Respiratory health of the endurance athlete: Prevalence of respiratory related conditions/illnesses in endurance athletes

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Declaration

I, **Carolette Cloete**, 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.

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(Date)

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- To the Creator of all, as I study the work of Your hands, I stand in awe!

Table of contents

List of tables

List of abbreviations

EIB	Exercise-induced bronchoconstriction
AHR	Airway hyperresponsiveness
ASM	Airway smooth muscle
PFT	Pulmonary function test
FEV_1	Forced expiratory volume in one second (FEV_1)
FVC	Forced vital capacity
PDA	Physician diagnosed asthma
RTS	Respiratory tract symptoms
URTS	Upper respiratory tract symptoms
LRTS	Lower respiratory tract symptoms
SS	Systemic symptoms
URTI	Upper respiratory tract infection
LRTI	Lower respiratory tract infection
SPT	Skin prick test
RAST	Radioallergosorbent test
BPT	Bronchial provocation test
EVH	Eucapnic voluntary hyperpnoea
FIFA	Fédération Internationale de Football Association
FINA	Fédération Internationale de Natation
IAAF	International Association of Athletics Federations

Abstract

Background: Endurance athletes, in particular triathletes and ultra-distance runners, undergo high volumes of intense training in preparation for events. There is recent epidemiological evidence that the respiratory tract is the most common system affected by illness in athletes during tournaments. Respiratory tract symptoms have also been shown to affect endurance athletes particularly in the post-event period. However, the prevalence of respiratory related illnesses including respiratory tract symptoms, asthma, and allergies in the pre-race period has not been well studied in endurance athletes.

Objective: The main aims of this dissertation were 1) to review the existing literature focussing on the epidemiology, pathogenesis, possible aetiology and management of respiratory tract symptoms, asthma and allergies in athletes, and 2) to conduct an investigation to determine the pre-event period prevalence (6 weeks and 1 week before an event) and nature of respiratory tract symptoms, asthma and allergies in Ironman triathletes and ultra-distance runners.

Methods: In the first part of the dissertation a review of the literature pertaining to respiratory tract symptoms and illness was undertaken. In the second part of the dissertation a cross-sectional descriptive study was undertaken in 441 triathletes entering the 2006 and 2007 Ironman Triathlon, and 152 ultra-distance runners in the 2009 Two Oceans Ultra-marathon. In the 1 to 3 days before the race (registration period), participants were requested to complete a validated pre-event medical questionnaire containing sections on demographics, training and previous competition, common medical conditions and detailed sections on respiratory symptoms in the 6 weeks and 1 week period before the race, as well as asthma and allergies experienced. Respiratory symptoms were divided into upper respiratory tract symptoms (URTS), lower respiratory tract symptoms (LRTS) and systemic symptoms (SS). All data obtained regarding these respiratory related illnesses were compared between the triathlete group and the ultra-distance runners.

Results: The main findings in the experimental section of the dissertation were that 1) triathletes trained significantly more hours in the 6 weeks and 1 week before an event than ultra-distance runners, 2) the period prevalence (6 weeks before the race) of respiratory tract symptoms was 50% of triathletes and 35% of ultra-distance runners, 3) upper respiratory tract symptoms and particularly nasal symptoms (nasal congestion and rhinorrhoea) were significantly more common in triathletes (21 to 27%) in comparison with ultra-distance runners (12 to 17%), 4) systemic symptoms (especially pyrexia) were significantly more common in ultra-distance runners in the 1 week before an event (9.2 vs. 2.4%), 5) the point prevalence of self-reported asthma was low in both study groups (ultra-distance runners 3.4% and triathletes 8.3%) although symptoms of dry cough, wheezing, shortness of breath and 'tight' chest were reported by 25 to 80% of athletes in both study populations, 6) in most cases the diagnosis of asthma was made by means of history taking and a physical examination by a physician, 7) majority of triathletes used beta 2-agonists only as the treatment of choice for asthma symptoms, while ultra-distance runners used combinations of corticosteroids and beta 2-agonist inhalers as first line treatment, 8) allergies were reported by 34% of triathletes and 22.3% of ultra-distance runners, 9) most allergic symptoms in both study groups were confined to the upper respiratory tract with hay fever ranging from 77 to 83% and sinusitis 55 to 64.2%, and 10) the most common medication used for allergies by triathletes and ultra-distance runners, were anti-histamine tablets.

Conclusion: There is a high period prevalence of respiratory symptoms in triathletes and ultra-distance runners in the 6 weeks before an endurance event. Triathletes had a significantly higher prevalence of upper respiratory tract symptoms (especially nasal symptoms) in comparison to ultra-distance runners which might be related to allergies and a higher training volume. There also appears to be a lack in proper diagnostic evaluation of asthma in these endurance athletes with suboptimal and improper treatment of asthma and allergies. Approximately 10% of ultra-distance runners had systemic symptoms in the week before the event, indicating a lack of athlete education on possible risks of exercising with a systemic illness.

CHAPTER 1

Introduction and scope of thesis

Endurance races such as the Ironman Triathlon (3.8km open water swim, 180km cycle and a 42.2km run) and Two Oceans Ultra-marathon (56 km run) are physically and mentally challenging. It is generally accepted that, in preparation for these events, endurance athletes are in optimal health, and free of disease. It has however been documented that endurance athletes can suffer from a variety of medical conditions [1]. In particular, a high prevalence of respiratory related conditions (mostly upper respiratory tract symptoms) have been reported in endurance athetes, particularly in the post race peroid [2-4].

Historically, respiratory symptoms in endurance athletes were automatically assumed to be of infective origin, because a decrease in host immunity as a result of intense exercise has been documented in these athletes [5;6]. However, in recent studies [7-10] the possibility of an infective cause in these athletes has been investigated. The results of these studies show that in many instances, no pathogen could be isolated. This led to the quest to find an alternative explanation for the high prevalence of respiratory related symptoms in endurance athletes during periods of intense training and competition. Possible non-infectious hypotheses are that the symptoms are caused by inflammation and allergy rather than infection [7;11;12] or induced by a variety of airway irritants [7;13].

Furthermore, the majority of research studies, to date, have focused on the occurrence of respiratory related symptoms in the period following an event [2-4] and little is known about the prevalence of these symptoms in the endurance athlete in the pre-event period. Therefore the aim of this thesis was to investigate the prevalence and the nature of respiratory related conditions affecting the respiratory health of the endurance athlete, in particular the triathlete and ultra-distance runner in the pre-event period.

In Chapter 2 of this dissertation, data on the prevalence of respiratory tract symptoms, asthma and allergies are reviewed. In particular, the terminology, pathogenesis, diagnosis and the influence of the each condition on the performance of the athlete are reviewed. In chapter 3 the results of a research study that investigated the prevalence of pre-event respiratory tract symptoms, asthma and allergic symptoms are presented. Finally in Chapter 4, the main findings of this dissertation are summarized and practical guidelines are presented to both athletes and sports physicians for the early recognition of respiratory tract symptoms and appropriate management of these conditions. This is important to optimise the respiratory health of the athlete, and consequently improving the performance of endurance athletes.

CHAPTER 2

Respiratory health of the endurance athlete: A review of the prevalence of respiratory related conditions/illnesses in the endurance athletes

2.1 Introduction

It is generally accepted that athletes are healthy individuals and that their bodies are in optimum condition to withstand the high stressors of athletic training and competition. This would seem particularly true for endurance athletes who spend considerable time training and competing in exhausting and physically challenging events. However, contradictory findings exist in the scientific literature when the role of exercise and its influence on physical health and wellbeing is investigated. On the one hand, exercise training is promoted to be beneficial in the prevention and management of many chronic diseases,[14] and moderate intensity exercise may even have a positive effect on immune function and reduced incidence of upper respiratory tract symptoms [15]. Yet, on the other hand, endurance athletes are at an apparent increased risk for developing symptoms of upper respiratory tract infections (URTI) during periods of intense training [5]. Therefore, a "J-curve" has been suggested to explain the relationship between exercise and symptoms of URTI, with moderate and regular exercise improving the ability to protect against these symptoms, whilst intense, acute or chronic exercise has been suggested to negatively affect immunity [16].

It is also interesting to note that respiratory related symptoms are the main presenting complaint at medical facilities, reported at a number of international sporting events and tournaments. In a number of different studies, focussing on the 2002 Winter Olympic Games [17], the 2008 Winter Olympic Games [18], the 2010 FIFA World Cup [19], the 2009 FINA championships [20], and the 2009 IAAF championships [21], respiratory complaints ranged from 40 to 62% of all athlete medical consultations during these

tournaments. This was only followed by gastrointestinal complaints (ranging from 20 to 26% of all consultations). Thus, respiratory complaints in athletes at these tournaments are very common, and therefore the understanding, detection, management and prevention of respiratory complaints are important for the team physician. The question is raised regarding the possible cause for this seemingly disproportionate high occurrence of respiratory illness in athletes.

Historically, following investigation of the cause for increased susceptibility of the athlete to exercise related respiratory symptoms, data suggests that the immune system is transiently suppressed after prolonged strenuous endurance exercise. This has been suggested as an explanation for the increased risk of subsequent infection [5;6;22;23]. Indeed, this immune suppression may become more apparent when the athlete goes through repeated cycles of high intensity and sustained training, and is often accompanied by other stressors to the immune system including lack of sleep, malnutrition, weight loss and severe mental stress [5]. These stressors are common for the travelling athlete, crossing different time zones and competing in major competitions.

The purpose of this Chapter is to review three different clinical entities that affect the respiratory health and symptomatology of the athlete, with special attention to the endurance athlete. These include respiratory tract symptoms and infections (section 2.4), asthma and asthma-like symptoms (section 2.5) and allergies (section 2.6). These clinical entities often have similar clinical manifestations and may coexist. This review will mainly focus on the prevalence of these conditions in athletes, but the pathophysiology, diagnosis, and the influence on training and performance of each of these clinical entities will also be briefly reviewed. A summary will be given at the end of each section and a conclusion will be given in section 2.7.

2.2 Terminology and definitions: Respiratory tract symptomatology

The respiratory tract can be divided anatomically into the upper respiratory tract (URT) and the lower respiratory tract (LRT). Upper respiratory tract symptoms (URTS) are confined to the airway above the oropharynx (above the neck) and include "blocked nose", "runny nose", a sore throat and swollen glands[24]. Symptoms such as cough, wheeze and chest pain are related to the lower respiratory tract (LRTS) [24]. In some instances, systemic symptoms (SS) can accompany respiratory tract symptoms (RTS). This is referred to as "flu-like" symptoms and athletes can present with muscle aches, joint pains, fever, headache and general fatigue in combination with RTS [24].

In the literature, the terms upper respiratory tract symptoms and upper respiratory tract infections have been used somewhat synonymously. This is also relevant to the lower respiratory tract. The reason for this is historical as URT and LRT symptoms have been assumed to be due to infection. However, in a laboratory and epidemiological study that reported at least a 30% incidence in URTI, no pathogens could be identified [7]. The lack of evidence to support an infective cause [7-10] for respiratory tract symptoms, led to the possibility of non-infectious hypotheses of URT and LRT symptoms. One of these hypotheses is the allergic hypothesis [7;12], and this hypothesis will be further explored in section 2.6. The terminology related to asthma and allergies will be outlined in the relevant sections to follow.

2.3 Terminology and definitions: Epidemiology

This review is primarily focused on the **prevalence** of respiratory related illnesses in the endurance athlete. It is thus important to define the epidemiological terms that will be used throughout the literature review and this dissertation. The term that will be used most is "prevalence". The **prevalence** of a

disease in a population is defined as the total number of cases of the disease in a population at a given time or a time period. Prevalence is usually calculated as the total number of cases in the population, divided by the total number of individuals in the population and is then expressed per 100 population (%) or as a proportion of the population. The prevalence is therefore an estimate of how common a condition is within a population at a certain time or over a defined period of time. The term **lifetime prevalence** refers to the proportion of individuals in a population that had the condition at any point in their life (up to the time of assessment). **Period prevalence** refers to the proportion of individuals in a population that had the condition during a specified period, e.g. last 12 months, or last 6 weeks. Period prevalence will be used in this dissertation to describe the proportion of athletes suffering from RTS in a period before or after an event. **Point prevalence** refers to the proportion of individuals that have the condition at a specific point in time (on the day of the assessment or measurement) (http://medical-dictionary.thefreedictionary.com/prevalence).

The term prevalence has to be differentiated from the term **incidence,** which is defined as the number of new conditions/illnesses in a population related to the exposure time (e.g. years, months, days, or hours of exposure) (http://medical-dictionary.thefreedictionary.com/incidence).

2.4 Respiratory tract symptoms (RTS) and illness in endurance athletes

2.4.1 Introduction

Historically, it has been assumed that respiratory tract symptoms in athletes, were caused by an infective pathogen due a decrease in body's immune system as a consequence of intense and prolonged exercise [5;6]. However, only a few studies in the literature have attempted to provide actual evidence of an infective

cause for RTS [7-10;25]. In most instances where this has been studied, no pathogens could be isolated. This led to the suggestion that RTS in athletes might also be due to non-infective causes which can include 1) allergies [7;11;12;24], 2) inhaled physical or chemical irritants [7;13], and 3) other medical conditions such as sinusitis, gastro-oesophageal reflux disorder (GORD), deconditioning, anxiety, cardiac abnormalities and vocal cord dysfunction [26]. It is clear that other pathophysiological mechanisms should be considered as possible causes of respiratory symptoms**.** For example, vocal cord dysfunction is often misdiagnosed as asthma and presents with increased inspiratory effort, stridor and wheeze. This condition is due to functional upper airway obstruction and occurs in 5 to 15 % of all athletes investigated for exercise-induced bronchoconstriction [26].

The focus of this dissertation is on respiratory tract symptoms that are suggestive of infections, allergies and asthma. Therefore, an in depth discussion of the other medical conditions (listed above) is beyond the scope of this review and this dissertation. However, for the sports physician, these conditions must be taken into consideration as a part of the differential diagnosis in the athlete presenting with respiratory tract symptoms.

2.4.2. Terminology and definitions: Respiratory tract and systemic symptoms

For the purposes of this review and this dissertation, it is important to define the terminology that relates to respiratory tract and systemic symptoms. The following list summarizes the terminology that will be used in this dissertation as these relate to the respiratory system:

- **Upper respiratory tract symptoms (URTS)**: These symptoms are localised to the nose and pharynx, and include 'runny nose', 'blocked nose' and sore throat [24].
- **Lower respiratory tract symptoms (LRTS)**: These are symptoms below the pharynx including cough, wheeze and chest pain [24].

- **Systemic symptoms (SS)**: Systemic symptoms include fever, headache, joint and muscle pains, and general fatigue [24].

2.4.3. Pathogenesis and risk factors for respiratory tract symptoms (RTS) in athletes

Currently, three different hypotheses have been proposed for the aetiology of RTS in athletes and these will now be reviewed briefly. To date, the majority of studies have assumed an infective hypothesis for the development of RTS in athletes. This hypothesis is based on the observations that an acute exercise bout as well as regular exercise training can alter various immune parameters. These alterations occur with respect to the systemic immunity [6], cytokines and mucosal immunity [27] in response to exercise. For example, salivary immunoglobulin A (IgA) concentration is decreased for several hours after prolonged intense exercise [23]. This observation has led to the hypothesis that there is an 'open window' period for a few hours after an exercise bout, during which there is decreased host defence [6]. During this period of decreased host defence, it is hypothesized that bacteria and viruses gain foothold, and cause subclinical and clinical respiratory tract infection [5;6]. It has also been noted that cortisol concentrations are elevated after prolonged exercise. Increased cortisol concentrations have been linked to immunosuppressive changes that may be experienced during recovery [5]. Data therefore suggest that the immune system is transiently suppressed after prolonged endurance exercise. These findings supported the view that host protection is compromised after endurance exercise [5]. However, in spite of many studies focussing on immune changes following exercise, there are no data supporting a direct relationship between changes in the immune parameters and the presence of URTS in athletes [28-30]. Furthermore, in studies where athletes with RTS following endurance events have been investigated, only few could obtain positive viral or bacterial cultures to support an infective hypothesis for the RTS [8;10]. In summary, there are little data to confirm that respiratory tract symptoms in athletes are mostly of infective origin [8-10], indicating that other possible causes for RTS in athletes have to be considered [7].

An alternative hypothesis for the pathophysiology of RTS in endurance athletes is to consider allergy (atopy). There is good evidence that allergies are very common in elite athletes, and in a number of studies it has been documented that the prevalence of atopy in elite athletes is high and ranges from 23 to 60% [12;31-34]. Clinically, symptoms of allergy may mimic those of infections, and it can be difficult to differentiate between these causes. Thus, the possibility that RTS in endurance athletes might be related to allergies rather than infections, should be considered [11;12].

Finally, the pathogenesis of RTS in endurance athletes may be related to various physical factors that are associated with sports participation. Physical factors that may be related to the pathophysiology of RTS in endurance athletes could include the high ventilation rate during high intensity exercise, inhalation of cold or dry air, increased air turbulence, mouth breathing and increased concentrations of inhaled irritants. These physical factors may all be associated with increased risk of developing RTS in athletes [11 8;13]. When ventilation rate exceeds 30 l/min, there is a tendency towards mouth breathing instead of nasal breathing. This may increase the exposure of upper and lower airways to airborne allergens and irritants[11;12]. Increased ventilation rate may also cause cooling and drying of the respiratory mucosa [35]. All of these mechanisms may increase risk of airway injury and predispose it to illness. Pollutants including sulphur dioxide, nitrogen oxide, ozone and airborne particulates may also be contributory factors [36]. Other factors reported to increase risk of RTS in athletes are female gender, perceived stress, sleep deprivation, a lack of awareness about nutrition [37;38] and decreased Vitamin C intake [3].

In summary, there are a number of pathophysiological mechanisms that may be responsible for the development of RTS in athletes. There is evidence from recent studies that the traditional infective hypothesis for RTS in athletes is not established, and that allergies or other physical factors may be important. This information is important for the sports physician as the return to play guidelines following RTS and the potential risk of medical complications during exercise following RTS are related to the

aetiology of RTS. The precise diagnosis of the cause of RTS in athletes is therefore important for the sports physician.

2.4.4. Diagnostic approach in athletes with respiratory tract symptoms (RTS)

A detailed discussion of the diagnostic approach to respiratory symptoms in athletes is beyond the scope of this review. However, a brief overview is important. As with any clinical condition, a thorough history and clinical examination should be performed with special attention to vital signs, and a comprehensive pulmonary and ear, nose and throat examination [8]. If an allergic component is suspected, skin prick tests followed by venous blood samples for allergen specific IgE are indicated. Specific identification of pathogens in the respiratory system can be achieved by performing various diagnostic and laboratory tests. Some of these tests are inexpensive and non-invasive, while others may be complex, expensive and invasive. Special investigations might include nasopharyngeal and throat swabs, which can be analysed using microscopy, culture, and polymerase chain reaction testing for bacterial, viral, chlamydial and mycoplasmal respiratory pathogens [7;10]. The cells present in sputum can also be investigated for the number of neutrophils, eosinophils and lymphocytes present [7]. Venous blood samples can be collected for a variety of infective markers [8]. More invasive procedures include bronchioalveolar lavage and bronchial biopsies [7].

2.4.5. Prevalence of respiratory tract symptoms (RTS) in athletes

Respiratory tract symptoms (RTS) suggestive of infections are common in both the general and the athletic population. Any individual (athletes and non-athletes) may have multiple episodes of infections pertaining to the respiratory system in one year, which may differ in severity and morbidity. These are usually viral infections and viruses can include rhinovirus, adenovirus and para-influenza virus [7;8].

Furthermore, in athletes, one of the most common non-injury causes for presenting to a sports physician during a tournament, is an episode of upper respiratory tract symptoms [19-21] and this was also the most common complaint in athletes participating in both the summer and winter Olympic Games [17;18;39]. The methodology described in these studies differs, and the duration of these tournaments also varied. This makes the precise comparison of the true prevalence of RTS during tournaments in athletes difficult.

Therefore, for the purpose of this review, it is more appropriate to consider the period prevalence (the number of cases of a disease which occur during a specified period) of RTS in athletes. Three different time periods can be identified where an athlete may develop RTS:

- Pre-event period: This period refers to the days or few weeks before an event and it is a time period that is characterized by intense training and preparation before an event.
- Period at the time of an event or tournament: This period refers to the time during an event, and most studies that have described RTS in athletes in this period, have focussed on the tournament setting lasting days or weeks.
- Post-event period: This period refers to the days or the weeks that follow an event (post-event period) and has also received some attention in the literature.

In some studies, the focus has been placed on the volume of training (hours or kilometres) to determine its effect of RTS prevalence, while other studies have focused on the type of sport or the time period before or after an event. A summary of the studies where data are available on RTS in these periods will now be discussed.

2.4.5.1. Pre-event respiratory tract symptoms (RTS) in athletes

There are very few data on the prevalence of pre-event RTS in athletes (Table 2.1). In one prospective cohort study the pre-event period prevalence (3 weeks before the event) incidence of “infectious

episodes" (IE) was recorded in 1694 (340 female and 1354 male) runners finishing the Stockholm marathon. In this study, the pre-event period prevalence (3 weeks) of "infectious episodes" was 17% [40]. In only one other study conducted in our Unit, the period prevalence of upper respiratory tract symptoms (URTS) and allergies was documented in the 6 weeks before an Ironman Triathlon. In this study, the pre-event period prevalence (6 weeks before the event) of RTS was 50%. In this study, there was also an association between pre-event RTS and allergies. However, there was no association between pre-event RTS and training volume, smoking history, or family history of allergies or asthma (M. Lichaba, Sept 2006).

Table 2.1. The pre-event period prevalence of respiratory tract symptoms (RTS) ("illness") in athletes

Type of study	Population	Diagnosis	Period studied	Period prevalence (%) of RTS	Additional comments	Reference
Prospective cohort study	1694 marathon runners	Self reported symptoms	3 weeks before the event	17% of runners	Higher risk for infection post race if symptoms are present pre race	Ekblom *et al* 2006
Cross-sectional survey	304 Ironman triathletes	Self reported symptoms	6 weeks before the event	50% of triathletes	Association made between prevalence of RTS and allergies (36%)	Lichaba 2006

It is important to note that in one other study, data on RTS in athletes were also collected over a period of time. However, this period was not related to a specific pre-event period, but rather to a 12-month period of training. In this prospective cohort study, 530 male and female runners completed a monthly training log over the 12-month period. In this group of runners, the average number of URT "infections" was 1.2 per person per year. It is important to note that, in this study, the diagnosis of an "infection" was not confirmed by laboratory testing. Factors influencing the number of URT "infections" experienced were also investigated. In particular, there was a significant interaction between alcohol use and gender with URT "infection", with the association of alcohol use and URT "infection" being positive in males and

negative in females. High running mileage was also identified as a significant risk factor for URT "infections" [41].

In summary, the period prevalence (few weeks before an event) of pre-event RTS has, to our knowledge, only been reported in two studies. The data from these studies indicate a high period prevalence of RTS in endurance athletes in the few weeks before an event (ranging from 17% to 50%). The causes for the high prevalence of RTS have not been investigated, although allergies have been linked to RTS in the one study. This apparent high prevalence of RTS in the pre-event period has clinical implications for the sports physician looking after a group of athletes. This is an area that requires further investigation and is one of the areas of focus in the experimental section of this dissertation.

2.4.5.2. Respiratory tract symptoms (RTS) in athletes during events or tournaments

In athletes, respiratory tract symptoms (RTS) can develop during events (that may vary from minutes to hours) or during tournaments (that can span over days to weeks). It is clear that there can be a wide variation in the duration of events or tournaments. It is only in recent years, that the pattern of illness in athletes participating in tournaments has been investigated (Table 2.2). These studies have focussed mainly on elite athletes participating in international tournaments such as the Olympic Games (summer and winter), and the World Championships in aquatic events, athletics and football. The data from these studies show that 12% of football players suffered from an illness during the 2010 FIFA World Cup[19], 7.1% of athletes reported illness in the 2009 FINA world championships[20], 6.8% of athletes suffered from an illness during the 2009 IAAF World championships[21], and 6.7% of athletes suffered from an illness during the 2010 Winter Olympic Games[42]. In all these studies, respiratory tract illness was the most common illness (Table 2.2).

Table 2.2. The period prevalence of respiratory tract symptoms (RTS) ("illness") in athletes during an event / tournament

Type of study	Population	Diagnosis	Period studied	Period prevalence (%) of RTS	Additional comments	Reference
Prospective cohort	Estimated 2500 Olympic athletes	Team physician diagnosis	4 weeks	49.3% of reported illnesses were RTS	Winter Olympics 2002	Reeser *et al* 2003
Prospective cohort	1979 Athletes	Team physician diagnosis	9 days	6.8% reported illness (30.4% were RTS)	IAAF Athletic World Championships 2009	Alonso *et al* 2010
Prospective cohort	2592 Athletes	Team physician diagnosis	17 days	7.1% reported illness (50.3% were RTS)	FINA World Championships 2009	Mountjoy *et al* 2010
Prospective cohort	2567 Olympic athletes	Team physician diagnosis	17 days	6.7% reported illness (62.8% were RTS)	Winter Olympics 2010	Engebretsen *et al* 2010
Prospective cohort	736 football players	Team physician diagnosis	4 weeks	12% athletes reported illnesses(40.4% were RTS)	FIFA World Cup 2010	Dvorak *et al* 2011

In summary, data show that RTS are very common in elite athletes participating in tournaments that last a few days to weeks. These studies show that the respiratory tract is a common system that is affected by illness in these athletes. However, the precise cause for RTS during tournaments has not been well investigated and diagnosis of RTS in all cases was by a clinical diagnosis of the team physician.

2.4.5.3. Post-event respiratory tract symptoms (RTS) in athletes

Post-event RTS in athletes have been investigated in a number of studies. In the majority of these studies, post-event respiratory tract symptoms (RTS) in endurance athletes (mainly runners) have been recorded in the immediate post-event period up to 2 weeks post-event (Table 2.3). The first study where post-event RTS data have been recorded in athletes was a prospective study conducted by Peters and Bateman in 1983. In this study, 150 randomly selected Two Oceans marathon runners and individually matched controls who did not participate in the race acted as participants. Runners were questioned on

the day before and 2 weeks after the race. Symptoms of URT "infection" were documented in 33.3% of the runners compared to 15.3% of controls (a 2-fold increase) in the 10-14 day post-race period. In addition, RTS were more common in those who achieved faster race times. The period prevalence of post-event RTS in slow runners was comparable to that in the control subjects [2].

In another study by the same investigators, the role of daily vitamin C supplementation (600mg) in reducing post-race upper respiratory tract symptoms (URTS) was studied using a double-blind-placebo-controlled study design. In this study 92 ultra-marathon runners competing in an ultra-marathon event and 92 control runners were recruited. This post event period prevalence or URTS was 33% in athletes on vitamin C supplements compared to 68% in athletes in the placebo group ($p<0.05$) [3].

In one other large epidemiological study, 2311 marathon runners were randomly selected 8 days before competing in the Los Angeles Marathon (LAM) [4]. The relationship between self-reported "infectious episodes" (IE), training data and participation to the LAM were evaluated by means of a questionnaire. Athletes varied widely in running ability and training habits. The period prevalence (1 week) of post-event IE was 12.9% in the runners compared with only 2.2% in a control running group that did not participate in the race. In addition, runners who trained >96km per week had an increased risk of post-event IE (double the odds ratio of developing symptoms) compared with runners training <32km per week [4].

In the previously mentioned prospective cohort study (section 2.4.5.1) in 1694 (340 female and 1354 male) runners where the period prevalence of pre-event "infectious episodes" (IE) 3 weeks before a race were investigated, post-event data were also recorded [40]. In this study, the pre-race period (3 weeks) prevalence of an IE of 17% was similar to the post-event period prevalence of IE of 19%. There was also no difference between male and female athletes. It is of interest to note in this study that the post-event prevalence of IE was 16% in runners who began the race in a healthy state. In the group of runners who had reported pre-event IE, 33% reported an IE in the post-event period. These findings suggest that the

increased risk for post-event IE was related to pre-event IE, as healthy athletes before the race had no increase in self reported IE after a race. Furthermore, pre-event training, gender, social status, training volume or running time could not explain the difference in post-event IE. It was however documented that faster finishing times, especially in younger athletes, could pose a risk for post-event IE [40].

These studies all indicate that endurance athletes have a high period prevalence of self-reported RTS in the 2-week period following events. Factors that are associated with the post-event RTS are increased training volume, increased exercise intensity and the presence of pre-event RTS. In one study, it appears that Vitamin C supplementation was associated with a decrease in post-event RTS.

Table 2.3. The post-event period prevalence of respiratory tract symptoms ("illness") in athletes

Type of study	Population	Diagnosis	Period studied	Period prevalence (%) of RTS	Additional comments	Reference
Prospective cohort	150 marathon runners 150 individual matched controls	Self reported symptoms	1 week after event	33.3% (runners) 15.3% (controls)	RTS more prevalent in runners with a faster race time	Peters and Bateman 1983
Prospective cohort	2311 marathon runners and controls	Self reported symptoms	1 week after event	12.9% (runners) 2.2% (controls)	>96km/wk training doubles odds for RTI compared to <32km/wk training	Nieman *et al* 1990
Prospective study (double-blind-placebo-controlled study)	92 ultra-marathon runners 92 controls	Self reported symptoms	2 weeks after event	33% (vitamin C supplement group) 68% (placebo group)	Study to determine if Vitamin C supplement decrease incidence of post race URTS	Peters *et al* 1993
Prospective cohort	1694 marathon runners	Self reported symptoms	3 weeks after event	16% (runners healthy at pre-race) 33% (runners with pre-race infectious episode)	Higher risk for infection post-race if symptoms are present pre-race	Ekblom *et al* 2006

2.4.5.4. Summary: Period prevalence of RTS in athletes

In this review on the period prevalence of RTS in athletes it is clear that RTS are common in the pre-event period, during tournaments, and in the post-endurance event period. Data are strongest in ultra-marathon runners, in the post-event period [2;3] and in elite athletes during tournaments. The pre-event period has not received much attention, despite the fact that pre-event RTS may be associated with increased risk of post-event RTS [40]. Also of note is the fact that very few studies have investigated the prevalence of RTS in triathletes [10;22;23].

Triathletes are a unique group of endurance athletes because the demand of training (volume and intensity) is spread across three disciplines. It has been suggested that triathletes are at a higher risk of development of URTS [22] due to increased physical stress during training and competition compared to runners, cyclists or swimmers. In one study, the effect of competing in a half-ironman triathlon (mean time 6.5hr) on the cell-mediated immunity was investigated by Bruunsgaard et al (2007). The results of this study showed that delayed-type hypersensitivity (DTH) reaction was suppressed in 60% of triathletes 2 days after the competition compared to the controls. This was the first study to show that the increased physical demands of training for and competing in a triathlon can decrease in vivo cell-mediated immunity and predispose these athletes to a higher risk of RTS [22].

In summary RTS are common in athletes during the pre-event period but there are very few studies that have focussed on this period. In one study, pre-event RTS were possibly related to allergies, but this requires further investigation. Secondly, during events or tournaments the period prevalence of RTS is lower, but RTS did account for most symptoms of illnesses seen by attending team physicians. Finally, post-event RTS are very common, and may be related to pre-event RTS as well as intensity and duration of the exercise performed during the competition. RTS in athletes need to be recognised and appropriate diagnoses should be made. The potential clinical implications of RTS will now be reviewed.

2.4.6. Clinical Implications: The effect of RTS on training and performance

As outlined above, it appears that athletes seem more prone to develop RTS in the period of intense training [5]. This usually occurs in the period prior to a race or event. During this period, the sports physician has to give the athlete sound advice regarding continuation or withdrawal from exercise training and racing. Unfortunately, there are few clear guidelines to assist the physician with return to play, especially with respect to the intensity and time interval at which exercise may be resumed [35].

Clinical guidelines to assist the sports physician in providing advice to the athlete presenting with RTS have been suggested [35]. These guidelines have been called the "neck check" and are primarily there to differentiate localized from regional or systemic symptoms and signs. If symptoms or signs are above the neck (e.g. "runny nose", nasal congestion, or sore throat), with no below the neck symptoms (e.g. cough, fever, malaise or gastrointestinal symptoms), it has been suggested that the athlete may train for 10 min at half the normal intensity level. If the symptoms then do not worsen, the workout can be continued as tolerated. If symptoms worsen following the 10 minute trial, training should be suspended until symptoms have resolved [35].

The distinction between localized and regional/systemic symptoms and signs is important. It has been shown that not all episodes of illness have a detrimental effect on the athlete's performance. A study in college students investigating experimental rhinovirus infection found no negative effects of this viral infection on pulmonary function tests, VO_2 max values or performance during sub maximal exercise testing. The authors however mentioned that the rhinovirus does not cause viremia, and symptoms are largely confined to the upper respiratory system [35].

It is however important to consider the possible serious consequences of certain infections in athletes [43]. In some cases, lower respiratory tract symptoms or systemic symptoms may be an indication of systemic viral or bacterial illness. These may present with systemic signs or symptoms such as fever that can affect an athlete's ability to train and compete. Fever has been shown to impair mental cognition, pulmonary perfusion and concentric muscle strength [35]. It also increases systemic metabolism and insensible fluid loss thereby increasing the body's requirements for caloric intake, oxygen and fluids. It has a negative effect on performance, can increase the risk for injury [44] and may predispose an athlete to heat illness e.g. heat stroke.

However, the most serious consequence of performing exercise training in the presence of a systemic illness, is the risk of myocarditis, which is a potential life threatening condition in exercising athletes [43]. Myocarditis is mostly caused by viruses, notably the Coxsackie virus. Symptoms associated with this condition are shortness of breath, chest pain, tachycardia at rest and systemic symptoms like fever and general body pains [24;43]. Furthermore, some viruses, in particular the Ebstein Barr virus, which is the responsible organism for infectious mononucleosis, can cause prolonged symptoms [35;43]. This infection commonly occurs in the 15-24 year age group, and more than 90% of the population demonstrate antibody titres by the age of 30 years [35]. Although infectious mononucleosis is seldom fatal and is usually self-limiting, recovery may take up to 6 to 8 weeks. Symptoms of anorexia, fatigue and nausea are often present, and this may complicate recovery. A highly trained athlete may take as long as 3 months to attain pre-illness fitness levels following infectious mononucleosis [35]. It has also been shown in several case histories that sudden and unexplained decreases in athletic performance could be traced to recent URTI or a subclinical viral infection [5]. In some athletes, a debilitating state known as "post viral fatigue" can also occur after a viral infection. Symptoms include easy fatigability, lethargy and myalgia and these can persist for several months [5]. It is therefore important to identify these illnesses and to give appropriate advice to the athlete to prevent such clinically important complications.

In summary, RTS in the exercising individual have a number of important clinical considerations. Firstly, the sports physician needs to make an accurate diagnosis to determine if the causes are infective or non-infective. Without the use of special investigations (that also require some time before results are known) this is a challenge to the sports physician. Secondly, clinical decisions have to be made regarding training or participation in competitions. Currently, distinguishing between localized and regional/systemic symptoms and signs are used in this decision ("neck check"). Thirdly, there are the potential life-threatening and long-term complications of infective causes of RTS in athletes. All these considerations are against a backdrop of data showing that RTS are very common in the pre-event period, during tournaments and following events. Appropriate measures to prevent RTS and to manage RTS in athletes are therefore important to consider.

2.4.7. Prevention and management of RTS in athletes

Athletes should be aware of possible ways to decrease the risk or spread of infection. This is an area that has not been studied well. In one recent study, some preventative measures were shown to be effective in reducing respiratory tract illness in a team travelling to the winter Olympic Games [45]. In this study, the measures that were introduced included the following; 1) basic hygiene (hand washing), 2) the use of alcohol hand gel and 3) to minimise close contact with ill individuals, 4) athletes with respiratory problems and subjected to heavy training loads, were accommodated in single rooms and 5) it was suggested that all athletes should be vaccinated prior to the training season and before travelling abroad [45].

The role of certain supplements in reducing RTS in athletes has also been investigated. A double-blind – placebo-controlled study was conducted to evaluate the role of vitamin C supplementation in the 14 day post-race period in a group of ultra-marathon runners. The results of this study show that 33% of vitamin C supplemented runners reported URTS compared to 68% in the placebo group. The study concluded that vitamin C supplementation decreased the incidence of URTS in athletes in the post-race period [3].

Whilst this effect has not been shown in all studies [46;47], it has been suggested by some authors that because Vitamin C is an antioxidant, it reduces the risk of RTS by clearing free oxygen radicals which are produced by heavy exertion [5]. Finally, there is recent evidence that the use of probiotics may modulate the immune response to training, thus reducing the duration and severity of RTS in endurance athletes[48;49].

The prevention and treatment of respiratory illnesses thus require a combined effort of athletes, physicians, coaches and administrators. It is the athlete's responsibility to report RTS immediately to the medical staff and to comply with the physician's recommendations. This measure may result in diminished impact of respiratory illness on training and general wellbeing of the athlete.

2.4.8. Summary: Respiratory tract symptoms (RTS) in athletes

- RTS are common in both the general and the athletic populations and have traditionally been attributed to infection.
- RTS are more prevalent after a period of high intensity and prolonged exercise or training. This has been traditionally thought to be due to the "open window" hypothesis of decreased immunity.
- The decrement in the immune status is usually only temporary.
- An infective cause for RTS in athletes has not been proven and hence there is a need to consider alternative hypotheses for the cause of RTS in athletes.
- RTS and allergic symptoms can often coexist.
- Respiratory tract infection can at times be prolonged with negative long-term consequences.
- Some preventative measures can be effectively taken to decrease infection exposure and susceptibility.
- Most studies on the prevalence of RTS in athletes were conducted in the post-race period.

- The majority of studies on RTS in athletes have been in runners and few studies documented RTS experienced by triathletes.
- Future studies on the prevalence of RTS, allergies and asthma in a defined study population might be of benefit to assess co-existence of these conditions. This may help explain the aetiology of RTS, which may have similar clinical manifestations.

2.5 Asthma and asthma-like symptoms

2.5.1 Introduction

Athletes may experience increased respiratory workload as a normal physiological response to the body's increased demand for oxygen during bouts of exercise. Under normal conditions, the respiratory system is able to adapt to the higher oxygen demand for increased cell metabolism and respiration. However, there are conditions in which the body fails to respond appropriately.

Asthma, exercise-induced bronchoconstriction (EIB) and airway hyper responsiveness (AHR) are common respiratory conditions found in both the athletic, as well as in the general population [50]. These conditions exist due to an abnormal response of the respiratory system to increased ventilation or other "triggers" and may present with symptoms of chest tightness, breathlessness, wheezing, phlegm, dyspnoea and cough [51]. In questioning athletes regarding respiratory symptoms, they may use a variety of descriptive terms to describe their sensation of respiratory discomfort experienced.

2.5.2 Terminology and definitions: Asthma and asthma-like symptoms

Airway hyper-responsiveness (AHR) occurs when airways constrict more than the normal response when exposed to physical stimuli (cold air and exercise), chemical substances (methacholine and histamine), or sensitising agents (allergens) in sensitised individuals [50]. **Exercise-induced bronchoconstriction (EIB)** is the transient airway narrowing that occurs in individuals with hyper-reactive airways, during or following vigorous physical activity, which results in a decrease in pulmonary function [52]. When this narrowing of airways occurs in response to exercise in a known asthmatic individual, this phenomenon is best described as **exercise-induced asthma (EIA)** [53]. Both of these conditions are characterized by respiratory symptoms including cough, breathlessness, and tightness of the chest, wheezing, chest pain and excess mucus production. These symptoms might result in fatigue, poor performance, and poor recovery from exercise [26;54]. **Asthma** is a clinical syndrome characterised by an increased response of the trachea and bronchi to a variety of stimuli [55]. It is a common, chronic disease in both the athletic population and sedentary individuals and is associated with intermittent episodes of airflow obstruction, that is at least partially reversible [56].

It is clear that EIB, AHR and asthma, may all present with similar symptoms. It is however important to understand the pathogenesis of these conditions, as this will determine the appropriate management.

2.5.3 Pathogenesis of asthma and asthma-like symptoms in athletes

Many theories exist for the development of asthma and the higher prevalence of asthma-like symptoms in the athletic population. The first of these theories is the **osmotic theory** (airway dehydration theory). Inspired air needs to be humidified and therefore water loss occurs from the airways during exercise can result in cooling and drying of the airways [57]. Airway dehydration causes the release of inflammatory

mediators including prostaglandins, leukotrienes, and histamine, which stimulate smooth muscle, causing contraction and change in the permeability of the airway vasculature. The ability to return water to the airway surface is likely to be different for healthy and inflamed lower and upper airways [57].

The second theory is the thermal theory or **airway cooling theory**. This theory proposes a purely mechanical cause of airway narrowing [57]. Airway cooling causes vasoconstriction of the bronchial vasculature, followed by reactive hyperaemia which causes vascular leakage and airway oedema [57]. With an increase in ventilation rate during higher intensity exercise, mouth breathing replaces nasal breathing resulting in decreased heating of inspired air [12].

A third theory relates to **epithelial injury and inflammation**. Cooling and dehydration of the air can also cause airway epithelial injury. There is some evidence that there is an increase in the number of neutrophils in sputum, and this is suggestive of epithelial injury [58]. The severity of EIB in asthmatic athletes appears to be related to the epithelial cell numbers in sputum at baseline [59]. The response to airway injury involves exudation of bulk plasma as part of the restorative process. In elite athletes exercising in cold weather conditions, this process of epithelial injury and repair would occur repetitively during the season. It was proposed that AHR and EIB could develop for the first time after repeated exposure [52], due to the effect of plasma-derived products on the contractile properties of airway smooth muscle (ASM) [57]. This concept was supported by the finding that airway responsiveness returned to normal out of season and after retirement of sport [57].

Hyperventilation during exercise also induces mechanical stress that is thought to increase local inflammatory processes in the airways [50]. Furthermore, it exposes the airways to increased concentrations of allergens, pollutants, or other particles suspended in the air. Outdoor exercise can expose the athletes to sulphur dioxide (SO_2), nitrogen oxide (NO_2) and ozone (O_3), all of which can induce

neutrophilic airway inflammation, and this in turn, cause increased airway smooth muscle responsiveness[57].

Swimmers are particularly prone to develop AHR due to inhalation of chlorine gas in chlorinated pools. A study conducted in Spain, measured concentrations of chlorine gas above the water surface [60]. It was calculated that if a swimmer trains for 2 hours, exposure to chlorine gas was in excess of 4 to 6gm during that period. This exceeded the recommended exposure of 4 to 7gm for a worker per 8-hour shift in the United States. This exposure to chlorine gas may increase airflow obstruction and increase bronchial responsiveness [60]. This finding may explain the high prevalence of asthma-like symptoms in swimmers.

Atopy also appears to be a significant risk factor for the development of asthma. In a study investigating logistic regression models of asthma in athletes, it was found that when atopy and sport participation were combined as risk factors, the relative risk of asthma increased 97-fold in atopic swimmers, 42-fold in atopic long distance runners; and 25-fold in atopic speed and power athletes, compared with non-atopic controls [61].

Besides the environmental triggers for EIB and asthma, a **genetic component** for the development of asthma has also been suggested. It has been shown that, if one or more family members have atopy and/or asthma, a child born into this family has a far greater risk of developing asthma [50].

It is thus evident that the aetiology of asthma-like symptoms is multi-factorial but that the common underlying pathology is inflammation of the airways with an abnormal response to certain triggers and increased ventilation. It is also important to note that symptoms of asthma may mimic that of respiratory tract illness and that asthma and atopic conditions frequently co-exist.

2.5.4. Diagnosis of asthma in athletes

Asthma is a clinical syndrome and therefore a thorough history and physical examination are the cornerstones of the diagnosis of asthma. Clinical assessment in combination with special investigations are used in the diagnosis of asthma [56]. In the history taking, the physician should take special note of symptoms exacerbated by triggers, sensitivity to drugs including aspirin or non steroidal anti-inflammatories as well as a history of allergies and atopic conditions [51 56]. The physician should also enquire about associated symptoms of sinusitis, gastro-oesophageal reflux disorder, and anxiety disorders as these can be contributing factors [26].

In the physical examination of the respiratory system, the athlete should be assessed for prolonged expiratory time and wheeze, decreased air movements and hyperexpansion of the chest cavity, as well as the use of accessory muscle use with respiration [56]. Athletes should be assessed both at rest and after exercise, as some of the symptoms may only become apparent with physical exertion.

Various special investigations can aid in the diagnosis of asthma and these should be used appropriately for the confirmation of this condition. Pulmonary Function Testing (PFT) or clinical spirometry, which measures the amount (volume) and speed (flow) of air that can be exhaled and inhaled, forms the gold standard of testing. Resting PFT is performed by asking the athlete to inhale the deepest possible breath and then to exhale quickly and forcefully [56]. The forced expiratory flow in the first second (FEV_1) is then compared to the entire volume of air that can be expelled in a forced expiration, and this measurement is known as the forced vital capacity (FVC) [56]. Airflow obstruction (asthma) is present if $FEV_1/FVC < 0.7$ or FEV1<80% of baseline or predicted values [26].

To assess for EIB, baseline PFT is performed and the athlete is then requested to perform an 8-minute exercise test (running or cycling) at an exercise intensity where 90% of predicted maximum heart rate is reached within 2 minutes after the start of the exercise. PFT tests are repeated at 5, 10 and 30 minutes after the cessation of the exercise test. If the FEV_1 decreases by at least 10% from baseline values, the post-exercise challenge test for EIB is considered positive [26].

Athletes who have airflow obstruction on PFT are given 2-4 puffs of a short-acting bronchodilator e.g. salbutamol [26], and PFT are repeated after 10-15 minutes. A reversible airflow obstruction is defined when an improvement of >12% or >0.2L in baseline FEV_1 [26;56]. It should be noted that peak flow meters should not be used in the diagnostic evaluation of asthma as spirometry is much more accurate (3% vs.10%) and FEV_1 is less effort-dependant than peak flow measurements [56].

If the physician still suspects asthma or EIB, but has failed to demonstrate bronchoconstriction, he/she may assess the athlete for hyper-responsive airways by conducting bronchial provocation tests (BPTs)[62;63].

Direct BPTs include the methacholine and histamine challenge tests. These are very useful tests to evaluate for asthma [62]. Methacholine stimulates the airway smooth muscle directly and interpretation is based on the provocational concentration (PC) of methacholine that causes a 20% decrease in baseline FEV_1 (PC_{20}) [56;62]. A normal methacholine challenge test is a decrease in the FEV_1 by 20% at a methacholine concentration of >16mg/mL, while the same response at a methacholine concentration of <4mg/ml is considered a confirmatory test of AHR [56]. Histamine has a shorter half-life than methacholine but unfortunately has a greater side effect profile e.g. voice changes, headache and flushing, dizziness, chest tightness and cough and should therefore only be used if alternative BPT's are unavailable [56].

Indirect testing for AHR includes exercise challenge tests (test of choice to evaluate for EIB) [62], eucapnic voluntary hyperpnoea (EVH) and inhalation of hyperosmolar aerosols e.g. hypertonic saline and mannitol[26;63]. These challenge tests cause the release of mediators from inflammatory cells which in turn, stimulate bronchoconstriction [26].

2.5.5 Prevalence of asthma and asthma-like symptoms in athletes

For the purposes of this review, the prevalence of asthma will be considered as either lifetime prevalence (ever diagnosed asthma; also known as total asthma) or point prevalence (current asthma). Studies documenting the prevalence of asthma and asthma-like symptoms investigated different variables, e.g. the influence of training and environment on symptoms, the prevalence of asthma in different sports and differences among genders. The main focus of this component of the literature review will be on the prevalence of asthma in endurance athletes as this will be studied in the experimental section of this dissertation. However, where appropriate, studies conducted in the general athletic population will also be mentioned (Table 2.4).

Asthma is common in both athletes and sedentary individuals. In the general population, 5-10% of individuals suffer from this condition [50]. In the athletic population, however, the prevalence of diagnosed asthma is higher and has been reported to vary from 14 to 28%. Furthermore, the prevalence of EIA (23-35%) and AHR (23-52%) is even higher [50]. Possible explanations for the higher prevalence of these conditions among athletes include the higher physical demand (and thus trigger mechanism) on the respiratory system compared with sedentary counterparts. Another hypothesis is that the high levels of exercise (duration, frequency and intensity) may cause a change in the contractile properties of airway smooth muscle (ASM) and this may contribute to the development of asthma in previously unaffected athletes [57 64].

A study of 424 elite athletes (18-29 years), from the Queensland Academy of Sport was conducted to determine if the prevalence of asthma was different in the elite athlete population compared to an age-matched non-athletic population. The athletes included in this study represented 19 different sports disciplines and participants completed a questionnaire regarding respiratory symptoms experienced over a 12-month period. The lifetime prevalence of asthma in this group of athletes was 26% [65]. Current asthma (point prevalence) was experienced by 12% of athletes compared to 11% in the control population. Medication was used by 9% of athletes with a current history of asthma. The type of sport was independently related to the risk of having current asthma and the highest prevalence of current asthma was among endurance athletes. The point prevalence (current asthma) within this group was 22%, and the lifetime prevalence was 36% compared to 29% in the control group [65].

In another descriptive study among Danish elite athletes, 329 athletes participating in different sports completed a self-administered questionnaire [66]. Symptoms over a 12-month period were recalled and the authors documented that 55% of athletes reported asthma-like symptoms, of which cough and wheeze were the most common. In this study, 16% of athletes were previously diagnosed with asthma, while 14% had a current diagnosis of asthma but only 7% were taking medication. Endurance athletes had a higher prevalence of current asthma, when compared to the other athletes. Indeed, asthma-like symptoms occurred in 74% of the endurance athletes and yet only 15% used medication for these symptoms. Within the endurance sports, 93% of swimmers reported asthma- like symptoms, 57% had a current diagnosis of asthma and 50% used asthma medication. This study shows that many athletes have asthma-like symptoms without a formal diagnosis of asthma. Therefore, objective measures are needed to diagnose asthma and facilitate appropriate treatment [66].

There is an apparent discrepancy between symptoms of asthma that are experienced by athletes and a formal diagnosis of asthma. In a study in competitive swimmers the prevalence of AHR to methacholine or histamine ranged from 36 to 79% [50]. In contrast to this high figure, the prevalence of physician-

diagnosed asthma in swimmers was only 8% [64]. Therefore, it was suggested that these differences could be due to the fact that symptoms are either well tolerated by athletes, or the symptoms are denied or not perceived as requiring medical assessment [50].

In 2003, a review was conducted to determine the possible reasons for the above-mentioned discrepancies [67]. In this report, EIB and AHR were measured by objective methods (exercise challenge test and broncho-provocation challenge tests respectively). The authors found that the prevalence of self-reported or physician-diagnosed asthma in athletes is usually lower than if it was diagnosed using AHR or EIB. This review reported a discrepancy between subjective and objective assessment of airway dysfunction. Possible explanations for these differences were; 1) AHR is a transient and reversible result of supra-physiological stimulus to prolonged and intense exercise, 2) the possibility that AHR might be asymptomatic and therefore is not reported by athletes, 3) asthma is under-diagnosed in athletes due to poor perception of symptoms, adaptation to nociceptive stimuli, or underreporting of symptoms and 4) under diagnosis by physicians due to misinterpretation of symptoms or the lack of objective measurements [67].

A further review of the prevalence of asthma and AHR in different sports (including sprinting, football, basketball and other track and field events) revealed the prevalence of physician-diagnosed asthma, EIA and AHR to range from 8 to 21%. This study did not report the prevalence in endurance athletes [50]. However, some studies reported higher point prevalence (current asthma) in endurance athletes (17-22%) in comparison to team sports (7%) or speed and power sport types (5-8%) [65;68]. This was confirmed by findings with respect to athletes participating in the 1996 Summer Olympics in which the prevalence of asthma was higher in endurance sports like cycling, swimming and rowing [34]. Yet another study on the prevalence of asthma and bronchial hyper-responsiveness indicated a higher prevalence in endurance athletes when compared to other athletic disciplines [69].

In 1998, a total of 162 athletes (49 power athletes, 71 long-distance runners and 42 swimmers) were compared to a control group of 45 subjects [61]. Both groups were studied by completing a respiratory symptom questionnaire, skin prick testing, resting flow-volume spirometry, and a histamine challenge test. Of the swimmers, 50% were atopic and 36% displayed AHR in response to histamine challenge tests. Current asthma was found in 26% of swimmers and previous physician-diagnosed asthma occurred in 29%. The adjusted risk of total asthma was nearly 6-fold in swimmers when compared to controls. When atopy and swimming were combined as risk factors in the multivariate analysis, the risk of asthma in atopic swimmers was 96-fold as compared with non-atopic control subjects without atopy [61].

It is evident from a number of studies that asthma and asthma-like symptoms are more prevalent in swimmers compared to athletes from other sport disciplines [61;66]. An interesting phenomenon studied in a 5-year prospective study was the effect of discontinuing high level swimming on airway inflammation, bronchial hyper-responsiveness and asthma [70]. 42 elite Finnish national team swimmers completed a questionnaire and had resting spirometry, histamine challenge testing and skin prick testing performed at baseline and at follow up. Of these, 16 (38%) swimmers had continued their competitive career at the time of follow up (active swimmers), whilst 26 (62%) had stopped competing more than 3 months prior to follow up (past swimmers). Bronchial hyper-responsiveness at baseline was documented in 7 (44%) of active swimmers compared to 8 (31%) of past swimmers. When the same test was performed at follow up, 8 (50%) of active swimmers had bronchial hyper-responsiveness in contrast to only 3 (12%) of the past swimmers. Current asthma was found in 5 (31%) of active swimmers at baseline and 6 (23%) of past swimmers. At follow up there was an increase to 7 (44%) of active swimmers compared to only one (4%) past swimmers with current asthma [70]. The results of this study suggests that asthma may result from high intensity and prolonged exercise and that the condition is partly reversible on cessation of an active sports career [70].

The possibility of gender differences with respect to prevalence of AHR, physician-diagnosed asthma and respiratory symptoms were explored in a retrospective analysis [71]. Subjects were divided into 2 groups.

One hundred athletes (group 1) underwent a methacholine challenge test (PC20<16mg/ml) to assess prevalence of AHR, and a second group of 698 subjects (group 2) completed a questionnaire to assess prevalence of physician-diagnosed asthma (PDA). Both groups also completed a questionnaire regarding exercise related respiratory symptoms. In group 1, 60% of female athletes had AHR to methacholine compared to only 21.5% of male athletes. However, it is of interest that there were no gender differences in the prevalence of AHR within the control group of sedentary individuals. Respiratory symptoms during exercise were also reported more often in females compared with males (19.4% vs. 12.2%). However, in this study, the prevalence of physician-diagnosed asthma was similar between female and male athletes (17.1 % vs. 15.4%) [71]. Female athletes therefore seem to experience respiratory symptoms more often with exercise compared to males, although the diagnosis of asthma seems to be similar among the genders. It should be noted that there was no uniform diagnostic testing for establishing the diagnosis of asthma among subjects and across studies. This factor may need to be considered for more accurate investigation for possible gender differences in PDA in future studies. It is of further interest that after adjusting for age and body mass index, or even for airway calibre and lung volume, the gender difference for AHR still remains higher in females [71;72].

Possible explanations for the observed gender difference are; 1) that the menstrual cycle, and therefore hormonal status, is associated with changes in the airway. Females in their mid-luteal phase (day 21 of menstruation), demonstrated more severe EIB and a more frequent use of bronchodilator medication. This finding has been attributed to the higher levels of progesterone during this phase [73], 2) female athletes demonstrate a more sensitive perception or better recognition of symptoms and may therefore report symptoms more often than their male counterparts [71], and 3) females may perceive the presence of these symptoms, or the reporting thereof as a sign of weakness. They may also choose to ignore it due to fear that it may be potentially limiting for performance development [71]. They may therefore not seek medical assessment and thus lack a formal diagnosis.

Table 2.4. The point prevalence of asthma and asthma-like illness in athletes

Type of study	Population	Diagnosis	Point prevalence of asthma	Medication	Additional comments	Reference
Case control	424 athletes 243 age matched controls	Questionnaire on PDA[a] and symptoms	12% all athletes 11% in controls	73% any asthma medicine, 44%ICS[b] alone	Highest prevalence asthma in endurance athletes (22%)	Locke and Marks 2007
Cross sectional survey	329 elite athletes	Questionnaire on PDA[a] and symptoms	14% athletes	7% used medication: 67% used combined ICS[b] and IBA[c]; 13% ICS[b] only; 21% IBA[c] only	55% all athletes reported asthma-like symptoms; 74% of endurance athletes had symptoms	Lund *et al* 2009
Case control study	49 power 71 LDR[d] 42 swimmers 45 controls	Questionnaire SPT[e] Resting flow volume spirometry Histamine challenge test	7% LDR[d] 26% swimmers 2.2% controls		50% swimmers had atopy. AHR[f] to histamine in: 9% LDR[d], 36% swimmers, and 11% in controls	Helenius *et al* 1998
Retro-spective analysis	100 athletes	Questionnaire on PDA[a] Methacholine challenge (PC_{20}< 16mg/ml)	17.1% females 15.4% males		Study gender differences AHR[f] in 60% females and 21.6% males	Langdeau *et al* 2009

[a] PDA, Physician diagnosed asthma; [b]ICS, Inhaled corticosteroids; [c] IBA, Inhaled beta 2-agonists; [d]LDR, Long-distance runner; [e]SPT, Skin prick test; [f]AHR, Airway hyper-responsiveness

2.5.5.1 Summary: Point prevalence of asthma in athletes

In summary, it is evident that there is a high reported prevalence of asthma in athletes but that there is also great discrepancy between asthma-like symptoms experienced and the actual diagnosis of asthma, AHR or EIB. Secondly, the need to make a proper diagnosis by means of a thorough history, physical examination and appropriate special investigations, should be emphasized. Thirdly, the prevalence of asthma is higher in the endurance athletes but these studies were mainly conducted on swimmers, rowers and cyclists, with little mention of ultra-distance runners or triathletes, and finally, the treatment of

asthma-like symptoms are often sub-optimal or inappropriate. The impact of asthma and training will performance will now be reviewed.

2.5.6 Influence of asthma-like symptoms on training and performance

Asthma and EIB may pose a challenge for the training and competing athlete, but may not necessarily influence athletic performance if it is well controlled. It is interesting to note that Olympic athletes at Salt Lake City, Athens and Torino, who used beta 2-agonists for asthma-like symptoms, won more individual medals than their counterparts without asthma at each Games [53]. Most of these medals were for endurance events during winter competitions. There are two possible theories to explain this observation; 1) either endurance athletes develop asthma after achieving success as an elite athlete or 2) having a chronic disease (in this instance asthma) and competing at a high level may represent as a "psychological" training stimulus for the elite athlete [53].

However, in view of the above findings, concerns have been raised that the use of beta 2-agonist inhalers (bronchodilators) could enhance athletic performance. However, to date studies have shown no significant increase in physical performance with the use of inhaled short- or long acting beta 2-agonists, inhaled corticosteroids or inhaled anticholinergics [69;74]. However, the use of oral salbutamol remains prohibited as it does increase strength [75]. As from 1 January 2011, an "Abbreviated therapeutic use exemption (ATUE)" is no longer required for the use of salbutamol or salmeterol {www.wada-ama.org}. Athletes should however still report in writing all medication/substances ingested/inhaled in the 7 days prior to the test, on the Doping Control form. In addition, urine concentrations of beta-2 stimulants may not exceed 1000ng/ml as this would indicate supra-therapeutic doses. However, it should be noted that at present, terbutaline and formeterol are prohibited, and use of these agents require completion, submission and approval of a Therapeutic Use Exemption (TUE) certificate from the relevant authority.

All forms of corticosteroids by means of oral, intramuscular or intravenous routes are also prohibited (http://www.wada-ama.org).

It is therefore evident that asthma, AHR and EIB, if adequately managed, do not have to prevent an athlete from achieving performance goals. However, this is dependent on early recognition of symptoms, confirmation with diagnostic testing, and the implementation of appropriate treatment within anti-doping regulations.

2.5.7 Summary: Prevalence of asthma and asthma-like symptoms in athletes

- Asthma, EIB and AHR are commonly observed in both the general and athletic population.
- Endurance athletes tend to have a higher prevalence of asthma-like symptoms compared to other athletes.
- Swimmers have a high prevalence of AHR and EIB. This is thought to be due to high exposure to chlorine derivatives. It could also be that athletes with asthma traditionally chose swimming as the sport of preference.
- Respiratory symptoms are more prevalent in females than male athletes but physician-diagnosed asthma is similar in both genders.
- The pathogenesis of asthma is multifactorial. Some risk factors can be altered or avoided; others cannot be changed e.g. genetic predisposition.
- Asthma appears to be reversible after the cessation of high-level sports.
- Athletes with rhinitis should be screened for asthma and asthmatic athletes should have allergy testing as these conditions often co-exist.
- There is a great discrepancy between asthma-like symptoms experienced and diagnosis made – physicians should be vigilant to perform appropriate diagnostic testing.
- Many athletes are under- or inappropriately treated for asthma symptoms.

- Few studies available on the prevalence of asthma in specifically the triathlete and endurance runners.

2.6 Allergic conditions in athletes

2.6.1 Introduction

The athletic population often suffer from allergic conditions and the prevalence of allergic conditions has been increasing over the past 20 years [76]. Allergies can manifest as a variety of clinical entities, some of which can be potentially debilitating. In the lung, allergies may cause bronchoconstriction or asthma; in the skin, urticaria; in the nose, rhinitis and in the eyes, allergy can manifest as conjunctivitis [37]. The manifestations of allergic symptoms depends on the type of allergen, the length of exposure and the atopic tendency of the individual [37]. As most endurance training occurs outdoors, it is evident that athletes, and in particular the endurance athlete, might have a higher exposure to allergens during periods of prolonged training.

The most common clinical manifestations of allergic disorders in the athletic population are allergic rhinitis and conjunctivitis [77]. Allergic rhinitis usually presents in the 6 to 25 year age group, and is important to note that most elite athletes belong to this age group [77]. Allergic conjunctivitis is a localised manifestation of allergies and may present with redness and itching of the eyes, tearing and at times photophobia and swelling [77]. Allergic conditions of the skin present as allergic contact dermatitis (ACD) and irritant contact dermatitis (ICD), the symptoms and signs of which are very similar and both are treated topical corticosteroids and avoidance of triggers [78]. Allergies can however also present systemically, as in the case of urticaria. The most severe systemic manifestation of allergy is anaphylaxis, which is potentially

life threatening and requires immediate medical intervention [37]. An in depth discussion of each of these conditions is beyond the scope of this review.

Allergic symptoms can however at times be subtle and athletes may only complain of poor quality sleep, poor exercise performance, fatigue, headaches or even depression and anxiety [12;37]. Allergies are therefore likely to be under-diagnosed and under-treated possibly due to the fact that they are often under reported [77]. On the other hand, athletes may have more obvious symptoms including nasal congestion and sneezing, post nasal drip, rhinorrhoea, cough and itchiness of the ears, throat or nose [37;77].

Allergic conditions may make an athlete more prone to other clinical conditions influencing their respiratory health, including infection. Allergic rhinitis can often precede the onset of asthma and can therefore represent a predisposing condition for the development of asthma [79]. These two conditions can also frequently coexist [69;80]. The WHO-ARIA (Allergic rhinitis and its impact on asthma) therefore recommended to investigate asthmatics for rhinitis and to test subjects with rhinitis, for asthma [81].

It is important to note that allergic conditions that affect the respiratory tract may have the same clinical presentation as symptoms of URTI and it may be difficult to differentiate between these two conditions [24]. This highlights the need to consider non-infectious causes for RTS as discussed in the previous section.

2.6.2. Terminology and definitions: Allergies in athletes

As mentioned, allergic conditions have a wide array of clinical manifestations and affect various systems. For the purpose of this review, the main focus will be on allergies pertaining to the respiratory tract.
Allergic rhinitis is clinically defined as a symptomatic allergic disorder of the nose. Exposure to an allergen induces immunoglobulin E (IgE) - mediated inflammation of the membrane lining the nose [81].

This condition can be subdivided into **intermittent allergic rhinitis (IAR)** or **persistent allergic rhinitis (PER)** and the symptoms can be graded from “moderate” or “severe” [81]. In some instances, referral is made to “**allergic rhinoconjunctivitis**” [11], which implies rhinitis in conjunction with allergic conjunctivitis.

2.6.3. Pathophysiology of allergies in athletes

Recent evidence suggests that chronic exercise training can lead to changes in the innate and adaptive immunity [82]. This includes the tendency of T-helper lymphocytes to proliferate into the T-helper type 2 (Th2) phenotype [83], which are responsible for the allergic reaction that could predispose an athlete to allergic rhinitis and upper respiratory tract symptoms [31;37].

Allergens occur from multiple sources, including the environment (e.g. pollen, dust and mold), insects, foods and a variety of drugs [37]. Aeroallergens like tree, grass and weed pollen, are seasonal, while mold and dust, are non-seasonal aeroallergens [84]. Exposure to these allergens, results in the secretion of specific immunoglobulin E (IgE) antibodies which in turn causes acute, recurrent or chronic inflammation[37]. As previously described, an athlete can greatly increase ventilation (up to 200L/min) during exercise [37]. For this reason, the athlete is more exposed to allergens, poor quality air and particulate matter during the exercise bout. Clinically, this exposure may present in the respiratory tract, skin or systemic symptoms and can have a profound effect on exercise tolerance.

Allergic rhinitis is characterized by swelling of the nasal mucosa as a result of IgE-mediated release of cytokines. These promote infiltration of the mucosa with inflammatory cells, and the athletes then presents with nasal congestion, sneezing, rhinorrhoea, itching of the nose or a post nasal drip [37]. Swelling of the nasal mucosa also compromises drainage of the related anatomical systems, and this may result in acute or chronic infection [11]. Other consequences of nasal congestion are snoring with associated sleep

disturbances and resultant fatigue, which have negative effects on training performance and quality of life of the athlete [12]. “Blocked” nasal passages are also undesirable for a sprinting athlete who is dependent on both nasal and mouth breathing for optimal performance [12].

Localized allergic symptoms may also have remote consequences. For example, a post nasal drip due to allergic rhinitis, may also affect the function of the vocal cords. During exertion with an increase in body temperature, the viscosity of mucus decreases, allowing it to reach the vocal cords and subsequently a reflex increase in bronchial hyperreactivity [85].

The upper respiratory tract acts as a filter and humidifier of inhaled air [12]. Any alternation to the upper airway function, would therefore alter lower respiratory function [12]. This may lead lower respiratory tract symptoms including wheeze, cough and breathlessness. It is thus evident that allergies may have systemic consequences, and therefore it is important to recognize these conditions and manage them appropriately.

2.6.4. Diagnosis of allergies in athletes

Optimal management starts with the clinician making an accurate diagnosis and identification of factors that may trigger allergic symptoms [11]. In the first instance, a thorough history and physical examination should be conducted with special attention given to the respiratory tract, skin and ear, nose and throat systems [77]. It is important to consider that symptoms may be seasonal or intermittent and thus it may not be present at the time of examination [81].

Special investigations for allergies can include skin prick (SPT) and intradermal testing, which are conducted to determine IgE-mediated hypersensitivity in the skin [37]. A test is considered positive if a

wheal or flare response occurs 15 minutes after allergen contact [37]. If the skin response is decreased or inconclusive, a radioallergosorbent (RAST) can be performed on a serum sample. This test detects specific IgE antibodies with comparable specificity and sensitivity to skin-prick testing [86]. When an allergic pathogenesis is thought to be the cause for upper respiratory tract symptoms, the 'gold standard' practice should include the SPT and measurement of allergen specific IgE in serum [31].

Symptoms similar to that of allergic rhinitis, can manifest in conditions such as aspirin sensitivity, side-effects to medications, vasomotor rhinitis, misuse of topical decongestants (rhinitis medicamentosa) as well as in mechanical factors including deviated nasal septum or foreign body [81]. These factors should always be considered in the differential diagnosis of any allergic type manifestation. Due to the high prevalence of asthma in atopic athletes, it may be advisable to screen atopic patients for asthma [11;80;81;87]. The diagnostic tests for asthma have already been described in this review.

Furthermore, it has been suggested that allergy testing should form a standard part of the pre-season screening or periodic health assessment of all athletes [31;77], as many may have symptoms, but never seek proper medical advice or investigation. This may aid in appropriate prophylaxis, the avoidance of triggers and lead to better athletic performance [11;37;88].

2.6.5. Prevalence of allergies in athletes

Allergic rhinitis is a common condition with an apparent high prevalence among elite competitive athletes[11;34].This condition remains one of the most common reasons for a visit to local pharmacist or medical practitioner [11]. A number of studies have been conducted to determine the prevalence of allergies in different sporting disciplines (Table 2.5).

On evaluation, the type of sport and the presence of allergic symptoms show some interesting trends emerge. Sports participants in aquatic sports such as swimming, rowing and diving, were more likely to have allergic rhinoconjunctivitis compared to non-aquatic sports [11]. This is of particular interest because, in Australia, there has been a tendency to encourage children suffering from asthma to participate in aquatic activities [11]. This advice could explain the higher prevalence of asthma and possible associated atopic symptoms in this group. In contrast to this, the least likely athletes to show atopic tendencies were equestrians. This is however thought to be due to "natural selection" [11].

A group of 214 Australian elite athletes, preparing for the Sydney Olympics in 2000, was studied for the prevalence of allergic symptoms. Allergy testing for common aeroallergens and the most prevalent pollens were conducted and the impact of allergic symptoms on the quality of life was also assessed. Furthermore, athletes diarized their daily symptoms for 8 weeks during the pollen season. In this study, 56% of athletes had a self-reported history of symptoms of allergy compared to a 41% prevalence of current symptoms of allergic rhinoconjunctivitis (AR/C) that was confirmed by positive allergen tests. Seasonal AR/C was documented in 29% of athletes, and was also confirmed with positive skin test. In this group of athletes, 21% suffered from asthma. Swimmers and divers were the group of athletes most likely to show allergic sensitization. Allergic athletes had a higher symptom score and lower quality of life ratings during the pollen season compared with non-allergic athletes. It is of interest to note that even after the pollen count decreased, allergic athletes showed no improvement in their nasal symptoms. This phenomenon has been termed the "priming effect" [33].

These findings were compared to the findings in a survey study on the prevalence of atopy in 81 South African Olympic athletes preparing for the same Olympic Games. In the South African study, participants completed a detailed allergy questionnaire, were examined for physical signs of atopy and underwent a SPT for 14 aero-allergens. Atopy was identified in 62% of athletes and 33% had seasonal allergic rhinitis

(SAR) [32]. This was far more than the currently believed allergy prevalence of 30% in the general South African population [32].

In 2006, a questionnaire-based study on the prevalence of allergic and asthma-like symptoms was conducted on 63 British track and field athletes. In this study, 60% of athletes reported symptoms of hay fever in the past of which only 8% had specific clinical allergy testing to confirm the diagnosis. Despite having symptoms that could possibly affect performance and health in general, only few athletes pursued further clinical confirmation of their symptoms [31]. This could also be due to the fact that athletes are poor at recognizing symptoms as being caused by allergy [11]. Since then, the author implemented an active allergy screening program in British track and field athletes [31].

Atopy has also been associated with other conditions of the respiratory tract e.g. asthma. A survey of 162 athletes competing in summer events was conducted to determine the prevalence and the risk factors for asthma and increased bronchial responsiveness (study population and asthma prevalence discussed in previous section) [61]. Atopy by SPT was documented in 77 (48%) of athletes compared to 16 (36%) of controls. Pollen allergy was more common in athletes than in controls. In relation to respiratory symptoms, atopic athletes showed significantly greater bronchial responsiveness and asthma than non-atopic athletes. Furthermore, a strong association was made between increased bronchial responsiveness and the severity of atopic tendency in these elite athletes [61].

A higher prevalence of allergic conditions in endurance athletes, was observed in a cross-sectional survey on 446 Finnish national level athletes [12]. A representative sample of 1504 Finnish young adults served as controls. All participants completed a questionnaire regarding symptoms of asthma and allergies, medication use and type of sports activities. The results of this study show that 36.1 % of

endurance athletes indicated having physician-diagnosed allergic rhinitis compared to only 20.4% of speed and power athletes and 20.2% of controls. There was no significant difference in allergic rhinitis between summer and winter sports. In the group of athletes reporting allergic rhinitis, 34.7% also had a clinical diagnosis of asthma. The use of anti-allergic medication use was reported in 33.3% of endurance athletes, 15.7% of speed and power athletes and 15.6% of controls. This study clearly indicated the higher prevalence of allergies in the endurance sports, but also emphasized the lack of appropriate diagnostic allergy testing and treatment [12].

Table 2.5. A summary of the prevalence of allergic symptoms in athletes

Type of study	Population	Diagnosis	Point prevalence of allergies	Additional Comments	Reference
Retrospective analysis	63 track and field athletes	Questionnaire	60% symptoms of hay fever	8% had specific clinical allergy testing done in past	Dijkstra *et al* 2011
Cross sectional survey	446 elite athletes 1504 controls	Questionnaire	Rhinitis diagnosed in: 36% endurance athletes 20% speed and power athletes 20% in controls	34.7% of athletes with rhinitis had a diagnosis of asthma	Alaranta *et al* 2005
Cross sectional survey	81 Olympic athletes	Questionnaire SPT[a]	62% atopy 33% SAR[b]	14 Aeroallergens tested	Hawarden *et al* 2002
Cross sectional survey	214 Olympic athletes	Symptom diary SPT[a]	56% symptoms of allergy 41% AR/C[c] with positive allergen test 29% seasonal AR/C[c] with positive allergen test 21% asthma	8 Allergens tested	Katelaris *et al* 2000
Case control	49 speed and power athletes 71 LDR[d] 42 swimmers 45 controls	Questionnaire SPT[a] Resting flow-volume spirometry Histamine challenge test	48% atopy in athletes 36% atopy in controls 30% pollen allergy in athletes 13% pollen allergy in controls	43% atopy speed and power athletes 49% atopy LDR[d] 50% atopy swimmers	Helenius *et al* 1998

[a]SPT, Skin Prick test; [b]SAR, Seasonal allergic rhinitis; [c]AR/C, Allergic rhinoconjunctivitis; [d]LDR, Long-distance runners

2.6.6. The effect of allergies on athletic performance

It may appear that atopic diseases including allergic rhinitis seem trivial and localized, but these

conditions may lead to a cascade of effects, which negatively impact the physical wellbeing and the physical performance of the athlete. Allergic disease may present with inflammatory response manifesting in asthma, rhinitis, urticaria and conjunctivitis, thus affecting multiple systems [37]. Allergic rhinitis can cause rhinorrhoea, nasal obstruction and sinus pressure and this in turn may have a negative effect on sleep, resulting in fatigue and tiredness and ultimately affecting the athlete's recovery and performance [12;33]. Allergic rhinitis may even have a negative effect on cognitive processing, as tests in subjects with allergic rhinitis revealed decrements in reaction time, vigilance and attention when the individual is exposed to pollen [89].

2.6.7. Prevention and management of allergies in athletes

Prevention and optimal treatment of allergies in athletes is dependent on the correct diagnosis, and identification of triggering factors [11]. Yet, many athletes may be ignorant as to their allergic symptoms and the origin/nature of their allergic triggers [31;77]. It has already been suggested that allergic screening be included in the periodic health examination of athletes in order to prevent complications of allergies, and to optimize management.

Management of allergic rhinitis can be divided into non-pharmacologic and pharmacologic treatment. Non-pharmacological interventions include the following; 1) the avoidance of allergens, although this is not always feasible for the athlete training outdoors [77], 2) saline nasal irrigation has been shown to be effective and safe in cleansing the nasal mucosa of allergens [90], and 3) external nasal dilators can also be used and in one study, have been shown to decrease submaximal exercise-perceived exertion, ventilation, oxygen use and heart rate in comparison to not using nasal dilators [91].

The mainstay of pharmacological treatment and the first line choice for allergic rhinitis are intranasal

corticosteroids [11;31;88]. Corticosteroids have a strong anti-inflammatory action and attenuate the release of cytokines, antigen presenting cells and cellular infiltration within the nasal mucosa [11]. Regular prophylactic use of intranasal corticosteroids, is effective in reducing symptoms of sneezing, nose itching, rhinorrhoea and nose "blockage" [11;88]. A meta-analysis showed intranasal corticosteroids to be superior to systemic anti-histamines in the treatment of allergic rhinoconjunctivitis [92].

Other medication to consider are the oral non-sedating anti-histamines e.g. fexofenadine, which have demonstrated minimal disruptive effects on the central nervous system and can be used as a second line of treatment [93]. Another drug to consider is ipratropium bromide and although it has no effect on sneezing, it is effective in the control of watery rhinorrhoea. It is therefore more effective in winter sports where watery rhinorrhoea due to cold air exposure is more prevalent [11].

Athletes with allergic rhinitis without clinical evidence of asthma may often have increased nonspecific bronchial hyper-responsiveness. It is interesting to note, that treating rhinitis by means of intranasal corticosteroids, may also alleviate asthma-like symptoms and it can also decrease nonspecific bronchial reactivity that is associated with seasonal pollen exposure [87]. This re-emphasizes the need to have a high index of suspicion for co-existing respiratory illnesses in the presence of allergic disorders.

In treating allergic conditions, sports physicians should take extra care to make sure they comply with the WADA guidelines. The 2011 guidelines state that pseudoephedrine is prohibited in-competition if the urine concentration exceeds 150 micrograms per ml. Although the use of this agent is not recommended as effective management of allergy in athletes, athletes sometimes use it as an over-the-counter decongestant. Finally, it is important to note that all glucocorticosteriods are prohibited when these are administered by oral, intravenous, intramuscular or rectal routes. These forms of management are

sometimes used in the treatment of allergies by general practitioners. However, the use of intranasal corticosteroids is not prohibited and does not require a Therapeutic Use Exemption (www.wada-ama.org).

2.6.8. Summary: Allergies in athletes

- Allergic conditions are very common in athletes, especially endurance athletes.
- Allergic symptoms may mimic other conditions of the respiratory tract.
- Allergies and asthma may co-exist and therefore athletes with allergies should be tested for asthma and asthmatic athletes should be screened for allergies.
- Athletes tend to be ignorant about atopic conditions and may be unaware of the influence these conditions may have on quality of daily life and athletic performance.
- Allergy screening should be considered part of the periodic health evaluation of athletes.
- Special care should be taken in prescribing anti-allergic medication of high level athletes in compliance with WADA regulations.

2.7. Summary: Respiratory symptoms, asthma and allergies in athletes

In this Chapter, respiratory symptoms, asthma and allergies in athletes were reviewed. These conditions can affect the physical wellbeing of the athlete, can negatively affect performance, particularly during the preparation for an event (pre-event period) and in some cases may cause life threatening illness such as myocarditis. Symptoms from these respiratory illnesses can often co-exist and may have similar clinical presentations. The prevalence of these conditions, which can influence the respiratory health of the endurance athlete, and in particular the triathlete and ultra-distance runner, has not been studied well in the pre-event period. Further studies are therefore suggested to determine the prevalence of these

respiratory illnesses, particularly in the pre-event period. This is the focus of the experimental component of this dissertation.

CHAPTER 3

Prevalence of pre-event respiratory illness and symptoms in Ironman Triathletes and Ultra-distance runners: A cross-sectional study

3.1 Introduction

The Ironman Triathlon is an ultra-endurance race comprising of a 3.8km open water swim, a 180km cycle and a 42.2km run. In the past few years, it was held during the summer months at the eastern coastal town of Port Elizabeth in South Africa. The Two Oceans ultra-marathon, on the other hand, is an ultra-distance road running race of 56km, which is usually held in March or April in Cape Town, South Africa. Athletes regard both these two ultra-distance events as ultimate tests of their physical and mental endurance. Despite the fact that it is generally accepted by both athletes and health professionals that individuals participating in these events are largely free of illness, it has been noted that these endurance athletes can suffer from a variety of medical conditions during training before, during, or after the event [1].

Therefore, in recent years, there has been an increasing focus on not only injury prevention, but also on protecting the health of the athlete. More specifically, a number of recently published studies have shown that the respiratory system is the system most likely affected by illness, particularly during sports tournaments [17-19]. Furthermore, it has been shown that upper respiratory tract (URT) complaints are very common, especially after endurance races [2;3;5]. It has also been noted that upper respiratory tract symptoms (URTS) are also common during periods of increased training load and intensity and a "J-curve" has been suggested to explain the relationship between exercise and upper respiratory tract (URT) symptoms. Data suggest that moderate intensity and regular exercise is associated with protection against URT symptoms, while high intensity, acute or chronic exercise, such as during training and participation in endurance events, is associated with increased risk of URT symptoms [2;4;16;40]. To date,

most studies in endurance athletes have focussed on post-event URT symptoms [2-4;40] and only few studies addressed pre-event URT symptoms [4;40]{Lichaba 2006}.

Until recently, it was suggested that respiratory symptoms in athletes during training (pre-event) and post-event were caused by pathogens (infective hypothesis) due to a decrease in host immunity as a result of intense or prolonged exercise [5]. However, this hypothesis has recently been challenged, particularly because an infective pathogen could seldom be isolated in athletes with these symptoms [7-10]. These findings led to the suggestion that alternative processes could be involved in the pathogenesis of respiratory symptoms in endurance athletes. One of the alternative hypotheses that have been proposed as an explanation of the common occurrence of respiratory tract symptoms in endurance athletes is the allergic hypothesis [7].

In recent years there is increasing evidence suggesting that allergies are very common among athletes, particularly in endurance athletes [11;12;31;32;77]. Allergic rhinitis can present with symptoms including nasal congestion and rhinorrhoea and these may mimic symptoms of respiratory tract infection. Other clinical entities that may also mimic symptoms of respiratory tract infection include asthma and asthma-like symptoms. Asthma classically presents with coughing, wheezing and shortness of breath and these same symptoms can also occur during respiratory tract infections [26;51].

It is thus clear that symptoms of respiratory tract illness are apparently very common in endurance athletes in the post-event period, and that these symptoms may not always be due to an infection. The presence of allergies and asthma may contribute to the development of both post- and pre-event respiratory tract symptoms of the athlete, and in particular, the endurance athlete [77]. However, the prevalence of respiratory tract symptoms, particularly in the pre-event period has not been investigated thoroughly in ultra-endurance athletes.

The primary aim of this study is to document the pre-event point prevalence of respiratory tract symptoms in two groups of endurance athletes. A secondary aim is to document the nature of respiratory related illnesses in the two groups of endurance athletes.

3.2 Methods

3.2.1 Type of study

This study was a cross-sectional descriptive study.

3.2.2. Participants

For this study, participants were recruited from two groups of endurance athletes – Ironman triathletes and ultra-distance runners. All the triathletes participating in the 2006 and 2007 'Spec-Savers 'Ironman Triathlons (3.8km open water swim, 180km cycle and 42.2km run) in Port Elizabeth, South Africa and ultra-distance runners participating in the 2009 Old Mutual Two Oceans ultra-marathon (56km road run) in Cape Town, South Africa, were considered as potential participants for this study. There were in total 1136 (85% males and 15% females) entrants in the Ironman Triathlon held in March 2006, 1566 (75% males and 25% females) entrants in the Ironman Triathlon of April 2007, and 5824 (77% male and 23% female) athletes who entered the Two Oceans Ultra-marathon in April 2009.

Two months before the events, information pertaining to the study was posted on the official race websites. The website content included information about study procedures (Appendix A), the informed consent form (Appendix B) and copies of the questionnaires (Appendix C) to be completed. Before these studies commenced, the protocols were approved by the Human Research and Ethics Committee of the Faculty of Health Sciences at the University of Cape Town (REC ref. 425/2005, REC ref. 002/2007 and REC ref. 066/2009) (Appendix D), as well as the general organizing committees of the 2006 and 2007 'Spec-savers' Triathlon and the 2009 Old Mutual Two Oceans Ultra-marathon.

Potential participants for the studies were recruited during registration in the 3 days prior to each event. At all three events, research 'stations' were established in close proximity to the registration desk and athletes were informed about the study at registration. Those who agreed to participate were then accompanied to the research area where voluntary staff gave further information regarding the study and the procedure to follow. Once athletes gave written informed consent, they were handed a questionnaire and encouraged to complete it on site. Alternatively, athletes were allowed to take the questionnaire with them and to return it the next day, or the morning of the race day (less than 10% of questionnaires were returned in this way).

One hundred and fifty-two ultra-distance runners and 470 triathletes completed the questionnaire. Twenty-nine triathletes completed both the 2006 and the 2007 questionnaires, and for triathletes who completed the questionnaire in both years, only the data from 2007 were used in this study. Therefore, the final participants in the study were 441 triathletes (279 from 2006 and 162 from 2007) and 152 ultra-distance runners (2009). The response rates for each event were as follows: 26.5% of the triathlete entrants in 2006, 10.5% of the triathlete entrants in 2007, and 2.2% of the ultra-distance runners in 2009.

3.2.3. Pre-event medical questionnaire

This study made use of previously validated pre-event medical questionnaires which were modified and used [94-96]. The questionnaires for the two Ironman events and the Two Oceans were very similar, with only a few changes made to the questions regarding training relevant to the specific event. The pre-event questionnaire for the Ironman event consisted of 28 pages and that of Two Oceans contained 25 pages. The main differences were related to cycling and swimming training for the Ironman triathlon, which was not relevant to the Two Oceans participants. The remaining sections included details of the athlete's medical history. The sections of the questionnaires relevant to this study were therefore very similar in all three events (Ironman 2006, 2007 and Two Oceans 2009).

In this particular study, information from the following sections were used: 1) demographic details including age, gender, weight and height, 2) racing and training history of the 15 weeks and 1 week period prior to the event (training distances for running only and hours spent training for all disciplines in the Ironman triathletes compared to hours running in ultra-distance running), including personal best times in 10km, 21.1km and 42.2km running races, 3) lifestyle habits, particularly smoking history and 4) personal general medical history. In the general medical history, the athlete was asked to report any history of symptoms experienced in 14 different medical conditions.

3.2.3.1. General questions regarding respiratory tract illness

For the purposes of this study, the focus was to obtain information on the following three main questions in the general medical history that were related to respiratory tract illness: 1) "In the 6 weeks before this race did you suffer from any symptoms of flu (fever, sore throat, blocked or runny nose, cough, wheeze, muscle aches and pains)?" 2) "Have you ever in your triathlon/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?" 3) "Do you currently suffer from asthma including exercise induced asthma, or symptoms of asthma such as shortness of breath, wheezing, or chronic coughing?" Throughout the questionnaire, layman's terms were used e.g. flu-like symptoms were used instead of respiratory symptoms, and fever, "blocked nose", "runny nose", muscle aches and joint pains were used instead of pyrexia, nasal congestion, rhinorrhoea, myalgia and arthralgia respectively. If the athlete reported symptoms of a specific condition in the general medical section, they were then requested to complete a more detailed section on the relevant medical condition in a different section of the questionnaire.

3.2.3.2. Detailed questions on respiratory tract illness

In a detailed section on respiratory symptoms, athletes were requested to complete details on a) symptoms of respiratory tract illness in the period (6 weeks and 1 week) before the events, b) history of asthma, and c) history of allergies.

a. Symptoms of respiratory tract illness in the period (6 weeks and 1 week) before the events

Athletes were asked to report symptoms of upper respiratory tract (URTS) illness including sore throat, 'blocked' or 'runny' nose, lower respiratory tract symptoms (LRTS) (cough and wheeze), and systemic symptoms (SS) (fever, joint pains and muscle aches) and a category was provided for 'other' symptoms. All symptoms were reported in time frames of 6 weeks and one week before the race.

b. Asthma

In the detailed section on asthma, athletes were requested to report the following; if they are currently suffering from asthma and for how many years they suffered from it as well as the method by which the diagnosis was made, whether symptoms were related to exercise as well as the frequency of symptoms

and a history of previous hospital admissions for asthma in the past 12 months. In addition, athletes were asked to report current symptoms experienced, type and frequency of medication use and if they obtained a TUE (therapeutic use exemption) for the use of medication, if applicable.

c. Allergies

The detailed section on allergies contained questions regarding the duration of allergies, current and past types of allergy (hay fever, sinusitis, skin allergies, eye allergies, allergies to plant material, animal, food and medication). Athletes were requested to report the use of medication (corticosteroid nasal spray/ inhaler, anti-histamine tablets, corticosteroid and anti-histamine creams and other inhalers or creams). Information regarding current symptoms experienced (sneezing, itchy 'runny' nose, headaches, itchy palate, streaming eyes, itchy eyes, 'blocked 'nose, post-nasal drip, coughing, fatigue, wheezing and poor sleep) as well as seasonal variation in allergies (by calendar month) was obtained.

3.2.4. Statistical analysis of data

All the data from the questionnaires were entered onto an Excel spreadsheet Microsoft 2011 (Redmond, Washington, USA). Data were analysed using the STATISTICA 10.0 (Stat-soft Inc, Tulsa, Oklahoma, USA) and GraphPad InStat 2.05a (GraphPad Software Inc, San Diego, California, USA) statistical programs.

All numerical data were presented by the mean ± standard deviation, with the number of subjects with non missing data who answered the relevant question in parenthesis. A one-way analysis of variance (ANOVA) was used to determine any significant differences between groups. Where the overall F values were significant, a Turkey's honest significant difference post hoc test was used to identify where the

differences were. Categorical data are expressed as frequencies, and significant differences between the groups were analyzed using the Pearson's chi-square or Fisher's exact tests. The numbers of subjects or observations (n) are usually in parenthesis. Statistical significance was accepted as $p<0.05$.

3.3. Results

3.3.1. General characteristics (age, anthropometry, and gender) of the study population

The general characteristics of the triathletes and ultra-distance runners are depicted in Table 3.1.

Table 3.1. Characteristics (age, anthropometry, and gender) of the study population of triathletes and ultra-distance runners

	Ironman triathletes (IM)[a] n=441	**Ultra-distance runners (UD) n=152**	**p-Value IM vs. UD**
Age (years)	38.6 ± 8.6 (403)	40.2 ± 9.5 (152)	0.052
Height (cm)[b]	178.0 ± 8.2 (401)	171.3 ± 14.9 (129)	**<0.001**
Weight (kg)[c]	75.1 ± 11.3 (424)	69.2 ± 11.1 (151)	**<0.001**
BMI (kg/m^2)[d]	23.7 ± 2.6 (397)	23.6 ± 4.3 (128)	0.610
Gender (% male)	83.4 (428)	84.0 (144)	0.863

Values are expressed as average ± standard deviation, with the number of subjects (n) in parentheses.
[a] For the athletes that completed both the 2006 and 2007 events, only the 2007 data were included in the combined Ironman values.
[b] Self reported height in centimetres.
[c] Self reported weight in kilograms.
[d] Body mass index calculated as weight in kilogram divided by height in metre squared.

The Ironman triathletes were significantly taller and weighed more than the ultra-distance runners, but when the body mass index (BMI) was calculated, no significant difference was found between the two

groups. The majority of participants in both groups were male with no significant difference in the % males between the two groups.

3.3.2. Training history of the triathletes and ultra-distance runners 15 weeks and 1 week before the event

The training history of the triathletes and ultra-distance runners is depicted in Table 3.2. The training distances (km) for the 15 weeks and the 1 week before the events only include the running component of the triathletes so that these distances could be compared to those of the ultra-distance runners. However, the total hours spent training for the triathlete group, is the combined hours of training incorporating running, cycling and swimming.

Table 3.2. Training history of the 15 weeks and the 1 week before the event for the triathletes and ultra-distance runners

Training	Ironman triathletes (IM)[a] n=441	Ultra-distance runners (UD) n=152	p-Value IM vs. UD
Days training/week past 15 weeks	5.7 ± 0.9 (404)	4.6 ± 1.4 (146)	**<0.001**
Running km/week past 15 weeks	46.4 ± 17.8 (406)	54.2 ± 26.8 (144)	**<0.001**
Hours running/week past 15 weeks	4.6 ± 2.0 (391)	8.1 ± 12.0 (138)	**<0.001**
Total hours training/week past 15 weeks	15.2 ± 4.7 (414)	6.6 ± 3.6 (138)	**<0.001**
Running km in week before	13.3 ± 11.4 (393)	27.4 ± 26.4 (148)	**<0.001**
Running hours in week before	1.4 ± 2.0 (404)	5.2 ± 12.4 (139)	**<0.001**
Total hours training in week before	4.7 ± 5.1 (441)	3.8 ± 4.0 (139)	**<0.001**

Values are expressed as average ± standard deviation, with the number of subjects (n) in parentheses.
[a] For the athletes that completed both the 2006 and 2007 events, only the 2007 data were included in the combined Ironman values.

In the 15 weeks before the event, the ironman triathletes had a significantly greater training volume (spent significantly more days and more hours training) than the ultra-distance runners. It should be noted that this includes all disciplines for the triathlon namely running, cycling and swimming. However, the ultra-distance runners ran significantly longer distances and spent more hours running in the 15 weeks before the event. Similarly, in the 1-week period before the events, triathletes trained significantly more hours while the ultra-distance runners ran significantly longer distances and spent more hours running.

3.3.3. Personal best times for 10km, 21.1km and 42.2km running races for triathletes and ultra-distance runners

The self reported personal best times ever achieved for a 10km, 21.1km and 42.2km as well as the self reported personal best times for a running race in the past 15 weeks as shown in Table 3.3.

Table 3.3. Personal best times ever achieved and the personal best times for a 10km, 21.1km and 42.2km running race in the past 15 weeks for Ironman triathletes and ultra-distance runners

	Ironman triathletes (IM)[a] n=441	Ultra-distance runners (UD) n=152	p-Value IM vs. UD
Personal best (PB) ever achieved (minutes)			
10 km	42.7 ± 6.9 (361)	42.8 ± 10.1 (115)	0.916
21.1 km	91.1 ± 16.9 (374)	101.4 ± 35.5 (128)	0.066
42.2 km	213.7 ± 33.5 (319)	216.6 ± 46.2 (135)	0.456
Personal best (PB) in past 15 weeks (minutes)			
10 km	47.2 ± 8.6 (166)	47.3 ± 10.2 (63)	0.937
21.1 km	108.0 ± 17.9 (201)	112.8 ± 41.8 (91)	0.173
42.2 km	231.7 ± 40.1 (114)	236.5 ± 44.2 (111)	0.397

Values are expressed as average ± standard deviation, with the number of subjects (n) in parentheses.
[a] For the athletes that completed both the 2006 and 2007 events, only the 2007 data were included in the combined Ironman values.

In assessing the "running caliber" of the Ironman triathletes and the ultra-distance runners, there were no significant differences in the self reported personal best times ever achieved or the personal best times achieved for a 10km, 21.1km and 42.2km running race in the 15 weeks before the events.

3.3.4. Smoking habits of Ironman triathletes compared to ultra-distance runners

The smoking habits of Ironman triathletes and ultra-distance runners are depicted in Table 3.4.

Table 3.4. Smoking habits of Ironman triathletes and ultra-distance runners

Smoking history	Ironman triathletes (IM)[a] n=441	Ultra-distance runners (UD) n=152	p-Value IM vs. UD
Never smoked	70.6 (438)	73.7 (152)	0.697
Ex-smoker	26.5 (438)	23.0 (152)	0.451
Current smoker	3.0 (438)	3.3 (152)	0.789
Smoking duration (years)	11.0 ± 6.8 (101)	13.9 ± 9.6 (22)	0.094
Number of cigarettes/day	15.5 ± 11 (118)	13.4 ± 13.8 (37)	0.359
Number of years since smoking cessation	10.9 ± 8.3 (107)	9.3 ± 7.3 (28)	0.338

Values are presented as frequencies (%) with the number of participants with non-missing or valid data (n) in parentheses.
[a] For the athletes that completed both the 2006 and 2007 events, only the 2007 data were included in the combined Ironman values.

In comparing the smoking history in both groups of athletes, the majority of the athletes in both groups never smoked and there was no significant difference between the number of triathletes and ultra-distance runners that were (then) currently smoking. Furthermore, there were no significant differences in the duration of smoking or the number of cigarettes smoked per day among the current smokers or the amount of years since cessation of smoking in the 'ex-smoker' group of athletes.

3.3.5. Period prevalence (%) of respiratory tract symptoms in the Ironman triathletes and ultra-distance runners in the 6 weeks before the events

The period prevalence (%) (6 weeks before the race) of respiratory tract symptoms in the two groups of athletes is depicted in Table 3.5.

Table 3.5. The period prevalence (%) (6 weeks before the race) of respiratory tract symptoms in the Ironman triathletes and ultra-distance runners

Respiratory tract symptom groups	Specific respiratory tract symptoms	Ironman triathletes (IM)[a] n=432	Ultra-distance runners (UD) n=152	p-Value IM vs. UD
All respiratory tract symptoms (RTS)	All RTS	49.8 (432)	35.3 (152)	**0.004**
Upper respiratory tract symptoms (URTS)	All URTS	40.5 (407)	29.0 (152)	**0.012**
	Nasal congestion	20.9 (407)	12.5 (152)	**0.028**
	Rhinorrhoea	26.8 (407)	17.1 (152)	**0.020**
	Sore throat	11.8 (407)	15.1 (152)	0.318
Lower respiratory tract symptoms (LRTS)	All LRTS	17.7 (407)	13.8 (152)	0.274
	Cough	15.5 (407)	12.5 (152)	0.422
	Wheezing	5.2 (407)	2.6 (152)	0.253
Systemic symptoms (SS)	All SS	15.2 (407)	17.1 (152)	0.589
	Pyrexia	9.6 (407)	11.2 (152)	0.635
	Arthralgia	4.2 (407)	7.2 (152)	0.189
	Myalgia	7.6 (407)	8.6 (152)	0.724
LRTS and SS	All LRTS and SS	25.6 (407)	24.3 (152)	0.769
6 week 'any' symptom		46.3 (421)	34.2 (152)	**0.010**
6 week 'other' symptom		8.3 (421)	2.6 (152)	**0.015**

Values are presented as frequencies (%) with the number of participants with non-missing or valid data (n) in parentheses.
[a] For the athletes that completed both the 2006 and 2007 events, only the 2007 data were included in the combined Ironman values.

In the 6 weeks before the event, the period prevalence of URTS, nasal congestion and rhinorrhoea was significantly higher in the Ironman triathletes compared to the ultra-distance runners. There was however

no significant difference in the period prevalence of LRTS and SS between the two groups of endurance athletes. There was also a significantly higher period prevalence of 'any' or 'other' symptoms. These categories allowed the participant to fill in symptoms they experienced but that were not listed. Symptoms additionally reported by athletes were swollen lymph nodes, headaches, sinus, exhaustion, malaise, and 'fluid in right lung'.

3.3.6. Period prevalence (%) of respiratory tract symptoms in the Ironman triathletes and ultra-distance runners in the 1 week before the event

The period prevalence (%) of respiratory tract symptoms in Ironman triathletes and ultra-distance runners 1 week before the event is depicted in Table 3.6.

Table 3.6. The period prevalence (%) (1 week before the event) of respiratory tract symptoms in Ironman triathletes compared to ultra-distance runners

Respiratory tract symptoms groups	Specific respiratory tract symptoms	Ironman triathletes (IM)[a] n=432	Ultra-distance runners (UD) n=152	p-Value IM vs. UD
Upper respiratory tract symptoms (URTS)	All URTS	20.1 (417)	15.1 (152)	0.176
	Nasal congestion	10.1 (417)	5.9 (152)	0.138
	Rhinorrhoea	10.8 (417)	8.6 (152)	0.532
	Sore throat	4.9 (417)	5.3 (152)	0.828
Lower respiratory tract symptoms (LRTS)	All LRTS	7.0 (417)	6.6 (152)	0.875
	Cough	5.3 (417)	5.9 (152)	0.835
	Wheezing	3.1(417)	0.7 (152)	0.127
Systemic symptoms (SS)	All SS	2.4 (417)	9.2 (152)	**<0.001**
	Pyrexia	1.2 (417)	5.3 (152)	**0.008**
	Arthralgia	0.7 (417)	2.6 (152)	0.086
	Myalgia	1.2 (417)	2.6 (152)	0.257
LRTS and SS	All LRTS and SS	8.4 (417)	13.8 (152)	0.055
1 week 'any' symptom		25.0 (424)	21.7 (152)	0.416
1 week 'other' symptom		3.1 (424)	1.3 (152)	0.375

Values are presented as frequencies (%) with the number of participants with non-missing or valid data (n) in parentheses.
[a] For the athletes that completed both the 2006 and 2007 events, only the 2007 data were included in the combined Ironman values.

In the week before the event, ultra-distance runners reported a significantly higher period prevalence of all SS, and specifically pyrexia, compared with the Ironman triathletes. There were no significant differences in the period prevalence of other symptoms between the two groups. It is important to note

that over 9% of ultra-distance runners reported systemic symptoms in the week before the event and this finding has significant clinical implications.

3.3.7. Point prevalence (%) and characteristics of asthma in Ironman triathletes and ultra-distance runners

The self-reported point prevalence of asthma (% athletes) was 7.1% for all the athletes (41/581), 8.3% for triathletes (36/435) and 3.4% for ultra-distance runners (5/146). In the 41 athletes who reported current asthma, the methods used to make the diagnosis of asthma in the two study groups are depicted in Table 3.7. It should be noted that, the sample size of athletes who reported a current history of asthma, was too small to allow comparison between triathletes and ultra-distance runners.

Table 3.7. The method used to make the diagnosis of asthma in Ironman triathletes and ultra-distance runners

Diagnostic test for asthma	All athletes n=41	Ironman triathletes (IM) n=36	Ultra-distance runners (UD) n=5
Physician history and examination	61.0 (25)	58.3 (21)	80.0 (4)
LFT[a] without exercise	34.1 (14)	33.3 (12)	40.0 (2)
LFT with exercise	24.4 (10)	25.0 (9)	20.0 (1)
Methacholine challenge test	0	0	0
Eucapnic hyperventilation test	4.9 (2)	5.6 (2)	0
Other test	4.9 (2)	2.8 (1)*	20.0 (1)[¥]

Values are presented as frequencies (%) with the number of subjects (n) in parentheses.
[a] LFT, Lung function test
* Self diagnosed
[¥] Diagnosed by means of X-Ray (according to subject)

The diagnosis of asthma in both groups was most commonly made by history taking and conducting a physical examination. The second most common method of diagnosing was by means of a lung function test without exercise, followed by a lung function test with exercise. No athletes in these 2 groups were diagnosed by means of a methacholine challenge test and two athletes had a eucapnic hyperventilation test. One athlete in the triathletes group made a self-diagnosis and one athlete in the ultra-distance runners group reported that the diagnosis was made by means of an X-Ray.

The occurrence of asthma symptoms in relation to exercise in Ironman triathletes and ultra-distance runners with a current history of asthma is depicted in Table 3.8.

Table 3.8. The occurrence of asthma symptoms in relation to exercise

Asthma and exercise	All athletes n=41	Ironman triathletes (IM) n=36	Ultra-distance runners (UD) n=5
Any time but not with exercise	31.7 (13)	27.8 (10)	60.0 (3)
Any time and with exercise	34.1 (14)	36.1 (13)	20.0 (1)
Only during exercise	48.8 (20)	50.0 (18)	40.0 (2)

Values are presented as frequencies (%) with the number of subjects (n) in parentheses.

The Ironman triathletes with a current history of asthma, experienced asthma symptoms mostly related to exercise and the minority experienced symptoms at rest. The ultra-distance runners experienced asthma symptoms mostly at anytime, with no relation to exercise, followed by symptoms which occur mostly during exercise.

The symptoms experienced by Ironman triathletes and ultra-distance runners with a current history of asthma are shown in Table 3.9.

Table 3.9. Current symptoms of asthma experienced by athletes in both study groups

Symptoms of asthma	All athletes n=41	Ironman triathletes (IM) n=36	Ultra-distance runners (UD) n=5
Wheezing	58.5 (24)	55.6 (20)	80.0 (4)
Tight chest	46.3 (19)	44.4 (16)	60.0 (3)
Dry Cough	29.3 (12)	25.0 (9)	60.0 (3)
Chest pain	9.8 (4)	2.8 (1)	60.0 (3)
Shortness of breath	58.5 (24)	61.1 (22)	40.0 (2)
Other	4.9 (2)	2.8 (1)	20.0 (1)$^{\Omega}$

Values are presented as frequencies (%) with the number of subjects (n) in parentheses.
$^{\Omega}$ Pain at ribs

In the triathlete group, the most common symptoms experienced by athletes with a current history of asthma were shortness of breath and wheezing, followed by a tight chest, dry cough, chest pain and 'other' symptoms. The ultra-distance runners reported mostly wheezing; followed by tight chest, dry cough, and chest pain, with the minority reporting shortness of breath and 'other' symptoms.

The medication currently used by Ironman triathletes and ultra-distance runners with a history of asthma is depicted in Table 3.10.

Table 3.10. The current asthma medication used by Ironman triathletes and ultra-distance runners

Medication for asthma	All athletes n=41	Ironman triathletes (IM) n=36	Ultra-distance runners (UD) n=5
Corticosteroid inhaler	22.0 (9)	25.0 (9)	0
Salbutamol (Ventolin, Asthavent)	61.0 (25)	63.9 (23)	40.0 (2)
Salmeterol (Serevent)	2.4 (1)	2.8 (1)	0
Fenoterol (Berotec)	4.9 (2)	5.6 (2)	0
Corticosteroid and bronchodilator	29.3 (12)	22.2 (8)	80.0 (4)
Corticosteroid tablets	2.4 (1)	0	20.0 (1)
Bronchodilator tablets	2.4 (1)	2.8 (1)	0
Leukotriene receptor antagonist (Singulair)	2.4 (1)	2.8 (1)	0
Other medication	2.4 (1)	2.8 (1)	0

Values are presented as frequencies (%) with the number of subjects (n) in parentheses.

The most common anti-asthmatic medication used by Ironman triathletes was salbutamol inhalers, followed by a corticosteroid inhaler, a combination of corticosteroid and bronchodilator inhaler, and long-acting beta 2-agonists fenoterol and salmeterol. Few athletes reported using bronchodilator tablets and leukotriene receptor antagonists. In the ultra-distance runners, the combination of corticosteroid and bronchodilator inhalers was most frequently used. Two of the five asthmatic runners used the short acting beta 2-agonist salbutamol only and one athlete made use of corticosteroid tablets for the control of asthma symptoms. Only one athlete in both the triathletes and the ultra-distance runner groups had a therapeutic use exemption (TUE) which was obtained for the use of the relevant anti-asthmatic medication (table not shown).

3.3.11. Point prevalence and characteristics of allergies in Ironman triathletes and ultra-distance runners

The self reported point prevalence (%) of allergies in both groups was high, but in Ironman triathletes (34.0%) it was significantly higher than in ultra-distance runners (22.3%) (p=0.011). The type of allergies that endurance athletes experienced is depicted in Table 3.11.

Table 3.11. Current allergy manifestation in Ironman triathletes and ultra-distance runners

Specific allergy manifestation	Ironman triathletes (IM)[a]	Ultra-distance runners (UD)	p-Value IM vs. UD
Nasal manifestation (hay fever)	77.8 (126)	83.3 (30)	0.503
Sinusitis	64.2 (120)	55.0 (20)	0.432
Lung manifestation (wheezing)	17.0 (112)	33.3 (12)	0.233
Skin manifestation	21.1 (114)	38.5 (13)	0.171
Eye manifestation	18.9 (111)	25.0 (12)	0.701
Plant material trigger	21.4 (112)	16.7 (12)	1.000
Food material trigger	14.8 (115)	23.1 (13)	0.427
Animal material trigger	27.3 (110)	23.1 (13)	1.000
Medication trigger	31.8 (22)	0 (13)	**0.031**
Allergy 'other'	4.6 (88)	0 (0)	1.000

Values are presented as frequencies (%) with the number of participants with non-missing or valid data (n) in parentheses.
[a] For the athletes that completed both the 2006 and 2007 events, only the 2007 data were included in the combined Ironman values.

There was no significant difference between the prevalence of different types of allergic manifestations (hay fever, sinusitis, allergic type asthma, skin allergies and allergies to plant material, food and animals) among athletes in both study groups. However, significantly more Ironman triathletes reported allergies to medication compared with the ultra-distance runners.

The type of specific allergies for which medication was taken in the two groups of endurance is shown in Table 3.12.

Table 3.12. The type of allergy manifestation for which medication was taken by Ironman triathletes and ultra-distance runners

Specific allergy manifestation	Ironman triathletes (IM)[a]	Ultra-distance runners (UD)	p-Value IM vs. UD
Nasal manifestation (hay fever)	62.8 (51)	50.0 (20)	0.326
Sinusitis	66.7 (51)	35.7 (14)	0.062
Lung manifestation (wheezing)	45.7 (35)	25.0 (12)	0.310
Skin manifestation	23.1 (26)	36.4 (11)	0.442
Eye manifestation	16.7(24)	0 (11)	0.285
Plant material trigger	17.4 (23)	8.3 (12)	0.640
Food material trigger	4.5 (22)	8.3 (12)	1.000
Animals material trigger	20.8 (24)	0 (11)	0.157

Values are presented as frequencies (%) with the number of participants with non-missing or valid data (n) in parentheses.
[a] For the athletes that completed both the 2006 and 2007 events, only the 2007 data were included in the combined Ironman values.

There were no significant differences between the two groups for allergies that required medication. The types of anti-allergic medications used by Ironman triathletes and ultra-distance runners are shown in Table 3.13.

Table 3.13. Medication used by Ironman triathletes and ultra-distance runners for allergy symptoms

Current medication use for allergies	Ironman triathletes (IM)[a]	Ultra-distance runners	p-Value IM vs. UD
Corticosteroid nasal spray	48.4 (31)	35.7 (14)	0.428
Corticosteroid nasal inhaler	30.4 (23)	16.7 (12)	0.450
Antihistamine tablets	74.0 (50)	46.7 (15)	**0.047**
Corticosteroid cream	11.1 (18)	25.0 (12)	0.364
Anti-histamine cream	11.8 (17)	23.1 (13)	0.628
Other inhaler/tablets/cream	57.1 (35)	38.5 (13)	0.250

Values are presented as frequencies (%) with the number of participants with non-missing or valid data (n) in parentheses.
[a] For the athletes that completed both the 2006 and 2007 events, only the 2007 data were included in the combined Ironman values.

The most common medication used by both groups, was anti-histamine tablets and the use of these tablets was significantly higher in Ironman triathletes compared to ultra-distance runners. Less than 50% of athletes in both study groups made use of corticosteroid nasal spray/inhaler.

The current allergic symptoms that endurance athletes in the study population experienced are depicted in Table 3.14.

Table 3.14. Current symptoms of allergies experienced by Ironman triathletes and ultra-distance runners

Current symptoms of allergies	Ironman triathletes (IM)[a]	Ultra-distance runners (UD)	p-Value IM vs. UD
Sneezing	91.3 (69)	68.2 (22)	**0.007**
Itchy palate	61.8 (34)	41.7 (12)	0.227
Itchy eyes	80.4 (56)	46.2 (13)	**0.011**
Post nasal drip	91.7 (72)	58.2 (17)	**0.001**
Itchy runny nose	83.6 (55)	78.3 (23)	0.573
Streaming eyes	55.2 (29)	25.0 (12)	0.098
Nasal congestion	80.8 (52)	42.9 (14)	**0.005**
Coughing	36.0 (25)	38.5 (13)	0.881
Headache	71.1 (38)	28.6 (14)	**0.010**
Fatigue	42.9 (21)	30.8 (13)	0.718
Poor sleep	57.7 (26)	25.0 (12)	0.086
Wheezing	46.2 (26)	16.7 (12)	0.147

Values are presented as frequencies (%) with the number of participants with non-missing or valid data (n) in parentheses.
[a] For the athletes that completed both the 2006 and 2007 events, only the 2007 data were included in the combined Ironman values.

The Ironman triathlete group reported significantly more symptoms of post nasal drip, sneezing, nasal congestion, itchy eyes and headaches than ultra-distance runners.

3.4. Discussion

The focus of this study was the pre-event period prevalence (6 weeks and 1 week before an event) and the nature of the symptoms of respiratory tract illness in endurance athletes. In particular, the areas that were studied were pre-event point prevalence and nature of respiratory tract symptoms, asthma, and allergies in two groups of endurance athletes.

The first group of main findings were that; 1) respiratory tract symptoms in endurance athletes are common in the pre-event period, 2) upper respiratory tract symptoms, and in particular nasal symptoms are more common in triathletes in the 6 weeks before an event, and 3) systemic symptoms were present in almost 10% of ultra-distance runners, 1 week before an endurance event.

The second group of main findings of this study were related to asthma. The point prevalence of self-reported asthma was low in both the triathletes and the ultra-distance runners. However, clinically significant findings pertaining to asthma in these athletes were; 1) that the diagnosis of asthma was mostly made by history taking and physical examination by a physician without the diagnostic assistance of any special investigations, and 2) most asthmatic athletes used beta 2-agonists only for the treatment of asthma, rather than inhaled corticosteroids or combination therapy.

The third group of main findings in this study pertain to allergic conditions in our study population. In general; 1) the point prevalence of self-reported allergies was high in both triathletes and ultra-distance runners and 2) in fact it was significantly higher in triathletes compared with ultra-distance runners, 3) nasal symptoms (nasal congestion and postnasal drip) were more commonly reported by triathletes in comparison to ultra-distance runners and 4) of clinical importance was the use of anti-histamine tablets as

the first choice in the treatment of allergic symptoms in triathletes and ultra-distance runners rather than the use of topical corticosteroids.

Pre-event period prevalence of respiratory tract symptoms in endurance athletes

A novel finding from this study was that the period prevalence of respiratory tract symptoms in the 6 weeks before a race was high in endurance athletes. Specifically, about 50% of triathletes and 35% of the ultra-distance runners reported respiratory tract symptoms in the 6 week period before the events. More specifically, upper respiratory tract symptoms were more prevalent during this period in the triathletes (40.5%) compared to the ultra-distance runners (29.0%). The most common upper respiratory symptoms were nasal symptoms including nasal congestion (ranging from 12 to 21%) and rhinorrhoea (17 to 27%), the higher percentage pertaining to the triathlete group.

To date, most studies of the prevalence of respiratory tract symptoms in athletes have been conducted during the post-race period. The results of this study are novel and could only be compared to post-event prevalence data. In these studies conducted during the post-event period, the period prevalence of RTS in the 10-14 days post-event ranged from 12.9% to 68% [2-4;40].

Our study was not designed to document the possible causes of pre-event RTS. However, we could speculate that the high prevalence of pre-event RTS in athletes 6 weeks before the event might be related to training load in preparation for the event. Our data on the training history 15 weeks before the race, show that the triathletes spent more hours training (15.2 ± 4.7 hours per week) compared to the ultra-distance runners (6.6 ± 3.6 hours per week) and even in the week before the race, triathletes spent more hours training (4.7 ± 5.1 hours per week) than the runners (3.8 ± 4.0 hours per week). Even though

endurance runners focused only on one training discipline (running) there was no significant difference in the "running caliber" between the two study groups.

It has been suggested that athletes are more susceptible to develop respiratory tract symptoms in periods of increased training load (volume and intensity). The relationship between training load and risk of RTS has been depicted as a "J-curve", indicating that moderate training load and regular exercise improve the body's ability to protect against infection, while high training loads decrease this protection [16]. It is postulated that intense exercise weakens the body's defence mechanism against infection and this might result in the "open window" period causing a higher susceptibility for infection [24]. However, despite this hypothesis of infection as a cause of symptoms, studies indicate that pathogens are rarely isolated in athletes presenting with post-event respiratory symptoms [7-10]. This raises the question of the possibility of other aetiological hypotheses for RTS, including allergy as a possible cause for symptomatology.

The period prevalence in the one week period before the race is important from a clinical perspective, as this reflects a period where tapering of training volume is common, and that athletes need to be in optimal health in preparation for the event. RTS in this period are also clinically important as decisions regarding participation in the event have to be made in athletes suffering from any RTS. In athletes presenting with RTS, return to play guidelines have been formulated [35]. Specifically, the clinical criteria for return to play are based on documenting localized upper respiratory tract symptoms vs. lower respiratory tract symptoms, or systemic symptoms. In current guidelines it is stated that the presence of any systemic symptoms or LRT symptoms constitute a contra-indication to exercise. This is known as the "neck check"[35]. In our study, the period prevalence of systemic symptoms in the week before the event was 9.2% in the ultra-distance running group. This was significantly higher than the 2.4% reported by the triathlete group. In particular, it should be noted that 5.3% of the ultra-distance runners reported pyrexia. These data indicate that a significant proportion of athletes, in particular runners, reported systemic symptoms and would have to be excluded from competing, based on current clinical criteria. It must be

noted that these were self-reported symptoms and were not confirmed by clinical examination or special investigations. However, this is clearly an area that does require further investigation. We suggest that studies should be conducted to determine the exact nature and cause of these symptoms. If athletes do suffer from acute active infections during this period, they should be educated regarding the risk of participation whilst ill.

Asthma in endurance athletes

The main findings regarding asthma in this study were that the point prevalence of asthma and asthma-like symptoms in endurance athletes was low, but it was higher in triathletes (8.3%) than in ultra-distance runners (3.4%). These prevalence data are lower when they are compared to that reported in most other studies where the prevalence of current asthma was reported as ranging from 7% to 26% [51;61;65;66;71]. However, these studies were not exclusively on endurance athletes and a higher prevalence of asthma was recorded, particularly in swimmers [61].

In our study, it was also evident that asthma is mostly diagnosed by means of history taking and examination without the assistance of results from special investigations. In the literature, it is well established that there is a great discrepancy between symptoms of asthma and the actual diagnosis [64;67]. The data from our study is therefore likely to reflect potential under-diagnosis of asthma and this may result in ineffective treatment. Athletes should therefore be properly informed and physicians should be encouraged to perform the necessary special investigations to confirm the appropriate diagnosis of RTS.

Our data indicate that triathletes reported most asthma-like symptoms while exercising. In the triathletes, shortness of breath and wheezing, were the most common symptoms of asthma while the ultra-distance runners reported wheezing, followed by tight chest, dry cough, and chest pain which occurred at anytime,

with no specific relation to exercise. In treating these symptoms, most triathletes (63.9%) made use of a short-acting beta 2-agonist (salbutamol) only, a quarter (25.0%) made use of a corticosteroid inhaler and 22.2% of triathletes used a combination of a corticosteroid and beta 2-agonist inhaler. In contrast, 80% of the ultra-distance runners used the combination inhaler (corticosteroid and beta 2-agonist) as first-line treatment, and 40% used salbutamol only. One athlete made use of oral corticosteroid tablets to control asthma symptoms.

Optimal treatment of asthma aims at reducing bronchial hyper-responsiveness and to maintain control over disease activity [69]. Anti-inflammatory treatment in the form of inhaled corticosteroids is currently the most important and effective treatment of asthma and EIA and effectiveness of the drug increases as treatment duration progresses [69]. Short-acting beta 2-agonists (e.g. salbutamol) have a rapid onset of action and are effective for the immediate relief of bronchoconstriction. However, regular use of beta 2-agonists result in decreased effectiveness, a phenomenon known as tolerance [69].

Allergies in endurance athletes

In our study there was a high point prevalence of self-reported allergic symptoms in endurance athletes (34.0% of triathletes and 22.3% of ultra-distance runners). In particular, allergic nasal symptoms (hay fever and sinusitis) were common. This finding is similar to that reported in the literature [12;31-33].

Furthermore, our data show that there was a particularly high point prevalence of allergic symptoms in the upper respiratory tract with hay fever ranging from 77.8 to 83.3% and sinusitis between 55.0 and 64.2%. Ultra-distance runners reported a higher point prevalence of hay fever while sinusitis was more prevalent in the triathletes. Despite the high point prevalence of these allergic symptoms, only 62.8% of triathletes and 50.0% of ultra-distance runners used medication for hay fever and 66.7% of triathletes and 35.7% of

ultra-distance runners received treatment for sinusitis. Furthermore, the most common medication used in both groups was oral anti-histamine tablets.

These findings do raise some concern and emphasize the need for further investigation. It was evident that despite the high prevalence of allergy related symptoms, the majority of symptomatic athletes do not receive any treatment, or are treated inappropriately with systemic anti-histamines (tablets) rather than using topical corticosteroids. In a systemic review, intranasal corticosteroids produced significantly greater relief than oral anti-histamines of nasal discharge, sneezing, nasal blockage, nasal itch and post nasal drip [92]. Another study on the use of intranasal budesonide for the treatment of seasonal allergic rhinoconjunctivitis, indicated significant improvement of symptoms, quality of life and performance on treatment with this topical corticosteroid [88]. Despite this knowledge, athletes still make use of oral anti-histamines as the first choice in the treatment of allergic symptoms [12].

In British track and field athletes, it has been noted that 60% of athletes reported symptoms of hay fever but only 8% underwent any specific form of clinical allergy testing [31]. This may raise yet another question regarding possible ignorance on behalf of the athlete, which makes effective management of allergic conditions an even greater challenge for the sports physician.

Strengths and limitations of our study

The study described above was cross-sectional in nature and the study tool used was a previously validated questionnaire. The following limitations therefore need to be discussed. Firstly, all data regarding RTS, asthma and allergies are self-reported by athletes and are therefore based on recall over a period of weeks. We could not verify the presence of reported infection, asthma or allergies by means of special investigations and therefore our findings need to be interpreted with this limitation in mind. This

study would have benefited from specific management interventions at the registration/start/finish of the event, e.g nasal swabs before and after the event to document possible pathogens as a cause for respiratory symptoms. Secondly, due to the nature of this descriptive study, no cause-effect relationships could be established. Thirdly, we acknowledge the possibility of selection bias with respect to recruitment of the study population, and the low response rate (particularly in the running group). It is possible that, the lengthy questionnaire might have been a reason that would explain the low response rate. Finally, as mentioned previously, the data pertaining to asthma and asthma-like symptoms in triathletes and ultra-distance runners could not be compared due to the small sample sizes.

However, there were also important strengths to be considered in the present study. Firstly, there was overall a large sample size. Secondly, we made use of questionnaires that had been previously validated. Thirdly, although this is a descriptive study, it focussed on a novel approach to determine the period prevalence of pre-event respiratory tract illness in two groups of endurance athletes. The findings are of clinical relevance to these groups of athletes for future advice and appropriate care. Finally, these findings regarding the prevalence of the different respiratory illnesses and the possible impact on the respiratory health of the endurance athlete, will direct future investigations in this clinically important area of sport and exercise medicine.

Summary

In summary, to our knowledge this is the first study that compared the period and point prevalence of respiratory illnesses (respiratory tract symptoms, asthma and allergies) between 2 groups of endurance athletes (triathletes and ultra-distance runners). These data revealed a higher prevalence of respiratory symptoms, particularly in the triathletes compared to the ultra-distance runners. There was also a very high prevalence of nasal symptoms in the triathlete group and it was evident that these symptoms were

not optimally treated. Another finding and cause for concern is the lack of appropriate diagnosis of asthma-like symptoms, and the finding that these symptoms seem to be treated sub-optimally.

We also documented that approximately 10% of ultra-distance runners reported systemic symptoms in the one week period before the race. This finding highlighted the need for more athlete education regarding respiratory health and athletes should be made aware of the possible risks of exercising while suffering from acute systemic illness. The “neck check” can be used as a general guideline for athletes on how to approach training in the presence of respiratory symptoms [35].

In conclusion, the results of our study show that endurance athletes, and in particular triathletes, in preparation for a race, report a high frequency of respiratory related symptoms, especially nasal symptoms which appear to be related to allergy. We also identified the lack of specific diagnostic testing and the need for appropriate pharmacological management of illnesses influencing the respiratory health of the endurance athlete.

Chapter 4

Summary and conclusion

4.1. Introduction

The focus of this dissertation was on respiratory tract symptoms and illnesses in endurance athletes. In particular, the prevalence of respiratory tract symptoms, asthma and symptoms of allergies was studied in two groups of endurance athletes.

4.2. Summary: Respiratory tract symptoms (RTS) in endurance athletes

In Chapter 2, a review of the literature was undertaken in which we indicated that there was a high prevalence of RTS in the athletic population, especially in the period following an event or competition. However, it was also evident from this review that little was known about the prevalence of respiratory symptoms, asthma and allergies in the pre-event period, particularly in the endurance athlete (Table 2.1). A cross-sectional study was therefore undertaken to investigate the period prevalence of RTS in triathletes and ultra-distance runners in the 6-week period before an event (Chapter 3). The main findings of this study were; 1) RTS were very common in endurance athletes during the pre-event period (6 weeks and 1 week before the event), 2) the 6-week period prevalence of nasal symptoms before an event was significantly higher in triathletes compared with ultra-distance runners , 3) the pre-event respiratory symptoms might be related to a higher training volume and higher prevalence of allergies in the triathletes, and 4) systemic symptoms were present in 10% of ultra-distance runners and were significantly higher in these athletes in the 1 week period before an event. A summary of how these data

have contributed to the knowledge of respiratory tract symptoms (RTS) in endurance athletes in the pre-event period is depicted in Table 4.1.

Table 4.1. The pre-event period prevalence of respiratory tract symptoms (RTS) ("illness") in athletes

Type of study	Population	Diagnosis	Period studied	Period prevalence (%) of RTS[a]	Additional comments	Reference
Prospective cohort study	1694 marathon runners	Self reported symptoms	3 weeks before the event	17% of runners	Higher risk for infection post-race if symptoms are present pre race	Ekblom *et al* 2006
Cross-sectional survey	304 Ironman triathletes	Self reported symptoms	6 weeks before the event	50% of triathletes	Association made between prevalence of RTS[a] and allergies (36%)	Lichaba 2006
Cross sectional survey	**432 Ironman triathletes and 152 ultra-distance runners**	**Self reported symptoms**	**6 weeks before the event**	**41% triathletes 29.0% ultra-distance runners**	**URTS[b] significantly higher in triathletes**	**Cloete (MPhil dissertation 2011)**
Cross sectional survey	**432 Ironman triathletes and 152 ultra-distance runners**	**Self reported symptoms**	**1 week before the event**	**20% triathletes 15.1% ultra-distance runners**	**SS[c] significantly higher in ultra-distance runners**	**Cloete (MPhil dissertation 2011)**

[a] RTS, Respiratory tract symptoms; [b]UTRS, Upper respiratory tract symptoms; [c]SS, Systemic symptoms

4.3. Summary: Prevalence of asthma in endurance athletes

In Chapter 2 (section 2.5) of this dissertation, a review on asthma and asthma-like symptoms in athletes was presented. The main findings from this review were that prevalence of asthma was high in endurance athletes but little was known about the prevalence of asthma in particularly the endurance triathlete and the ultra-distance runner (Table 2.4). Furthermore, there was a large discrepancy between symptoms of

asthma and the actual diagnosis of asthma in athletes. Finally, data from the review also emphasised the under-treatment of asthma related symptoms.

In Chapter 3, the results of a study on asthma and asthma like symptoms in two groups of endurance athletes (triathletes and ultra-distance runners) were presented. The main findings of this study on asthma in the pre-event period were; 1) that the point prevalence of asthma-like symptoms ranged from 25 to 80% in both athlete groups and this finding adds to the existing body of knowledge in this field (Table 4.2.), 2) that only 3.4% of ultra-distance runners and 8.3% of triathletes had a self-reported diagnosis of asthma, 3) the diagnosis of asthma was most commonly made only by means of history taking and physical examination by a physician without any contributory special investigations, and 4) the majority of athletes received sub-optimal treatment for asthma related symptoms.

Table 4.2. The point prevalence of asthma and asthma-like illness in athletes

Type of study	Population	Diagnosis	Point prevalence of asthma	Medication	Additional comments	Reference
Case control	424 athletes 243 age matched controls	Questionnaire on PDA[a] and symptoms	12% all athletes 11% in controls	73% any asthma medicine, 44%ICS[b] alone	Highest prevalence asthma in endurance athletes (22%)	Locke and Marks 2007
Cross sectional survey	329 elite athletes	Questionnaire on PDA[a] and symptoms	14% athletes	7% used medication: 67% used combined ICS[b] and IBA[c]; 13% ICS[b] only; 21% IBA[c] only	55% all athletes reported asthma-like symptoms; 74% of endurance athletes had symptoms	Lund *et al* 2009
Case control study	49 power 71 LDR[d] 42 swimmers 45 controls	Questionnaire SPT[e] Resting flow volume spirometry Histamine challenge test	7% LDR[d] 26% swimmers 2.2% controls		50% swimmers had atopy. AHR[f] to histamine in: 9% LDR[d], 36% swimmers, and 11% in controls	Helenius *et al* 1998
Retro-spective analysis	100 athletes	Questionnaire on PDA[a] Methacholine challenge (PC_{20}< 16mg/ml)	17.1% females 15.4% males		Study gender differences AHR[f] in 60% females and 21.6% males	Langdeau *et al* 2009
Cross sectional survey	**435 Ironman triathletes and 146 ultra-distance runners**	**Questionnaire (self reported symptoms)**	**8.3% triathletes 3.4% ultra-distance runners**	**Triathletes: 64% used IBA[c] only, 25% ICS[b] Ultra-distance runners: 80% IBA[c] & ICS[b] combined**	**Majority of diagnoses were made by history taking and physical examination only**	**Cloete (MPhil dissertation 2011)**

[a] PDA, Physician diagnosed asthma; [b]ICS, Inhaled corticosteroids; [c] IBA, Inhaled beta 2-agonists; [d]LDR, Long-distance runner; [e]SPT, Skin prick test; [f]AHR, Airway hyper-responsiveness

4.4. Summary: Allergic symptoms in endurance athletes

In Chapter 2, (Table 2.5) the prevalence of allergy in the athletic population was reviewed. In this review, it was clear that allergies are common among athletes of all sports disciplines. It was also interesting to note that the most common reported allergic conditions were rhinitis and hay fever.

In Chapter 3, the point prevalence of allergic symptoms including the nature and treatment of these symptoms was investigated in two groups of endurance athletes. The first main finding of this study was that allergies were common and were significantly more prevalent in triathletes than in ultra-distance runners. This finding has contributed to the body of knowledge of the prevalence of allergies in endurance athletes (Table 4.3). Other significant findings from this study were; 1) the majority of symptoms in both groups were confined to the upper respiratory tract, in particular nasal symptoms, 2) the Ironman triathlete group reported significantly more symptoms of post nasal drip, sneezing, nasal congestion, itchy eyes and headaches than ultra-distance runners, and 3) the first choice of medication used for allergic symptoms in both study groups was anti-histamine tablets.

Table 4.3. A summary of the prevalence of allergic symptoms in athletes

Type of study	Population	Diagnosis	Point prevalence of allergies	Additional Comments	Reference
Retrospective analysis	63 track and field athletes	Questionnaire	60% symptoms of hay fever	8% had specific clinical allergy testing done in past	Dijkstra *et al* 2011
Cross sectional survey	446 elite athletes 1504 controls	Questionnaire	Rhinitis diagnosed in: 36% endurance athletes 20% speed and power athletes 20% in controls	34.7% of athletes with rhinitis had a diagnosis of asthma	Alaranta *et al* 2005
Cross sectional survey	81 Olympic athletes	Questionnaire SPT[a]	62% atopy 33% SAR[b]	14 Aeroallergens tested	Hawarden *et al* 2002
Cross sectional survey	214 Olympic athletes	Symptom diary SPT[a]	56% symptoms of allergy 41% AR/C[c] with positive allergen test 29% seasonal AR/C[c] with positive allergen test 21% asthma	8 Allergens tested	Katelaris *et al* 2000
Case control	49 speed and power athletes 71 LDR[d] 42 swimmers 45 controls	Questionnaire SPT[a] Resting flow-volume spirometry Histamine challenge test	48% atopy in athletes 36% atopy in controls 30% pollen allergy in athletes 13% pollen allergy in controls	43% atopy speed and power athletes 49% atopy LDR[d] 50% atopy swimmers	Helenius *et al* 1998
Cross sectional survey	**433 Ironman triathletes and 148 ultra-distance runners**	**Questionnaire (self reported symptoms)**	**Symptoms of allergies in 34% triathletes and 22% ultra-distance runner**	**Anti-histamine tablets were most common medication used in both groups**	**Cloete (MPhil dissertation 2011)**

[a]SPT, Skin Prick test; [b]SAR, Seasonal allergic rhinitis; [c]AR/C, Allergic rhinoconjunctivitis; [d]LDR, Long-distance runners

4.5 Summary: Clinical implications

The main clinical implications of the research presented in this dissertation are as follows:

- For endurance athletes, the few weeks before the event is an important period of final preparation and is characterized by high volumes of intense training. This is therefore identified as a period in which illness is more likely to occur, but to date has not been well studied. It was evident from results of this study that in the 6 weeks before the event, respiratory symptoms are very common and athletes may present with these symptoms to the sports physician. The treating physician will need to have a sound clinical approach to managing these athletes, including an understanding of the aetiology of RTS. Finally, the sports physician requires a clinical approach to "return to play" in endurance athletes presenting with RTS in the pre-event period.
- The novel finding that about 10% of ultra-distance runners experienced systemic symptoms in the one week before the event has significant clinical implications. Current guidelines indicate that any athlete with regional or systemic symptoms should not participate in exercise training (including events) because of the potential risk of associated systemic illness and complications that may negatively impact the health of the athlete. Both athletes and coaches therefore should be educated regarding the current clinical guidelines ("neck-check") in the approach to training and competing under these circumstances.
- Although we report a low prevalence of asthma in this study, there is a discrepancy between asthma-like symptoms experienced and the actual diagnosis of asthma. This might indicate the under-reporting and possible under-diagnosis of asthma in endurance athletes.
- It was also of clinical relevance that the data from this study show that the diagnosis (by means of history taking and physical examination by the physician) was probably inadequate and special investigations should be implemented to confirm the diagnosis of asthma.
- Data from this study indicated that; 1) inhaled corticosteroids are not consistently used as the first choice of treatment, and 2) bronchodilators (beta 2-agonists) are not used appropriately – therefore, further education of physicians managing these athletes is required.

- Data from this and other studies consistently show that there is a high prevalence of allergies, especially nasal symptoms in endurance athletes. Therefore, we recommend that athletes should undergo allergy screening as part of their periodic health assessment.
- Athletes with allergies (particularly rhinitis) should also be investigated for asthma and asthmatic athletes should have allergy screening, as these conditions often co-exist.
- Athletes in this study were under-treated for allergic symptoms and anti-histamine tablets were inappropriately used as the drug of choice. The use of intranasal corticosteroids should be encouraged in these athletes as it has been shown not only to relieve allergic symptoms, but also to improve sleep, performance and quality of life.

4.6. Future studies

This study was a descriptive cross-sectional study and was not aimed at determining the cause of RTS in athletes. Future studies are needed to further investigate the non-infectious hypothesis of the cause of respiratory symptoms experienced by athletes in periods of intense training or competition. These studies should also explore the relationship between allergies and respiratory symptoms in the pre-event period. The need to investigate the aetiology of respiratory tract symptoms is important in the prevention and effective management of respiratory tract illness in athletes.

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Appendix A

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.
143
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.

144

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 B

TWO OCEANS RESEARCH STUDIES 2009

Race no:

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. Completion of a questionnaire: (all components)

The completion of personal details, racing, training, equipment use, medical, supplement use, fluid use and lifestyle history questionnaires are not associated with any risk. Completion of self-rated behavioural questionnaires has not previously been shown to be associated with risk. A potential risk is that people who have experienced significant past trauma will find questionnaires on this uncomfortable. The questions within the behavioural questionnaires are asking are about 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. Blood sample collection for re- serum creatine kinase (marker of muscle damage) levels (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. Measurement of Flexibility : (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
89
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.

90

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

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2007 IRONMAN – MEDICAL AND TRAINING QUESTIONNAIRES

These questionnaires have been constructed by the Medical Research team, in conjunction with the Medical Director of the Ironman 2007. The information obtained from these questionnaires is essential for the planning of medical care during events such as the Ironman. 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 Peter Schwartz (Medical Director, Ironman 2007)

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.

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

Please complete only the relevant questions in the following section

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

Section B. Racing and training history

Type of triathlon	**Standard (1.6, 40, 10)**	**Ironman**	
Which triathlons have you **ever** participated in?	Yes ☐ No☐	Yes ☐ No☐	
Year of first event			
How many triathlon events have you **ever** participated in?			
How many triathlon races have you completed over the **past 2 years**?			
Personal best time **ever**	_____ hrs:min	_____ hrs:min	
What was your time for your last triathlon race during the **past 12 months**?	_____ hrs:min	_____ hrs:min	
Type of running event	**10 km**	**21.1 km**	**42.2 km**
Which road running races have you **ever** participated in?	Yes ☐ No☐	Yes ☐ No☐	Yes ☐ No☐
Year of first event			
How many events have you **ever** participated in?			
Personal best time **ever**	_____ min	_____ min	_____ min
What is your best time, in a running race, in the **last 15 weeks**?	_____ min	_____ min	_____ min
Type of event	**Two Oceans Marathon**	**Comrades Marathon**	
Which races have you **ever** participated in?	Yes ☐ No☐	Yes ☐ No☐	
Year of first event			
How many events have you **ever** participated in?			
Personal best time	_____ hrs:min	_____ hrs:min	

What is your personal best cycling time in a race between **80 to 120 km** in the **last 15 weeks**?	Time: _____ min Distance: _____ km

South African Ironman Triathlon racing history

Did you enter any of the South African Ironman Triathlons?

2000 (Gordon's Bay)	Yes ☐ No☐ Race No _____
2001 (Gordon's Bay)	Yes ☐ No☐ Race No _____
2005 (Port Elizabeth)	Yes ☐ No☐ Race No _____
2006 (Port Elizabeth)	Yes ☐ No☐ Race No _____

What is your predicted time for the entire 2007 Ironman event and each of the three splits?	Entire event: _____ min Swim: _____ min Cycle: _____ min Run: _____ min

Please answer the following questions, with your answers reflecting your average in the **most recent 15 weeks i.e. beginning December 2006 to 18th March, 2007.**

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

Flexibility training history

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

Equipment use history			
Please indicate which type of **bicycle** you use?	☐ Kuota ☐ Aegis ☐ Felt ☐ Cervelo ☐ Elite ☐ Giant	☐ Kestrel ☐ Litespeed ☐ Quintana Roo ☐ Argon 18 ☐ Specialized ☐ Other: _____	☐ Trek ☐ Softride ☐ Javelin ☐ Scott ☐ Guru
Please indicate which type of **handle bars** you use?	☐ Bontrager ☐ Profile Design ☐ Deda ☐ Pedalsoft ☐ Other: _____	☐ HED ☐ Vision Tech ☐ Easton ☐ Kestrel	☐ Zipp ☐ Oval Concepts ☐ Syntace
Please indicate which type of **saddle** (Brand - model) you use?	☐ Selle San Marco- Azoto TriathGel ☐ Profile Design- Tri Stryke (with a groove) ☐ Selle San Marco- Rever Profil ☐ Fizik- Arione Tri ☐ Terry ☐ Koobi ☐ Other: _____		

Please indicate which brand of **helmet** you use?	☐ Trek ☐ Bell ☐ Giro ☐ MET ☐ Other: _____
Please indicate which type of **cycling shorts** you use?	☐ Thin lycra (no padding) ☐ Padded cycling shorts ☐ Triathlon shorts with some padding ☐ Swimming costume ☐ Other: _____
Do you normally wear **underwear** together with cycling shorts?	☐ Yes ☐ No
Please indicate which type of **cycling shoes** you use?	☐ Olympic ☐ Nike ☐ Diadora ☐ Shimano ☐ Carnac ☐ Sidi ☐ Other: _____
Please indicate which type of **kit** you use?	☐ Anatomic ☐ Nike ☐ Velo ☐ Howzit ☐ Adidas ☐ Orca ☐ De Soto ☐ Louis Garneau ☐ Quintana Roo ☐ Zoot ☐ Other: _____
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: _____

Section C. History of medication and supplement use

What medication, if any, are you currently using? (please list)	Name of medication	Years taken

Do you use protective skin sunscreen during training session or when competing?	Yes ☐ No ☐	☐ Every session	☐ 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 fluoroquinoline antibiotics? (refer to the following list)	Yes ☐ No ☐	☐ 3 months	☐ 6 months
		☐ 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					
How do you best describe your fluid intake during an Ironman triathlon race?	(a) I drink to thirst ☐ (b) I drink as much as tolerable ☐ (c) I drink according to a predetermined fluid intake schedule ☐ (d) I drink to prevent any weight loss during exercise ☐ (e) I combine (a) with (c) ☐ (f) I combine (b) with (c) ☐ (g) Other: _____ ☐				
What percentage of your fluid intake will consist of these beverages?	Water:	☐ 0-25%	☐ 26-50%	☐ 51-75%	☐ 76-100%
	Sports drink:	☐ 0-25%	☐ 26-50%	☐ 51-75%	☐ 76-100%
	Coke:	☐ 0-25%	☐ 26-51%	☐ 51-75%	☐ 76-100%
	Other:	☐ 0-25%	☐ 26-50%	☐ 51-75%	☐ 76-100%
	Specify other: _____				
What will be your estimated **total** fluid intake be **(if at all)** during the **swim**?	ml				
What will be your estimated **total** fluid intake be during the **cycle**?	ml				
What will be your estimated **total** fluid intake be during the **run**?	ml				
Rank the following sources of information on their importance in formulating your drinking strategy. (1 being most influential and the lowest number being least influential)	_____ Fellow triathletes _____ Coach / trainer _____ Magazines / books _____ Website (please specify: _____) _____ Drinking guidelines from sports associations _____ Adverts _____ Self-experimentation _____ Other: _____				

Section D. Psychological and Behavioural

Connor-Davidson Resilience Scale (CD-RISC)

Please indicate how much you agree with the following statements as they apply to you over the last **month**. If a particular situation has not occurred recently, answer according to how you think you would have felt.

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

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

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

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

K10					
Instructions: The following questions ask about how you have been feeling during the **past four weeks**. For each question, please circle the number that best describes how often you have had this feeling. Your answers will be kept confidential.					
In the past four weeks:	**None of the**	**A little of the time**	**Sometime of the time**	**Most of the**	**All of the time**

	time			time	
1. About how often did you feel tired of for no good reason?	1	2	3	4	5
2. About how often did you feel nervous?	1	2	3	4	5
3. About how often did you feel so nervous that nothing could calm you down?	1	2	3	4	5
4. About how often did you feel hopeless?	1	2	3	4	5
5. About how often did you feel restless or fidgety?	1	2	3	4	5
6. About how often did you feel restless you could not sit still?	1	2	3	4	5
7. About how often did you feel depressed?	1	2	3	4	5
8. About how often did you feel that everything is an effort?	1	2	3	4	5
9. About how often did you feel so sad that nothing could cheer you up?	1	2	3	4	5
10. About how often did you feel worthless?	1	2	3	4	5

Section E. Family medical history

Have any of your blood (biological) relatives <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. Personal general medical history

In this section, you are asked to read through 14 questions about your personal general medical history. If you answer "yes" to any of questions 1 to 12, please complete the additional questions at the end of the section (section G on page 18).

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

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

15d. Have you had a hysterectomy/ovarectomy?	Yes ☐ No ☐
15e. How many times have you been pregnant?	(times)

15f. What form of contraception are you currently using?	☐ None ☐ Oral contraceptive pill ☐ Injection ☐ Intra-uterine device ☐ Sterilization (tubes tied) ☐ Other: _____
15g. If yes to question 15f. above, for <u>oral contraceptive pill</u>, for what reason was the pill prescribed?	☐ Not applicable ☐ Dermatological ☐ Contraception ☐ Regulate period ☐ Other: _____

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE

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

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

Section G. Additional detailed medical history

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

1. Flu symptoms in the last 6 weeks

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

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

2. Muscle cramping

If you answered **YES** to **question 2** in section F, please complete the following questions (2a. to 2m.) related to your cramping.

(2a) For how many years have you suffered from cramping?	(years)
(2b) Did you suffer from cramping during or after exercise in the **last 12 months**?	Yes ☐ No ☐
(2c) With what **type of exercise** is your cramping associated (You can tick more than one form of exercise)?	☐ Swimming ☐ Cycling ☐ Running
(2d) In the **last 10 races or training sessions**, how many times have you experienced cramping?	Races: _____/10 Training sessions: _____/10
(2e) What treatment/s have you had that **successfully relieved** an acute cramp? (can tick more than one)	☐ Stretching ☐ Resting ☐ Drinking fluid ☐ Ice application ☐ Massage ☐ Magnesium ☐ Salt (tablets or solution) ☐ Other (Specify: _____)
(2f) At **what point in the race or training run** do you usually first experience cramping?	☐ First quarter ☐ Second quarter ☐ Third quarter ☐ Fourth quarter ☐ After the race ☐ No pattern
(2g) In which **muscles** do you usually cramp (please list the muscle by the one which cramps most frequently (as 1) and the others after that (2-4)?	☐ Calves ☐ Hamstrings ☐ Quadriceps (thigh) ☐ Foot muscles ☐ Other (Specify: _____)
(2h) Have you **ever** suffered from cramping in your **whole body** (arms and legs)?	Yes ☐ No ☐

(2i) Have you **ever** been **admitted to hospital** following cramping?	Yes ☐ No ☐
(2j) Have you **ever** been **confused or in a coma** during or after a cramping episode?	Yes ☐ No ☐
(2k) Have you ever had **"dark urine"** in the 3 days following a cramping episode?	Yes ☐ No ☐
(2l) If you cramp, **how long** does the cramp usually last for (min)?	(minutes)
(2m) If you cramp, how **severe** is the cramp usually? (please tick).	☐ Mild: < 5 minutes and you are able to continue exercising ☐ Moderate: 5-15 minutes and you are able to continue exercising ☐ Severe: >15 minutes or if you have to STOP exercising

3. Past Tendon and Ligament Injury History

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

	Tendon		Longstanding Pain (Tendinopathy)	Acute Tear/ Rupture
(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	Foot and ankle:	☐ Achilles tendon	☐	☐
		☐ Tibialis posterior	☐	☐
		☐ Plantar fascia	☐	☐
	Knee:	☐ Patellar tendon	☐	☐
	Elbow and wrist:	☐ Wrist extensor tendon	☐	☐
	Shoulder:	☐ Rotator cuff	☐	☐
	Other: _____		☐	☐

	Ligament	Sprain	Complete Tear
(3b) Please tick 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	

4. Use of medicines to treat an injury before or during participation

If you answered **YES** to **question 4** in section F, please complete the following two questions related to medicine use for injuries before or during races.

(4a) Which of the following medicines have you used in the past to treat an injury **in the week just before** a race?	☐ Paracetamol (e.g. Panado, Tylenol) ☐ Non-steroidal anti-inflammatories (e.g. Voltaren, Cataflam) ☐ Cortisone (pills) ☐ Cortisone injection ☐ Codeine ☐ Anti-inflammatory gels/creams/patches ☐ Any other pain killers (Specify: _____)
(4b) Which of the following medicines have you used in the past to treat an injury **during a race**?	☐ Paracetamol (e.g. Panado, Tylenol) ☐ Non-steroidal anti-inflammatories (e.g. Voltaren, Cataflam) ☐ Cortisone (pills) ☐ Cortisone injection ☐ Codeine ☐ Anti-inflammatory gels/creams/patches ☐ Any other pain killers (Specify: _____)

5. Gastrointestinal symptoms during exercise

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

Symptom	Number of times you experienced the GIT symptom in the last 12 months **(during exercise)**	Number of times you experienced the GIT symptom in the last 10 races **(during races)**	Please indicate which **type of exercise** is mostly associated with the GIT symptom	Please indicate the **"severity" of the GIT symptom** during exercise
Nausea			☐ Swimming ☐ Cycling ☐ Running	☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Vomiting			☐ Swimming ☐ Cycling ☐ Running	☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Heartburn			☐ Swimming ☐ Cycling ☐ Running	☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Abdominal pain			☐ Swimming ☐ Cycling ☐ Running	☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Urge to pass a stool (defecate)			☐ Swimming ☐ Cycling ☐ Running	☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Diarrhoea			☐ Swimming ☐ Cycling ☐ Running	☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Passing blood in the stool			☐ Swimming ☐ Cycling ☐ Running	☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing
Please indicate if you previously suffered from or had any of the following (you may tick more than one)?				☐ History of heartburn ☐ Gastroscopy ☐ Ulcer (gastric, duodenal) ☐ Irritable bowel syndrome ☐ Allergy to milk products ☐ Other past history of GIT disease

6. Diseases of the nervous system

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

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

7. Genital tract injury during cycling

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

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

8. Allergy history

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

(8a) Please indicate how long (years) have you been suffering from allergies?					years
(8b) Please tick which <u>type of allergy</u> do you currently suffer from					
Nose (hay fever)	Yes ☐ No ☐	Sinusitis	Yes ☐ No ☐	Asthma (allergic)	Yes ☐ No ☐
Skin allergies	Yes ☐ No ☐	Eye allergies	Yes ☐ No ☐	Allergy to plant material	Yes ☐ No ☐
Allergy to foods	Yes ☐ No ☐	Allergy to animals	Yes ☐ No ☐	Allergy to medication	Yes ☐ No ☐
(8c) Please tick which <u>type of allergy</u> do you <u>currently take medication</u> for					
Nose (hay fever)	Yes ☐ No ☐	Sinusitis	Yes ☐ No ☐	Asthma (allergic)	Yes ☐ No ☐
Skin allergies	Yes ☐ No ☐	Eye allergies	Yes ☐ No ☐	Allergy to plant material	Yes ☐ No ☐
Allergy to foods	Yes ☐ No ☐	Allergy to animals	Yes ☐ No ☐	Allergy to medication	Yes ☐ No ☐
(8d) Please tick which <u>type of medication</u> do you <u>currently take</u>					
Cortisone nose spray	Yes ☐ No ☐	Cortisone nose inhaler	Yes ☐ No ☐	Anti-histamine tablets	Yes ☐ No ☐
Cortisone cream	Yes ☐ No ☐	Anti-histamine cream	Yes ☐ No ☐	Other inhaler / tablets or cream	Yes ☐ No ☐
(8e) Please tick which <u>symptoms of allergy</u> do you <u>currently suffer</u> 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 <u>currently</u> have symptoms of allergies? (You tick more than one)	☐ Jan ☐ Feb ☐ March ☐ April ☐ May ☐ June ☐ July ☐ Aug ☐ Sept ☐ Oct ☐ Nov ☐ Dec				
(8f) Please tick which <u>type of allergy</u> did you suffer from in the past (NOT currently)					
Nose (hay fever)	Yes ☐ No ☐	Sinusitis	Yes ☐ No ☐	Asthma (allergic)	Yes ☐ No ☐
Skin allergies	Yes ☐ No ☐	Eye allergies	Yes ☐ No ☐	Allergy to plant material	Yes ☐ No ☐
Allergy to foods	Yes ☐ No ☐	Allergy to animals	Yes ☐ No ☐	Allergy to medication	Yes ☐ No ☐

9. Asthma history

If you answered **YES** to **question 9** in section F, please complete the following questions (9a. to 9k.) related to your current history of asthma

(9a) Do you currently suffer from asthma?	Yes ☐ No ☐
(9b) How many years have you suffered from asthma?	(years)

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

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

10. History of previous collapse

If you answered **YES** to **question 10** in section F, please complete the following questions (10a. to 10d.) related to your current history of asthma

(10a) Have you ever collapsed during training or racing?	☐ Training ☐ Racing ☐ Training and racing
(10b) How many times have you collapsed in training session or races during the last **five years**?	_____ training session _____ races
(10c) How many times have you collapsed in training session or races during the last **12 months** (1 year)?	
(10d) When you collapse, does it mostly occur before of after the finish line / completion of the training session?	☐ Before the finish ☐ After the finish
(10e) What is the cause of you collapse?	☐ Dehydration ☐ Heat illness ☐ Hyponatremia ☐ Low blood pressure ☐ Low blood sugar ☐ Other condition (Specify: _____)

11. History of any current injury that you suffer from

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

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

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

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2009 TWO OCEANS ULTRA-MARATHON – MEDICAL 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.

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

Please complete only the relevant questions in the following section

Section G Additional Detailed Medical History Pages 16-28

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	y y y y - m m - d d	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 and training 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 2008 Two Oceans ultra-marathon?	_____ hrs _____ min
What is your predicted time for the through the marathon mark during the 2008 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 questionnaire from the top of page 5 (Equipment use history).	
On average, how many days a week do you perform a stretching session?	days/week
On average, how times a day do you perform a stretching session?	times/day
Please tick which muscle groups do you include in your stretching session?	☐ Hamstrings ☐ Quadriceps ☐ Calf (gastrocnemius) ☐ Calf (soleus) ☐ Groin (inner thigh) ☐ Upper body limbs ☐ Other: _____

Please tick when you stretch? (before, during and/or after exercising. You can tick more than one box)	☐ Before Exercise ☐ During Exercise ☐ After Exercise
When you stretch an individual muscle group, on average, **how long do you hold the stretch** for?	seconds
When you stretch an individual muscle group, on average, **how many times do you stretch the muscle for**?	☐ Once ☐ Twice ☐ 3 times ☐ 4 times ☐ 5 times ☐ 6 or more times

Equipment use history	
Please indicate which **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: _____

Section C. History of medication and supplement use

What medication, if any, are you currently using? (please list)	Name of medication	Years taken

Do you use protective skin sunscreen during training session or when competing?	Yes ☐ No ☐	☐ Every session ☐ 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 fluoroquinoline antibiotics? (refer to the following list)	Yes ☐ No ☐	☐ 3 months ☐ 6 months ☐ 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		
How do you best describe your fluid intake during an Ironman triathlon race?	(a) I drink to thirst ☐ (b) I drink as much as tolerable ☐ (c) I drink according to a predetermined fluid intake schedule ☐ (d) I drink to prevent any weight loss during exercise ☐ (e) I combine (a) with (c) ☐ (f) I combine (b) with (c) ☐ (g) Other: _____ ☐	
What percentage of your fluid intake will consist of these beverages?	Water: ☐ 0-25% ☐ 26-50% ☐ 51-75% ☐ 76-100% Sports drink: ☐ 0-25% ☐ 26-50% ☐ 51-75% ☐ 76-100% Coke: ☐ 0-25% ☐ 26-51% ☐ 51-75% ☐ 76-100% Other: ☐ 0-25% ☐ 26-50% ☐ 51-75% ☐ 76-100% Specify other: _____	
What will be your estimated **total** fluid intake be **(if at all)** during the **swim**?		ml
What will be your estimated **total** fluid intake be during the **cycle**?		ml
What will be your estimated **total** fluid intake be during the **run**?		ml

Rank the following sources of information on their importance in formulating your drinking strategy. (1 being most influential and the lowest number being least influential)	_____ Fellow triathletes _____ Coach / trainer _____ Magazines / books _____ Website (please specify: _____) _____ Drinking guidelines from sports associations _____ Adverts _____ Self-experimentation _____ Other: _____

Section D. Psychological and Behavioural

Connor-Davidson Resilience Scale (CD-RISC)

Please indicate how much you agree with the following statements as they apply to you over the last **month**. If a particular situation has not occurred recently, answer according to how you think you would have felt.

	not true at all	**rarely true**	**sometimes true**	**often true**	**true nearly all the time**
26. I am able to adapt when changes occur.					
27. I have at least one close and secure relationship which helps me when I am stressed.					
28. When there are no clear solutions to my problems, sometimes fate or God can help.					
29. I can deal with whatever comes my way.					
30. Past successes give me confidence in dealing with new challenges and difficulties.					
31. I try to see the humorous side of things when I am faced with problems.					
32. Having to cope with stress can make me stronger.					
33. I tend to bounce back after illness, injury, or other hardships.					
34. Good or bad, I believe that most things happen for a reason.					
35. I give my best effort, no matter what the outcome may be.					
36. I believe I can achieve my goals, even if there are obstacles.					
37. Even when things look hopeless, I don't give up.					
38. During times of stress/crisis, I know where to turn for help.					
39. Under pressure, I stay focused and think clearly.					
40. I prefer to take the lead in solving problems, rather than letting others make all the decisions.					
41. I am not easily discouraged by failure.					
42. I think of myself as a strong person when dealing with life's challenges and difficulties.					
43. I can make unpopular or difficult decisions that affect other people, if it is necessary.					
44. I am able to handle unpleasant or painful feelings like sadness, fear and anger.					
45. In dealing with life's problems, sometimes you have to act on a hunch, without knowing why.					
46. I have a strong sense of purpose in life.					
47. I feel in control of my life.					

48. I like challenges.					
49. I work to attain my goals, no matter what roadblocks I encounter along the way.					
50. I take pride in my achievements.					

TPQ / TCI (96 shared items)

97. I usually am confident that everything will go ell, even in situations that worry most people.	True☐	False ☐
98. I often try new things just for fun or thrills, even if most people think it is a waste of time.	True☐	False ☐
99. I like to discuss my experiences and feelings openly with friends instead of keeping them to myself.	True☐	False ☐
100. When nothing new is happening, I usually start looking for something that is thrilling or exciting.	True☐	False ☐
101. Usually I am more worried about that most people that something might go wrong in the future.	True☐	False ☐
102. I don't mind discussing my personal problems with people whom I have known briefly or slightly.	True☐	False ☐
103. I would like to have warm and close friends with me most of the time.	True☐	False ☐
104. I nearly always stay relaxed and carefree even when nearly everyone else is fearful.	True☐	False ☐
105. I usually demand very good practical reasons before I am willing to change my old ways of doing things.	True☐	False ☐
106. I often have to stop what I am doing because I start worrying that something might go wrong.	True☐	False ☐
107. 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 ☐
108. My friends find it hard to know my feelings because I seldom tell them about my private thoughts.	True☐	False ☐
109. I like it when people can do exactly what they want without strict rules and regulations.	True☐	False ☐
110. I often stop what I am doing because I get worried, even when my friends tell me everything will go well.	True☐	False ☐
111. It wouldn't bother me to be alone all the time.	True☐	False ☐
112. I like to be very organized and set up rules for people whenever I can.	True☐	False ☐
113. I usually do things my own way, rather than giving in to the wishes of other people.	True☐	False ☐
114. I usually feel tense and worried when I have to do something new and unfamiliar.	True☐	False ☐
115. I often feel tense and worried in familiar situations, even when others feel there is little to worry about.	True☐	False ☐
116. Other people often think that I am too independent because I won't so what they want.	True☐	False ☐
117. Even when most people feel it is not important, I often insist on things being done in a strict and orderly way,	True☐	False ☐
118. I often do things based on how I feel at the moment, without thinking about how they are done in the past.	True☐	False ☐

119. I often feel tense and worried in unfamiliar situations, even when others feel there is no danger at all.	True ☐	False ☐
120. I often brake rules and regulations when I think I can get away with it.	True ☐	False ☐
121. I don't care very much whether other people like me or the way I do things.	True ☐	False ☐
122. I usually stay calm and secure in situations that most people would find physically dangerous.	True ☐	False ☐
123. I feel it is more important to be sympathetic and understanding of other people than to be practical and tough- minded.	True ☐	False ☐
124. I lose my temper more quickly than most people.	True ☐	False ☐
125. 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 ☐
126. I often react so strongly to unexpected news that I say or do things that I regret.	True ☐	False ☐
127. People find it easy to come to me for help, sympathy, and warm understanding.	True ☐	False ☐
128. I am much more reserved and controlled than most people.	True ☐	False ☐
129. When I have to meet a group of strangers, I am more shy than most people.	True ☐	False ☐
130. I am strongly moved by sentimental appeals (like when asked to helped crippled people).	True ☐	False ☐
131. I almost never get so excited that I lose control of myself.	True ☐	False ☐
132. I have a reputation as someone who is practical and does not act on emotion.	True ☐	False ☐
133. I often avoid meeting strangers because I lack confidence with people I do not know.	True ☐	False ☐
134. 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 ☐
135. I usually push myself harder than most people do because I want to do as well as I possibly can.	True ☐	False ☐
136. I often push myself to the point of exhaustion or try to do more than I really can.	True ☐	False ☐
137. I would probably stay relaxed and outgoing when meeting a group of strangers, even if I were told they were unfriendly.	True ☐	False ☐
138. It is difficult for me to keep the same interests for a long time because my attention often shifts to something else.	True ☐	False ☐
139. I think I would stay confident and relaxed when meeting strangers, even if I were told they are angry with me.	True ☐	False ☐
140. 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 ☐
141. I like to think about things for a long time before I make a decision.	True ☐	False ☐
142. 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 ☐
143. I often follow my instincts, hunches, or intuition without thinking through all the details.	True ☐	False ☐

144. I try to do as little work as possible, even when other people expect more of me.	True☐	False ☐
145. I often have to change my decisions because I had a wrong hunch or mistaken first impression.	True☐	False ☐
146. 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 ☐
147. I am satisfied with my accomplishments and have little desire to do better.	True☐	False ☐
148. I see no point in continuing to work on something unless there is a good chance of success.	True☐	False ☐
149. I have less energy and get tired more quickly than most people.	True☐	False ☐
150. I usually think about all the facts in detail before I make a decision.	True☐	False ☐
151. 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 ☐
152. I often need naps or extra rest periods because I get tired so easily.	True☐	False ☐
153. I don't go out of my way to please other people.	True☐	False ☐
154. I am more energetic and tire less quickly than most people.	True☐	False ☐
155. 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 ☐
156. 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 ☐
157. I usually can stay "on the go" all day without having to push myself.	True☐	False ☐
158. I am usually more upset than most people by the loss of a close friend.	True☐	False ☐
159. I have trouble telling a lie, even when it is meant to spare someone else's feelings.	True☐	False ☐
160. I am better at saving money than most people.	True☐	False ☐
161. Even after there are problems in a friendship, I nearly always try to keep it going anyway.	True☐	False ☐
162. I recover more slowly than most people from minor illnesses or stress.	True☐	False ☐
163. I need much extra rest, support, or reassurance to recover from minor illnesses or stress.	True☐	False ☐
164. I often spend money until I run out of cash or get into debt from using too much credit.	True☐	False ☐
165. 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 ☐
166. 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 ☐
167. If I am feeling upset, I usually feel better around friends than when left alone.	True☐	False ☐
168. I usually feel much more confident and energetic than most people, even after minor illnesses or stress.	True☐	False ☐

169. Some people think I am too stingy or tight with my money.	True☐	False ☐
170. I often keep trying the same thing over and over again, even when I have not had success in a long time.	True☐	False ☐
171. It is hard for me to enjoy spending money on myself, even when I have saved plenty of money.	True☐	False ☐
172. I recover more quickly than most people from minor illnesses or stress.	True☐	False ☐
173. I hate to make decisions based only on my first impressions.	True☐	False ☐
174. I think I will have very good luck in the future.	True☐	False ☐
175. I am most often moved deeply by fine speech or poetry.	True☐	False ☐
176. If I am embarassed or humiliated, I get over it very quickly.	True☐	False ☐
177. 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 ☐
178. I like to keep my problems to myself.	True☐	False ☐
179. I enjoy saving money more than spending it on entertainment or thrills.	True☐	False ☐
180. Even when I am with friends, I prefer not to “open up” very much	True☐	False ☐
181. I feel very confident and sure of myself in almost all social situations.	True☐	False ☐
182. I usually like to stay cool and detached from other people.	True☐	False ☐
183. I never worry about terrible things that might happen in the future.	True☐	False ☐
184. I am more hard-working than most people.	True☐	False ☐
185. In conversations I am much better as a listener than as a talker.	True☐	False ☐
186. I like to please other people as much as I can.	True☐	False ☐
187. Regardless of any temporary problem that I have to overcome, I always think it will turn out well.	True☐	False ☐
188. I like to stay at home better than to travel and explore new places.	True☐	False ☐
189. I am usually so determined that I continue to work long after other people have given up.	True☐	False ☐
190. I usually have good luck in whatever I try to do.	True☐	False ☐
191. I like to pay close attention to details in everything I do.	True☐	False ☐
192. It is easy for me to organize my thoughts while talking to someone.	True☐	False ☐

K10

Instructions: The following questions ask about how you have been feeling during the **past four weeks**. For each question, please circle the number that best describes how often you have had this feeling. Your answers will be kept confidential.

In the past four weeks:	None of the time	A little of the time	Sometime of the time	Most of the time	All of the time
1. About how often did you feel tired of for no good reason?	1	2	3	4	5
2. About how often did you feel nervous?	1	2	3	4	5
3.About how often did you feel so nervous that nothing could calm you down?	1	2	3	4	5
4. About how often did you feel hopeless?	1	2	3	4	5
5. About how often did you feel restless or fidgety?	1	2	3	4	5
6. About how often did you feel restless you could not sit still?	1	2	3	4	5
7. About how often did you feel depressed?	1	2	3	4	5
8. About how often did you feel that everything is an effort?	1	2	3	4	5
9. About how often did you feel so sad that nothing could cheer you up?	1	2	3	4	5
10. About how often did you feel worthless?	1	2	3	4	5

Section E. Family medical history

Have any of your blood (biological) relatives <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. Personal general medical history

In this section, you are asked to read through 14 questions about your personal general medical history. If you answer "yes" to any of questions 1 to 12, please complete the additional questions at the end of the section (section G on page 18).

16. 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 ☐
17. Have you **ever** in triathlon career suffered from **muscle cramping** (painful, spontaneous, sustained spasm of a muscle) during or immediately (within 6 hours) after exercise (in training or competition)?	Yes ☐ No ☐
18. Have you **ever** in your triathlon career suffered from **a tendon or ligament injury** (pain, swelling, stiffness) in any tendon (including Achilles tendon, knee tendons, and shoulder tendons) or ligaments (partial or complete tear)?	Yes ☐ No ☐
19. Have you **ever** in your triathlon career **used medicines to treat injuries** in the week **before or during a race** – including anti-inflammatory drugs, cortisone (pills, or injection), or pain killers?	Yes ☐ No ☐
20. Have you **ever** in your triathlon career suffered **gastrointestinal** symptoms **during exercise** including heartburn, nausea, vomiting, abdominal pain, urge to defecate (pass a stool), diarrhoea, or blood in the stools?	Yes ☐ No ☐
21. Have you **ever** in your triathlon career suffered from symptoms of the **nervous system** including exercise induced headaches, nerve tingling or loss of sensation?	Yes ☐ No ☐
22. Have you **ever** in your triathlon career suffered from **symptoms of allergies** including nose allergies (hay fever), allergic sinusitis, allergic asthma, skin allergies, a past history of allergies to medication, plant material or animal material?	Yes ☐ No ☐
23. 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 ☐
24. 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 ☐
25. Do you **currently** suffer from any **symptoms of injury** in the muscles, tendons, bones, ligaments or joints?	Yes ☐ No ☐
26. 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 ☐

27. 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: _____)
28. Management of pain during the last 3 months	
14a. Did you alter or stop your training schedule due to pain in any part of your body?	Yes ☐ No☐
If yes: For how long	_____ days
Did you adapt your training schedule for a while when your injury/illness was healed?	Yes ☐ No☐

14b. How do you feel when you experience pain? (you can tick more than one option)	☐ It does not bother me much ☐ Angry ☐ Frustrated ☐ Depressed ☐ Resentful ☐ Overwhelmed
14c.When you experience pain, do you? (you can tick more than one option)	☐ Adjust your training schedule ☐ Stop training ☐ Slowly get “back on track” of your training schedule ☐ Train harder to make up for the missed training sessions ☐ Ignore the pain and continue to train ☐ Feel scared to do anything that could aggravate the pain ☐ Think that the pain means that you have a severe injury ☐ Tell everybody about it

29. **Female athletes only:**
Please complete the following questions (14a. to 14g.) related to your menstrual cycle and other gynaecological history

15a. At what age did you start your periods (menstruating)?	(years)
15b. <u>In the last 12 months</u>, how many menstrual cycles did you have?	
15c. Have you ever had irregular menstrual periods in the past? (excluding pregnancy)?	Yes ☐ No ☐
15d. Have you had a hysterectomy/ovarectomy?	Yes ☐ No ☐
15e. How many times have you been pregnant?	(times)

15f. What form of contraception are you currently using?	☐ None ☐ Oral contraceptive pill ☐ Injection ☐ Intra-uterine device ☐ Sterilization (tubes tied) ☐ Other: _____
15g. If yes to question 15f. above, for <u>oral contraceptive pill</u>, for what reason was the pill prescribed?	☐ Not applicable ☐ Dermatological ☐ Contraception ☐ Regulate period ☐ Other: _____

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE

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

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

Section G. Additional detailed medical history

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

1. Flu symptoms in the last 6 weeks

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

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

2. Muscle cramping

If you answered **YES** to **question 2** in section F, please complete the following questions (2a. to 2m.) related to your cramping.

(2a) For how many years have you suffered from cramping?	(years)
(2b) Did you suffer from cramping during or after exercise in the **last 12 months**?	Yes ☐ No ☐
(2c) With what **type of exercise** is your cramping associated (You can tick more than one form of exercise)?	☐ Swimming ☐ Cycling ☐ Running
(2d) In the **last 10 races or training sessions**, how many times have you experienced cramping?	Races: _____/10 Training sessions: _____/10

(2e) What treatment/s have you had that **successfully relieved** an acute cramp? (can tick more than one)	☐ Stretching ☐ Resting ☐ Drinking fluid ☐ Ice application ☐ Massage ☐ Magnesium ☐ Salt (tablets or solution) ☐ Other (Specify: _____)
(2f) At **what point in the race or training run** do you usually first experience cramping?	☐ First quarter ☐ Second quarter ☐ Third quarter ☐ Fourth quarter ☐ After the race ☐ No pattern
(2g) In which **muscles** do you usually cramp (please list the muscle by the one which cramps most frequently (as 1) and the others after that (2-4)?	☐ Calves ☐ Hamstrings ☐ Quadriceps (thigh) ☐ Foot muscles ☐ Other (Specify: _____)

(2h) Have you **ever** suffered from cramping in your **whole body** (arms and legs)?	Yes ☐ No ☐
(2i) Have you **ever** been **admitted to hospital** following cramping?	Yes ☐ No ☐
(2j) Have you **ever** been **confused or in a coma** during or after a cramping episode?	Yes ☐ No ☐
(2k) Have you ever had **"dark urine"** in the 3 days following a cramping episode?	Yes ☐ No ☐
(2l) If you cramp, **how long** does the cramp usually last for (min)?	(minutes)
(2m) If you cramp, how **severe** is the cramp usually? (please tick).	☐ Mild: < 5 minutes and you are able to continue exercising ☐ Moderate: 5-15 minutes and you are able to continue exercising ☐ Severe: >15 minutes or if you have to STOP exercising

3. Past Tendon and Ligament Injury History

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

(3a) Please tick which **tendon/s** you have injured? (next column on	**Tendon**	**Longstanding Pain (Tendinopathy)**	**Acute Tear/ Rupture**

the tright) Also indicate (tick) if your injured tendon was longsatnding pain (tendinopathy) or an 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: _____		☐	☐

	Ligament	**Sprain**	**Complete Tear**
(3b) Please tick 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	

4. Use of medicines to treat an injury before or during participation

If you answered **YES** to **question 4** in section F, please complete the following two questions related to medicine use for injuries before or during races.

(4a) Which of the following medicines have you used in the past to treat an injury **in the week just before** a race?	☐ Paracetamol (e.g. Panado, Tylenol) ☐ Non-steroidal anti-inflammatories (e.g. Voltaren, Cataflam) ☐ Cortisone (pills) ☐ Cortisone injection ☐ Codeine ☐ Anti-inflammatory gels/creams/patches ☐ Any other pain killers (Specify: _____)
(4b) Which of the following medicines have you used in the past to treat an injury **during a race**?	☐ Paracetamol (e.g. Panado, Tylenol) ☐ Non-steroidal anti-inflammatories (e.g. Voltaren, Cataflam) ☐ Cortisone (pills) ☐ Cortisone injection ☐ Codeine ☐ Anti-inflammatory gels/creams/patches ☐ Any other pain killers (Specify: _____)

5. Gastrointestinal symptoms during exercise

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

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

Passing blood in the stool			☐ Swimming ☐ Cycling ☐ Running	☐ Does not affect training or racing ☐ Affects training/racing (slow down or reduce time) ☐ Prevents training/racing

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

6. Diseases of the nervous system

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

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

7. Allergy history

If you answered **YES** to **question 7** in section F, please complete the following questions (7a. to 7e.) related to your current and past history of allergies.

(7a) Please indicate how long (years) have you been suffering from allergies?					years
(7b) Please tick which <u>type of allergy</u> 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 <u>type of allergy</u> do you <u>currently take medication</u> 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 <u>type of medication</u> do you <u>currently take</u>					
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 <u>symptoms of allergy</u> do you <u>currently suffer</u> 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 <u>currently</u> 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 <u>type of allergy</u> 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 ☐

8. Asthma history

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

(9a) Do you currently suffer from asthma?	Yes ☐ No ☐
(8b) How many years have you suffered from asthma?	(years)

(8c) 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: _____)
(8d) 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
(8e) 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
(8f) 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

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

9. History of previous collapse

If you answered **YES** to **question 9** in section F, please complete the following questions (9a. to 9d.) related to your current history of asthma

(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: _____)

10. History of any current injury that you suffer from

If you answered **YES** to **question 11** in section F, please complete the following questions (10a. to 10g.) related to each of your current injury/ies (Space is provided for two injuries)

Injury 1

(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 currently 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 ☐ Ligament ☐ Tendon ☐ Joint ☐ Bone Other (Specify: _____)
(10e) Please indicate in which sport (discipline) the injury occurred	☐ Running ☐ Cycling ☐ Swimming 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

(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 currently 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	☐ Ligament	
	☐ Tendon	☐ Joint	
	☐ Bone		
	Other (Specify: _____)		
(10e) Please indicate in which sport (discipline) the injury occurred	☐ Running	☐ Cycling	
	☐ Swimming		
	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

(11g) 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: _____)

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13 January 2006

REC REF: 425/2005

Assoc Prof MP Schwellnus
Department of Human Biology
UCT/MRC Research Unit for Exercise Science and Sports Medicine
Medical School

Dear Prof Schwellnus

THE PORT ELIZABETH IRONMAN TRIATHLON 2006: MEDICAL CONSEQUENCES FOLLOWING ENDURANCE SPORTS.

Thank you for your letter to the Research Ethics Committee dated 14 December 2005, addressing the issues raised by the committee. It is a pleasure to inform you that the Ethics Committee has formally approved the above mentioned study.

Please quote the REC. REF in all your correspondence.

Yours sincerely

Signed by candidate

PROF. T ZABOW
CHAIRPERSON

KBonani

UNIVERSITY OF CAPE TOWN

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Research Ethics Committee
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09 February 2007

REC REF: 002/2007

Prof M Schwellnus
Human Biology

Dear Prof Schwellnus

PROJECT TITLE: THE PORT ELIZABETH IRONMAN TRIATHLON 2007: MEDICAL CONSEQUENCES FOLLOWING ENDURANCE SPORTS

Thank you for your letter to the Research Ethics Committee dated 07 February 2007.

It is a pleasure to inform you that the Ethics Committee has **formally approved** the above-mentioned study.

Your comments to the queries raised are noted with thanks.

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 (MRC-SA), 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 Regulation Part 50, 56 and 312.

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

Please quote the REC. REF in all your correspondence.

Yours sincerely

Signed by candidate

A/PROF. M. BLOCKMAN
CHAIRPERSON, HSF HUMAN ETHICS

UNIVERSITY OF CAPE TOWN

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18 March 2009

REC REF: 066/2009

Prof M Schwellnus
Sports Science Institute

Dear Prof Schwellnus

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

Signed by candidate

PROFESSOR M BLOCKMAN
CHAIRPERSON, HSF HUMAN ETHICS

Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938

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