	1	2	3	4	5
6. About how often did you feel restless you could not sit still?	1	2	3	4	5
7. About how often did you feel depressed?	1	2	3	4	5
8. About how often did you feel that everything is an effort?	1	2	3	4	5
9. About how often did you feel so sad that nothing could cheer you up?	1	2	3	4	5
10. About how often did you feel worthless?	1	2	3	4	5

Section E. Family medical history		
Have any of your blood (biological) relatives ever had the following? Please tick yes or no. If yes, please tick the relationship of that person to you (You may tick more than one of the relationship blocks).		
Description		**If Yes, please indicate the relationship**
Exercise associated muscle cramps	Yes ☐ No ☐	☐ Father ☐ Mother ☐ Brother ☐ Sister ☐ Child ☐ Grandfather ☐ Grandmother
Night muscle cramps	Yes ☐ No ☐	☐ Father ☐ Mother ☐ Brother ☐ Sister ☐ Child ☐ Grandfather ☐ Grandmother
Chronic Achilles tendon injury	Yes ☐ No ☐	☐ Father ☐ Mother ☐ Brother ☐ Sister ☐ Child ☐ Grandfather ☐ Grandmother
Achilles tendon rupture	Yes ☐ No ☐	☐ Father ☐ Mother ☐ Brother ☐ Sister ☐ Child ☐ Grandfather ☐ Grandmother
Any ligament injury	Yes ☐ No ☐	☐ Father ☐ Mother ☐ Brother ☐ Sister ☐ Child ☐ Grandfather ☐ Grandmother
Asthma	Yes ☐ No ☐	☐ Father ☐ Mother ☐ Brother ☐ Sister ☐ Child ☐ Grandfather ☐ Grandmother
Allergies (in general)	Yes ☐ No ☐	☐ Father ☐ Mother ☐ Brother ☐ Sister ☐ Child ☐ Grandfather ☐ Grandmother
Heart Disease	Yes ☐ No ☐	☐ Father ☐ Mother ☐ Brother ☐ Sister ☐ Child ☐ Grandfather ☐ Grandmother
Diabetes	Yes ☐ No ☐	☐ Father ☐ Mother ☐ Brother ☐ Sister ☐ Child ☐ Grandfather ☐ Grandmother
Depression, Anxiety attacks, Personality disorder	Yes ☐ No ☐	☐ Father ☐ Mother ☐ Brother ☐ Sister ☐ Child ☐ Grandfather ☐ Grandmother
Gastro-intestinal (GIT) disease	Yes ☐ No ☐	☐ Father ☐ Mother ☐ Brother ☐ Sister ☐ Child ☐ Grandfather ☐ Grandmother

Section F. Personal general medical history	
In this section, you are asked to read through 14 questions about your personal general medical history. If you answer "yes" to any of questions 1 to 12, please complete the additional questions at the end of the section (section G on page 18).	
1. In the **6 weeks before this race** (from 1st February) did you suffer from any **symptoms of flu** (fever, sore throat, blocked or runny nose, cough, wheeze, muscle aches and pains)?	Yes ☐ No ☐
2. Have you **ever** in triathlon career suffered from **muscle cramping** (painful, spontaneous, sustained spasm of a muscle) during or immediately (within 6 hours) after exercise (in training or competition)?	Yes ☐ No ☐
3. Have you **ever** in your triathlon career suffered from **a tendon or ligament injury** (pain, swelling, stiffness) in any tendon (including Achilles tendon, knee tendons, and shoulder tendons) or ligaments (partial or complete tear)?	Yes ☐ No ☐
4. Have you **ever** in your triathlon career **used medicines to treat injuries** in the week **before or during a race** – including anti-inflammatory drugs, cortisone (pills, or injection), or pain killers?	Yes ☐ No ☐
5. Have you **ever** in your triathlon career suffered **gastrointestinal** symptoms **during exercise** including heartburn, nausea, vomiting, abdominal pain, urge to defecate (pass a stool), diarrhoea, or blood in the stools?	Yes ☐ No ☐
6. Have you **ever** in your triathlon career suffered from symptoms of the **nervous system** including exercise induced headaches, nerve tingling or loss of sensation?	Yes ☐ No ☐
7. Have you **ever** in your triathlon or cycling career (in particular with **cycling**) suffered from **injury to the genital area** including genital numbness after cycling, genital pain after cycling, genital swelling or altered sexual function after cycling?	Yes ☐ No ☐
8. Have you **ever** in your triathlon career suffered from **symptoms of allergies** including nose allergies (hay fever), allergic sinusitis, allergic asthma, skin allergies, a past history of allergies to medication, plant material or animal material?	Yes ☐ No ☐
9. Do you **currently suffer from asthma** including exercise induced asthma, or symptoms of asthma such as shortness of breath, wheezing, or chronic coughing?	Yes ☐ No ☐
10. Have you ever **collapsed** (fell down **not because of an accident**, needing medical attention) during, at the finish or after a race or training session?	Yes ☐ No ☐
11. Do you **currently** suffer from any **symptoms of injury** in the muscles, tendons, bones, ligaments or joints?	Yes ☐ No ☐
12. Do you **currently**, or did you **in the last year**, suffer from any symptoms of **exercise related skin disease**?	Sunburn: Yes ☐ No ☐ Skin cancer: Yes ☐ No ☐ Other skin damage resulting sun exposure: Yes ☐ No ☐

13. Please tick in which anatomical area you ever had **surgery** performed.	☐ Gastric (stomach) ☐ Oesophageal (swallowing pipe) ☐ Small bowel ☐ Large bowel (colon) ☐ Rectum ☐ Gallbladder ☐ Pancreas ☐ Liver ☐ Abdomen (general) ☐ Wrist ☐ Head ☐ Finger ☐ Neck ☐ Lower back ☐ Face ☐ Hip ☐ Front chest ☐ Thigh ☐ Back chest ☐ Knee ☐ Shoulder ☐ Lower leg ☐ Upper arm ☐ Achilles ☐ Elbow ☐ Ankle ☐ Forearm ☐ Foot ☐ Other (Specify: _____)
14. Management of pain during the last 3 months	
14a. Did you alter or stop your training schedule due to pain in any part of your body?	Yes ☐ No ☐
If yes: For how long	_____ days
Did you adapt your training schedule for a while when your injury/illness was healed?	Yes ☐ No ☐
14b. How do you feel when you experience pain? (you can tick more than one option)	☐ It does not bother me much ☐ Angry ☐ Frustrated ☐ Depressed ☐ Resentful ☐ Overwhelmed
14c. When you experience pain, do you? (you can tick more than one option)	☐ Adjust your training schedule ☐ Stop training ☐ Slowly get "back on track" of your training schedule ☐ Train harder to make up for the missed training sessions ☐ Ignore the pain and continue to train ☐ Feel scared to do anything that could aggravate the pain ☐ Think that the pain means that you have a severe injury ☐ Tell everybody about it
15. **Female athletes only:** Please complete the following questions (14a. to 14g.) related to your menstrual cycle and other gynaecological history	
15a. At what age did you start your periods (menstruating)?	(years)
15b. In the last 12 months, how many menstrual cycles did you have?	
15c. Have you ever had irregular menstrual periods in the past? (excluding pregnancy)?	Yes ☐ No ☐

15d. Have you had a hysterectomy/ovarectomy?	Yes ☐ No ☐
15e. How many times have you been pregnant?	(times)
15f. What form of contraception are you currently using?	☐ None ☐ Oral contraceptive pill ☐ Injection ☐ Intra-uterine device ☐ Sterilization (tubes tied) ☐ Other: _____
15g. If yes to question 15f. above, for oral contraceptive pill, for what reason was the pill prescribed?	☐ Not applicable ☐ Dermatological ☐ Contraception ☐ Regulate period ☐ Other: _____

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE

If you have answered **YES** to any of the first 11 questions of the Personal General Medical History questionnaire (section F) please complete the relevant additional questions that follow in section G.

Please bring the completed forms together with the signed consent form to the pre-race facility or the research table at race registration.

Section G. Additional detailed medical history

(Please complete all the sections to which you answered "Yes" in the Personal general medical history)

1. Flu symptoms in the last 6 weeks

If you answered **YES** to **question 1** in section F, please complete the following two questions related to flu symptoms in the last 6 weeks.

(1a) Please tick which of these flu symptoms you suffered from **in the last 6 weeks**.	☐ Fever ☐ Cough ☐ Joint pains ☐ Blocked nose ☐ Wheezing ☐ Sore Throat ☐ Runny nose ☐ Muscle aches ☐ Any other flu symptoms (Specify: _____)
(1b) Please tick which of these flu symptoms you suffered from **in the last 7 days**.	☐ Fever ☐ Cough ☐ Joint pains ☐ Blocked nose ☐ Wheezing ☐ Sore Throat ☐ Runny nose ☐ Muscle aches ☐ Any other flu symptoms (Specify: _____)

2. Muscle cramping If you answered **YES** to **question 2** in section F, please complete the following questions (2a. to 2m.) related to your cramping.	
(2a) For how many years have you suffered from cramping?	(years)
(2b) Did you suffer from cramping during or after exercise in the **last 12 months**?	Yes ☐ No ☐
(2c) With what **type of exercise** is your cramping associated (You can tick more than one form of exercise)?	☐ Swimming ☐ Cycling ☐ Running
(2d) In the **last 10 races or training sessions**, how many times have you experienced cramping?	Races: _____/10 Training sessions: _____/10
(2e) What treatment/s have you had that **successfully relieved** an acute cramp? (can tick more than one)	☐ Stretching ☐ Resting ☐ Drinking fluid ☐ Ice application ☐ Massage ☐ Magnesium ☐ Salt (tablets or solution) ☐ Other (Specify: _____)
(2f) At **what point in the race or training run** do you usually first experience cramping?	☐ First quarter ☐ Second quarter ☐ Third quarter ☐ Fourth quarter ☐ After the race ☐ No pattern
(2g) In which **muscles** do you usually cramp (please list the muscle by the one which cramps most frequently (as 1) and the others after that (2-4)?	☐ Calves ☐ Hamstrings ☐ Quadriceps (thigh) ☐ Foot muscles ☐ Other (Specify: _____)
(2h) Have you **ever** suffered from cramping in your **whole body** (arms and legs)?	Yes ☐ No ☐
(2i) Have you **ever** been **admitted to hospital** following cramping?	Yes ☐ No ☐
(2j) Have you **ever** been **confused or in a coma** during or after a cramping episode?	Yes ☐ No ☐
(2k) Have you ever had **"dark urine"** in the 3 days following a cramping episode?	Yes ☐ No ☐
(2l) If you cramp, **how long** does the cramp usually last for (min)?	(minutes)
(2m) If you cramp, how **severe** is the cramp usually? (please tick).	☐ Mild: < 5 minutes and you are able to continue exercising ☐ Moderate: 5-15 minutes and you are able to continue exercising ☐ Severe: >15 minutes or if you have to STOP exercising

3. Past Tendon and Ligament Injury History

If you answered **YES** to **question 3** in section F, please complete the following questions (3a. to 3d.) related to your past history of tendon/ligament injury/ies.

(3a) Please tick which **tendon/s** you have injured? (next column on the tright) Also indicate (tick) if your injured tendon was longsatnding pain (tendinopathy) or an acute tear/rupture	**Tendon**		**Longstanding Pain (Tendinopathy)**	**Acute Tear/ Rupture**
	Foot and ankle:	☐ Achilles tendon	☐	☐
		☐ Tibialis posterior	☐	☐
		☐ Plantar fascia	☐	☐
	Knee:	☐ Patellar tendon	☐	☐
	Elbow and wrist:	☐ Wrist extensor tendon	☐	☐
	Shoulder:	☐ Rotator cuff	☐	☐
	Other: _____		☐	☐

(3b) Please tick which **ligament/s** you have injured? (next column on the tright) Also indicate if your sprained or completely tore the ligamant.	**Ligament**	**Sprain**	**Complete Tear**
	☐ Shoulder ligaments	☐	☐
	☐ Elbow ligaments	☐	☐
	☐ Wrist ligaments	☐	☐
	☐ Finger ligaments	☐	☐
	☐ Knee (ACL)	☐	☐
	☐ Knee (MCL)	☐	☐
	☐ Knee (PCL)	☐	☐
	☐ Knee (LCL)	☐	☐
	☐ Ankle lateral ligaments	☐	☐
	☐ Ankle medial ligaments	☐	☐
	☐ Spinal ligaments	☐	☐
	☐ Other: _____	☐	☐

(3c) Please tick if you have you ever suffered from any of the following **joint capsule** injuries?	☐ Acute shoulder dislocation ☐ Chronic shoulder instability ☐ Other: _____
(3d) Do you suffer from any other **connective tissue or rheumatological diseases** or disorders? (If yes, please specify which one)	Yes ☐ No ☐ (refer to the list on the next page) (If yes, specify: _____)

List of some Connective Tissue and/or Rheumatic Diseases and Disorders

Ankylosing Spondylitis	Lipid Storage Diseases	Pseudogout
Aspartylglycosaminuria (AGU)	Marfan Syndrome	Reactive Arthritis
Behcet's Syndrome	Menkes Kinky Hair Syndrome	Reiter's Syndrome
Crohn's Disease	Mucopolysaccharidoses	Relapsing Polychrondritis
Discoid Lupus Erythematosus	Myopathies and Dystrophies	Scleroderma
Ehlers-Danlos syndrome (EDS)	Ochronosis (Homocystinuria)	Sjogren's Syndrome
Eosinophilic Fascitis	Osteogenesis imperfecta (OI)	Systemic Lupus Erythematosus (SLE)
Giant Cell (Temporal) Arthritis	Polyarteritis Nodosa	Systemic Sclerosis
Gout	Polymyalgia Rheumatica	Wegener's Granulomatosis
Hypersentive Vasulatis	Polymyositis & Dermatomyositis	

4. Use of medicines to treat an injury before or during participation If you answered **YES** to **question 4** in section F, please complete the following two questions related to medicine use for injuries before or during races.	
(4a) Which of the following medicines have you used in the past to treat an injury **in the week just before** a race?	☐ Paracetamol (e.g. Panado, Tylenol) ☐ Non-steroidal anti-inflammatories (e.g. Voltaren, Cataflam) ☐ Cortisone (pills) ☐ Cortisone injection ☐ Codeine ☐ Anti-inflammatory gels/creams/patches ☐ Any other pain killers (Specify: _____)
(4b) Which of the following medicines have you used in the past to treat an injury **during a race**?	☐ Paracetamol (e.g. Panado, Tylenol) ☐ Non-steroidal anti-inflammatories (e.g. Voltaren, Cataflam) ☐ Cortisone (pills) ☐ Cortisone injection ☐ Codeine ☐ Anti-inflammatory gels/creams/patches ☐ Any other pain killers (Specify: _____)

5. Gastrointestinal symptoms during exercise

If you answered **YES to question 5** in section F, please indicate which gastrointestinal symptoms you have ever suffered from **during exercise** and, how frequently (in the last 12 months and in the last 10 races), and in which type of exercise.

Symptom	Number of times you experienced the GIT symptom in the last 12 months **(during exercise)**	Number of times you experienced the GIT symptom in the last 10 races **(during races)**	Please indicate which **type of exercise** is mostly associated with the GIT symptom	Please indicate the **"severity" of the GIT symptom** during exercise
Nausea			☐ Swimming ☐ Cycling ☐ Running	☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Vomiting			☐ Swimming ☐ Cycling ☐ Running	☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Heartburn			☐ Swimming ☐ Cycling ☐ Running	☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Abdominal pain			☐ Swimming ☐ Cycling ☐ Running	☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Urge to pass a stool (defecate)			☐ Swimming ☐ Cycling ☐ Running	☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Diarrhoea			☐ Swimming ☐ Cycling ☐ Running	☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Passing blood in the stool			☐ Swimming ☐ Cycling ☐ Running	☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing

Please indicate if you previously suffered from or had any of the following (you may tick more than one)?	☐ History of heartburn ☐ Gastroscopy ☐ Ulcer (gastric, duodenal) ☐ Irritable bowel syndrome ☐ Allergy to milk products ☐ Other past history of GIT disease

6. Diseases of the nervous system

If you answered **YES** to **question 6** in section F, please indicate which nervous disease symptoms you have ever suffered from **during exercise** and, how frequently (in the last 12 months and in the last 10 races), and in which type of exercise.

Symptom	Number of times in the last 12 months **(during exercise)**	Number of times in last 10 races **(during races)**	**Tick type of exercise**
Headaches			☐ Swimming, ☐ Cycling, ☐ Running
Nerve tingling in the hands			☐ Swimming, ☐ Cycling, ☐ Running
Loss of sensation in the hands			☐ Swimming, ☐ Cycling, ☐ Running

7. Genital tract injury during cycling

If you answered **YES** to **question 7** in section F, please indicate which symptoms of genital tract injury have you suffered from **during or after cycling**, how frequently (in the last 10 sessions), how long symptoms last, and what factors prevent or relieve symptoms?

Symptom	Number of times in the last 10 cycling sessions	Please indicate when the symptoms occur	Please indicate if any of the following reduce or prevent the symptoms (can tick more than one)
Genital numbness		☐ Only during cycling ☐ During and up to 1 hour after cycling ☐ During and 1-24 hours after cycling ☐ During and > 24 hours after cycling	☐ Changing the saddle type ☐ Changing the saddle position ☐ Using padded cycling shorts ☐ Wearing no underwear ☐ Wearing additional underwear ☐ Other (Specify: _____)
Genital pain		☐ Only during cycling ☐ During and up to 1 hour after cycling ☐ During and 1-24 hours after cycling ☐ During and > 24 hours after cycling	☐ Changing the saddle type ☐ Changing the saddle position ☐ Using padded cycling shorts ☐ Wearing no underwear ☐ Wearing additional underwear ☐ Other (Specify: _____)
Genital bruising		☐ Only during cycling ☐ During and up to 1 hour after cycling ☐ During and 1-24 hours after cycling ☐ During and > 24 hours after cycling	☐ Changing the saddle type ☐ Changing the saddle position ☐ Using padded cycling shorts ☐ Wearing no underwear ☐ Wearing additional underwear ☐ Other (Specify: _____)
Altered sexual function following a cycling session		☐ Up to 1 hour after cycling ☐ 1-24 hours after cycling ☐ > 24 hours after cycling	☐ Changing the saddle type ☐ Changing the saddle position ☐ Using padded cycling shorts ☐ Wearing no underwear ☐ Wearing additional underwear ☐ Other (Specify: _____)

8. Allergy history

If you answered **YES** to **question 8** in section F, please complete the following questions (8a. to 8e.) related to your current and past history of allergies.

(8a) Please indicate how long (years) have you been suffering from allergies?	years

(8b) Please tick which type of allergy do you currently suffer from					
Nose (hay fever)	Yes ☐ No ☐	Sinusitis	Yes ☐ No ☐	Asthma (allergic)	Yes ☐ No ☐
Skin allergies	Yes ☐ No ☐	Eye allergies	Yes ☐ No ☐	Allergy to plant material	Yes ☐ No ☐
Allergy to foods	Yes ☐ No ☐	Allergy to animals	Yes ☐ No ☐	Allergy to medication	Yes ☐ No ☐
(8c) Please tick which type of allergy do you currently take medication for					
Nose (hay fever)	Yes ☐ No ☐	Sinusitis	Yes ☐ No ☐	Asthma (allergic)	Yes ☐ No ☐
Skin allergies	Yes ☐ No ☐	Eye allergies	Yes ☐ No ☐	Allergy to plant material	Yes ☐ No ☐
Allergy to foods	Yes ☐ No ☐	Allergy to animals	Yes ☐ No ☐	Allergy to medication	Yes ☐ No ☐
(8d) Please tick which type of medication do you currently take					
Cortisone nose spray	Yes ☐ No ☐	Cortisone nose inhaler	Yes ☐ No ☐	Anti-histamine tablets	Yes ☐ No ☐
Cortisone cream	Yes ☐ No ☐	Anti-histamine cream	Yes ☐ No ☐	Other inhaler / tablets or cream	Yes ☐ No ☐
(8e) Please tick which symptoms of allergy do you currently suffer from					
Sneezing	Yes ☐ No ☐	Itchy runny nose	Yes ☐ No ☐	Headache	Yes ☐ No ☐
Itchy palate	Yes ☐ No ☐	Streaming eyes	Yes ☐ No ☐	Fatigue	Yes ☐ No ☐
Itchy eyes	Yes ☐ No ☐	Blocked nose	Yes ☐ No ☐	Poor sleep	Yes ☐ No ☐
Post nasal drip	Yes ☐ No ☐	Coughing	Yes ☐ No ☐	Wheezing	Yes ☐ No ☐
In which months of the year do you currently have symptoms of allergies? (You tick more than one)	☐ Jan ☐ Feb ☐ March ☐ April ☐ May ☐ June ☐ July ☐ Aug ☐ Sept ☐ Oct ☐ Nov ☐ Dec				
(8f) Please tick which type of allergy did you suffer from in the past (NOT currently)					
Nose (hay fever)	Yes ☐ No ☐	Sinusitis	Yes ☐ No ☐	Asthma (allergic)	Yes ☐ No ☐
Skin allergies	Yes ☐ No ☐	Eye allergies	Yes ☐ No ☐	Allergy to plant material	Yes ☐ No ☐
Allergy to foods	Yes ☐ No ☐	Allergy to animals	Yes ☐ No ☐	Allergy to medication	Yes ☐ No ☐

9. Asthma history If you answered **YES** to **question 9** in section F, please complete the following questions (9a. to 9k.) related to your current history of asthma	
(9a) Do you currently suffer from asthma?	Yes ☐ No ☐
(9b) How many years have you suffered from asthma?	(years)
(9c) How was your asthma diagnosed?	☐ A doctor taking a history and performing an examination ☐ Lung function test (blow test) but no exercise ☐ Lung function test (blow test) before and after exercise ☐ Metacholine challenge test ☐ Eucapnic hyperventilation test (rebreathing test) ☐ Other test (Specify: _____)
(9d) Which **type of asthma** do you currently suffer from?	☐ Asthma that occurs at any time but not during exercise ☐ Asthma that occurs at any time including during exercise ☐ Asthma that only occurs during exercise
(9e) Please indicate **how frequently do you currently experience the symptoms** of asthma (shortness of breath, wheezing, coughing or coughing after exercise)?	**Daytime symptoms (per week)** ☐ < 2 / week ☐ 2-4 / week ☐ >4 / week ☐ All the time **Night time symptoms (per month)** ☐ < 1 / month ☐ 2-3 / month ☐ ≥4 / month ☐ All the time **Exercise related symptoms (per 10 exercise sessions)** ☐ <1 per 10 sessions ☐ 2-3 per 10 sessions ☐ ≥4 per 10 sessions
(9f) Please indicate if you had symptoms of asthma that were severe enough to necessitate **hospital admission in the last 12 months**	☐ No hospital admission for asthma in the last 12 months ☐ 1-2 hospital admissions for asthma in the last 12 months ☐ 3-4 hospital admissions for asthma in the last 12 months ☐ >4 hospital admissions for asthma in the last 12 months
(9g) Which **symptoms of asthma** do you currently suffer from?	☐ Wheezing ☐ Dry cough ☐ Shortness of breath ☐ Tight chest ☐ Chest pain ☐ Other (Specify: _____)

(9h) What **medication do you currently use** for your asthma? (you may tick more than one option)	☐ Cortisone inhaler (e.g. Beclate, Becloforte, Becodisks, Becotide, Budeflam, Flixotide, Inflammide, Pulmicort, Qvar, etc) ☐ Salbutamol (bronchodilator) inhaler (e.g. Ventolin, Venteze, Vomax, Airomir, Asthavent etc.) ☐ Salmeterol (bronchodilator) inhaler (Serevent) ☐ Fenoterol (bronchodilator) inhaler (Berotec) ☐ Terbutaline (bronchodilator) inhaler (Bricanyl) ☐ Formoterol (bronchodilator) inhaler (e.g. Foradil, Foratec, Oxis) ☐ Ipratropium (bronchodilator) inhaler (Atrovent) ☐ Tiotropium (bronchodilator) inhaler (Spiriva) ☐ Combined cortisone and bronchodilator inhaler (e.g. Atrovent, Berodual, Combivent, Duolin, Duovent, Seretide, Symbicord) ☐ Cortisone tablets ☐ Bronchodilator tablets ☐ Leukotriene receptor antagonist tablets (e.g. Acccolate, Singulair) ☐ Other inhaler ☐ Other medication (Specify: _____)
(9i) **When do you use your medication** for your asthma?	☐ Daily (irrespective of exercise) ☐ Only before exercise ☐ Other (Specify: _____)
(9j) **How long before an exercise session** do you use your medication for asthma?	min
(9k) Have you obtained **TUE (therapeutic use exemption forms)** for your asthma medication?	Yes ☐ No ☐

10. History of previous collapse If you answered **YES** to **question 10** in section F, please complete the following questions (10a. to 10d.) related to your current history of asthma	
(10a) Have you ever collapsed during training or racing?	☐ Training ☐ Racing ☐ Training and racing
(10b) How many times have you collapsed in training session or races during the last **five years**?	_____ training session _____ races
(10c) How many times have you collapsed in training session or races during the last **12 months** (1 year)?	
(10d) When you collapse, does it mostly occur before of after the finish line / completion of the training session?	☐ Before the finish ☐ After the finish
(10e) What is the cause of you collapse?	☐ Dehydration ☐ Heat illness ☐ Hyponatremia ☐ Low blood pressure ☐ Low blood sugar ☐ Other condition (Specify: _____)

11. History of any current injury that you suffer from

If you answered **YES** to **question 11** in section F, please complete the following questions (11a. to 11g.) related to each of your current injury/ies (Space is provided for two injuries)

Injury 1	
(11a) What was the approximate date when you first became aware of the injury?	Month Year
(11b) Please indicate which side of your body is injured (if applicable)	☐ Right ☐ Left
(11c) Please indicate which anatomical area is currently injured	☐ Head ☐ Neck ☐ Face ☐ Front chest ☐ Back chest ☐ Shoulder ☐ Upper arm ☐ Elbow ☐ Forearm ☐ Wrist ☐ Finger ☐ Lower back ☐ Hip ☐ Thigh ☐ Hamstring ☐ Quadriceps ☐ Knee ☐ Shin ☐ Achilles ☐ Ankle ☐ Foot Other (Specify: _____)
(11d) Please indicate the type of structure that was injured	☐ Muscle ☐ Tendon ☐ Bone ☐ Ligament ☐ Joint Other (Specify: _____)
(11e) Please indicate in which sport (discipline) the injury occurred	☐ Running ☐ Cycling ☐ Swimming Other (Specify: _____)
(11f) Please indicate the severity of the injury (tick one box please)	☐ I only experience symptoms after exercise - Grade 1 ☐ I experience symptoms during exercise, but it does not interfere with exercise - Grade 2 ☐ I experience symptoms during exercise that may interfere with my training/ competition - Grade 3 ☐ I am so painful that I may not be able to train or compete - Grade 4
(11g) Please indicate how your injury was treated to date (you can tick more than one)?	☐ Rest ☐ Stretches ☐ Physiotherapy ☐ Surgery ☐ Strengthening exercises ☐ Equipment change ☐ Tablets ☐ Cortisone injection ☐ Other injection ☐ Orthotics Other (Specify: _____)

Injury 2			
(11a) What was the approximate date when you first became aware of the injury?			Month Year
(11b) Please indicate which side of your body is injured (if applicable)			☐ Right ☐ Left
(11c) Please indicate which anatomical area is currently injured	☐ Head ☐ Neck ☐ Face ☐ Front chest ☐ Back chest ☐ Shoulder ☐ Upper arm	☐ Elbow ☐ Forearm ☐ Wrist ☐ Finger ☐ Lower back ☐ Hip ☐ Thigh	☐ Hamstring ☐ Quadriceps ☐ Knee ☐ Shin ☐ Achilles ☐ Ankle ☐ Foot
	Other (Specify: _____)		
(11d) Please indicate the type of structure that was injured	☐ Muscle ☐ Tendon ☐ Bone	☐ Ligament ☐ Joint	
	Other (Specify: _____)		
(11e) Please indicate in which sport (discipline) the injury occurred	☐ Running ☐ Swimming	☐ Cycling	
	Other (Specify: _____)		
(11f) Please indicate the severity of the injury (tick one box please)	☐ I only experience symptoms after exercise - Grade 1 ☐ I experience symptoms during exercise, but it does not interfere with exercise - Grade 2 ☐ I experience symptoms during exercise that may interfere with my training/ competition - Grade 3 ☐ I am so painful that I may not be able to train or compete - Grade 4		
(11g) Please indicate how your injury was treated to date (you can tick more than one)?	☐ Rest ☐ Stretches ☐ Physiotherapy ☐ Surgery ☐ Strengthening exercises ☐ Equipment change	☐ Tablets ☐ Cortisone injection ☐ Other injection ☐ Orthotics	
	Other (Specify: _____)		

ISMJ
International SportMed Journal

Reviewer's Assessment Form

Date Sent: 6 November 2008

Assessment Due: 27 November 2008

Please complete this form, where applicable, as an assessment of the suitability of the enclosed contribution for publication in the *International SportMed Journal*. The options under each category may be ticked. Where applicable, tick more than one category. Where necessary, more detailed comments may be included and attached separately.

Reviewer's Name: Dr Romuald Lepers

Title: Optimal cadence selection during cycling

1. **The contribution is**
   - (a) of general interest
   - (b) very important to the sports medicine field
   - x(c) relevant to the field of sport sciences/cycling exercise
   - (d) too specialised for the scope of the Journal
   - (e) of no value to the sports medicine field
   - (f) falls outside my field of expertise, and should be submitted to

2. **The information is**
   - x(a) new
   - (b) valuable
   - (c) repetition of generally well-known information
   - (d) of doubtful value

3. **Selection of information/data for the review has been**
   - x(a) systematic, critical, and based on sound scientific evidence
   - (b) adequate, but lacks coherent analysis
   - (c) poorly selected and is inadequate. It is recommended that ——

4. **The assessments of literature and data sources with regard to clinical topics emphasise the following factors:**
   x(a) aetiology
   (b) diagnosis
   (c) management
   (d) prognosis
   (e) prevention
   (a) emphasize none of the above. It is recommended that _____

5. ***Statistical treatment of data (if applicable)**
   (a) adequate/appropriate
   (b) inadequate
   (c) erroneous

6. **Interpretation of the available literature**
   x(a) adequate
   (b) not warranted by the literature
   (c) important omissions (please specify) _____
   (d) too much generalization

7. **Title**
   x(a) adequate
   (b) a more suitable title is _____

8. **Abstract**
   x(a) clear and adequate
   (b) should be rewritten

9. **Language**
   x(a) clear
   (b) grammatically good
   (c) poor, and needs revision

10. **Presentation and style**
    x(a) adequate
    (b) too brief for clarity
    (c) too comprehensive - must be shortened
    (d) contains irrelevant material
    (e) unsatisfactory arrangement - should be better subdivided or ordered

11. **Illustrations/Figures**
    x(a) the number and quality are adequate
    (b) Figure(s)_____ may be left out
    (c) a Figure is required to illustrate _____
    (d) Figure — is inadequate and should be redrawn
    (e) quality of graphs/prints/drawings is poor

* A more detailed statistical checklist may be necessary and can be requested by the reviewer

12. Tables

(a) adequate
(b) insufficient
(c) should be rearranged to represent data more clearly

13. Abbreviations, formulas, units

x(a) conform with accepted standards
(b) do not conform with accepted standards
(b) should be explained _____

14. Literature references

x(a) adequate
(b) inadequate
(c) do not conform to the specified format
(d) Reference(s)—— cannot be located

15. In general, the contribution is graded as

(a) excellent
(b) good
x(c) acceptable with minor revisions
(d) acceptable with major revisions
(e) unacceptable
(f) too general
(g) confirmatory
(h) significance not obvious
(i) weak
(j) too speculative
(k) falls outside the scope of the Journal

16. Further information is necessary before a decision can be made (please specify):

This review article "optimal cadence selection during cycling" is the first on the topics and it is therefore relevant in the field of sport sciences especially for cycling exercises.

17. Additional comments are attached separately (as a MS Word file).

18. A statistical checklist is attached.

Reviewer's signature: _____

Signed

Comments to the authors.

This review article "optimal cadence selection during cycling" is the first on the topics and it is therefore relevant in the field of sport sciences especially for cycling exercises.

Specific comments:

In Figure 1 (a) : precise the cycling cadence,
In figure 1(b) : precise the power output

Page 17 Line 3 :
The authors do not say anything about the effect of fatigue on the freely chosen cadence (FCC). It could be interesting to know if the optimal cadence changes with fatigue statement. For example, previous studies showed that FCC tended to decrease with exercise duration (e.g. Lepers et al. Med Sci Sport Exerc 2000, Brisswalter et al. Int J sport Med 2000).