Psychological correlates of performance, injury and illness in Two Oceans Ultramarathon athletes

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Declaration

I, Sachin Ramanlali Baba, 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

Sachin R Baba

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Table of Contents

List of Tables

List of Figures

Abbreviations

BMI	body mass index
CD-RISC	Connor-Davidson Resilience Scale
CHD	coronary heart disease
cm	Centimetre
EI	emotional intelligence
HA	harm avoidance
Kg	Kilogram
kg/m²	kilogram per metre squared
Km	Kilometre
K10	Kessler 10 psychological distress test
Min	Minute
NS	novelty seeking
RD	reward dependence
TCI	temperament and character inventory
TPQ	Tri-dimensional personality questionnaire
CD-RISC	Connor Davidson Resilience Scale

Abstract

Background: It is well accepted that psychological factors play an important role in athletic performance, illness and injury. Yet, few studies have investigated the effects of psychological factors on performance, illness and injury in endurance athletes. While general psychological traits of athletes and the non-athletic population has been described in the past, the specific relationship between psychological factors and their effects on performance in ultra-marathon athletes has not been fully described. Further, unlike their influence in the general population, the influence these psychological factors may have on the onset of injury and illnesses in an athletics population is not as well known. The availability of psychometric instruments that have shown potential when applied specifically to athletic population is promising for application in this area of research.

Objective: The aim of this study was to describe the relationship between the psychological factors (personality traits, resilience and general psychological distress scores) and athletic performance and susceptibility to injuries and illnesses prior to the race in a cohort of ultra-marathon runners participating in the 2009 Two Oceans 56 km road ultra-marathon.

Methods: The study data for this descriptive cross sectional study was collected from a sample of 105 athletes who ran the 2009 Two Oceans Marathon. Each athlete completed a questionnaire during the registration weekend preceding the race day. The questionnaire included information on the demographics, medical and injury history as well as training history. Each athlete also completed a set of

psychometric questionnaires including the Tridimensional Personality Questionnaire (TPQ), a measure of aspects of personality; the Connor Davidson Resilience scale, a measure of resilience; and the Kessler psychological distress scale (K10), a measure of depression and anxiety. The finishing time and split times of all athletes completing the race was obtained from the race organisers after the race weekend.

Results: The lighter and younger athletes were faster runners on the day. Athletes with higher K10 (Kessler 10) and HA (harm avoidance) scores ran faster races, with the athletes with high K10 scores also predicting they will complete the race faster than their lower scoring counterparts. The training history during the 15 weeks prior to the race was important as it was also a predictor of performance (p=0.005). Based on these finding a model for performance was created including: age, sex, height, weight, weekly average distance run, K10 scores and the Tridimensional personality score for harm avoidance (TPQ-HA), which revealed the ideal performing athletes (variance 33,4%) would be a young, light weight, tall athlete, who trains at a fast pace for at least 3 months prior to the race and has moderate levels of psychological distress and a harm avoidant personality.

Athletes with a history of medication usage had significantly (p=0.042) higher K10 scores (16.7 ± 4.9 vs 14.8 ± 3.6) and CD-RISC scores (Connor Davidson Resilience Scale) (109.8 ± 11.8 vs102.0 ± 9.8). The reasons for this were not identified in this study. Novelty seeking (NS) traits were significantly (p=0.041) associated with higher levels of tendons or ligament injuries (14.2 ± 6.2 vs 17.0 ± 5.7) when compared to athletes with no self-reported history of tendons or ligament injuries. Of the athletes with pre-existing medical conditions, asthmatics scored significantly lower on the CD-

RISC (97.8 ± 12.1 vs 106.5 ± 10.8 p=0,018) and RD (reward dependence) (10.8 ± 1.5 vs 14.5 ± 4.5 p=0,099) scores. The only significant difference between the psychometric scores and illness was for nervous system symptoms, which had significantly (p=0.018) higher HA scores (21.7 ± 5.8 vs 14.6 ± 9.4). There was however a trend (p=0.070) for athletes with allergy symptoms to having lower NS scores, while the asthmatic athletes had lower scores (p=0.099) on RD (reward dependence) scores.

Conclusion: The results of this study described a model, which included psychological variables, for the factors possibly affecting performance during a 56 km road race. Whereas the investigation into the effects of the psychological variables on illness revealed limited information, i.e. the relationship between nervous system complaints and harm avoidance. The study also revealed important findings where psychological variables affecting injury were concerned. The finding that novelty seeking traits are associated with higher levels of injuries adds a different dimension to the existing knowledge on tendon and ligaments injuries in athletes.

This study has fulfilled its objectives in determining the psychological factors that show correlation with athletic performance, injuries and illnesses in Two Oceans ultra-marathon athletes. A performance model has been identified to assist in possibly preparing the ideal ultramarathon athlete, but few correlations were made with injury and illness and psychological factors. This study has added weight the commonly held belief that psychological factors have a key role to play in athletic

performance, injury and illness, however, future studies on a larger population are needed to confirm these findings.

Keywords: psychological factors, ultramarathon, athletes, personality, resilience, performance, injury, illness, CD-RISC, TPQ, K10

Chapter 1

Introduction and scope of the dissertation

Both elite and recreational athletes continue to make strides in optimizing their performance and reducing the likelihood of injury and/or illness during either training or during competition. Training, physiological and other variables are therefore constantly being investigated and identified which could allow the athlete to maximize any measure of advantage over competitors, either by improving performance and/or reducing injury and illness. With perfections in optimizing physical wellbeing approaching a pinnacle, focus has shifted to the psychology of athletes and competition.

The concept of sport psychology has long been recognized as a possible factor influencing athletic performance and susceptibility to injury and/or illness. However this has largely remained a theoretical concept until the last two decades during which steadily greater number of researchers have investigated the relationship between these two factors. With improvements in psychological testing instruments, we are now able to investigate how, if at all, do psychological traits correlate with injury and illnesses in athletes.

In Chapter 2, a review of the literature exploring the relationship between psychological attributes and athletic performance, illness and injury is presented.

The Two Oceans 56 km ultra-marathon road race set in Cape Town South Africa attracts athletes from all over world, from the novice ultra-marathon runner to the

world’s most elite. Both the elite and recreational ultra-marathon runner requires months of training and mental preparation to succeed in completing the race. Factors, especially the psychological attributes, which sets this group apart from other athletes has not yet been clearly defined. This event provides an ideal opportunity to study the psychological profiles of these athletes and their association with performance, illness and injury. In Chapter 3, the findings of this descriptive cross sectional study are presented.

Finally, Chapter 4 summarises the findings of this dissertation and proposes possible clinical applications and future directions in the field of Sport and Exercise Medicine.

Chapter 2

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

Although many of the causal factors in sport injuries are physical and biomechanical in nature, psychosocial factors may also contribute to injury and illness vulnerability and performance(1-8).

Indeed, sports physicians frequently encounter psychological factors that constitute important considerations in the diagnosis and management of illness, injury and performance issues with patient-athletes. Thus, a need for an improved understanding of the personality and psychological factors which play a role in performance, illness and injury in athletes; and the tools that can assist in the measurement of these variables would enable the sports physician to improve services to their athletes(9-12).

This review will place the above subject in a historical context (Section 2.1), and appraises the existing literature regarding the understanding of psychological characteristics, personality, stress and coping mechanisms and their influence on performance (Section 2.2), injury (Section 2.3) and illness (Section 2.4) in athlete populations.

2.1. Historical overview

The unique physiological attributes of marathoners have long been recognized, but until the pioneering research of Morgan and Pollock (1977) little was known about their psychological characteristics. Their work revealed marathoners have significantly better mental health compared with non-athletes, with desirable mental health variables being most pronounced in elite competitors. More recent research indicates there are considerable individual differences in the psychological responses of marathoners to the stressors associated with training and competition, and in some cases negative emotions traditionally presumed to be harmful, can be of actual benefit to performance(13).

2.1.1. Psychological factors and sports performance

From the inception of the field of Sport and Exercise Medicine (SEM), efforts to identify the factors most crucial for athletic success have largely centered on biological variables(14). However, the contribution of psychological factors was recognised as early as the 19th century, as stated by Dudley in an article on the psychology of the athlete published in 1888, ‘in all success in athletics the mental qualities of the athlete figure largely’(15).

It is well established that physical performance is influenced by stress, but the underlying mechanisms of the pressure performance(16-18) relationship are poorly understood(19). The pressure to perform well and achieve in sport is influenced by situational incentives including social comparison, evaluation, and rewards for

success(20). Thus its logical that investigation into the how these factors may be manipulated to achieve optimum outcomes is beneficlal.

In Section 2.2 the link between sports performance and mental well being and the association of personality factors and performance will be further discussed.

2.1.2. Psychological factors and illness

Psychological factors have been recognised since the early 20thcentury to be of utmost importance in the understanding of both the origin and course of disease, infection and rehabilitation after illness(21, 22). In fact, it has been hypothesised that chronic stressors are a more important determinant of disease risk than are acute stressful events. Studies have highlighted the effects of life -stress and the development of colds (viral infection), as well as recognised the association between chronic stressors and development of other non-infective illnesses(23). Dickens, in his study of patients post myocardial infarction reported that other psychological components including depression and anxiety significantly influenced not only morbidity and mortality but also impaired the quality of life of patients with chronic cardiovascular disease(24).

The concept of post traumatic growth, defined as the positive psychological change experienced as a result of the highly life challenging events as described by Tedeschi and Calhoun(25), attempts to explain the impact of traumatic events. In motor vehicle accident survivors, it was shown that some factors related to post traumatic growth were correlated with resilience and others with post traumatic

stress disorder (PTSD)(26), showing that traumatic events not only lead to psychological distress but may lead to psychological strengthening. Attempting to enhance resilience in athletes may result in the more favorable posttraumatic growth and hence possibly negate negative effects the traumatic event may have had on the athlete.

2.1.3. Psychological factors and sports injury

Investigators have long studied the relationship between psychological factors and sports injury. The earliest studies were conducted in an effort to identify the personality variables and other factors, including life stress, that predisposed athletic competitors to injury or were related to the occurrence of injury(27, 28). Over the last 10 years, the evidence that psychological risk factors contribute to injury vulnerability and resilience (defined as stress coping in the face of adversity)(29) has increased substantially(30-33). The historical research consistently supports the relations between injury and psychometric indices of stressful life events in specific athletic populations, although the directly explained variances are often modest(8, 34-37).

2.2. Psychology of performance

2.2.1. Mental well-being and performance

It is well established that performance is influenced by pressure(studied in golf players in response to varying levels of competiong), but the underlying mechanisms of the pressure performance relationship are poorly understood(19). Pressure to

perform well is elicited by situational incentives such as social comparison, evaluation, and rewards for success(19, 20).

The relationship between anxiety and athletic performance is of interest to both researchers and athletes. Pre-competition anxiety levels within a moderate range (based upon population norms) should benefit performance, whereas values either above or below this range should result in worsened performance(38-40). A model to determine optimal anxiety has been introduced by Hanin(41, 42), where he proposed that each individual experiences psychological states that either promote or hinder performance. Hanin's Zones of Optimal Functioning (ZOF) theory, proposed that best performance should occur when precompetition anxiety lies within a narrow range specific to the individual. Performance worsened in cases in which anxiety was either above or below the optimal anxiety range of an athlete as established by ZOF methods. Cases of nonoptimal anxiety were common and subjects were as likely to have anxiety levels that fell below the optimal zone as above(43).

Depression has been investigated in athletes performance and injury incidences with Lane et al. examining how unpleasant emotions(eg depression) affected cycling performance(44), their results concluded that negative emotions can result in increased physiological exertion. Furtherore, in high school college athletes, severe depression was associated with more concussion symptoms(45). In both the studies, the performance was affected negatively when higher levels of depression were associated. The early diagnosis of athletes presenting with depression should not

only be beneficial from a mental health standpoint but will also positively affect athletic performance, injury and illness rates.

2.2.2. Personality and performance

Different personality traits have been shown to have correlations with performance in table tennis(6), football players(3), endurance athletes(46), individual and collective sports athletes(47). Common to the table tennis and football players was that conscientiousness (organized, punctual and hard working) was a positive predictor for performance whereas the endurance atheletes displayed extroversion (sociable, outgoing, active).

Gyomber et al., in their study of athletes in team and individual sports, significant differences between male and female athletes were described(4). Females showed higher levels of sociability and this attribute had a positive correlation with performance. In contrast, ego/control neuroticism was a trait strongly associated with male athletes performance. Reasons for this finding were that females were more likely to spend more time with sports peers and this trait would most likely assist with cohesion, males alternatively, used ego control/neuroticism to support internal control by decreasing anxiety and other negative emotions.

In a 15 year predictive study on professional hockey players(48), it was shown that a selection model based on personality inventories and traditional scouting parameters(junior-level performance, height, weight, strength, aerobic capacity) was a predictor of a players performance in that sport, adding that not only does

personality traits play a role in performance but it can also be a useful predictor for future potential.

The body of evidence crediting personality traits with superior performance is shown to be slowly expanding, with not only various sports attracting differing personalities, but also different genders exhibiting differing personalities. And most importantly, in some sporting disciplines the ideal personality traits for optimal performance are beginning to be appreciated.

2.2.3. Summary

Mental well-being and personality have both been shown to have good predictability and correlation of performance in a variety of sporting disciplines. Investigation of these psychological traits in ultra marathon runners should add to the existing evidence and possibly provide new information in this specific group of athletes.

2.3. Psychological factors influencing injury

Participation in competitive sports sets high demands on athletes' physical skills(49). Interest in the pathogenesis of sport injuries has led to the general conclusion that two major factors influence injury vulnerability: extrinsic factors (e.g., type of sport and weather conditions) and intrinsic factors (e.g., physiological and psychological factors)(50).

Previous research has established that certain models, which include specific psychological variables, could predict the development of sport injuries. An example

of one such model is the Williams and Andersen's stress–injury model(27). The Williams and Andersen model proposes possible mechanisms underlying the relationship to injury, and suggests specific interventions for reducing the risk of injury sustained during sport. According to the model, when athletes are put in a stressful situation such as a demanding practice or crucial competition, the athlete's history of stressors, personality characteristics, and coping resources contribute interactively or in isolation, to the stress response. The model hypothesizes that the combination of stressful circumstances and certain personality characteristics can possibly lead to injury predisposition(51).

2.3.1. Stress and injury

"Stress" or "stressor" refers to any environmental, social, or internal demand which requires the individual to readjust his/her usual behavior patterns(52).
Another definition of stress is offered by Lazurus(53), "stress occurs when an individual perceives that the demands of an external situation are beyond his or her perceived ability to cope with them."

Three major forms of stressors have been investigated in the literature: "life events (acute changes which require major behavioral readjustments within a relatively short period of time (e.g., birth of first child, divorce)) chronic strain(persistent or recurrent demands which require readjustments over prolonged periods of time (e.g., disabling injury, poverty, marital problems)), and daily hassles(mini-events which require small behavioral readjustments during the course of a day (e.g., traffic jams,

unexpected visitors, having a good meal))". The review of the literature shows that the different stressors have been investigated and show associations with injury.

Johnson studied junior soccer players(54) and concluded that life event stress, somatic trait anxiety, mistrust and ineffective coping combined could account for 23% of injury occurrence, findings that lend credence to Williams and Andersen's model. In elite junior soccer players, daily hassles either high initial levels or smaller decreases over the 10 week period were found to be significantly associated with injury occurrence(55). In terms of minor life events investigated in cohort of athletes involved in team and individual sports (hockey, volleyball, triathlon), revealed a tendency to more injuries being noted in athletes with events in the week prior to injury(56), similar finding were noted by Ivarsson in senior soccer player where a tendency for higher daily hassles levels to be experienced in the injured athletes(57).

Of the major forms of stressors, life event stress has been the most extensively researched psychological risk factor. In a review of 20 sports medicine studies, Williams and Roepke reported that injuries tended to occur two to five times more frequently in athletes with high rather than low life event stress(51, 58). Although findings showed that measures of mood and life stress predicted injury, it is unpractical to rely on prevention of these psychological factors alone to decrease injury incidence(34).

Although it has been shown that stress is a risk factor for injury vulnerability, it also has a positive bearing on development of subsequent resilience(44-49),(59, 60), a positive trait that may assist in injury prevention.

2.3.2. Personality and injury

It has been shown by Petrie that certain personality traits can lead to athletes perception of stressful situations(61). Personality factors that may influence an athletes risk of injury was propsed by Williams and Andersen(62). Trait anxiety has been shown to be assoiciated with higher injury risk in football players(54, 57, 60) and using the Willams and Andersen model it may be explained that athletes with higher anxiety level are prone to feeling more stressed and hence sustained more injuries due to reduced peripheral abilities(61, 62).

Type A behavior, is characterized by above average achievement drive, aggressiveness, hostility, impatience, time urgency, and competitiveness(63-65), and has been associated with significantly more injuries than other personality types, as shown by Fields in a group of runners(66). Its is interesting that athletes in different sports, soccer and running, exhibited differing personality traits that predisposed to injury. One would have assumed that certain traits should bear some similarities in terms of injury prediction but this is not evident in the literature, in fact it seems that personality traits when coupled with the appropriate sport maybe protective against injuries.

2.3.3. A history of stressors

One of the most consistent findings within this vast research literature is the variability in well-being that people exhibit when they experience stressful life events. The precise mechanism by which stressful events might increase vulnerability to injuries is unknown(33). The effect past stressor have on has been shown to be associated with increased injury incidences(54, 55, 57).

2.3.4. Coping resources

Coping defined by Lazarus and Richards is a “constantly changing cognitive and behavioural efforts to manage internal and external demands”(67).

Raglin found that athletes least likely to become injured possessed either high coping skills or had adequate social support, but the presence of both factors did not further enhance resilience(15). Coping resources are associated with the prediction of injury severity and number of injuries(68, 69) athletes with poor coping resources were prone to not only sustaining injuries, but also were prone to having injuries more frequently and of greater severity than their counterparts.

In Ivarsson’s study of elite soccer players(60), behavioural disengagement and self blame strategies were associated with injury risk. This was explained by the fact the behavioural disengagement developed into a maladaptive strategy associated with injury risk(70), self blame resulted in decreased self esteem which has been shown

by Anshel and Sutarso(71). Diminished self esteem has been associated with increase injury risk(72).

Negative coping resources also have association with increased injury risk(54, 60, 68-70, 73, 74), Furthermore, modification of coping strategies may enable one to change their psychological risk profile for injuries(50).

2.3.5. Summary

Data confirm that stress and stress responses are influential in predisposing athletes 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, injury recurrence rate and injury severity.

2.4. The psychology of illness

2.4.1. Stress and illness

Stress is thought to have an influence on the pathogenesis of physical disease by causing negative affective states, which in turn directly affects biological processes and/or behavioral patterns that increase disease risk(75, 76).

Research has shown that stress does indeed influence the immune system, but the degree of which it alters disease susceptibility is unclear(77, 78).

Psychological stress is associated with increased risk for developing respiratory illness, cardiovascular disease, cancer and pregnancy complications and that the longer the duration of the stressor the greater the risk. The link between stress and susceptibility may be mediated by stress-induced disruption of the regulation of proinflammatory cytokines(78-80).

In athletes (team and individual sports) multifactorial etiology of illness has been described including training and competition, and psychological stress(33, 62, 81, 82). It is with this in mind that Perna et al. decided to investigate cognitive behavioral stress management in rowers and found that stress management "may be an effective prophylactic treatment to reduce the incidence of injury and illness among competitive collegiate athletes(83)."

2.4.2. Anxiety, depression and illness

Dickens, in his study examining health-related quality of life (HRQoL) in post myocardial infarction patients, reported that of importance is detecting and treating depression and anxiety as this would be expected to not only improve quality of life and reducing absence from work, but also decrease mortality(24, 84).

Evidence is provided to suggest that high-level athletes are vulnerable to emotional reactions following illness including increased depression and anxiety and reduced self-esteem, and that in some instances, these emotional responses reach similar levels of intensities to clients receiving outpatient

psychotherapy(85). This should make coaches more vigilant and attempt to help athletes seek therapy.

2.4.3. Social support

Multiple ties to friends, family, work, and community seem to be rather advantageous in terms of physical health(10,11). However, having a diverse social network may not always be a positive factor. Cobb et al.(3) also failed to find support for a protective effect of social support in the stress – health relationship. This makes sense for infectious disease, since exposure to the pathogenic agents is more likely for individuals with a larger social network than for socially inhibited people(86). The opposing evidence from the literature shows that whilst having a strong social support system may be the socially accepted goal, it may also inadvertently be a source of illness through interactions with individuals and the spread of pathogens.

2.4.4. Coping strategies

An athlete's response to a stressful situation is the definition of coping strategies described by Lazarus and Folkman(74). Persons under stress tend to engage in poor health practices, they may smoke more, drink more alcohol, eat poorly, and sleep less(87, 88), all of which may influence immune response(89).

Of the different coping strategies, described by Viltaliano(90), that an athlete may utilize, problem focused coping, seeking social support, minimizing threat, wishful

thinking, blaming others, avoidance coping, the latter three have been shown to be maladaptive and associated with higher rates of illness(91, 92).

Stressed persons often engage in social coping—drawing on the resources of their social networks(93).This leads to increased probability of infection through increased exposure. However, under some conditions stress may lead to social withdrawal and decreased risk of exposure. Other stress-elicited behaviors, for example, unsafe sexual practices or poor hygienic practices, could also increase exposure to infectious agents.

It is now well accepted that the behavioral changes which occur as adaptations or coping responses to stress may also influence immunity(92, 94-96).

2.4.5. Summary

There is an abundance of literature showing the negative effects of stress, anxiety, depression, social support and poor coping strategies, and their relationships to illness in the general population and athletes. Perna et al(83) have shown that cognitive behavioural stress management may be implented in athletes training to attempt to reduce the incidence of illnesses and potentially affect performance.

2.5. **Description of personality and other psychological factors**

2.5.1. Personality

Cloninger et al(97) proposed a psychological model of personality which included four temperament dimensions, namely Novelty Seeking (NS), Harm Avoidance (HA), Reward Dependence (RD) and Persistence (P) and three character dimensions ie. Self Directedness (SD) , Co-operativeness (C) and Self-Transcendence (ST). This model, with its neurobiochemical basis, has since its first description been used extensively by psychologists. In the general public these traits have been shown to play an important role in behavioral characteristics.

Results have shown that injured runners scored higher than non-injured runners on inventories measuring Type A behaviour pattern(66) and exercise dependency. In another study highly motivated runners with Type A behaviour were at greater risk for injuries(63).

In a recent study that examined personality traits in sports, it was shown that not only did male and female athletes exhibit personality differences, but also higher and lower level athletes and between team and individual sports(94) Females were more agreeable, conscientious and had higher levels of neuroticism, higher level athletes compared to lower level counterparts were more conscientious, compassionate and emotionally stable, in contrast to the work of Egloff showing a link between extroversion and skill(46). Lastly, teams sports attracted extroverted, emotionally unstable and less conscientious athletes.

2.5.2. Resilience

The original definition of resilience was framed in terms of a personality trait. More recently, resilience has been redefined as a dynamic, modifiable process, the individuals ability to maintain psychological and physical well being when faced with adversity(92, 98), but that definition is still debated(99)

It has been noted that some individuals are able to cope and survive better than others in the face of adverse conditions, and resilience research has focused on factors or characteristics that help individuals manage adversity(100, 101). Resilient individuals have a comprehensive ability to adapt to various work and social situations as well as psychological and physical health states, resilience is also noted to be a protective factor against depression, anxiety, post traumatic stress disorder, and other psychiatric disorders(102)(and is strongly associated with positive affect, which in turn is positively related to self-esteem(103)).

In the fields of exercise Machida showed, in spinal cord injured patient, that sports played a significant role in resilience process(37). In fact work by Chung et al on junior athletes(windsurfing, table tennis, fencing, billiard, and squash) showed that resiliency training could also improve this process(11).

2.5.3. General psychological distress

Athletes with psychological distress have shown that the longer the duration of the stressor the greater the injury. Investigations have revealed that even unrealistically

optimistic beliefs about the future may be health protective. The ability to find meaning in the experience is also associated with a less rapid course of illness. Taken together, the research suggests" that psychological beliefs such as meaning, control, and optimism act as resources, which may not only preserve mental health in the context of traumatic or life-threatening events but be protective of physical health as well.

The psychologically and physiologically protective functions of positive beliefs versus psychological distress, are only beginning to be understood.

2.5.4. Psychometric instruments

The three psychometric instruments which are commonly used in research of this nature, and are therefore used in this thesis are: The Tri-Dimensional Personality Questionnaire(TPQ) for personality(104), Connor Davidson Resilience Scale(CD-RISC))(105) for resilience, the Kessler 10(K10)(106), for general psychological distress. These three tools will now briefly be reviewed.

2.5.4.1. The Tri-dimensionalPersonality Questionnaire (TPQ)

Cloninger's biosocial model of personality includes the psychobiological dimensions of temperament and character. He concentrated on three biogenetic dimensions of temperament and designed the self reported Tridimensional Personality Questionnaire(TPQ).

The biosocial model appears to be able to provide a comprehensive multidimensional analysis of human personality as it has been used in general population of Korea(107), Britain(108), Finland(109) United States of America(104) and in Ironman athletes(110). The breakdown of the scores are described in Table 2.1

Table 2.1: 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)

The Tridimensional personality questionnaire was chosen as it has previously been used in differing sporting disciplines (triathletes(110), tennis players(111),

endurance/combat and team sports(112)) with good response. It allows for comparison with not only other endurance events but also other differing sporting codes.

2.5.4.2. The Connor-Davidson Resilience Scale (CD-RISC)(105)

The CD-RISC developed by Connor and Davidson in 2003 has sound psychometric properties and distinguishes between those with greater and lesser resilience. The scale, having been used in differing study populations(clinical(113, 114) and general(95, 115)) and athletes(cricketers(12), triathletes(110) and mixed sports(116, 117)) demonstrates that resilience is modifiable and can improve with treatment, with greater improvement corresponding to higher levels of global improvement(105).

The CD-RISC is used in our heterogenous group of ultra marathon runners as it has been well utilised in general and athletic populations, allowing for comparison with past evidence.

2.5.4.3. The Kessler Psychological Distress Scale (K10)

The brevity, strong psychometric properties, and ability to discriminate DSM-IV cases from non-cases make the K10 attractive for use in general-purpose health surveys(118). It has shown consistent levels of precision across socio-demographic samples(118-120). In the study by Hugo(110) in triathletes, the use of the K10 scale revealed associations between illness and medication usage.

The ability of this scale and its ease of use made it a logical choice for the investigations we sought to perform on the ultra marathon runners.

2.7 Conclusion

Researchers have long proved that psychological factors feature strongly in the development of injury, illness and disease, and performance. With the progressive development of well validated psychometric instruments, our understanding of the impact of psychological variables has grown substantially.

This review has made clear that the knowledge of psychological profiles of athletes is proving to becoming invaluable to sports physicians in assisting to prevent and help treating injury and illness as well as optimising athletes to achieve peak performance.

This study, as described in Chapter 3, aims to add to the sparse literature on predictive value of personality, resilience and general psychological distress with regards to injury, illness and performance a subset of the athletic population, the Ultra-marathon runners.

Chapter 3

Psychological correlates of performance, injury and illness in ultra-marathon athletes

3.1 Introduction

In view of the increasing frequency of injury, not only during leisure time activities but also in professional sports, it is clear that analyses of additional risk factors for sports injury are required as a prerequisite to the development of prevention programs. Not only should the level of physical fitness, other physiological factors, appropriate training and competition conditions be considered, but psychological factors should also be considered, as these can be expected to be of importance(121-123)

Johnson previously described extrinsic factors (e.g. type of sport and weather) in combination with intrinsic factors (e.g. physiological and psychological) factors could impact the incidence of sports injuries and illnesses(124). Further studies have also added weight to his description, notably in recent studies examining soccer players as participants(2, 4, 8, 54, 60, 125, 126), concluding that psychological factors play an important role injury, illness and performance in athletes. A recent dissertation from our department(110) investigated Ironman triathletes and found that select personality and psychological factors may be predictive of injury, illness and performance in this sport. Even though the body of evidence is growing on the effect of athletes psychological traits and sporting impact, little is known about ultra marathon runners.

Psychosomatic medicine has been concerned with examining the influence of psychosocial factors on the origin and course of psychological disturbances and physical illnesses(121, 122). However, the relationship between psychological factors and both illness and injury in endurance athletes has been somewhat neglected and, there is only limited scientific data with soccer players as the chief group investigated(60, 127, 128). Yet, injury and illness are a leading cause of loss of participation (and associated health risks) as well as potentially a loss of income in professional athletes.

The paucity of existing evidence assisting medical and paramedical professionals to understand the psychological traits that influence the incidence, treatment and rehabilitation of athletes with injuries, illnesses and their performance has been the stimulus for this study. Although numerous studies have been conducted to ascertain the impact of psychological factors on exercise performance, illness, health, and injury incidence(in soccer players), very little is known about the endurance athletes(127, 129).

With the ability to run long distances being considered to have played a role in human evolution(130), and the increasing popularity of this sport in countries such as US, Europe, Japan, Korea, and South Africa, especially in the era marked by adoption of sedentary lifestyles in the industrialised nations(131), it seems logical to study endurance, ultramarathon runners, as more people choose to adopt healthier, athletic lifestyles, and very little is know about this population of athletes.

3.2 Objective

The objective of this study was to assess and explore possible associations of psychological distress, as well as, temperament and resilience traits in a group of Two Oceans (56 km) ultra-marathon road runners with respect to performance variables, as well as, injury and illness profiles at the time of the ultra-marathon.

3.3 Research methodology

3.3.1 Type of study

This was a descriptive cross-sectional study.

3.3.2 Subjects

The study subjects were recruited from all the entrants for the 2009 56km Two Oceans ultra-marathon (5824 athletes completed the race in the official 7 hour cut-off time). The study protocol was approved by both the Human Research Ethics Committee of the Faculty of Health Science within the University of Cape Town (reference number 066/2009) (Appendix A) and the official organisers of the “Old Mutual“ Two Oceans Marathon which included both the general organising committee and the medical sub-committee.

All subjects were recruited during the 3-day registration period immediately prior to the race. A research area was established at the race registration venue, where athletes were approached and informed regarding the nature of the study (Appendix B) and then if interested, were voluntarily recruited. All subjects were then required to give their written informed consent for the study (Appendix C). One-hundred and five entrants consented to participate in this study and partially or completely filled in the Two Oceans Marathon medical and training questionnaires.

3.3.3 Data collection

Previously validated questionnaires (Appendix D) were used to gather all the data required, which included (1) personal details, (2) medical history, (3) injury history, (4) current or recent illnesses or injuries, and (5) psychometric questionnaires. Psychometric questionnaires consisted of the (1) Kessler Psychological Distress Scale (K10)(106), (2) the Connor-Davidson Resilience Scale (CD-Risc)(105), and the (3) Tri-Dimensional Personality Questionaire (TPQ)(104).

The Psychometric tools are “paper and pencil” based tests that the subjects completed. The K10 is a 10 question tool used to detect trends of general distress in large communities. Questions are rated on a nominal scale of 1 to 5 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 based on 25 questions also rated on a nominal scale, with higher scores correlating with greater resilience. The scale consisted of the following options: (1) not true at all, (2) rarely true, (3) sometimes true, (4) often true, and (5) true nearly all of the time. Scores assigned to each option for the K10 and CD-RISC were equal to the option chosen ie. a score of 1 if option 1 was selected, 2 for option 2, 3 for option 3, 4 for option 4 and 5 for option 5. Total scores ranged from 5 to 50 and 25-125 are obtained for the K10 and CD-RISC respectively.

The TPQ is normally a 100 question test, however for this study only 96 were used, questions 40/61/71/79 are those excluded, since there were not used in the three temperament dimensions tested in this study. The questions are answered as either

true (1) or false (0). The TPQ is used to measure the main temperament dimensions, novelty seeking (NS), harm avoidance (HA), and reward dependence (RD).

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

(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 question on the questionnaire. For example Q1 is question 1.

3.3.4 Race Results

The overall race results for each subject, as well as their 28km and 42.2km split times were obtained from the race organisers on completion of the event.

3.3.5 Data analysis

All the data was captured into Microsoft Excel (Microsoft 2007) and analysed using the Statistica 9.0 (Stat-soft Inc, Tulsa, Oklahoma, USA) statistical program. All normally distributed numerical data are represented by the mean ± standard deviation, with the number of subjects with non-missing data for the specific variable 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. Due to the limited number of athletes with complete set of data, a pair-wise multivariate analysis was used to determine the model that best predicted overall race time with significantly associated factors. Statistical significance was accepted when $P<0.05$.

3.4 Results

3.4.1 Psychometric scores, performance times and subject anthropometric characteristics

A total of 105 subjects completed all or part of the medical questionnaire. Ninety subjects completed the K10 and 58 completed the CD-RISC psychometric questionnaires. Eighty-two, 72 and 88 subjects completed the Novelty Seeking (NS), Harm Avoidance (HA) and Reward Dependence (RD) questionnaires of the TPQ questionnaire respectively. Only 35 subjects completed all parts of the questionnaire.

The male subjects (42.1 ± 9.2 years) were on average significantly older (P=0.031) than the female subjects (37.1 ± 9.3 years) (Table 3.1). As expected, the males were taller (175 ± 8 cm vs 168 ± 6 cm, P<0.001) and when co-varied for sex and age also heavier (70.7 ± 10.9 kg vs 61.1 ± 6.3 kg, P<0.001) than the females. There was a trend for the males to have a higher average BMI than the females 23.4 ± 3.0 kg/m^2 vs 21.7 ± 2.6 kg/m^2, P=0.071) (Table 3.1).

The performance times of the athletes varied from 208 minutes for the fastest runner, finishing in position 27, and 414 minutes for the slowest runner, finishing in position 5686 (Table 3.1). The average overall time was 335 ± 49 min, with the average 28km and 42.2km split times being 151 ± 22 and 240 ± 36 minutes, respectively. As shown in table 3.1, when co-varied for age, sex and weight the male subjects complete each split and the overall race significantly faster than the female subjects.

Subjects scored an average of 106 ± 11, ranging from 75 to 125, for the CD-RISC questionnaire. For the K10 questionnaire subjects scored an average of 15.9 ± 4.6, ranging from 10 to 30. For the TPQ questionnaire, athletes scored an average of 15.9 ± 6.0, ranging from 5 to 29 for novelty seeking, 15.8 ± 9.2, ranging from 0 to 32,

for harm avoidance, and 14.4 ± 4.5, ranging from 4 to 23, for reward dependence. There were no significant differences in any of the psychometric scores between the male and female athletes (Table 3.1).

The correlations of the athletes anthropometric characteristics and psychometric score for the K10, CD-RISC and TPQ questionnaires are summarised in Table 3.2. There was a significant negative correlation between K10 scores and age ($r= -0.328$, $p= 0.002$, $N= 89$), suggesting that the older athletes were less psychologically distressed (Figure 3.1). There was a trend for the harm avoidance scores to be negatively correlated with height and weight with the taller or heavier athletes being more likely to exhibit less harm avoidance traits (Figures 3.2 A and B). Similarly the heavier athletes were also more likely to exhibit less novelty seeking traits (Figure 3.2 C).

Table 3.1: General characteristics, performance times and psychometric scores of the athletes who participated in this study during the 2009 56 km Two Oceans ultra-marathon, as well as a comparison between the male and female athletes.

	All (N=105)	**Male** (N= 80)	**Female** (N= 20)	**P Value** [a]
Age (years)	42.1 ± 9.2 (99) 22 - 73	42.1 ± 9.2 (79)	37.1 ± 9.3 (20)	0.031
Height (cm)	173 ± 9 (83) 153 - 189	175 ± 8 (64)	168 ± 6 (19)	<0.001
Weight (kg)	68.7 ± 10.8 (97) 50 - 101	70.7 ± 10.9 (77)	61.1 ± 6.3 (20)	<0.001 <0.001 [b]
BMI (kg/m²)	23.0 ± 3.0 (83) 17.3 - 30.8	23.4 ± 3.0 (64)	21.7 ± 2.6 (19)	0.034 0.071 [b]
56 km Overall Time (min)	335 ± 49 (92) 208 - 414	334 ± 52 (78)	344 ± 27 (14)	0.015 0.024 [c]
Split time on 28km (min)	151 ± 22 (92) 95 - 192	149 ± 23 (78)	165 ± 15 (14)	0.129 <0.001 [c]
Split time on 42km (min)	240 ± 36 (92) 148 - 309	238 ± 37 (78)	254 ± 21 (14)	0.487 0.003[c]
RISC	106 ± 11 (55) 75 - 125	107 ± 11(43)	104 ± 14 (12)	0.434
K10	15.9 ± 4.6 (86) 10 - 30	15.7 ± 4.7 (67)	16.6 ± 4.6 (19)	0.455
TPQ NS	16.0 ± 6.2 (78) 5 - 29	15.9 ± 6.0 (60)	16.3 ± 6.8 (18)	0.795
TPQ HA	15.9 ± 9.2 (68) 0 - 32	15.1 ± 9.0 (51)	18.3 ± 9.6 (17)	0.219
TPQ RD	14.4 ± 4.4 (84) 4 - 23	14.6 ± 4.3 (65)	13.7 ± 4.9 (19)	0.417

Values are expressed as a mean ± standard deviation with the number of subjects (N) with non-missing data for the variable in parenthesis. Ranges are also given for only all the subjects.

[a] male vs female

[b] co-varied for age

[c] co-varied for age, height and weight

Abbreviations: cm - centimetre; kg - kilogram; kg/m² - 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

Table 3.2: Correlations of demographic and anthropometric measurements with psychometric scores in a sample of athletes who completed the 2009 56km Two Oceans ultra-marathon.

	RISC	K10	TPQ NS	TPQ HA	TPQ RD
Age (years)	0.140 (0.305)	-0.328** (0.002)	-0.141 (0.211)	0.010 (0.932)	0.039 (0.721)
Height (cm)	0.117 (0.420)	-0.010 (0.930)	-0.104 (0.398)	-0.229* (0.078)	0.122 (0.311)
Weight (kg)	0.168 (0.212)	-0.059 (0.584)	-0.195* (0.083)	-0.214* (0.076)	0.055 (0.618)
BMI (kg/m²)	0.058 (0.688)	-0.109 (0.358)	-0.116 (0.351)	-0.048 (0.715)	0.015 (0.901)

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/m² - 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

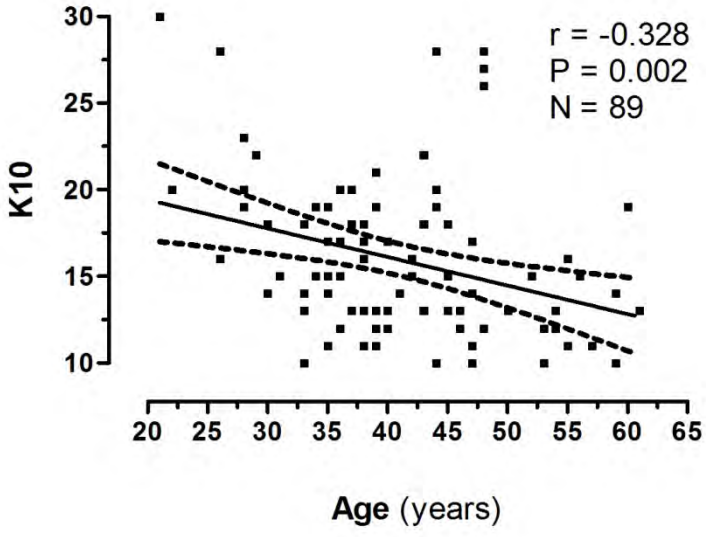

Figure 3.1: The correlation (r) of the Kessler 10 (K10) score with age. The line of best fit is indicated as the solid line with the 95% confidence intervals as the dashed lines. P-values and the number of subjects (N) are indicated on the graphs.

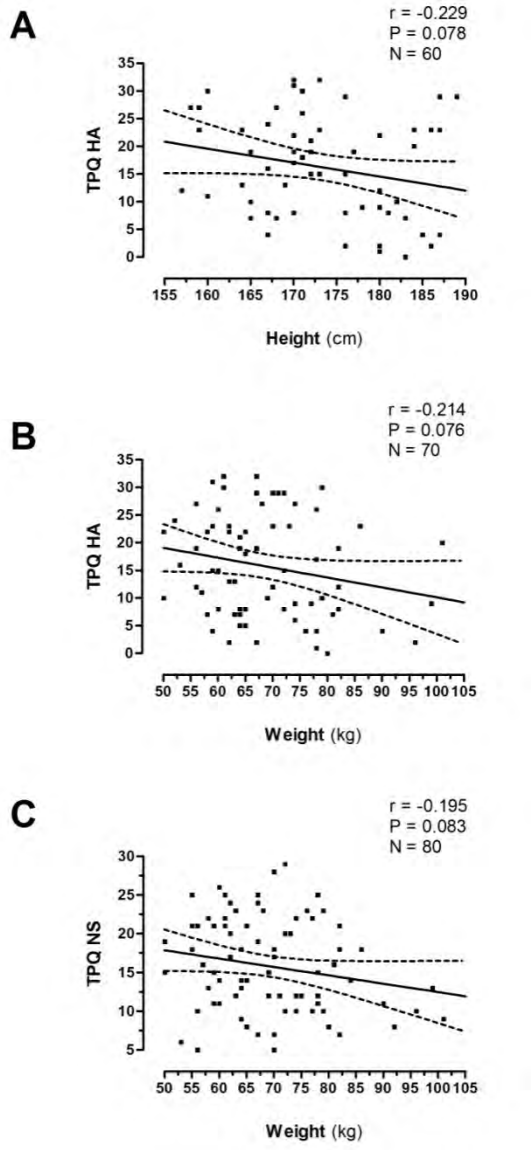

Figure 3.2: Correlations (r) of Harm Avoidance (HA) scores and the anthropometric characteristics of (**A**) height and (**B**) weight in the athletes who completed the 2009 56km Two Oceans ultra-marathon. **(C)** Correlation of Novelty Seeking (NS) scores and the weight of the athletes. The line of best fit is indicated as the solid line with the 95% confidence intervals as the dashed lines. P-values and the number of subjects (N) are indicated on the graphs. Abbreviations: cm - centimetre; kg - kilogram; TPQ - Tri-dimensional Personality Questionnaire.

The relationship of the psychometric score with each other is summarised in table 3.3. The athletes reward dependence scores were significantly negatively correlated with their novelty seeking and harm avoidance scores, while the novelty seeking scores were positively correlated with the harm avoidance scores. Therefore athletes with a low reward dependence score were more likely to have a high novelty seeking and harm avoidance scores. There was a trend for athletes with a low psychological distress (K10) score to have a higher resilience score (Table 3.3).

Table 3.3: Relationships of psychometric scores in a sample of athletes who completed the 2009 56km Two Oceans ultra-marathon.

	RISC	**K10**	**TPQ NS**	**TPQ HA**
K10	-0.269 (0.068)*	-	-	-
TPQ NS	0.170 (0.274)	-0.120 (0.295)	-	-
TPQ HA	-0.071 (0.673)	0.035 (0.774)	0.532 (<0.001)**	-
TPQ RD	0.043 (0.781)	-0.053 (0.635)	-0.266 (0.017)**	-0.493 (<0.001)**

Values are expressed as correlations (r) with P values in parenthesis; ** indicates significant differences (P<0.05) and * indicates trends (P<0.1).

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 correlations of the psychometric scores with the predicted, actual and relative times for the overall event and the 28km and/or 42.2km split times are summarised in table 3.4. Of note, there was a significant linear trend of the K10 scores with the predicted and actual overall and split times of the athletes (Figure 3.3). The athletes with a higher psychological distress not only predicted that they would complete the race in a faster time, but actually did so. Interestingly, although the athletes with higher harm avoidance score also completed the overall and split distances faster than those with a lower score (Figure 3.4), they did not predict this prior to the race.

As expected there were significant positive correlations between weight and BMI with both the predicted and actual overall and split times, with the lighter athletes predicting and actually completing the race in a faster time (Table 3.5 and Figure 3.5). Similarly the younger athletes also completed the race and the 42.2 km split in a faster time than the older athletes (Table 3.5 and Figure 3.5). There was however only a positive trend for the younger athletes to predict faster times prior to the race.

Table 3.4: The correlation of psychological variables with the predicted, actual and relative times for the overall event and the respective 28km, 42km distance in the athletes who completed the 2009 56km Two Oceans ultra-marathon.

	RISC (N= 52)	**K10** (N= 79)	**TPQ NS** (N= 73)	**TPQ HA** (N= 62)	**TPQ RD** (N=78)
Predicted Times					
56 km Overall (min)	0.211 (0.133)	-0.343 (0.002)**	-0.093 (0.436)	-0.162 (0.208)	0.063 (0.582)
42Km Split (min)	0.139 (0.357)	-0.351 (0.002)**	-0.025 (0.842)	-0.102 (0.448)	0.122 (0.305)
Actual Times					
56 Km Overall (min)	0.209 (0.146)	-0.298 (0.008)**	-0.149 (0.214)	-0.336 (0.009)**	0.134 (0.248)
28 km Split (min)	0.245 (0.087)*	-0.323 (0.004)**	-0.125 (0.298)	-0.335 (0.009)**	0.152 (0.190)
42 km Split (min)	0.236 (0.100)	-0.307 (0.006)**	-0.151 (0.210)	-0.346 (0.007)**	0.155 (0.182)
Relative Times [a]					
56 km Overall (min)	0.015 (0.921)	0.043 (0.718)	0.102 (0.408)	0.005 (0.997)	-0.052 (0.661)

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

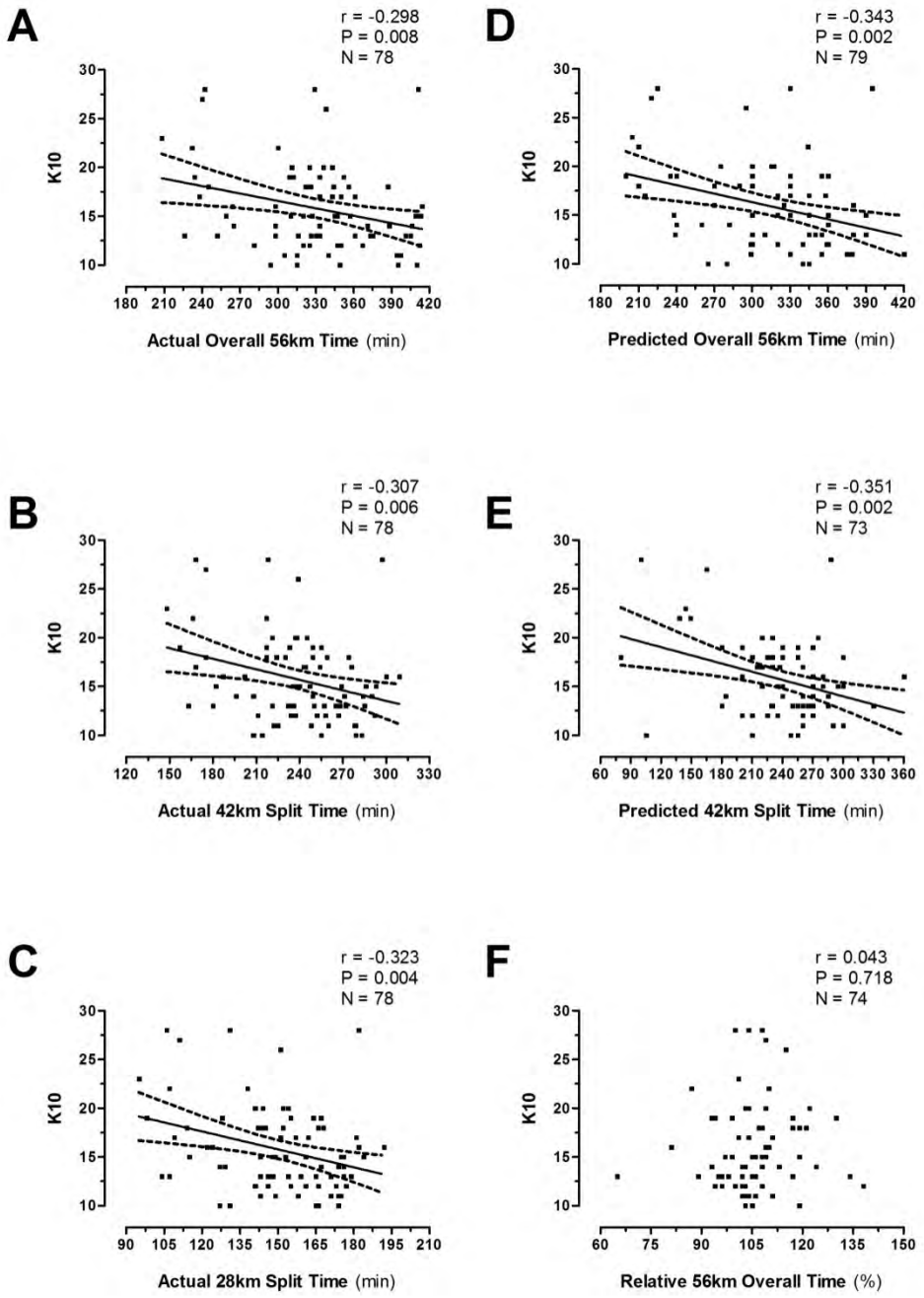

Figure 3.3: Correlations (r) between K10 scores and the **(A)** actual 56km time, **(B)** actual 42.2km split time (min), **(C)** actual 28km split time, **(D)** predicted 56km time, **(E)** predicted 42.2km split time, and **(F)** Relative 56km time (actual time divided by the predicted time, expressed as a percentage, %). The line of best fit is indicated as the solid line with the 95% confidence intervals as the dashed lines. P-values and the number of subjects (N) are indicated on the graphs.

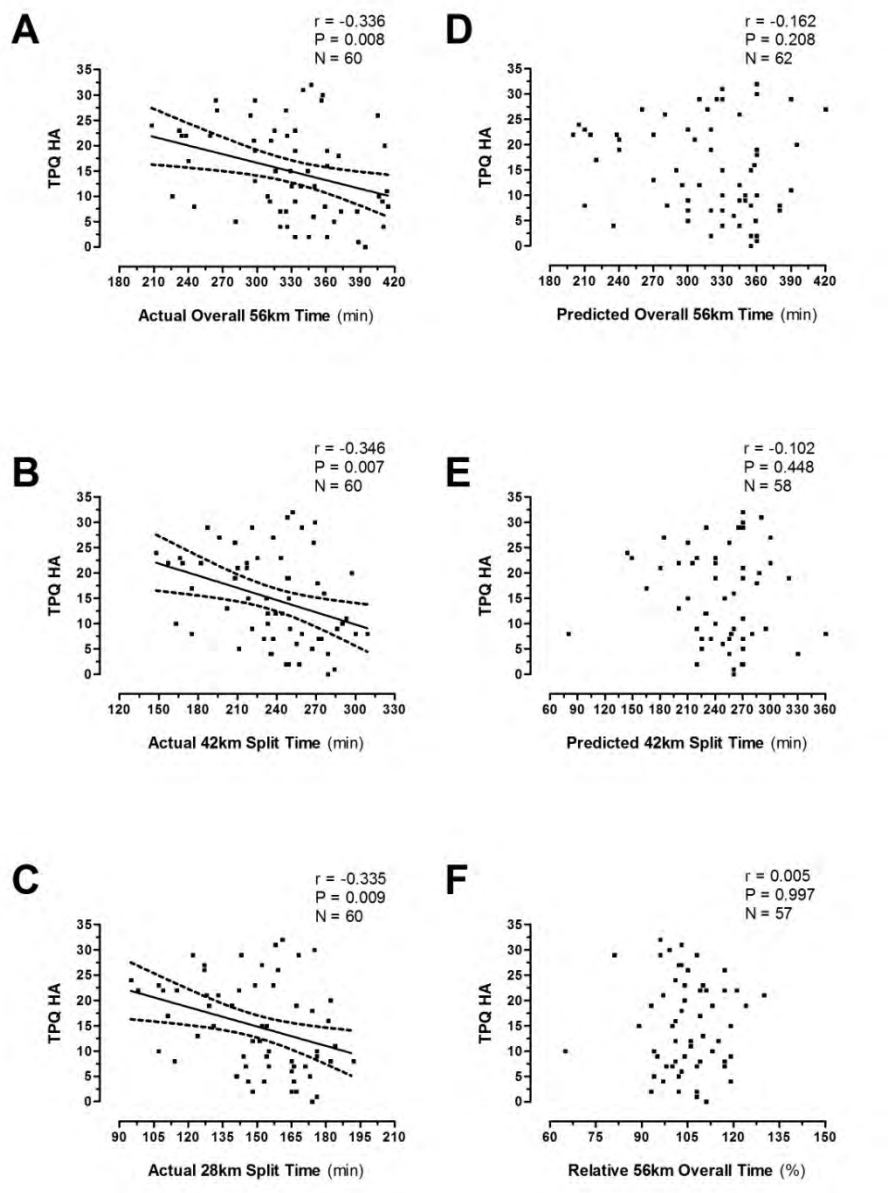

Figure 3.4: Correlations (r) between Tri-dimensional Personality (TPQ) harm avoidance (HA) scores and the **(A)** actual 56km time, **(B)** actual 42.2km split time (min), **(C)** actual 28km split time, **(D)** predicted 56km time, **(E)** predicted 42.2km split time, and **(F)** Relative 56km time (actual time divided by the predicted time, expressed as a percentage, %). The line of best fit is indicated as the solid line with the 95% confidence intervals as the dashed lines. P-values and the number of subjects (N) are indicated on the graphs.

Table 3.5: The correlation of anthropometric variables with the predicted, actual and relative times for the overall event and the respective 28km, 42km distance in the athletes who completed the 2009 56km Two Oceans ultra-marathon.

	Age (N=91)	**Height** (N=76)	**Weight** (N=89)	**BMI** (N=76)
Predicted Times				
56 km Overall (min)	0.196 (0.063)*	0.006 (0.958)	0.251 (0.019)**	0.282 (0.016)**
42 km Split (min)	0.087 (0.432)	0.096 (0.438)	0.257 (0.021)**	0.296 (0.015)**
Actual Times				
56 km Overall (min)	0.228 (0.030)**	-0.026 (0.825)	0.320 (0.004)**	0.365 (0.001)**
28 km Split (min)	0.180 (0.089)*	-0.034 (0.769)	0.226 (0.033)**	0.246 (0.032)**
42 km Split (min)	0.218 (0.038)**	-0.036 (0.757)	0.270 (0.011)**	0.315 (0.005)**
Relative Times [a]				
56 km Overall (%)	0.119 (0.278)	-0.099 (0.416)	-0.010 (0.929)	0.073 (0.548)

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

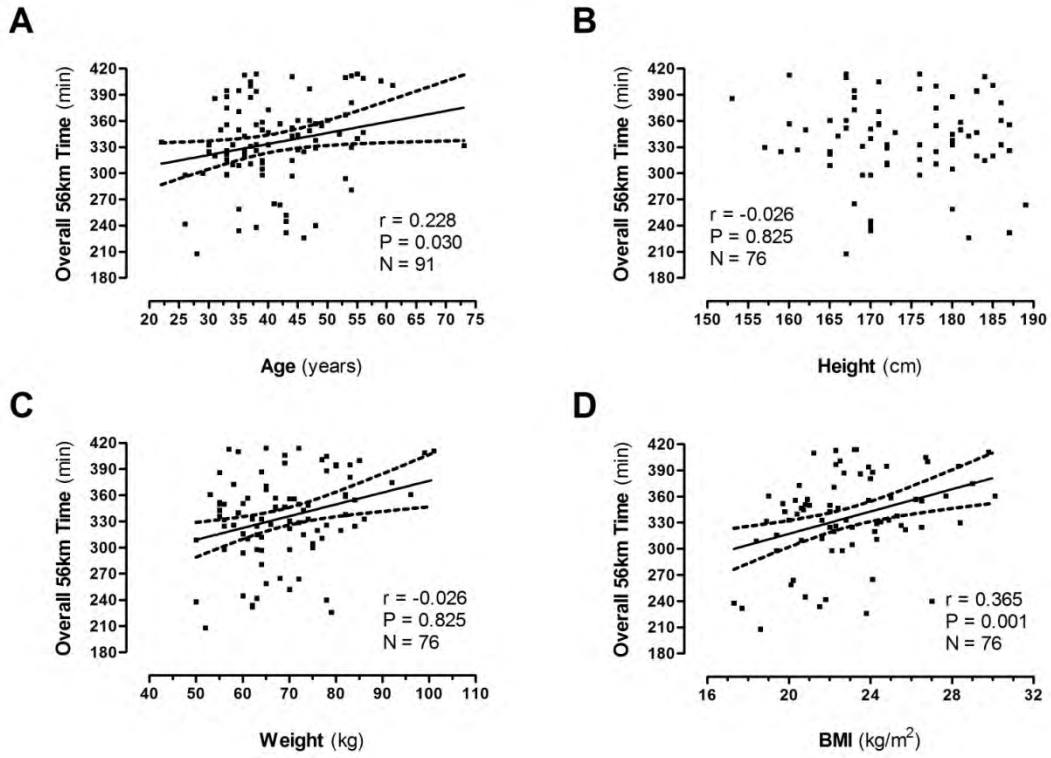

Figure 3.5: Correlations (r) of overall time to complete the 2009 56 km Two Oceans ultra-marathon with **(A)** age, **(B)** height, **(C)** weight, and **(D)** body mass index (BMI). The line of best fit is indicated as the solid line with the 95% confidence intervals as the dashed lines. P-values and the number of subjects (N) are indicated on the graphs.

The correlations of the 15 week and 1 week training volume with the actual and predicted Two Oceans split and overall performance times are summarised in Table 3.6. Of note, there was a significant negative correlation with the average distance the athletes trained per week (km/wk) during the 15 weeks prior to the race and their actual finishing and split times (Table 3.6 and Figure 3.6) for the ultra-marathon. There was also a significant negative correlation with the distance the athletes trained during the 1 week immediately prior the race and their overall finishing time (Table 3.6 and Figure 3.6). Since there were no significant correlations with hours trained per week during this period, collectively this data suggested that the fastest athletes trained at a faster pace during the 3 to 4 months before the race when compared to the slower athletes. Interestingly the athletes who trained more during the 15 weeks prior to the race also predicted a faster marathon split, but not an overall time (Table 3.6).

The correlations of psychological variables and training (Table 3.7) showed that there was a significant positive correlation with the athletes harm avoidance score and the average hours trained per week during the 15 week period before the race (Figure 3.7).

Table 3.6: The correlation of 15 weeks and 1 week training history prior to the event with the predicted, actual and relative times for the overall event and the respective 28km, 42km distance in the athletes who completed the 2009 56km Two Oceans ultra-marathon.

	15 weeks Training (km/wk)	**15 weeks Training** (hrs/wk)	**1 week Training** (km)	**1 week Training** (hrs)
Predicted Times (min)				
56 km Overall	-0.161 (0.160)	-0.188 (0.103)	-0.139 (0.213)	-0.161 (0.164)
42 km Split	-0.272 (0.020)**	-0.257 (0.030)**	0.064 (0.582)	0.171 (0.153)
Actual Times (min)				
56 km Overall	-0.315 (0.005)**	-0.226 (0.051)*	-0.244 (0.028)**	-0.143 (0.216)
28 km Split	-0.235 (0.040)**	-0.161 (0.169)	-0.175 (0.117)	-0.117 (0.311)
42 km Split	-0.264 (0.020)**	-0.215 (0.063)*	-0.209 (0.061)*	-0.151 (0.193)
Relative Times (%) [a]				
56 km Overall	-0.131 (0.267)	-0.148 (0.902)	-0.095 (0.410)	0.004 (0.972)

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: km - kilometres; wk - week.

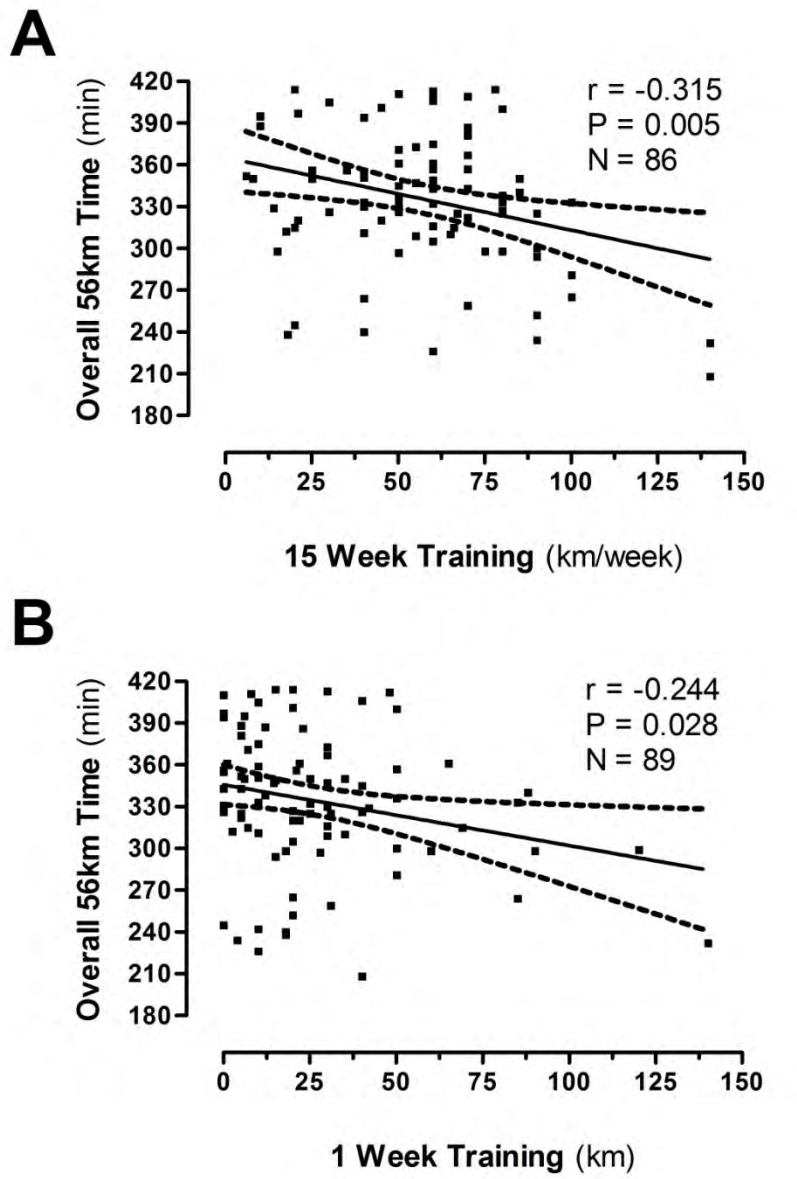

Figure 3.6: Correlations (r) of overall time to complete the 2009 56 km Two Oceans ultra-marathon with self-reported **(A)** 15 weeks and **(B)** 1 week training history prior to the race. The line of best fit is indicated as the solid line with the 95% confidence intervals as the dashed lines. P-values and the number of subjects (N) are indicated on the graphs.

Table 3.7: The correlation of psychological variables with athletes self-reported 15 weeks and 1 week training history prior to the 2009 56 km Two Oceans ultra-marathon.

	RISC	**K10**	**TPQ NS**	**TPQ HA**	**TPQ RD**
15 wk Training (km/wk)	0.212 (0.162)	0.025 (0.820)	-0.002 (0.987)	0.154 (0.209)	-0.063 (0.573)
15 wk Training (hrs/wk)	0.107 (0.492)	0.084 (0.459)	0.079 (0.506)	0.282 (0.025)**	-0.055 (0.630)
1 wk Training (km)	0.075 (0.621)	-0.019 (0.865)	0.189 (0.096)*	0.219 (0.071)*	-0.026 (0.815)
1 wk Training (hrs)	-0.187 (0.235)	0.031 (0.784)	0.118 (0.309)	0.177 (0.160)	-0.060 (0.602)

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; km - kilometres; wk - week; hrs - hours

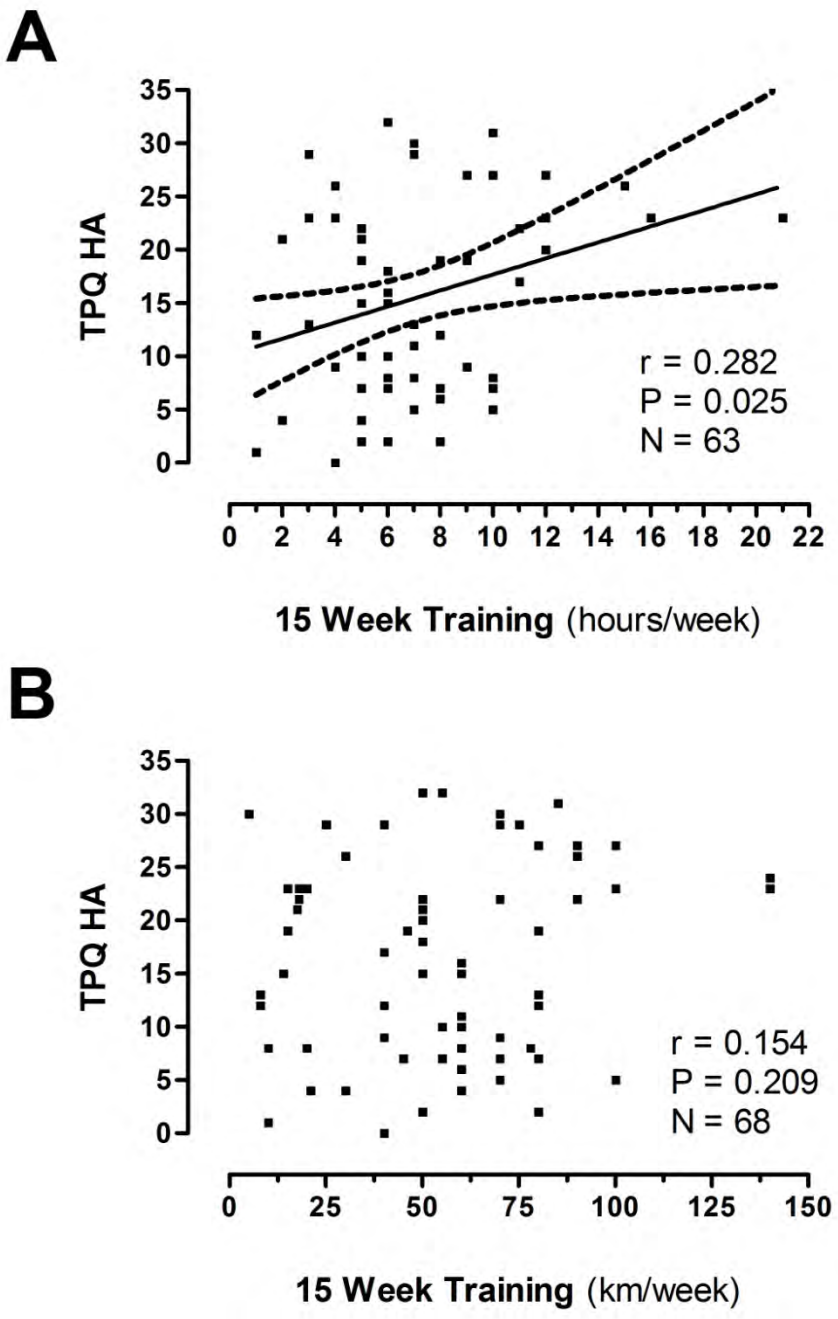

Figure 3.7: Correlations (r) of the harm avoidance (TPQ HA) scores with self-reported 15 weeks **(A)** average weekly hours and **(B)** average weekly distance trained prior to the race. The line of best fit is indicated as the solid line with the 95% confidence intervals as the dashed lines. P-values and the number of subjects (N) are indicated on the graphs.

3.4.3 Contributors to variance in race times

For the overall race performance (56 km), age, sex, height, weight, BMI, weekly average training distance and time during the 15 weeks prior to the race, as well as the K10 and TPQ HA scores were assessed for their contribution to race time variance. The model with the highest variance, 33.4%, included age, sex, height, weight, weekly average training distance during the 15 weeks prior to the race, K10 score and TPQ HA score (Table 3.8). Only weight (p=0.010), average weekly training distance (P=0.026), K10 score (P=0.010) and HA score (P=0.047) contributed significantly to the overall race time model. The inclusion of the other non-significant variables (age, sex and height) significantly improved the variance (33.3%) of the model. A slightly lower variance was obtained with height and weight was replaced by BMI and the contribution of the remaining variables remained similar (data not shown).

Table 3.8: Pair-wise multivariate analysis for the actual 56 km performance times of the athletes who completed the 2009 56 km Two Oceans ultra-marathon.

	β	B	P value	N
Age (years)	0.151	0.85	0.211	94
Sex	0.214	26.48	0.076*	91
Height (cm)	-0.229	-1.39	0.096*	77
Weight (kg)	0.367	1.72	0.010**	91
15 Week Training (km/wk)	-0.248	-0.44	0.026**	87
K10	-0.297	-1.65	0.010**	72
TPQ HA	-0.229	-2.55	0.047**	90

Abbreviations: cm - centimetre; kg - kilogram; wk - week; K10 - Kessler 10 score; TPQ HA - harm avoidance; β - partial correlation coefficient; B - parameter estimate; ** indicates significant differences (P<0.05) and * indicates trends (P<0.1).
R=0.643; R^2=0.413 Adjusted R^2=0.334; Standard Error of Estimate (SEE)=41.48; P<0.00015.

3.4.4 Psychometric scores, injuries and illness

There were no significant differences in the average K10 scores when athletes who reported a history of an illness (flu-like symptoms, muscle cramps, history of collapse, gastrointestinal symptoms, nervous system symptoms, allergy symptoms and asthma) or injury (current symptoms of injury and tendon or ligament injuries) were compared to those who did not report the illness or injury (Table 3.9).

The average K10 scores of the athletes was significantly higher in those who reported the use of medications to treat injuries in the week before or during a race

(P=0.042) (Table 3.9). Similarly the average resilience (RISC) scores of the athletes who reported medication usage were also significantly higher than those who did not use medication (P=0.007) (Table 3.10).

The average RISC scores of the four athletes who currently suffered from asthma was significantly lower than those who were not asthmatic (P=0.018) (Table 3.10). There were no other significant differences in the average RISC scores for any of the other illness groups or the injury groups (Table 3.10).

With the exception of the age of the athletes with a history of exercise-associated collapse (history of collapse: 52.5 ± 7.7 years, N=4 vs. no history: 40.7 ± 8.6 years, N=87; P=0.009), all the remaining illness, injury and medication groups were similarly matched for age, height, weight, BMI, performance times and the 15 week training variables (data not shown).

Table 3.9: The K10 scores of the athletes who completed the 2009 56 km Two Oceans ultra-marathon with (Yes) and without (No) self-reported specific illness or injury symptomatology and medication usage.

	Yes	No	P value
Illness			
Flu-like Symptoms	15.4 ± 3.8 (26)	15.5 ± 4.4 (59)	0.918
EAMC	16.1 ± 4.9 (45)	15.3 ± 3.8 (42)	0.407
Collapse	16.3 ± 1.9 (4)	15.7 ± 4.5 (83)	0.794
Exercise Related GIT Symptoms	16.4 ± 4.4 (40)	15.1 ± 4.1 (45)	0.155
Nervous system Symptoms	16.3 ± 4.7 (12)	15.6 ± 4.3 (75)	0.599
Allergy Symptoms	16.7 ± 4.3 (20)	15.4 ± 4.4 (65)	0.238
Asthma	17.3 ± 3.9 (4)	15.6 ± 4.4 (83)	0.467
Injury			
Current Symptoms of Injury	15.5 ± 4.4 (55)	16.2 ± 4.3 (33)	0.451
Tendon or Ligament Injuries	15.6 ± 4.6 (35)	15.8 ± 4.2 (53)	0.825
Medication Usage	16.7 ± 4.9 (40)	14.8 ± 3.6 (47)	0.042**

Values are expressed as average ± standard deviation, with the number of subjects (N) with non-missing data for each variable in parentheses. Abbreviations: EAMC - exercise associated muscle cramps; GIT - gastrointestinal. ** indicates significant differences (P<0.05).

There was no significant differences in the novelty seeking (Table 3.11), harm avoidance (Table 3.12) or reward dependence (Table 3.13) scores between those who reported the use of medications to treat injuries in the week before or during a race and whose who did not use medication.

The average novelty seeking score of the athletes who reported a past-history from a tendon or ligament injury (pain, swelling, stiffness, partial and/or complete tear/rupture) was significantly lower than those who reported no history of tendon or ligament injuries (P=0.041) (Table 3.11). There were no significant differences in the average harm avoidance (Table 3.12) and reward dependence (Table 3.13) scores between those with and without a tendon or ligament injury. Similarly the three personality traits were also similar between those who reported current symptoms of injury and those who were asymptomatic (Table 3.11, Table 3.12 and Table 3.13).

With respect to the illness groups, (1) there was a trend (P=0.070) for the athletes with a history of allergy symptoms to have on average a lower novelty seeking score (Table 3.11); (2) the average harm avoidance scores were significantly higher (P=0.018) in the athletes who reported nervous system symptoms, which included exercise induced headaches, nerve tingling or loss of sensation, (Table 3.12); and (3) finally, there was also a trend (P=0.099) for the four asthmatic athletes to have a lower average reward dependence score (Table 3.13). There were no other differences between any of the other documented illnesses and the personality traits (Table 3.11, Table 3.12 and Table 3.13).

Table 3.10: The resilience (RISC) scores of the athletes who completed the 2009 56 km Two Oceans ultra-marathon with (Yes) and without (No) self-reported specific illness or injury symptomatology and medication usage.

	Yes	No	P value
Illness			
Flu-like Symptoms	102.9 ± 11.8 (19)	106.9 ± 11.1 (37)	0.215
EAMC	107.2 ± 12.1 (31)	104.1 ± 10.8 (26)	0.320
Exercise Related GIT Symptoms	105.2 ± 10.7 (29)	105.3 ± 12.0 (26)	0.993
Nervous System Symptoms	101.6 ± 13.9 (8)	106.1 ± 10.9 (49)	0.300
Allergy Symptoms	102.1 ± 13.7 (9)	106.5 ± 11.1 (48)	0.296
Asthma	97.8 ± 12.1 (4)	106.5 ± 10.8 (52)	0.018**
Collapse	115.7 ± 12.1 (3)	104.9 ± 11.2 (53)	0.112
Injuries			
Current Symptoms of Injury	105.9 ± 10.7 (35)	105.5 ± 12.7 (23)	0.892
Tendon or Ligament Injuries	103.8 ± 11.9 (27)	107.5 ± 10.8 (31)	0.216
Medication Usage	109.8 ± 11.8 (28)	102.0 ± 9.8 (30)	0.007**

Values are expressed as average ± standard deviation, with the number of subjects (n) with non-missing data for each variable in parentheses. Abbreviations: EAMC - exercise associated muscle cramps; GIT - gastrointestina. ** indicates significant differences (P<0.05).

Table 3.11: The novelty seeking (TPQ NS) scores of the athletes who completed the 2009 56 km Two Oceans ultra-marathon with (Yes) and without (No) self-reported specific illness or injury symptomatology and medication usage.

	Yes	No	P value
Illness			
Flu-like Symptoms	16.7 ± 6.7 (26)	15.6 ± 5.7 (52)	0.460
EAMC	15.0 ± 5.6 (44)	16.8 ± 6.6 (35)	0.204
Exercise Related GIT Symptoms	15.1 ± 5.9 (34)	16.5 ± 5.9 (43)	0.290
Nervous system Symptoms	14.8 ± 7.7 (10)	15.9 ± 5.9 (69)	0.591
Allergy Symptoms	13.6 ± 6.1 (18)	16.5 ± 6.0 (59)	0.070*
Asthma	11.5 ± 5.0 (4)	16.1 ± 6.1 (75)	0.145
Collapse	14.5 ± 5.8 (4)	15.9 ± 6.1 (75)	0.658
Injury			
Current Symptoms of Injury	15.5 ± 5.8 (48)	16.3 ± 6.5 (32)	0.564
Tendon or Ligament Injuries	14.2 ± 6.2 (34)	17.0 ± 5.7 (46)	0.041**
Medication Usage	15.5 ± 6.5 (35)	16.0 ± 5.8 (45)	0.684

Values are expressed as average ± standard deviation, with the number of subjects (N) with non-missing data for each variable in parentheses. Abbreviations: EAMC - exercise associated muscle cramps; GIT - gastrointestinal. ** indicates significant differences ($P<0.05$) and * indicates trends ($P<0.1$).

Table 3.12: The harm avoidance (TPQ HA) scores of the athletes who completed the 2009 56 km Two Oceans ultra-marathon with (Yes) and without (No) self-reported specific illness or injury symptomatology and medication usage.

	Yes	No	P value
Illness			
Flu-like Symptoms	18.1 ± 9.0 (23)	14.6 ± 9.4 (45)	0.149
EAMC	15.8 ± 8.6 (35)	15.7 ± 10.2 (34)	0.967
Exercise Related GIT Symptoms	15.4 ± 9.3 (28)	16.2± 9.0 (39)	0.709
Nervous System Symptoms	21.7 ± 5.8 (11)	14.6 ± 9.4 (58)	0.018**
Allergy Symptoms	13.9 ± 9.1 (16)	16.4 ± 9.4 (51)	0.362
Asthma	18.0 ± 8.9 (4)	15.6 ± 9.4 (65)	0.619
Collapse	15.8 ± 12.4 (4)	15.7 ± 9.2 (65)	0.996
Injury			
Current Symptoms of Injury	15.8 ± 9.8 (42)	15.8 ±8.7 (28)	0.988
Tendon or Ligament Injuries	17.0 ± 9.8 (27)	15.0 ± 9.0 (43)	0.381
Medication Usage	17.1 ± 9.3 (28)	14.9 ± 9.3 (42)	0.339

Values are expressed as average ± standard deviation, with the number of subjects (N) with non-missing data for each variable in parentheses. Abbreviations: EAMC - exercise associated muscle cramps; GIT - gastrointestinal. ** indicates significant differences (P<0.05).

Table 3.13: The reward dependence (TPQ RD) scores of the athletes who completed the 2009 56km Two Oceans Ultra Marathon with (Yes) and without (No) self-reported specific illness or injury symptomatology and medication usage.

	Yes	No	P value
Illness			
Flu-like Symptoms	14.0 ± 4.5 (28)	14.6 ± 4.5 (55)	0.556
EAMC	14.7 ± 3.8 (48)	13.9 ± 5.2 (37)	0.447
Exercise Related GIT Symptoms	14.0 ± 4.6 (37)	14.5 ± 4.5 (46)	0.628
Nervous system Symptoms	14.9 ± 2.8 (12)	14.2 ± 4.7 (73)	0.632
Allergy Symptoms	14.7 ± 3.2 (20)	14.3 ± 4.8 (63)	0.742
Asthma	10.8 ± 1.5 (4)	14.5 ± 4.5 (81)	0.099*
Collapse	12.8 ± 3.2 (4)	14.4 ± 4.5 (81)	0.469
Injury			
Current Symptoms of Injury	14.7 ± 4.1 (51)	13.8 ± 4.6 (35)	0.381
Tendon or Ligament Injuries	14.5 ± 4.2 (34)	14.2 ± 4.6 (52)	0.785
Medication Usage	14.9 ± 3.9 (38)	13.9 ± 4.8 (47)	0.299

Values are expressed as average ± standard deviation, with the number of subjects (N) with non-missing data for each variable in parentheses. Abbreviations: EAMC - exercise associated muscle cramps; GIT – gastrointestinal. * indicates trends (P<0.1).

3.5 Discussion

3.5.1 General discussion

The first main finding of this study was that the average resilience (CD-RISC) score (106 ± 11) of the convenience sample of ultra-marathon athletes was higher than those reported by Connor Davidson(105) for the general population, where the average score was 80.4 ± 12.8. The CD-RISC scores for people suffering from general anxiety disorders is lower, 62.4 ± 10.7. Although the athletes competing in the Two Oceans 56 km ultra-marathon were more resilient than the average population they were similar to the previously investigated ultra-endurance Ironman triathletes (104.2)(110). Within the Two oceans cohort, there was a trend for the athletes who were more resilient to experience less psychological distress prior to the race. These athletes were capable of managing their distress effectively and possibly even were less likely to be plagued with distress.

The average psychological distress (K10) score (15.9 ± 4.6) of the ultra-marathon athletes was higher than a previously reported score of 14.2 for general population by Andrew and Slade(106), but lower than the average reported for Ironman triatheletes (16.8 ± 4.3)(110). However, it must be noted that the K10 questionnaire within both athletic populations was completed in the 2 to 3 days preceding the race, a time when the enormity of the challenge may have hit home and this value might have been much lower if the questionnaire was completed well before the race.

The avearge novelty seeking, harm avoidance and reward dependence scores of the ultra-marathoners investigated in this study were 16.0 ± 6.2, 15.9 ± 9.2, 14.4 ± 4.4, respectively. The novelty seeking scores (16.5 ± 50) were similar to a previously reported values for Northern Finland general population, while the harm avoidance (13.1 ± 5.9) and reward dependence (17.7 ± 3.9) were both higher in the Two Oceans athletes(132) but similar to those of Han(133) whom credited his higher scores to the possibility that cohort effect, trait anxiety differences or the environment. Interestingly, lower novelty seeking (14.7 ± 5.7) and harm avoidance (8.1 ± 5.5) scores have been reported in Ironman triathletes(110). This could lead to the assertion that the two oceans athletes, when compared with general population, were driven to compete in the race to but not at the expense of possible injury, however the Ironman triathletes were more willing to risk possible injury in their competition.

The novelty seeking and harm avoidance scores of the ultra-marathon runners were positively correlated, while those with a low reward dependence score were more likely have a high novelty seeking and harm avoidance scores. This suggests that even though athletes were prepared to be impulsive and exploratory they were indeed willing to be optimistic and daring to achieve their goals. It may also be postulated that those athletes whom were open, sentimental and sympathetic, lower reward dependence, were more likely to balance those qualities with stoicism, reservation and frugality.

Older athletes experience less distress(132), this was confirmed in our study(p=0.002). With age, athletes are better equipped to deal with distress and possibly, are more resilient.

Significantly heavier athletes had lower NS(p=0.083) and HA(p=0.076) scores, with taller athletes also scoring higher on HA (p=0.078), possibly as a result of their heightened perception of developing injuries.

3.5.2 Psychometric scores and performance

Athletes with higher K10 scores not only predicted they would finish the race at a faster pace than those with less psychological distress, they also ran the race in a faster time. This is in contrast to the finding of Dr. Hugo(110) and his findings from the Iron Man Triathlon where the more distressed finished at a slower pace.
A possible explanation could be that athletes were expected to compete after having completed their race registration in the 2 days preceding the race, and might have felt overwhelmed as the reality of their entry struck home. A further postulate could be that these athlete felt more pressured to attain their predicted times and managed to finish faster.

Athletes with higher harm avoidance scores, the personality characteristics of these runners being fearful and pessimistic, accounting for their predictions, completed the race in a faster time without having predicted that they would. The deduction that athletes with higher HA scores might have finished faster due to less injuries or as a result past history of injuries is not seen in the results analysis.

As seen in the modern area of ultramarathon running, the lighter athletes were faster runners on the day and also were better at predicting the pace they would run at. The younger athletes showed a faster pace than their older counterparts and also were better predictors of their ability.

Training also made a significant impact on athletes performance. Those who reported that they had covered more kilometers in the 15 weeks prior to the race, were faster finishers. When one evaluated the time trained, it revealed no correlation, hence those who trained at a faster pace in the 15 weeks prior to the race performed better. Of note, those who covered more distance training in the week preceding the event, were better performers. This data suggests that the athletes whom were prepared to run at a faster pace in training were better conditioned to maintain that pace during the race an achieve their pre-race goals/predictions.

A multivariate analysis incorporating: age, sex, height, weight, weekly average distance run, K10 scores and TPQ HA scores, showed the highest variance (33.4%). Unsurprisingly, weight ($p=0.010$), average distance run ($p=0.026$), and the psychometric scores of K10 ($p=0.010$) and TPQ HA ($p=0.047$) were the major contributors to the time race model. The ideal athlete would appear to be a young, light weight, tall athlete whom trains at a fast pace for at least 3 months prior to the race, has a moderate level of psychological distress, and has a harm avoidant personality.

3.5.3 **Psychometric scores, illness and injury**

Higher psychosocial distress and resilience traits were associated with higher medication usage in the weeks preceding the race. The use of medication in the absence of any correlation with injuries or flu symptoms is in contrast to that seen in the litrature(86, 134, 135), the reasons for this are presently not well known.

A history of tendon or ligament injury proved to be higher in the athletes with NS personality traits(p=0.041), a finding not seen in the other personality trait groups(RD, HA) and in contrast to the Ironman triathlete group which showed a correlation with higher RD scores(110). This finding in the marathon runners may explain why this group of athletes did not perform at their predicted pace, nor did they perform and better than their counterparts reward with dependence traits.

Athletes with asthma displayed similar personality traits to that described in the literature(86), asthmatics appeared to have lower CD RISC scores. They also tended to have lower reward dependence scores (p=0.099) allowing them to be more independent runners and critical in their decision making to avoid acute exacerbation.

Nervous system symptoms, like in the Ironman study, were correlated with higher harm avoidance scores (p=0.018), however no concomitant association was seen with increased medication usage that may have aided in substantiation. No further clear significant correlations were noted between the psychometric scores and

illness. However trends were noted: when allergy symptoms were present lower novelty seeking scores (p= 0.070) were prevalent.

The study has revealed significant associations with performance, illness and injury, helping underline the value of recognising and implementing strategies to overcome the impact of psychological variables on athletes perfomance. A time-race model with its contributors has been identified, a young, light weight, tall athlete whom trains at a fast pace for at least 3 months prior to the race, has a moderate level of psychological distress, and has harm avoidant personality appears to be the ideal characteristics for an ultramarathon athlete.

More research needs to be conducted to prove if these psychological variables may be manipulated to improve athletic outcomes, decrease injury incidence and illnesses, or even to help predict the ideal athlete. Further, the model identified needs further research to be validated in this group of athletes.

3.5.4 Limitations of this study

Although every attempt was made to recruit as many athletes as possible for this study, only 105 athletes completed parts of the questionnaire. A larger sample group would have assisted in overcoming limitations when performing the multi-variate analyses, and to also provide more information to allow application of these findings to other groups of athletes. Furthermore, this study was undertaken on a specific

subset of athletes, ultra marathon runners, making its application in other sporting disciplines less feasible.

Comparisons made to data in the literature need to be viewed in the light that they are undertaken on a sub-set of individuals culturally dissimilar to the athletes in South Africa. Further a prospective, cohort study over a longer duration would have revealed more accurate findings.

3.5.5 **Future directions**

Further research including not only larger sample sizes but also different sporting codes needs to be conducted. The model described in this study showing the impact of factors on performance needs to be investigated further. Furthermore, comparisons need to be made between recreational and professional athletes.

Continuing research in the field of genetics may be beneficial in understanding other psychological aspects overlooked in this study, as well determining any effects that genetic plays in psychological make-up of athletes.

3.6 Conclusion

This study has helped further our knowledge as to the effects psychological factors play on performance, injury and illness. Higher K10 scores were associated with poorer performance, and increased medication usage to treat illness and injuries

prior to the race. Higher TPQ-HA also correlated well with poorer performance times, and increased nervous system complaints. TPQ NS scored correlated with increased tendon or ligament injuries. Asthma and higher rates of medication usage was reported in those with higher CD-RISC scores, showing these athletes had lower resilience. A model appears to have been developed: weight, training history, K10 and TPQ HA were noted to collectively have a significant correlation with performance. These finding collaborate findings that psychological factors may have an impact on illness, injury and performance.

The clinical application of this study would be useful in determining athletes with detrimental psychometric scores, and implementing intervention programs. However further research in this field of sports psychology is needed to determine if interventions to athletes training programs may result in improved performance, and fewer illnesses and injuries.

Chapter 4

Summary and conclusion

This descriptive cross sectional study described the psychological correlates with performance, injury and illness in the cohort of 105 ultra-marathon road runners who completed the 2009 56km Two Oceans Marathon.

The athletes in this study proved to be more resilient but experienced greater psychological distress, when sampled during the pre-race registration, than has previously been documented for the general population. In addition, the psychological personality traits harm avoidance (HA) and reward dependence (RD) were also higher than that previously documented in the general population, while lack of novelty seeking (NS) traits within this cohort was noted in the heavier athletes. The HA and NS scores are of interest as these are both higher than that seen in the Ironman triathlete study by Hugo et al(110) but similar to that of the Northern Finland general population. With the exception of HA and NS these findings are not surprising in ultra-endurance athletes, especially during the registration period 1 to 3 days prior to the race. Older athletes were more resilient, while heavier athletes were less inclined to be risk takers (i.e. they had a higher harm avoidance and a lower novelty seeking scores). The taller athletes were also more inclined to be harm avoiders

A multivariate analysis of performance included the athlete's age, height, weight, weekly average running training, K10 scores and TPQ HA scores were included.

This model allowed postulation that the ideal runner would be young, light weight, tall trains at a fast pace for at least 3 months prior to the race and has a moderate level of psychological distress prior to the race and a harm avoidant personality.

The investigation into the effect of an athletes' psychological factors with injury and illness revealed that a novelty seeking personality trait was a positive risk factor for tendon or ligament injuries .The only psychological factors found in the ill athletes was that asthmatic athletes experienced less psychological distress and had lower reward dependence traits. Harm avoidant traits, like in the Ironman cohort, were described in athletes with symptoms of nervous system disorders.

This study has described the psychological make up of a cohort of ultra-marathon runners and further postulated a possible model, which included these factors, for predicting the elite athlete for coaches to recognize and nurture. The associations of the illness and injuries were somewhat limited in hard findings.

This study has added to the growing literature on the field of sports psychology. Further investigations are required to confirm the findings described and to evaluate if findings described in this heterogeneous group of athletes (recreational and competitive) maybe be extended to the competitive athletes. Lastly and importantly, the model described needs to be investigated and validated so that it may be applied on the training fields.

References

1. Smith RE, Ptacek JT, Smoll FL. Sensation seeking, stress, and adolescent injuries: a test of stress-buffering, risk-taking, and coping skills hypotheses. Journal of personality and social psychology. 1992;62(6):1016-24.

2. Thomas S, Reeves C, Agombar J, Greenlees I. Personality hardiness at different levels of competitiv motocycing. Perceptual and Motor Skills. 2013 2013/02/01;116(1):315-21.

3. Mirzaei A, Nikbakhsh R, Sharififar F. The relationship between personality traits and sport performance. European Journal of Experimental Biology. 2013;3(3):439-42.

4. Gyomber N, Lenart A, Kovacs K. Differences between personality characteristics and sport performance by age and gender. Publicatio LIII/II. 2013:5.

5. Freund W, Weber F, Billich C, Birklein F, Breimhorst M, Schuetz UH. Ultra-Marathon Runners Are Different: Investigations into Pain Tolerance and Personality Traits of Participants of the TransEurope FootRace 2009. Pain Practice. 2013;13(7):524-32.

6. Lopez AV, Santelices O. Personality characteristics of elite table tennis athletes of the Philippines: basis for a proposed recruitment program. International Journal of Table Tennis Sciences. 2012;7:1-4.

7. Ilyasi G, Salehian MH. Comparison of Personality Traits Between Individual and Team Athletes. Middle-East Journal of Scientific Research. 2011;9(4):527-30.

8. Ardern CL, Taylor NF, Feller JA, Webster KE. A systematic review of the psychological factors associated with returning to sport following injury. British Journal of Sports Medicine. 2013 November 1, 2013;47(17):1120-6.

9. Mann BJ, Grana WA, Indelicato PA, O'Neill DF, George SZ. A survey of sports medicine physicians regarding psychological issues in patient-athletes. The American Journal of Sports Medicine. 2007;35(12):2140-7.

10. Sarkar M, Fletcher D. How Should We Measure Psychological Resilience in Sport Performers? Measurement in Physical Education and Exercise Science. 2013 2013/10/01;17(4):264-80.

11. Chung P-K, Cheng KC, Li HY, Jiang X, Su N, Zhang C, et al. The effect of resilience training for Hong Kong junior athletes. International Journal of Sport and Exercise Psychology. 2013 2013/06/01;11(2):228-42.

12. Gucciardi DF, Jackson B, Coulter TJ, Mallett CJ. The Connor-Davidson Resilience Scale (CD-RISC): Dimensionality and age-related measurement invariance with Australian cricketers. Psychology of Sport and Exercise. 2011 7//;12(4):423-33.

13. Raglin JS. The psychology of the marathoner : of one mind and many. Sports medicine (Auckland, NZ). 2007;37(4-5):404-7.

14. Costill DL, Dunlop JD. Inside running: basics of sports physiology: Benchmark Press Indianapolis; 1986.

15. Raglin JS. Psychological factors in sport performance: the Mental Health Model revisited. Sports medicine (Auckland, NZ). 2001;31(12):875-90.

16. Beilock SL, Carr TH. On the fragility of skilled performance: What governs choking under pressure? Journal of Experimental Psychology: General. 2001;130(4):701-25.

17. Beilock SL, Gray R. Why do athletes choke under pressure? 2007.

18. Gucciardi DF, Dimmock JA. Choking under pressure in sensorimotor skills: Conscious processing or depleted attentional resources? Psychology of Sport and Exercise. 2008;9(1):45-59.

19. Cooke A, Kavussanu M, McIntyre D, Ring C. Psychological, muscular and kinematic factors mediate performance under pressure. Psychophysiology. 2010 (Journal Article).

20. Baumeister RF, Showers CJ. A review of paradoxical performance effects: Choking under pressure in sports and mental tests. European Journal of Social Psychology. 1986;16(4):361-83.

21. Adler N, Matthews K. Health psychology: why do some people get sick and some stay well? Annual Review of Psychology. 1994;45(Journal Article):229-59.

22. Baum A, Posluszny DM. Health psychology: mapping biobehavioral contributions to health and illness. Annual Review of Psychology. 1999;50(Journal Article):137-63.

23. Cohen S, Frank E, Doyle WJ, Skoner DP, Rabin BS, Gwaltney JM, Jr. Types of stressors that increase susceptibility to the common cold in healthy adults. Health psychology : official journal of the Division of Health Psychology, American Psychological Association. 1998;17(3):214-23.

24. Dickens CM, McGowan L, Percival C, Tomenson B, Cotter L, Heagerty A, et al. Contribution of depression and anxiety to impaired health-related quality of life following first myocardial infarction. The British journal of psychiatry : the journal of mental science. 2006;189(Journal Article):367-72.

25. Tedeschi RG, Calhoun LG. Posttraumatic Growth: Conceptual Foundations and Empirical Evidence. Psychological Inquiry. 2004;15(1):1-18. PubMed PMID: 12650841.

26. Nishi D, Matsuoka Y, Kim Y. Research Posttraumatic growth, posttraumatic stress disorder and resilience of motor vehicle accident survivors. 2010.

27. Andersen MB, Williams JM. A model of stress and athletic injury: prediction and prevention. Journal of Sport & Exercise Psychology. 1988.

28. Coddington J, Troxell J. The significance of life events as eliologic factors in the disease of the children. Journal of Human Stress. 1980;6:3.

29. Fletcher D, Sarkar M. Psychological resilience: A review and critique of definitions, concepts, and theory. European Psychologist. 2013;18(1):12-23. PubMed PMID: 2013-13184-003. Psycarticles Identifier: epp-18-1-12. First Author & Affiliation: Fletcher, David.

30. Williams JM, Andersen MB. Psychosocial influences on central and peripheral vision and reaction time during demanding tasks. Behavioral medicine (Washington, DC). 1997;22(4):160-7.

31. Brewer BW, Linder DE, Phelps CM. Situational Correlates of Emotional Adjustment to Athletic Injury. Clinical Journal of Sport Medicine. 1995;5(4):241-5.

32. Schaal K, Tafflet M, Nassif H, Thibault V, Pichard C, Alcotte M, et al. Psychological balance in high level athletes: gender-based differences and sport-specific patterns. PloS one. 2011;6(5):e19007.

33. Smith RE, Smoll FL, Ptacek JT. Conjunctive moderator variables in vulnerability and resiliency research: Life stress, social support and coping skills, and adolescent sport injuries. Journal of Personality and Social Psychology. 1990;58(2):360-70.

34. Galambos SA, Terry PC, Moyle GM, Locke SA, Lane AM. Psychological predictors of injury among elite athletes. British journal of sports medicine. 2005;39(6):351-4; discussion -4.

35. Brewer BW. Developmental Differences in Psychological Aspects of Sport-Injury Rehabilitation. Journal of athletic training. 2003;38(2):152-3.

36. van Mechelen W, Hlobil H, Kemper HC. Incidence, severity, aetiology and prevention of sports injuries. A review of concepts. Sports medicine (Auckland, NZ). 1992;14(2):82-99.

37. Machida M, Irwin B, Feltz D. Resilience in Competitive Athletes With Spinal Cord Injury The Role of Sport Participation. Qualitative health research. 2013;23(8):1054-65.

38. Landers DM, Boutcher SH, Wang MQ. A psychobiological study of archery performance. Research Quarterly for Exercise and Sport. 1986;57(3):236-44.

39. Oxendine JB. Emotional arousal and motor performance. Quest. 1970;13(1):23-32.

40. Raglin JS. Anxiety and sport performance. Exercise and sport sciences reviews. 1992;20(Journal Article):243-74.

41. Hanin Y. A study of anxiety in sports. An analysis of athlete behavior Ithaca NY: Movement. 1978.

42. Hanin Y. State-trait anxiety research on sports in the USSR. Cross-cultural anxiety. 1986;3:45-64.

43. Turner PE, Raglin JS. Variability in precompetition anxiety and performance in college track and field athletes. Medicine and science in sports and exercise. 1996;28(3):378-85.

44. Lane AM, Wilson MG, Whyte GP, Shave R. Physiological correlates of emotion-regulation during prolonged cycling performance. Appl Psychophysiol Biofeedback. 2011;36(3):181-4.

45. Covassin T, Elbin RJI, Larson E, Kontos AP. Sex and Age Differences in Depression and Baseline Sport-Related Concussion Neurocognitive Performance and Symptoms. Clinical Journal of Sport Medicine. 2012;22(2):98-104 10.1097/JSM.0b013e31823403d2.

46. Egloff B, Jan Gruhn A. Personality and endurance sports. Personality and Individual Differences. 1996 8//;21(2):223-9.

47. Tohănean D, Chicomban M. Personality and performance sport. Ovidius University Annals, Physical Education and Sport/Science, Movement and Health Series. 2010;10(2 Suppl.):609-13.

48. Gee CJ, Marshall JC, King JF. Should coaches use personality assessments in the talent identification process? A 15 year predictive study on professional hockey players. International Journal of Coaching Science. 2010;4(1).

49. Pargman D. Psychological bases of sport injuries. Pargman D, editor: Morgantown; 2007 2007.

50. Williams JM, Andersen MB. Psychosocial antecedents of sport injury and interventions for risk reduction. Handbook of Sport Psychology, Third Edition. 2007:379-403.

51. Williams JM, Hogan TD, Andersen MB. Positive states of mind and athletic injury risk. Psychosomatic medicine. 1993;55(5):468-72.

52. Holmes TH, Rahe RH. The Social Readjustment Rating Scale. Journal of psychosomatic research. 1967;11(2):213-8.

53. Lazarus R. S.(1966). Psychological stress and the coping process. New York. 1966:9.

54. Johnson U, Ivarsson A. Psychological predictors of sport injuries among junior soccer players. Scandinavian journal of medicine & science in sports. 2010 (Journal Article).

55. Ivarsson A, Johnson U, Lindwall M, Gustafsson H, Altemyr M. Psychosocial stress as a predictor of injury in elite junior soccer: A latent growth curve analysis. Journal of Science and Medicine in Sport.

56. Fawkner HJ, McMurrary NE, Summers JJ. Athletic injury and minor life events: A prospective study. Journal of Science and Medicine in Sport. 1999 6//;2(2):117-24.

57. Ivarsson A, Johnson U. Psychological factors as predictors of injuries among senior soccer players. A prospective study. Journal of sports science & medicine. 2010;9(2):347.

58. Thoits PA. Stress, coping, and social support processes: where are we? What next? Journal of health and social behavior. 1995;Spec No(Journal Article):53-79.

59. Steffen K, Pensgaard A, Bahr R. Self−reported psychological characteristics as risk factors for injuries in female youth football. Scandinavian journal of medicine & science in sports. 2009;19(3):442-51.

60. Ivarsson A Fau - Johnson U, Johnson U Fau - Podlog L, Podlog L. Psychological predictors of injury occurrence: A prospective investigation of professional Swedish soccer players. 20120305(1543-3072 (Electronic)). Eng.

61. Petrie TA. Coping skills, competitive trait anxiety, and playing status: Moderating effects on the life stress-injury relationship. Journal of Sport and Exercise Psychology. 1993;15:261-.

62. Williams JM, Andersen MB. Psychosocial antecedents of sport injury: Review and critique of the stress and injury model'. Journal of applied sport psychology. 1998;10(1):5-25.

63. Ekenman I, Hassmen P, Koivula N, Rolf C, Fellander-Tsai L. Stress fractures of the tibia: can personality traits help us detect the injury-prone athlete? Scandinavian journal of medicine & science in sports. 2001;11(2):87-95.

64. Carver CS, Coleman AE, Glass DC. The coronary-prone behavior pattern and the suppression of fatigue on a treadmill test. Journal of Personality and Social Psychology. 1976;33(4):460.

65. Rosenman RH. Type A behavior pattern: A personal overview. Journal of Social Behavior & Personality. 1990.

66. Fields KB, Delaney M, Hinkle JS. A prospective study of Type A behavior and running injuries. The Journal of Family Practice. 1990;30(4):425-9.

67. Lazarus RS. Folkman. S.(1984) Stress, Appraisal, and Coping. New York. 1986;1.

68. Williams JM, Tonymon P, Wadsworth WA. Relationship of life stress to injury i n intercollegiate volleyball. Journal of Human Stress. 1986;12(1):38-43.

69. Hanson SJ, McCullagh P, Tonymon P. The Relationship of Personality Characteristics, Life Stress, and Coping Resources to Athletic Injury. Journal of sport & exercise psychology. 1992;14(3).

70. Carver CS, Scheier MF, Weintraub JK. Assessing coping strategies: a theoretically based approach. Journal of personality and social psychology. 1989;56(2):267.

71. Anshel MH, Sutarso T. Relationships between sources of acute stress and athletes' coping style in competitive sport as a function of gender. Psychology of Sport and Exercise. 2007;8(1):1-24.

72. Smith AM, STUART MJ, WIESE-BJORNSTAL DM, MILLINER EK, O'FALLON WM, CROWSON CS, editors. Competitive athletes: preinjury and postinjury mood state and self-esteem. Mayo Clinic Proceedings; 1993: Elsevier.

73. Junge A. The influence of psychological factors on sports injuries. Review of the literature. The American Journal of Sports Medicine. 2000;28(5 Suppl):S10-5.

74. Lazarus RS, Folkman S. Stress. Appraisal and Coping, New York. 1984.

75. Cohen S, Evans GW, Stokols D, Krantz DS. Behavior, health, and environmental stress: Plenum Press New York:; 1986.

76. Krantz D, Glass D, Contrada R, Miller N. Behavior and health: Mechanisms and research issues. Social Science Research Council: ITEMS. 1981;35:1-6.

77. Calabrese JR, Kling MA, Gold PW. Alterations in immunocompetence during stress, bereavement, and depression: Focus on neuroendrocrine regulation. The American journal of psychiatry. 1987.

78. Jemmott JB, Locke SE. Psychosocial factors, immunologic mediation, and human susceptibility to infectious diseases: How much do we know? Psychological Bulletin. 1984;95(1):78.

79. Cohen S, Doyle WJ, Skoner DP. Psychological stress, cytokine production, and severity of upper respiratory illness. Psychosomatic Medicine. 1999;61(2):175-80.

80. Cohen S, Doyle WJ, Turner RB, Alper CM, Skoner DP. Emotional style and susceptibility to the common cold. Psychosomatic medicine. 2003;65(4):652-7.

81. Petrie TA. Psychosocial antecedents of athletic injury: the effects of life stress and social support on female collegiate gymnasts. Behavioral medicine (Washington, DC). 1992;18(3):127-38.

82. Brink MS, Visscher C, Arends S, Zwerver J, Post WJ, Lemmink KA. Monitoring stress and recovery: new insights for the prevention of injuries and illnesses in elite youth soccer players. British journal of sports medicine. 2010;44(11):809-15.

83. Perna FM, Antoni MH, Baum A, Gordon P, Schneiderman N. Cognitive behavioral stress management effects on injury and illness among competitive athletes: a randomized clinical trial. Annals of behavioral medicine. 2003;25(1):66-73.

84. Barth J, Schumacher M, Herrmann-Lingen C. Depression as a risk factor for mortality in patients with coronary heart disease: a meta-analysis. Psychosomatic medicine. 2004;66(6):802-13.

85. Leddy MH, Lambert MJ, Ogles BM. Psychological consequences of athletic injury among high-level competitors. Research quarterly for exercise and sport. 1994;65(4):347-54.

86. Smolderen KG, Vingerhoets AJ, Croon MA, Denollet J. Personality, psychological stress, and self-reported influenza symptomatology. BMC public health. 2007;7(Journal Article):339.

87. Cohen S, Williamson G, Spacapan S, Oskamp S. The social psychology of health. The social psychology of health. 1988.

88. Conway TL, Vickers RR, Ward HW, Rahe RH. Occupational stress and variation in cigarette, coffee, and alcohol consumption. Journal of Health and Social Behavior. 1981.

89. Kiecolt-Glaser JK, Glaser R. Methodological issues in behavioral immunology research with humans. Brain, Behavior, and Immunity. 1988 3//;2(1):67-78.

90. Vitaliano PP, Russo J, Carr JE, Maiuro RD, Becker J. The ways of coping checklist: Revision and psychometric properties. Multivariate Behavioral Research. 1985;20(1):3-26.

91. Suls J, Fletcher B. The relative efficacy of avoidant and nonavoidant coping strategies: a meta-analysis. Health psychology. 1985;4(3):249.

92. Joyce PY, Smith RE, Vitaliano PP. Stress-resilience, illness, and coping: a person-focused investigation of young women athletes. Journal of Behavioral Medicine. 2005;28(3):257-65.

93. Cohen S, Wills TA. Stress, social support, and the buffering hypothesis. Psychological bulletin. 1985;98(2):310.

94. Allen MS, Greenlees I, Jones M. An investigation of the five-factor model of personality and coping behaviour in sport. Journal of sports sciences. 2011;29(8):841-50.

95. Sexton MB, Byrd MR, von Kluge S. Measuring resilience in women experiencing infertility using the CD-RISC: examining infertility-related stress, general distress, and coping styles. Journal of psychiatric research. 2010;44(4):236-41.

96. Yi JP, Smith RE, Vitaliano PP. Stress-resilience, illness, and coping: a person-focused investigation of young women athletes. Journal of Behavioral Medicine. 2005;28(3):257-65.

97. Cloninger CR, Svrakic DM. Integrative psychobiological approach to psychiatric assessment and treatment. Psychiatry. 1997;60(2):120-41.

98. Luthar SS, Cicchetti D, Becker B. The construct of resilience: A critical evaluation and guidelines for future work. Child development. 2000;71(3):543-62.

99. Davydov DM, Stewart R, Ritchie K, Chaudieu I. Resilience and mental health. Clinical Psychology Review. 2010 7//;30(5):479-95.

100. Garmezy N. Stress-resistant children: The search for protective factors. Recent research in developmental psychopathology. 1985;4:213-33.

101. Rutter M. Resilience in the face of adversity. British journal of psychiatry. 1985;147(1):598-611.

102. Rutter M. Psychosocial resilience and protective mechanisms. American journal of orthopsychiatry. 1987;57(3):316.

103. Baek HS, Lee KU, Joo EJ, Lee MY, Choi KS. Reliability and validity of the korean version of the connor-davidson resilience scale. Psychiatry investigation. 2010;7(2):109-15.

104. Cloninger CR, Przybeck TR, Svrakic DM. The Tridimensional Personality Questionnaire: U.S. normative data. Psychological reports. 1991;69(3 Pt 1):1047-57.

105. Connor KM, Davidson JR. Development of a new resilience scale: the Connor-Davidson Resilience Scale (CD-RISC). Depression and anxiety. 2003;18(2):76-82.

106. Andrews G, Slade T. Interpreting scores on the Kessler Psychological Distress Scale (K10). Australian and New Zealand Journal of Public Health. 2001;25(6):494-7.

107. Sung SM, Kim JH, Yang E, Abrams KY, Lyoo IK. Reliability and validity of the Korean version of the Temperament and Character Inventory. Comprehensive psychiatry. 2002;43(3):235-43.

108. Stewart ME, Ebmeier KP, Deary IJ. The structure of Cloninger's Tridimensional Personality Questionnaire in a British sample. Personality and Individual Differences. 2004;36(6):1403-18.

109. Miettunen J, Kantojärvi L, Ekelund J, Veijola J, Karvonen J, Peltonen L, et al. A large population cohort provides normative data for investigation of temperament. Acta Psychiatrica Scandinavica. 2004;110(2):150-7.

110. Hugo D. Psychological correlates of injury, illness and performance in Ironman triathletes: University of Cape Town; 2008.

111. Seznec J, Lepine J, Pelissolo A. [Dimensional personality assessment of the members of the French junior national team of road cycling]. L'Encephale. 2002;29(1):29-33.

112. Han DH, Kim JH, Lee YS, Bae SJ, Bae SJ, Kim HJ, et al. Influence of temperament and anxiety on athletic performance. Journal of sports science & medicine. 2006;5(3):381.

113. Davidson J, Stein DJ, Rothbaum BO, Pedersen R, Szumski A, Baldwin DS. Resilience as a predictor of treatment response in patients with posttraumatic stress disorder treated with venlafaxine extended release or placebo. Journal of Psychopharmacology. 2012;26(6):778-83.

114. Karaırmak Ö. Establishing the psychometric qualities of the Connor–Davidson Resilience Scale (CD-RISC) using exploratory and confirmatory factor analysis in a trauma survivor sample. Psychiatry Research. 2010;179(3):350-6.

115. Brown DL. African American resiliency: Examining racial socialization and social support as protective factors. Journal of Black Psychology. 2008;34(1):32-48.

116. Hosseini SA, Besharat MA. Relation of resilience whit sport achievement and mental health in a sample of athletes. Procedia - Social and Behavioral Sciences. 2010 //;5(0):633-8.

117. Nezhad MAS, Besharat MA. Relations of resilience and hardiness with sport achievement and mental health in a sample of athletes. Procedia - Social and Behavioral Sciences. 2010 //;5(0):757-63.

118. Kessler RC, Andrews G, Colpe LJ, Hiripi E, Mroczek DK, Normand SL, et al. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. Psychological medicine. 2002;32(6):959-76.

119. Anderson TM, Sunderland M, Andrews G, Titov N, Dear BF, Sachdev PS. The 10-Item Kessler Psychological Distress Scale (K10) as a Screening Instrument in Older Individuals. The American Journal of Geriatric Psychiatry. 2013 7//;21(7):596-606.

120. Byles JE, Robinson I, Banks E, Gibson R, Leigh L, Rodgers B, et al. Psychological distress and comorbid physical conditions: disease or disability? Depression and Anxiety. 2014;31(6):524-32.

121. Inklaar H. Soccer injuries. II: Aetiology and prevention. Sports medicine (Auckland, NZ). 1994;18(2):81-93.

122. Taimela S, Kujala UM, Osterman K. Intrinsic risk factors and athletic injuries. Sports medicine (Auckland, NZ). 1990;9(4):205-15.

123. Williams JaAM. Psychosocial antecedents of sport injury and interventions for risk reduction. In: Tenenbaum gaER, editor. Handbook of sports psychology. 3rd ed. New York: John Wiley and Sons; 2007. p. 379-403.

124. Johnson U. Mental återhämtning och rehabilitering efter idrottsskada. Svensk Idrottsforskning: Organ för Centrum för Idrottsforskning **17**(1): 36-39.

125. Rogers T.M LDM. Mediating effects of peripheral vision in the life event stress/athletic injury relationship. Journal of Sport & Exercise Psychology. 2005;27:271-88.

126. Vasilica G, Cristina AI, Iulian AD, Georgeta M, Radu P. The Profile of the Emotional-affective State of the Middle and Long Distance Running Athletes during the Competition. Procedia - Social and Behavioral Sciences. 2013 7/9/;84(0):1269-74.

127. Brink MS, Visscher C, Arends S, Zwerver J, Post WJ, Lemmink KA. Monitoring stress and recovery: new insights for the prevention of injuries and illnesses in elite youth soccer players. Br J Sports Med. 2010 Sep;44(11):809-15. PubMed PMID: 20511621. Epub 2010/06/01. eng.

128. Weinberg RS, & Gould, D. Foundations of Sport & Exercise Psychology2003.

129. Maddison R PH. Preventing sport injuries: a case for psychology intervention . In: Pargman D, editor. Psychological bases of sport injuries: Morgantown; 2007. p. 25-38.

130. Bramble DM, Lieberman DE. Endurance running and the evolution of Homo. Nature. 2004 Nov 18;432(7015):345-52. PubMed PMID: 15549097. Epub 2004/11/19. eng.

131. Millet GP, Millet GY. Ultramarathon is an outstanding model for the study of adaptive responses to extreme load and stress. BMC medicine. 2012;10:77. PubMed PMID: 22812424. Pubmed Central PMCID: 3407019. Epub 2012/07/21. eng.

132. Miettunen J, Kantojarvi L, Ekelund J, Veijola J, Karvonen JT, Peltonen L, et al. A large population cohort provides normative data for investigation of temperament. Acta Psychiatrica Scandinavica. 2004;110(2):150-7.

133. Han DH, Kim JH, Lee YS, Bae SJ, Bae SJ, Kim HJ, et al. Influence of temperament and anxiety on athletic performance. Journal of Sports Science and Medicine. 2006;5:381-9.

134. Cohen S. Psychological stress and susceptibility to upper respiratory infections. American journal of respiratory and critical care medicine. 1995;152(4 Pt 2):S53-8.

135. Faulkner S, Smith A. A longitudinal study of the relationship between psychological distress and recurrence of upper respiratory tract infections in chronic fatigue syndrome. British journal of health psychology. 2008;13(Pt 1):177-86.

Appendices

Appendix A

UNIVERSITY OF CAPE TO\'VN
Health Sciences Faculty
Research Ethics Committee
Room E52-24 Groote Schuur Hospital Old Main Building
Observatory 7925

Telephone [021]4066338 **. Facsimile** [021]406 6411
e-mail: lamees.emjccli@uct.ac.za
18 March 2009
REC REF: 066/2009
Prof M Schwellnus
Sports Science Institute
Dear Prof Schwel1nus
PROJECT TITLE: TWO OCEANS ULTRA-MARATHON 2009: MEDICAL CONSEQUENCES FOLLOWING ENDURANCE SPORTS
Thank you for submitting your study to the Research Ethics Committee for review.
It is a pleasure to inform you that the Ethics Committee has **formally approved** the above-mentioned study.
Approval is granted for one year till the 20th March 2010.
Please send us an annual progress report if your research continues beyond the approval period. Alternatively,
please send us a brief summary of your findings so that we can close the research file.
Your comments to the queries raised are noted with thanks.
Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.
Please quote the REC. REF in all your correspondence.

Yours sincerely **PROFESSOR M BLOCKMAN**

CHAIRPERSON. HSF HUMAN ETHICS
Federal Wide Assurance Number: FWAOOO01637.
Institutional Review Board (IRB) number: IRBOOO01938
lemjedi
This serves to confirm that the University of Cape Town Research Ethics Committee complies to the Ethics
Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRCSA),
Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP) and Declaration of Helsinki guidelines.
The Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite
Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP /ICH/135/95) and FDA Code Federal
Regulations Part 50, 56 and 312.
Lemjedi

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

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26 June 2014

HREC REF: 066/2009

Prof M Schwellnus
Sports Science Institute

Dear Prof Schwellnus

PROJECT TITLE: TWO OCEANS ULTRA-MARATHON 2009: MEDICAL CONSEQUENCES FOLLOWING ENDURANCE SPORTS

The HREC confirms that the MPhil Sport & Exercise Medicine student, Dr S Baba, is part of the above-mentioned study and his approval is covered under this HREC reference number.

We are aware that he has now completed his thesis and is in the process of submitting.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please quote the HREC reference no in all your correspondence.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN ETHICS

Appendix B

RES CH PROPOSAL

University
Of
Cape Town

TWO OCEANS ULTRA-MARATHON 2009:

MEDICAL CONSEQUENCES FOLLOWING ENDURANCE SPORTS

Principle Investigator
Prof Martin Schwellnus

Co-investigators
Prof Malcolm Collins
Prof Mike Lambert
Prof Andrew Bosch
Prof Wayne Derman
Dr Laurie Rauch
Dr Alison September

Post graduate students

MPhil Sports Medicine students (UCT) (Dr Craig Nossel, Dr Sid Allie, Dr Sachin Baba, Dr Fayruz Sattar, Dr Carolette Cloete, Dr William Lubinga, Dr Osimah Omogbai-Musa)

Collaborators
Dr Richard De Villiers (Private Radiologist)

Medical Officer for the Two Oceans 2009
Dr Karen Schwabe MBBCh, MPhil (Sports Medicine)

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DETAILED PROTOCOL

Introduction AND BACKGROUND

The Two Oceans ultra-marathon is a 56km road race that is held annually in Cape Town. It attracts a large field of ultra-distance runners with varying ability. It is considered one of the most physically demanding ultra-endurance running events. In addition, as the event is held in late summer, athletes may also encounter unfavourable environmental conditions, over and above the extreme physical distance to be covered. It is well established that a significant number of runners seek medical attention at the finish of the race. However, relatively little is still known why these runners seek medical attention at the finish of the event. It is known that most runners who are admitted to the medical facility suffer from dizziness, postural hypotension, muscle cramping. Other medical conditions are related to gastro-intestinal distress, respiratory tract symptoms, injuries (in particular muscle and tendon injuries) and others.

The MRC/UCT Research Unit for Exercise Science and Sports Medicine together with a number of MSc students, and MPhil Sports Medicine students are planning a unit project to study the medical issues that are related to participation in endurance events of this nature. The research study at the 2009 race will focus on a number of medical conditions that runners frequently report. These research areas are similar to those, and will follow on from the findings of studies that were previously conducted by our Unit during 1) the 2000 (REC 005/2000), 2001 Ironman (REC 099/2001), 2006 Ironman (REC 425/2005) competitions held in Cape Town, 2) the 2001 Two Oceans ultra-marathon in Cape Town, 3) the 2005 Comrades ultra-marathon (REC 185/2005) and the 2006 (REC 425/2005) and 2007 (REC 007/2007) Ironman competitions in Port Elizabeth. In 2009, the following research areas will be investigated:

1. Causes of Exercise Associated Muscle Cramping (EAMC) in ultra-marathon runners
2. The genetic basis for common running related injuries, particularly the response of soft tissues (Achilles tendon) to repeated mechanical loading
3. Pre-race predictors (including training parameters, medical history, medication use, and psychological traits) of medical conditions that may occur in runners during and after the Two Oceans ultra-marathon

4. Factors associated with pre-race and post-race (up to 10 days) respiratory tract symptoms in runners
5. Neural Fatigue following the Two Oceans ultra-marathon

BACKGROUND

The brief backgrounds to each of the components of the study are as follows:

Causes of Exercise Associated Muscle Cramping (EAMC) in ultra-marathon runners

The majority of research into possible causes of Exercise Associated Muscle Cramps (EAMC) has focused its attention on factors such as serum electrolyte concentrations, percentage dehydration, heat and metabolic abnormalities. We and others have, however, shown that muscle cramping is not the result of imbalances in fluid or electrolyte status and this led us to suggest that EAMC is not only associated with, but indirectly caused by muscle fatigue. In the 2006 and 2007 Ironman, we have shown that triathletes are more likely to experience cramping if they predict a faster time for the race, and then proceed to compete at a relatively faster time (compared with their past race performance) than a control group. Furthermore, data from the 2007 Ironman indicated that there was an association between the development of EAMC and pre-race injury. Increased training in the pre-race period could therefore result in muscle damage which could predispose to EAMC (reviewed in Schwellnus, 2008).

The genetic basis for common running related injuries, particularly the response of soft tissues (Achilles tendon) to repeated mechanical loading

Data from our laboratory suggests that several genetic polymorphisms are associated with a number of musculoskeletal soft tissue injuries, including Achilles tendon injuries (reviewed in September et al. 2006, 2007) and anterior cruciate ligament ruptures (Collins et al, In Press). These variants might also be associated with flexibility measurements (Collins et al, In Press) and morphological characteristics of the Achilles tendon as determined by soft-tissue diagnostic ultrasound. The exact point prevalence of athletes with asymptomatic tendinopathy with underlying abnormalities is currently unknown. Anecdotal evidence suggests however, that this may be as high as 10-20%.

Pre-race predictors (including training parameters, medical history, medication use, and psychological traits) of medical complications that may occur in runners during and immediately after the Two Oceans ultra-marathon

A significant number of medical complications occur during and following an ultra-marathon running race. The factors that predict may which runner will be admitted to the medical facility can be classified as extrinsic (notably environmental conditions, training) and intrinsic factors. Intrinsic risk factors for admission have not been well studied. More recently, there has been specific interest to determine if psychological parameters increase the risk of injury or medical complication (Hugo D, 2008).

Factors associated with pre-race and post-race (up to 10 days) respiratory tract symptoms in runners

The precise mechanism/s causing an increased incidence of URT symptoms following ultra-endurance events is not well established, but it appears to represent airway inflammatory processes of a non-infectious origin. Alterations in systemic and airway immune function or respiratory tract allergies may explain the mechanisms underlying the URT symptoms reported by athletes, but this requires further investigation (Lichaba M, 2006; Baxter P, 2007).

Neural Fatigue following the Two Oceans ultra-marathon

The extent to which neural fatigue negatively affects exhaustive endurance racing has received scant attention. Difficulty in finding an adequate physiological marker, combined with the logistics of measuring neural processing during a race has precluded research into this very important aspect of endurance performance. It is however possible to measure neural processing immediately following a prolonged endurance event using a portable electroenchaphlography (EEG) machine. In a recent novel case study we tested a medical intern 2 days before and immediately after a 24 h shift. We found marked slowing of information processing in the parietal and occipital areas of the brain and in the P300 component of an Event Related Potential (ERP), generated by colour word prompts presented on a computer monitor during the completion of a modified Stroop test. The propagation of action potentials along nerve fibres are very energy expensive. The energy is supplied by lactate arriving predominantly from glial cell glygogenolysis and glycolysis (derived from blood glucose). Low glycogen availability in brain glial cells would thus influence the speed of action potential propagation (Russell et al. 2006).

AIMS OF THE STUDY

The specific research questions related to each component of the study are as follows:

1. Is EAMC associated with pre-race training regimen, pre-race muscle damage (symptoms and serum creatine kinase activity), pre-race musculoskeletal flexibility, and subsequent race intensity (split times sand finishing times)?
2. What is the point prevalence of underlying Achilles tendon pathology in asymptomatic athletes using ultrasound to demonstrate changes to the Achilles tendons and is there a higher frequency of the “susceptible” variants of the genes shown to be associated with tendon pathology in these athletes?
3. Which factors (mainly intrinsic factors) are associated with an increased likelihood of admission to the medical facility after an ultra-distance running event?
4. Are pre-race factors such as history of allergies, pre-race symptoms, training parameters and other medical conditions related to the development of post-exercise upper respiratory tract symptoms in athletes?
5. Are cognitive neural processes hampered immediately following an ultra-endurance event, and are there alterations in heart rate variability (HRV) as well as in sympathovagal balance?

METHODOLOGY

Pre-race: Website information

In the 6 weeks prior to the race, information about all the components of the study will be made available to all the participants of the race through a number of channels including the following:

1. The Unit (ESSM) website through a link form the race organizers website
2. Electronic mail to participants from the race organisers (through the race organizers database)

3. Mailing by post to participants from the race organisers (if required)

Subject selection and sampling

Using electronic mailing, all individual participants (n ≈ 10 000) taking part in the 2009 Two Oceans Ultra-marathon (11 April 2009) will be approached to volunteer to participate in components of the study. General information about the research study components will be made available to the athletes in the 6 weeks period prior to the race via the organizers (including the Chief Medical Officer of the race) through mailing, electronic mailing and their official website of the race.

Once runners have been sent information about the research study, they will be invited to contact researchers at the UCT/MRC Research Unit for Exercise Science and Sports Medicine (Newlands, Cape Town). Runners will also have the option of participating in the research project by obtaining information and volunteering for the study by contacting researchers who will be present at the time of registration in Cape Town 2-3 days before the event.

Detailed information will be made available about the nature of the different components of the research study, and all the potential risks and benefits of each component of the study will be explained to them through a detailed subject information sheet (Appendix A). Members of the research team will also be available at designated areas at the registration to answer any questions regarding the overall study and its components. Subjects will be free to volunteer to participate in one or more components of the study. At the time of the pre-race registration, written informed consent (Appendix B) will be obtained from the runners taking part in the each component of the study. Specific pre-race testing for different components of the study will also be done at this time.

Pre-race testing for each component of the study

The main data collection for the study will be in the form of a detailed medical and training questionnaire (Appendix C). The questionnaire, which has been used previously during the 2007 Ironman study, does include measures of behavioural endophenotypes (Cloninger's

Temperament and Character Inventory (TCI), the Connor-Davidson Resilience (CDR) scale, and K10 questionnaire].

The TCI measures three traits namely novelty-seeking, harm avoidances and reward dependence. The items were chosen on the basis of psychobiological data, and have been widely used around the world. The CDR measures resilience in response to stressors. In addition, the self-rated K10 questionnaire, which is a 10 question screening tool that is used to detect trends of general distress, will be administered. Completion of self-rated questionnaires has not previously been shown to be associated with risk. The questions within the questionnaires are asking are about temperament and none of the scales are directed at detecting psychopathology.

This questionnaire has been validated and is based, with minor modifications, on the questionnaire that was used successfully in the 2000, 2001, 2006 and 2007 Ironman Research studies (REC 005/2000, 099/2001, 425/2005 and 007/2007). This questionnaire will be available in the 6 weeks before the race and/or during the pre-race registration process (over 3 days before the race).

Additional pre-race data collection procedures for different components of the study are as follows:

Causes of Exercise Associated Muscle Cramping (EAMC) in ultra-marathon runners

In addition to completing the comprehensive medical and training questionnaire subjects volunteering for this component of the study will be asked to donate a venous blood sample, and volunteer for a lower limb range of motion assessment.

Venous blood sample donation

Venous blood (5 ml) for the determination of pre-race serum creatinine kinase activity will be obtained by a phlebotomist from each consenting runner by venipuncture of a forearm vein and collected into an EDTA vacutainer tube. Blood samples were stored at 4°C until analysis is performed.

Lower limb range of motion (ROM) assessment

A previously validated standard lower leg flexibility assessments (straight leg raise and sit and reach tests) will also be done as follows.

Hip joint range of motion (ROM) will be measured indirectly by the straight leg raise (SLR) method (Gajdosik et al. 1993;Goeken & Hof 1991;Goeken & Hof 1993). This method measures hip flexion ROM, thereby providing an index of hamstring musculotendinous unit length (Bullock-Saxton JE & Bullock M 1994). The SLR test will be used to measure hip joint ROM in each subject.

Testing begins by placing each subject in the prone position on a plinth. The length of the posterior aspect of the thigh from the gluteal fold to the popliteal crease is bisected cephalo-caudally into three equal sections. Two disposable self-adhesive surface electrodes are then placed four cm either side of the midline, at the junction between the middle third and the distal third of the thigh. One electrode is placed over the bony prominence at the elbow as an earth (Turker 1993). The electrodes are connected to an electromyographic (EMG) recorder. The EMG recorder is set to scan at a speed equivalent to 10-second sweeps. The raw signal is filtered for background interference and then amplified to detect electrical activity greater than 0.5 mV.

Each subject is requested to lie in a supine position with arms relaxed and folded on the chest and the head resting comfortably on the plinth without a pillow. The ankle joint is held in a 15° plantar flexion position by means of a rigid plasterzoate splint. The splint is lined with three layers of stockinet for subject comfort. The subject's foot is secured in the splint using three Velcro straps. The control leg is placed in 90° knee flexion with the foot supported on the plinth. The pelvis is placed in a posteriorly tilted position to allow the lumbar spine to make contact with the plinth. The pelvis is stabilized in this position using a nine cm wide, rigid belt made of a tightly woven, nylon fibre that is secured around the anterior superior iliac spines and the plinth by means of a two metre long Velcro strap.

An inclinometer is secured to the lateral side of the fibula, on a line drawn between the fibula head and the lateral malleolus of the ankle of the leg to be tested. A point one centimetre distal to the fibula head is used as a reference point for the proximal end of the inclinometer arm. The inclinometer is calibrated before each test to ensure that it is set to the correct starting position of 0°, with the leg fully extended on the plinth. The importance of complete relaxation of the muscle during the procedure is emphasized to each subject. One hand of the tester is placed over the distal anterior thigh and knee of the leg to ensure that full knee

extension is maintained throughout the testing procedure. The tester's other hand is placed under the subject's heel, which is secured in the plasterzoate splint. The tester then lifted the subject's experimental leg at a speed of approximately 30° per second. Prior to the onset of the study, the rate of lifting the leg by the tester will be validated. During this validation procedure, the tester placed various subjects in the supine position on a plinth. Repeated measurements of the time taken to move from neutral (0°) to 90° of hip flexion are taken, using a stopwatch. If the tester deviated from three seconds (3 x 30°) for the procedure, it is repeated. Once the procedure is repeated 10 times consecutively at the correct speed, the investigator is satisfied that the speed would be kept accurately at 30° per second during testing. Throughout all the tests, the tester ensured continued reliability of speed, by measuring the speed of limb movement before the start of each day's testing with a stopwatch as described above.

The tester will record the degree of hip flexion at the end-point of the ROM. This end-point is defined as a spike in EMG activity recorded from the surface electrodes. The subject's leg is then returned to the starting position at a speed of 30° per second.

A static stretch session will then be performed on either the dominant or the non-dominant limbs of each subject. The choice of using the dominant or the non-dominant limb as the experimental leg for each subject will be randomly determined before the start of the study. This will be done to ensure that testing is performed equally on dominant and non-dominant limbs in order to negate the possibility that dominance introduces a bias. The opposite limb will be used as a control.

A standard stretching procedure will be used to increase hamstring musculotendinous unit flexibility (measure of hip joint ROM) and shoulder internal rotation ROM in this study. Briefly, the tester moves the limb undergoing stretching, at a rate of 30° per second, into a position where the subject first reported the feeling of discomfort but not pain. The limb is held at the position in which the subject reported discomfort but not pain for a 30-second duration of the stretch. Once the stretch procedure has been completed, the limb is returned to the neutral position for a rest period of one minute. The stretch procedure is then repeated (30 second hold, followed by 1 min rest) for a total of three stretches. The hip joint ROM measurements will then be repeated 1 minute after the final 30 second stretch.

The genetic basis for common running related injuries, particularly the response of soft tissues (Achilles tendon) to repeated mechanical loading

In addition to completing the comprehensive medical and training questionnaire subjects volunteering for this component of the study will be asked to donate an additional 5ml venous blood sample for DNA analysis, and volunteer for a soft tissue ultrasound examination of the Achilles tendons

Venous blood sample

At one of the pre-race recruitment centres or at race registration, approximately 5 ml of venous blood will be obtained by a phlebotomist from each consenting runner by venipuncture of a forearm vein and collected into an EDTA vacutainer tube. Blood samples were stored at 4°C until total DNA extraction.

Ultrasound examination of the Achilles tendons

At registration, the Achilles tendons of all consenting subjects will be examined by the same radiologist using largely the method described by Gibbon et al (Gibbon, 2000). During each examination the subject will be in a prone position with the heels overhanging the examination couch, with the ankles in their naturally relaxed position with the Achilles tendon fairly taut. For each subject, both Achilles tendons will be examined from the musculotendinous junction to the calcaneal insertion in their transverse and longitudinal axes. The sonographic probe will be placed parallel to the Achilles tendon for transverse scans to avoid anisotrophy artifacts according to Fornage (Fornage, 1987). Tendon degeneration will be defined as an area of decreased echogenecity, heterogeneous echogenecity, or both within a tendon, with or without associated thickening. Paratendinitis will be diagnosed if the paratenon was thickened or contained fluid. Bursitis will be defined by an area of increased fluid distention, adjacent oedema, or both in the region of the retrocalcaneal or superficial precalcaneal bursa. Colour doppler will be used to detect abnormal blood flow in and around the tendon substance. Additionally, tendon sagittal and transverse diameters in the antero-posterior positions will be measured at the thickest point of Achilles tendon. The number of abnormalities found in the tendons of each individual will be counted, documented and allocated a weighted score.

Pre-race predictors (including training parameters, medical history, medication use, and psychological traits) of medical complications that may occur in runners during and immediately after the Two Oceans ultra-marathon

Apart from the questionnaire, no additional methods for pre-race data collection will be used for this component of the study.

Factors associated with pre-race and post-race (up to 10 days) respiratory tract symptoms in runners

Apart from the questionnaire, no additional methods for pre-race data collection will be obtained for this component of the study.

Neural Fatigue following the Two Oceans ultra-marathon

About twenty triathletes, from the greater Cape Town area, will be recruited for this study according to their projected finishing times. A familiarisation trial in the EEG room at the MRC&UCT Research Unit for Exercise Science and Sports Medicine will be conducted during the pre-race testing period (6 weeks before the test), and these tests will be repeated during the 2-3 day registration period before the race.

The tests will be conducted as follows. Each subject will be seated and three ECG electrodes will be attached to their wrists and left ankle, respectively. Subjects will then be positioned in front of a laptop and asked to rest with eyes closed for 2 minutes. Immediately after this they will complete a 5 min Modified Stroop colour word task.

Modified Stroop task:

This task entails the presentation of a cue word in the centre of the laptop screen on a black background (400 msec duration, 2cm in height). The cue word will be the name of one of 4 colours (red, blue, green or yellow), which will be presented either as: (i) neutral - grey colour with the word reading either red, blue, green or yellow; or (ii) incongruent - the word will read either red, blue, green or yellow, while the colour will be different to the word, but not in grey. Subjects will be required to respond as quickly and correctly as possible by pressing one of

four buttons to indicate either the colour of the word on the screen (if the *colour* of word is red, blue, green or yellow), or of the word itself (if *colour* of word is grey). Subjects will be required to use only their two index fingers to press the relevant response button (red and blue buttons with left index finger and green and yellow buttons with right index finger).

The modified Stroop Task will entail 144 colour-word prompts with a 2 second response period allowed. The test will consist of 20% neutral (grey) and 80% incongruent colour words, to increase the cognitive demand of the subjects.

ECG recordings will be done with a BIOPAC MP150WSW System (Goletta, California, USA):

HRV - 3 electrodes placed in Eindhoven triangle positions will measure microvolt ECG signals amplified by the Biopac System and recorded on a laptop PC, before and during the Stroop test.

Pre-race: Morning of the race

No data collection will take place in the morning before the race.

During the race

No data collection will take place during the race.

Post-race data collection: In medical facility

The following components of the study will require data collection in the immediate post-race period. These data will be collected by research teams in a special designated area of the medical care facility which is situated at the finish line of the race.

Causes of Exercise Associated Muscle Cramping (EAMC) in ultra-marathon runners

Following the race, volunteers for this component soft the study will be asked to report to the designated research area within the medical tent. Runners who developed EAMC will be treated in the medical facility in the usual manner, and runners with no EAMC will complete a

short interview to confirm that they did not suffer from any EAMC. Muscle symptoms will be documented and lower limb flexibility (ROM) testing will be repeated.

The genetic basis for common running related injuries, particularly the response of soft tissues (Achilles tendon) to repeated mechanical loading

Both Achilles tendons of all the subjects will undergo a repeat soft tissue diagnostic ultrasound examination by a qualified radiologist in the medical facility after the race

Pre-race predictors (including training parameters, medical history, medication use, and psychological traits) of medical complications that may occur in runners during and immediately after the Two Oceans ultra-marathon

No additional methods for immediate post-race data collection in the medical facility will be used for this component of the study.

Factors associated with pre-race and post-race (up to 10 days) respiratory tract symptoms in runners

No additional methods for immediate post-race data collection in the medical facility will be used for this component of the study.

Neural Fatigue following an Ironman triathlon

Repeat testing will take place in the medical facility after the race. The testing will follow exactly the same protocol as for pre-race testing. Since subjects will be recruited according to their projected finishing times, ~30 minute gaps between the arrival of each subject is expected.

Post race follow-up

Telephonic follow-up and short questionnaire

Runners who volunteer for the EAMC study, and the URT symptoms components of the study will undergo telephonic follow up (short questions) and be requested to complete an abbreviated medical questionnaire (sent via email to them in the 4 week period after the race). The post race questionnaires will not include new questions. Only questions to obtain

medical information from athletes during the race and in the four weeks after the race will be included.

Repeat ultrasound of the Achilles tendons

Runners volunteering for the genetic basis for common running related injuries component of the study will be requested to undergo repeat Achilles tendon ultrasound examinations in the 8 weeks following the race. Both Achilles tendons of all the subjects will undergo a repeat soft tissue diagnostic ultrasound examination by a qualified radiologist.

Post-race laboratory analysis

DNA extraction:

Total DNA was extracted from the sample as described by Lahiri and Nurnberger (1991).

Genotyping of samples:

The DNA samples will be genotyped for polymorphisms within the genes shown or believed to be associated with musculoskeletal soft tissue injuries (reviewed in September et al. 2006, 2007).

Serum creatine kinase activity:

Plasma creatine kinase (CK) activity is the most commonly used indicator of muscle damage (Kryöläinen et al., 2000). Creatine kinase is released into the blood when the cell membrane is damaged, or when there is an alteration in cell membrane permeability (Armstrong, 1986). Blood samples (5 ml) will be collected from an antecubital vein by a qualified phlebotomist under the supervision of a medical practitioner. Samples will be collected into vacutainer tubes containing lithium heparin, and will be kept on ice until centrifugation at 2000 x g for 10 minutes at 4° C. Samples will be stored at -20° C until the analysis of plasma CK activity. Plasma CK activity will be measured by spectrophotometric (Beckman DU-62, Beckman Instruments, Fullerton, CA) enzymatic assays (CK-NAC activated, Boehringer Mannheim Automated Analysis for BM/Hitachi Systems 704, Meylan, France). Once the analysis of plasma CK activity has been completed, the samples will be destroyed.

ETHICAL CONSIDERATIONS OF THE STUDY

The study will be performed in accordance with the principals of the Declaration of Helsinki. Subjects will be informed about the purpose of the study, the testing to be undertaken, the possible risks relating to the trial, and their right to withdraw from the study at any stage. Subjects will be provided with full, adequate and understandable oral and written explanations of the testing procedures, including all possible risks, involved in this study. All subjects will be required to provide written informed consent (Appendix B) before being allowed to take part in the study. Subjects will be given the right to withdraw from the study at any time without reason or prejudice. All data will be kept confidential and anonymous.

This research study will be covered by a liability insurance policy with the University of Cape Town. In addition, each of the medical practitioners involved in the medical care of athletes will have up to date professional medical insurance.

POTENTIAL RISKS AND BENEFITS OF COMPONENTS OF THE STUDY

General potential risks of the study

A number of components of this study involve completion of a questionnaire, collection of electronic data, and collection of blood samples, measurement of flexibility of the lower limb (straight leg raise test) and ultrasound examination of the Achilles tendons.

The completion of a 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. Electronic files containing Stroop test data (neural fatigue component) will also be kept confidential.

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 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.

Lower limb flexibility will be measured using standard techniques, and there is no risk associated with this procedure.

In healthy individuals competing in a running event Achilles tendon ultrasound examination, which is a non-invasive procedure, has no known risk.

Specific potential risks of components of the study

Causes of Exercise Associated Muscle Cramping (EAMC) in ultra-marathon runners

The flexibility tests are standard tests that are used daily in clinics and are associated with minimal risk. The only risk is to overstretch, but (1) an experienced tester will be administering the tests, (2) all normal precautions will be taken to avoid over-stretching, (3) and the participant will be asked to indicate when the stretch becomes uncomfortable, which is the normal clinical end point for the test.

Neural Fatigue following an Ultra-marathon

Measurements taken for this component of the study will be completely non-invasive. The ECG electrodes merely records millivolt electric activity generated by the heart.

Potential benefits of components of the study

The general results of each component of the study will be made known to all the participating subjects. The results will be posted on the website, sent by email, and subjects will be invited to attend a research subject feedback evening at the Sports Science Institute. No individual results of athletes will be made known.

All the research questions that will be addressed by this study have been identified to have a direct impact on improving medical care to triathletes, preventing medical complications, and understanding risk factors for medical conditions that can occur during triathlon.

STATISTICAL ANALYSIS OF DATA

All the data will be recorded and transferred to an Excel spreadsheet. Data analysis will take place using Statistica software. Standard descriptive statistical analysis will be conducted, using uni- and bi-variate analysis where appropriate.

REFERENCES

Armstrong RB. Muscle damage and endurance events. Sports Medicine 3: 370-381, 1986

Baxter P. Clinical and immunological factors associated with post-race Upper Respiratory Tract Symptoms (URTS) in Ironman triathletes. MPhil Sports Medicine dissertation, UCT, 2007

Bullock-Saxton JE & Bullock M 1994, "Repeatability of muscle length measures around the hip", Physiotherapy Canada, vol. 46, no. 2, pp. 105-109.

Burkett, L. N. 1970, "Causative factors in hamstring strains", Med.Sci.Sports, vol. 2, no. 1, pp. 39-42.

Collins M., Posthumus, M. and Schwellnus, M.P. The COL1A1 gene and acute soft tissue rupture. British Journal of Sports Medicine, In Press.

Collins, M., Mokone, G.G., September, A.V., van der Merve, L. and Schwellnus, M.P. The COL5A1 genotype is associated with range of motion measurements. Scandinavian Journal of Medicine and Science in Sports, In Press.

Gajdosik, R. L., Rieck, M. A., Sullivan, D. K., & Wightman, S. E. 1993, "Comparison of four clinical tests for assessing hamstring muscle length", J Orthop Sports Phys Ther, vol. 18, no. 5, pp. 614-618.

Goeken, L. N. & Hof, A. L. 1991, "Instrumental straight-leg raising: a new approach to Lasegue's test", Arch.Phys Med Rehabil., vol. 72, no. 12, pp. 959-966.

Goeken, L. N. & Hof, A. L. 1993, "Instrumental straight-leg raising: results in healthy subjects", Arch.Phys Med Rehabil., vol. 74, no. 2, pp. 194-203.

Hugo D. Psychological correlates of injury, illness and performance in ironman triathletes, MPhil Sports Medicine dissertation, UCT, 2008

Kryöläinen H, Pullinen T, Candau R, Avela J, Huttunen P, and Komi PV. Effects of marathon running on running economy and kinematics. Eur J Appl Physiol 82: 297-304, 2000.

Lahiri,K, J I Nurnberger, 1991, A rapid non-enzymaticmethod for the preparation of HMW DNA from blood for RFLP studies: Nucleic Acids Research, v. 19, p. 5444.

Lichaba M. Upper respiratory tract symptoms and allergies in Ironman triathletes. MPhil Sports Medicine dissertation, UCT, 2006

Schwellnus MP. Cause of Exercise Associated Muscle Cramps (EAMC) - Altered Neuromuscular Control, Dehydration or Electrolyte Depletion? Br J Sports Med (in press), 2009

September AV, Mokone GG, Schwellnus MP, Collins M. Genetic risk factors for Achilles tendon injuries. International SportMed Journal 2006;7:201-15.

September AV, Schwellnus MP, Collins M. Tendon and ligament injuries: the genetic component. Br J Sports Med 2007;41:241-6.

Turker, K. S. 1993, "Electromyography: some methodological problems and issues", Phys Ther, vol. 73, no. 10, pp. 698-710.

Appendix C

Race n^{o}:
_____

TWO OCEANS RESEARCH STUDIES 2009

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. Causes of Exercise Associated Muscle Cramping (EAMC) in ultra-marathon runners
2. The genetic basis for common running related injuries, particularly the response of soft tissues (Achilles tendon) to repeated forces during running (mechanical loading)
3. Pre-race predictors (including training parameters, medical history, medication use, and psychological characteristics (traits) of medical complications that may occur in runners during and immediately after the Two Oceans ultra-marathon
4. Factors associated with pre-race and post-race (up to 10 days) respiratory tract symptoms in runners
5. Brain and nervous system tiredness (Neural Fatigue) following the Two Oceans ultra-marathon

I understand that my participation in this research project has no direct benefits to me during the Two Oceans 2009 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:

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

1. <u>Completion of a questionnaire:</u> (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 personality characteristics (temperament) and none of the scales are directed at picking up psychological abnormalities (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 Two Oceans marathon, 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 ultramarathon.

2. <u>Blood sample collection for re- serum creatine kinase (marker of muscle damage) levels</u> (only for the cramps component)

I have agreed to donate 5 milliliters (1 teaspoon) of venous blood during registration. The sample will be used to measure my levels of a muscle enzyme that is released if muscle is damaged (serum creatine kinase levels). The potential risks associated with blood collection technique from the veins on my arm (ante-cubital veins) are: infection, delayed healing, blood clot (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 staff that is trained to take blood samples (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.

3. <u>Measurement of Flexibility :</u> (only for the cramps component)

I have agreed to undergo measurements of my lower limb flexibility. I understand that the two tests are the straight-leg raise test, and the sit-and-reach test. In both these test my limbs will be relaxed and electrodes to measure muscle activity will be attached to my skin (back of the thigh). A tester who is experienced in

administering these test, will then perform the tests as follows: 1) my leg will be raised (with the knee straight) until it feels "tight" and a muscle activity signal is registered on a machine that measures electrical signals from the muscles (electromyographic machine - EMG) - the degree to which my leg is lifted will be measured. 2) I will be asked to sit on the floor and then reach forward with both hands until it feels tight – the distance from my fingertips to my toes will then be measured. These are standard tests that are used daily in clinics and are associated with minimal risk. The only risk is to overstretch, but I will have the freedom to stop the test at any time if the stretch becomes uncomfortable.

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

   The stroop test is a simple, computer based test (similar to a computer game). 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

5. **Soft tissue diagnostic ultrasound examination: (only for the Achilles tendon component)**

   I understand that I will be subjected to a test where gel is applied to my skin and a special machine is used to see the Achilles tendon underneath the skin (soft tissue diagnostic ultrasound examination of my Achilles tendons) during the registration period, on completion of the race, and if possible 6 weeks after the race at a medical facility close to my home. I understand that I will not receive any direct financial compensation to attend this centre for the ultrasound, but that the investigation will be free of charge. I understand that these investigations are not associated with any risk, and will be performed by a trained radiologist.

6. **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 associated with blood collection technique from the veins on my arm (ante-cubital veins) are: infection, delayed healing, blood clot (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 staff that is trained to take blood samples (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 genetic material that is extracted from my blood (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 my inherent behaviour and responses (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 without revealing any of my personal details (anonymously) and my DNA sample will be destroyed on completion of the study.

   I understand that some of the DNA extracted from 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 published in journals on the condition that neither my name nor any other identifying information is used.

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 athlete: _____

Signature of athlete _____

Date: _____ April 2009

Name of main investigator: Prof Martin Schwellnus

Signature of main Investigator: _____

Date: _____ April 2009

Appendix D

Race n°:
_____

Human Biology
NIT FOR EXERCISE SCIENCE & SPORTS MEDICINE
es, University of Cape Town
ı 7700, South Africa

2009 TWO OCEANS ULTRA-MARATHON – MEDICAL, INJURY AND TRAINING QUESTIONNAIRES

These questionnaires have been constructed by the Medical Research team, in conjunction with the Medical Director of the 2008 Two Oceans Ultra-Marathon. The information obtained from these questionnaires is essential for the planning of medical care during events such as the Two Oceans. We acknowledge that the questionnaires are long, but we are asking about 30 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 downloading and completing this before the event and handing in the completed questionnaire, at the research area during race registration.

Prof Martin Schwellnus (Chairman, Research Team)
Dr Karen Schwabe (Medical Officer, Two Oceans 2009)

Instructions

Please answer each question by filling in the details in the allocated space or checking one or more of the option boxes.

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

Section A	Personal Details
Section B	Racing, Training and Equipment Use History
Section C	History of Medication, Supplement and Fluid Use as well as Lifestyle and Habits History
Section D	General Personal Medical and Injury History
Section E	Family Medical History
Section F	Psychological and Behavioural History

Section A: Personal details			
2008 Two Oceans 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	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) _____ %		

Section B. Racing, training and equipment history			
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 of these 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 Ultra-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 predicted time for the 2009 Two Oceans ultra-marathon?	_____ hrs _____ min		
What is your predicted time for the through the marathon mark during the 2009 Two Oceans ultra-marathon?	_____ hrs _____ min		

Please answer the following questions, with your answers reflecting your average in the **most recent 15 weeks i.e. beginning January 2009 to 11th April, 2009.**	
Do you train with a heart rate monitor?	Yes ☐ No ☐
Do you race with a heart rate monitor?	Yes ☐ No ☐
Do you use heart rate information to control your training pace?	Yes ☐ No ☐
Do you use heart rate information to control your racing pace?	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/wk
What distance did you train in an average week during the **last 15 weeks**?	km/wk
How many hours a week did you **train** in an average week during the **last 15 weeks**?	hrs/wk
How many hours a week did you **work** in an average week during the **last 15 weeks**?	hrs/wk
What **distances** did you train in the week before the race?	km
How many **hours** did you train in the **week before** the race?	hours
How many fast/ hard sessions did you do per week in the **last 8 weeks**?	
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 42.2 km speed or faster?	%
How many hours did you train 3 days before the race	hours
How many hours did you train 2 days before the race	hours
How many hours did you train the day before the race	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 Equipment use section of questionnaire**	
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 in a stretch session, 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 **brand of running shoe** you use?	☐ Adidas ☐ Asics ☐ Brooks ☐ New Balance ☐ Nike ☐ Mizuno ☐ Puma ☐ Reebok ☐ Saucony ☐ Other: _____
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: _____
Please indicate whether you use any of the following **inserts/orthotics** in your shoes?	☐ Soft shock absorbing insole for pronation ☐ Rigid full length orthotic ☐ Soft heel lift for pronation ☐ Rigid ¾ length orthotic ☐ Soft arch support ☐ Forefoot support only ☐ Other: _____

Section C. History of medication, supplement and fluid use as well as lifestyle and habits history		
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 ☐ Most sessions ☐ Some 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 ☐ 6 months ☐ 12 months ☐ 24 or more months
Have you ever been given an injection with corticosteroids? (If **yes**, how long ago?)	Yes ☐ No ☐	☐ 3 months ☐ 6 months ☐ 12 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 ☐ Twice ☐ 3 times ☐ >3 times
Have you ever used	Yes ☐ No	☐ 3 months ☐ 6 months

fluoroquinoline antibiotics? (refer to the following list)	☐	☐ 12 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 history	
How do you best describe your fluid intake during a 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 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 athletes _____ Coach / trainer _____ Magazines / books _____ Website (please specify: _____) _____ Drinking guidelines from sports associations _____ Adverts _____ Self-experimentation _____ Other: _____

Section D. General personal medical and injury history	
In this section, you are asked to read through 13 questions about your personal general medical and injury history. If you answer "yes" to any of questions, please complete the additional questions about that symptom/injury.	
Question 1: Flu symptoms	
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 ☐
If you answered **NO** to **question 1 – Please go to Question 2 below** If you answered **YES** to **question 1 -** please complete the following additional questions	
(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: _____)

Question 2: Muscle cramping	
Have you **ever** in your running 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 ☐
If you answered **NO** to **question 2 – Please go to Question 3 below** If you answered **YES** to **question 2 -** please complete the following additional questions	
(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

Question 3: Tendon or ligament injury			
Have you **ever** in your running 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 ☐
If you answered **NO** to **question 3 – Please go to Question 4 below** If you answered **YES** to **question 3 -** please complete the following additional questions			
(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	**Ligament**		**Sprain** / **Complete Tear**

which **ligament/s** you have injured? (next column on the tright) Also indicate if your sprained or completely tore the ligamant.	☐ 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	

Question 4: Medicine use to treat injuries	
Have you **ever** in your running 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 ☐
If you answered **NO** to **question 4 – Please go to Question 5 below** If you answered **YES** to **question 4 -** please complete the following additional questions	

(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: _____)

Question 5: Gastro-intestinal symptoms during running	
Have you **ever** in your running career suffered **gastrointestinal** symptoms **during running** including heartburn, nausea, vomiting, abdominal pain, urge to defecate (pass a stool), diarrhoea, or blood in the stools?	Yes ☐ No ☐
If you answered **NO** to **question 5 – Please go to Question 6 below** If you answered **YES** to **question 5 -** please complete the following Table	

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 the **"severity" of the GIT symptom** during exercise
Nausea			☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Vomiting			☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Heartburn			☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Abdominal pain			☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Urge to pass a stool (defecate)			☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Diarrhoea			☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Passing blood in the stool			☐ 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

Question 6: Nervous system symptoms during running

Have you **ever** in your running career suffered from symptoms of the **nervous system** including exercise induced headaches, nerve tingling or loss of sensation?	Yes ☐ No ☐
If you answered **NO** to **question 6 – Please go to Question 7 below** If you answered **YES** to **question 6 -** please complete the following Table	

Symptom	Number of times in the last 12 months **(during exercise)**	Number of times in last 10 races **(during races)**	Please indicate the **"severity" of the symptom** during exercise
Headaches			☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Nerve tingling in the hands			☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Loss of sensation in the hands			☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing

Question 7: Allergy symptoms	
Have you **ever** in your running 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 ☐
If you answered **NO** to **question 7 – Please go to Question 8 below** If you answered **YES** to **question 7 -** please complete the following Table	

(7a) Please indicate how long (years) have you been suffering from allergies?					years
(7b) 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 ☐
(7c) 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 ☐
(7d) 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 ☐
(7e) 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				

(7f) 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 ☐

Question 8: Asthma	
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 ☐
If you answered **NO** to **question 8 – Please go to Question 9 below** If you answered **YES** to **question 8 -** please complete the following questions	
(8a) How many years have you suffered from asthma?	(years)
(8b) 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: _____)
(8c) 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
(8d) 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

(8e) 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
(8f) Which **symptoms of asthma** do you currently suffer from?	☐ Wheezing ☐ Dry cough ☐ Shortness of breath ☐ Tight chest ☐ Chest pain ☐ Other (Specify: _____)
(8g) 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: _____)
(8h) **When do you use your medication** for your asthma?	☐ Daily (irrespective of exercise) ☐ Only before exercise ☐ Other (Specify: _____)
(8i) **How long before an exercise session** do you use your medication for asthma?	min
(8j) Have you obtained **TUE (therapeutic use exemption forms)** for your asthma medication?	Yes ☐ No ☐

Question 9: History of collapse	
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 ☐
If you answered **NO** to **question 9 – Please go to Question 10 below** If you answered **YES** to **question 9 -** please complete the following questions	
(9a) Have you ever collapsed during training or racing?	☐ Training ☐ Racing ☐ Training and racing
(9b) How many times have you collapsed in training session or races during the last **five years**?	_____ training session _____ races
(9c) How many times have you collapsed in training session or races during the last **12 months** (1 year)?	
(9d) When you collapse, does it mostly occur before of after the finish line / completion of the training session?	☐ Before the finish ☐ After the finish
(9e) What is the cause of you collapse?	☐ Dehydration ☐ Heat illness ☐ Hyponatremia ☐ Low blood pressure ☐ Low blood sugar ☐ Other condition (Specify: _____)

Question 10: History of running injury	
Did you suffer from any **symptoms of a running injury** (muscles, tendons, bones, ligaments or joints) in the **past 12 months**?	Yes ☐ No ☐
Do you **currently** suffer from any **symptoms of a running injury (**muscles, tendons, bones, ligaments or joints)?	Yes ☐ No ☐
If you answered **YES** to **question 10 above (past injury or current injury)**, please complete the following questions (10a. to 10g.) related to **each of your past or current injury/ies** (Space is provided for two injuries)	
Injury 1 **Please tick if past or current: ☐ Past ☐ Current**	

(10a) What was the approximate date when you first became aware of the injury?	Month Year
(10b) Please indicate which side of your body is injured (if applicable)	☐ Right ☐ Left
(10c) Please indicate which anatomical area is/was injured	☐ Head ☐ Elbow ☐ Hamstring ☐ Neck ☐ Forearm ☐ Quadriceps ☐ Face ☐ Wrist ☐ Knee ☐ Front chest ☐ Finger ☐ Shin ☐ Back chest ☐ Lower back ☐ Achilles ☐ Shoulder ☐ Hip ☐ Ankle ☐ Upper arm ☐ Thigh ☐ Foot Other (Specify: _____)
(10d) Please indicate the type of structure that was injured	☐ Muscle strain ☐ Ligament sprain ☐ Tendinosis ☐ Joint (arthritis) ☐ Bone bruise (stress fracture) Other (Specify: _____)
(10e) Please indicate if you injury was any of the following common running injuries	☐ Patellofemoral pain ☐ Iliotibial band (ITB) ☐ Plantar fasciitis ☐ Achilles tendonitis ☐ Lower back pain ☐ Hip muscle injury ☐ Hamstring injury ☐ Quadriceps muscle injury ☐ Shin splints (bone) ☐ Shin splints (muscle/tendon) ☐ Foot pain ☐ Heel pain Other (Specify: _____)
(10f) 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

(10g) Please indicate how your injury was treated to date (you can tick more than one)?	☐ Rest ☐ Tablets ☐ Stretches ☐ Cortisone injection ☐ Physiotherapy ☐ Other injection ☐ Surgery ☐ Orthotics ☐ Strengthening exercises ☐ Equipment change Other (Specify: _____)
Injury 2 **Please tick if past or current: ☐ Past ☐ Current**	
(10a) What was the approximate date when you first became aware of the injury?	Month Year
(10b) Please indicate which side of your body is injured (if applicable)	☐ Right ☐ Left
(10c) Please indicate which anatomical area is/was injured	☐ Head ☐ Elbow ☐ Hamstring ☐ Neck ☐ Forearm ☐ Quadriceps ☐ Face ☐ Wrist ☐ Knee ☐ Front chest ☐ Finger ☐ Shin ☐ Back chest ☐ Lower back ☐ Achilles ☐ Shoulder ☐ Hip ☐ Ankle ☐ Upper arm ☐ Thigh ☐ Foot Other (Specify: _____)
(10d) Please indicate the type of structure that was injured	☐ Muscle strain ☐ Ligament sprain ☐ Tendinosis ☐ Joint (arthritis) ☐ Bone bruise (stress fracture) Other (Specify: _____)

(10e) Please indicate if you injury was any of the following common running injuries	☐ Patellofemoral pain ☐ Iliotibial band (ITB) ☐ Plantar fasciitis ☐ Achilles tendonitis ☐ Lower back pain ☐ Hip muscle injury ☐ Hamstring injury ☐ Quadriceps muscle injury ☐ Shin splints (bone) ☐ Shin splints (muscle/tendon) ☐ Foot pain ☐ Heel pain Other (Specify: _____)
(10f) 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
(10g) Please indicate how your injury was treated to date (you can tick more than one)?	☐ Rest ☐ Tablets ☐ Stretches ☐ Cortisone injection ☐ Physiotherapy ☐ Other injection ☐ Surgery ☐ Orthotics ☐ Strengthening exercises ☐ Equipment change Other (Specify: _____)

Question 11 and 12: Other medical history	
11. 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 ☐

12. 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: _____)

Question 13: Female runners only:
Please complete the following questions (13a. to 13g.) related to your menstrual cycle and other gynaecological history

13a. At what age did you start your periods (menstruating)?	(years)
13b. In the last 12 months, how many menstrual cycles did you have?	
13c. Have you ever had irregular menstrual periods in the past? (excluding pregnancy)?	Yes ☐ No ☐
13d. Have you had a hysterectomy/ovarectomy?	Yes ☐ No ☐
13e. How many times have you been pregnant?	(times)
13f. What form of contraception are you currently using?	☐ None ☐ Oral contraceptive pill ☐ Injection ☐ Intra-uterine device ☐ Sterilization (tubes tied) ☐ Other: _____
13g. If yes to question 15f. above, for oral contraceptive pill, for what reason was the pill prescribed?	☐ Not applicable ☐ Dermatological ☐ Contraception ☐ Regulate period ☐ Other: _____

Section E. Family medical history		
Have any of your blood (biological) relatives <u>ever</u> 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. Psychological and Behavioural questions					
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

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE

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

Appendix E

TWO OCEANS RESEARCH STUDIES 2009

SUBJECT INFORMATION SHEET

Dear Athlete

We have the privilege to inform you that scientific research at the 2009 Two Oceans ultra-marathon 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 ultra-marathon. 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 5 main components that will ultimately lead to an **improvement in medical and physiological knowledge which may improve training strategies and medical treatment** at future ultra-marathon and other endurance events:

6. Causes of Exercise Associated Muscle Cramping (EAMC) in ultra-marathon runners
7. The genetic basis for common running related injuries, particularly the response of soft tissues (Achilles tendon) to repeated mechanical loading
8. Pre-race predictors (including training parameters, medical history, medication use, and psychological traits) of medical complications that may occur in runners during and immediately after the Two Oceans ultra-marathon
9. Factors associated with pre-race and post-race (up to 10 days) respiratory tract symptoms in runners
10. Neural Fatigue following the Two Oceans ultra-marathon

As a participant in the 2009 Two Oceans ultra-marathon, you are given the choice to participate in this research effort. Your participation is entirely voluntary. Please read through the details of the following five 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: (021) 650 4567

SUBJECT INFORMATION SHEET:

COMPONENTS OF THE RESEARCH STUDY TO BE CONDUCTED AT THE

2009 TWO OCEANS ULTRA-MARATHON

The research study at the 2009 Two Oceans ultra-marathon will have five components. You will be free participate in all, or some of the components of the study. The detailed information on each of these components of the study is as follows:

Component 1: Causes of Exercise Associated Muscle Cramping (EAMC) in ultra-marathon runners

The purpose of this component of the study is to determine the possible causes of exercise associated muscle cramping (EAMC) in endurance athletes. At registration, athletes will be given the opportunity to volunteer to participate in this component of the study.
Details of the study are as follows:

- Prior to, or at registration, a questionnaire detailing personal particulars, medical information, training information, and history of muscle cramping will be completed.
- At registration, a blood sample (5ml – 1 teaspoon) will be collected from the vein in the arm using standard procedures.
- In the 8 weeks after the race, you may be contacted by telephone or email, and asked to complete a short questionnaire so that the researchers can determine if you suffered from EAMC during or after the race

Potential risks of this component of the study

- The completion of a 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.
- 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 blood collection technique from the veins on my arm (ante-cubital veins) are: infection, delayed healing, blood clot (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 staff that is trained to take blood samples (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 flexibility tests that will be used are standard tests that are used daily in clinics and are associated with minimal risk. The only risk is to overstretch, but (1) an experienced tester will be administering the tests, (2) all normal precautions will be taken to avoid over-stretching, (3) and you will be asked to indicate when the stretch becomes uncomfortable, which is the normal clinical end point for the test.
- All medical conditions, including EAMC, will be treated appropriately on the course and in the medical facility at the finish of the race. The most appropriate treatment will be initiated and administered by the medical staff at the event, and the patient will be transported to the local hospital if necessary. The support from the local hospital is part of the normal standard medical care associated with this event.

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 cause of EAMC is better understood, this will improve our ability to prevent this condition, and to treat it effectively if it does occur.

Component 2: The genetic basis for common running related injuries, particularly the response of soft tissues (Achilles tendon) to repeated mechanical loading

Data from our laboratory suggests that several genetic variants are associated with a number of tendon and ligament injuries. These genetic variants might also be associated with flexibility measurements and structural characteristics of the Achilles tendon. The purpose of this component of the study will be to (i) to determine what the effect of an endurance event (such as the Two Oceans) is on the structure of the Achilles tendon and (ii) to determine whether there is a higher frequency of the "susceptible" variants of the genes shown to be associated with tendon injury (pathology) in these athletes.

At registration you will be required to complete a questionnaire with personal details, training details, past injury details, and details about family history. In addition, a 5ml (1 teaspoon) blood sample will be taken from a vein in your arm.

You can then volunteer that a qualified radiologist examines both your Achilles tendons using a soft tissue diagnostic ultrasound machine. This procedure entails putting a clear jelly on your skin, and then using a probe to examine the tendon by passing it over the skin. This is not associated with any discomfort. You will be given immediate feedback on the imaging results of this examination, and will be given any advice the management of any findings.

After you complete the race, you may be asked to undergo the same procedure (ultrasound examination) in the medical facility at the finish. Finally, you may be asked to report to the Sports Science Institute of South Africa in Newlands for a final ultrasound examination approximately 6 weeks after the race. The cost of this will be free, but you will not receive any financial compensation to attend this centre.

The blood sample will be used for the extraction and analysis of genetic material (DNA). The DNA will only be used for scientific research purposes relating to medical complaints during ultra-endurance events. All data will be analysed anonymously and DNA samples will be destroyed on completion of the study.

Potential risks of this component of the study

- The completion of a 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.
- 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 veins on my arm (ante-cubital veins) are: infection, delayed healing, blood clot (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 staff that is trained to take blood samples (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.
- Soft tissue diagnostic ultrasound is a well described and common clinical diagnostic procedure that is associated with no known risk. This procedure will be undertaken by a trained radiologist.

Potential benefits of this component of the study

- The anticipated benefits of this component of the study are that the results will clarify why certain runners may be more or less prone to chronic tendon injuries, based on their genetic make-up. In future, this work may lead to the screening and early identification of an increased risk for tendon injuries, so that preventative measures can be undertaken.

Component 3: Pre-race predictors (including training parameters, medical history, medication use, and psychological traits) of medical complications that may occur in runners during and immediately after the Two Oceans ultra-marathon

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. The main aim of this component is to determine if there are any factors that can be identified before the race that will predict whether a runner is likely to develop a medical problem during or after the race. The details of the study are as follows:

- Prior to, or at registration, a detailed questionnaire detailing personal particulars, medical information, training information, and psychological parameters will be completed.
- In the 8 weeks after the race, you may be contacted by telephone or email, and asked to complete a short questionnaire so that the researchers can determine if you suffered from a medical problem during or after the race

Potential risks of this component of the study

- The completion of a 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.

Potential benefits of this component of the study

- There is not direct benefit to an individual in participating in this component of the study. However, the long term anticipated benefits of this component of the research study are to identify factors that may predispose an increased risk of medical consequences during running. This information will eventually assist runners in predicting and improving their performance, and decrease their risk of medical complications during running.

Component 4: Factors associated with pre-race and post-race (up to 10 days) respiratory tract symptoms in runners

Upper respiratory tract (URT) symptoms such as a sore throat, runny or blocked nose, and throat irritation are particularly common in ultra distance athletes including tri-athletes. These symptoms occur mostly in the 2 weeks after a race. It has been shown to occur in 30-50% of all athletes after endurance events. It is important to understanding the relationship between exercise and URT symptoms as it is known that infections have potential negative effects for the athlete. Having an infection or not may mean the difference between being able to compete safely, performing at a sub-optimum level at risk, or missing the event altogether because of illness. In recent years we have become aware that the symptoms of URT infections that endurance athlete suffer from after a race, may NOT be caused by an infection. Instead this may reflect an irritation of the inner cell lining of the nose and throat due to allergy or perhaps pollution. However, we still need more evidence to prove this.

The aim of this component of our research is to determine which factors may predict the development of upper respiratory tract symptoms that are commonly experienced by athletes after a race.

The details of the study are as follows:

- Prior to, or at registration, a detailed questionnaire detailing personal particulars, medical information, training information, respiratory tract symptoms and psychological parameters will be completed.
- In the 8 weeks after the race, you may be contacted by telephone or email, and asked to complete a short questionnaire so that the researchers can determine if you suffered from respiratory tract symptoms during or after the race

Potential risks of this component of the study

- The completion of a 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.

Potential benefits of this component of the study

- The anticipated benefits to subjects participating in this component of the study are firstly that the knowledge of the cause of the symptoms of the URT after an endurance event will be known, secondly that runners can be given accurate and safe advice on training during the recovery period.

Component 5: Neural Fatigue following the Two Oceans ultra-marathon

The aim of this study is to increase our understanding of the extent of the nervous systems ability to manage information and whether it has become slowed down or tired (neural processing slowdown/changes and arousal changes) that occurs in athletes having just completed an exhaustive ultra-marathon. 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 test similar to a computer game (Stroop tes)t – 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 subtle variations in the heart rate (heart rate variability - HRV).

A familiarisation test will be conducted 6 weeks prior to the Two Oceans in a laboratory 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 Two Oceans during registration in a separate testing area; and finally a post-event test will be done within 30 min of completing the Two Oceans in the medical tent.

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

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 personality characteristics (temperament) and none of the scales are directed at picking up psychological abnormalities (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

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.

Appendix F

Race number:
_____

Two Oceans Research Project
MUSCLE PAIN SCORE SHEET

Subject Name: _____

Quadriceps (front of thigh)

No pain Unbearable pain

Pain at rest

No pain Unbearable pain

Pain during normal daily activities (e.g. walking, stairs)

No pain Unbearable pain

Pain during stretch (pull heel back towards buttock)

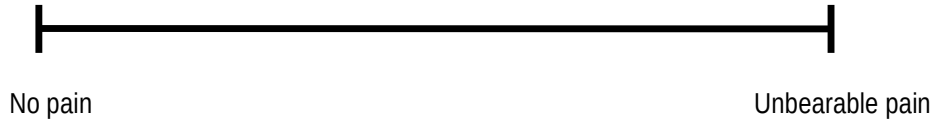
No pain Unbearable pain

Pressure pain (apply pressure to front of thigh)

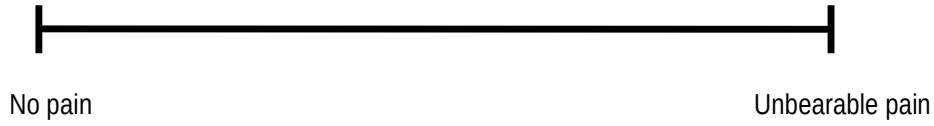
Subject Name: _____

Race number: _____

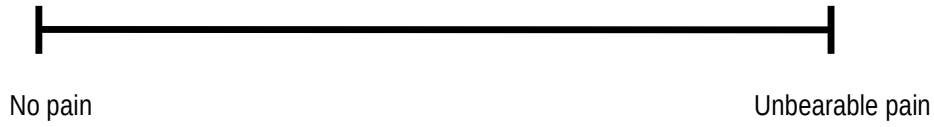
Hamstrings (back of thigh)



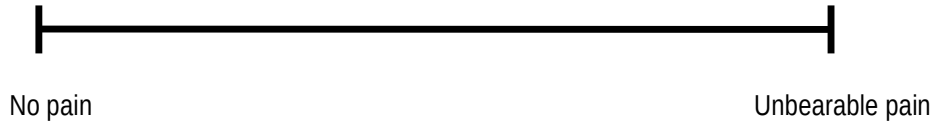
Pain at rest



Pain during normal daily activities (e.g. walking, stairs)



Pain during stretch (standing, reach down and touch toes)



Pressure pain (apply pressure to back of thigh)

Subject Name: _____

Race number: _____

Gastrocnemius (calf muscle)

No pain Unbearable pain

Pain at rest

No pain Unbearable pain

Pain during normal daily activities (e.g. walking, stairs)

No pain Unbearable pain

Pain during stretch (leg back, heel flat on floor, knee straight, lunge forwards)

No pain Unbearable pain

Pressure pain (apply pressure to calf)