DETECTION OF RESPIRATORY ILLNESS IN ATHLETES OF THE UNIVERSITY OF THE FREE STATE THROUGH A PERIODIC HEALTH EVALUATION WITH AND WITHOUT SPIROMETRY

by

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DECLARATION

I, Dr. Isstelle J. Joubert, 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 or any part of it has been, is being, or has to be submitted for another degree in this or any other University.

It is being submitted for the degree of Masters in Sports Medicine in the School of Medicine in the Faculty of Health Sciences of the University of the Free State, Bloemfontein.

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ABSTRACT

Background: Exercise-induced bronchospasm (EIB) is a common medical condition which can have devastating complications, particularly in otherwise healthy active athletes. Since EIB is unpredictable but preventable, medical personnel and coaches are often the primary support givers in such events and need to be informed about the risk factors and proper management of the athlete with this, sometimes undiagnosed, respiratory problem. The periodic health evaluation (PHE) is mandatory in some, but not all, sports and covers a few basic questions regarding the athlete's respiratory health.

Aims: The objective of this study was to determine the prevalence of underlying respiratory disease in a population of varsity level athletes. In addition, the study aimed to test whether the addition of a specific tool would increase the sensitivity of the PHE as it is implemented by the International Olympic Committee (IOC), therefore investigating if spirometry before and after an exercise challenge would diagnose any new athletes with exercise-induced bronchospasm (EIB).

Methods: Thirty-two participants met the inclusion criteria. Periodic health evaluations were done to enquire about a detailed history from the athletes and physical examination with special attention to the respiratory system. Baseline spirometry followed by an exercise challenge test and serial post-exercise spirometries were done on all the participants according to the guidelines provided by the American Thoracic Society.

Results: The results of this study confirmed that a thorough history and clinical examination alone do not lead to the diagnosis of EIB. Furthermore, we conclude that a resting baseline spirometry does not indicate that an athlete is at risk for or has EIB. In the absence of eucapnic voluntary hyperpnea (EVH) as the preferred challenge test according to the International Olympic Committee-Medical Commission (IOC-MC), an exercise challenge test will be as valuable. Almost 10% of the athletes in our study, which were healthy according to the PHE and baseline spirometry, had a positive spirometry for EIB after an exercise challenge test as indicated by a fall of ≥ 10% from the baseline forced expiratory volume in one second (FEV_1).

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LIST OF ABBREVIATIONS

ATS	American Thoracic Society
°C	Degrees celsius
BPT's	Bronchial provocation tests
EIA	Exercise-induced asthma
EIB	Exercise-induced bronchospasm
EVH	Eucapnic voluntary hyperpnea
FEV_1	Forced expiratory volume in one second
FVC	Forced vital capacity
HR	Heart rate
IOC	International Olympic Committee
IOC-MC	International Olympic Committee-Medical Commission
MVV	Maximal voluntary ventilation
NAEPP	National Asthma Education and Prevention Program
NATA	National Athletic Trainers' Association
OG	Olympic Games
PEFR	Peak expiratory flow rate
PHE	Periodic health examination
PHE's	Periodic health examinations
PPE	Pre-participation physical examination
US	United States
THR	Target heart rate
$VO_{2\ max}$	Maximal volume of oxygen utilized in one minute during maximal exercise

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CHAPTER 1
INTRODUCTION

1.1 SCOPE OF RESEARCH

The International Olympic Committee (IOC) aims to detect and prevent injuries and illnesses that could be potentially harmful to the health and performance of an athlete. This aim is attempted to be reached by the periodic health evaluation (PHE), previously known as the pre-participation physical examination (PPE). The efficacy in detecting serious or subclinical medical illnesses with a PHE has been questioned as exercise-induced bronchospasm (EIB) frequently occurs but is not accurately detected by physical examination and obtaining of a medical history. Undiagnosed EIB could have health, medical, career and financial implications. The existence of EIB and its negative impacts are very real. In case of early detection, proper management and regular monitoring the morbidity and mortality associated with this phenomenon will be attenuated.

The current PHE as suggested by the IOC include the following (Ljungqvist *et al*., 2009):

"*Medical History: do you have a past history or currently suffer from any symptoms of respiratory (lung) disease, including asthma, wheezing, cough, postnasal drip, hay fever or repeated flu-like illness?".*

"Physical Examination: comprehensive examination including assessment of chest including percussion and auscultation".

"(if a positive finding is identified, further in-depth assessment with appropriate special investigations is required)".

Thus there are no clear guidelines of what the "appropriate special investigations" should be. With the global focus of "Exercise is Medicine" no athlete, regardless of level of competition,

age, motivation to participate and to perform, should be hindered to partake in exercise because of the fear of exacerbated asthmatic attacks or even death.

1.2 AIM OF THE STUDY

The diagnosis of EIB mainly consists out of high index of suspicion, detailed history, physical examination as well as specific measurable and repeatable changes as recorded with spirometry. With these vague guidelines of the PHE in mind the aim of the study is to determine if the addition of serial post-exercise spirometry would increase the sensitivity of the PHE to identify respiratory illnesses – specifically EIB, or not.

1.3 STUDY SYNTHESIS

In order to systematically present the research to answer the research questions as set out above, this thesis consists of six chapters. Chapter Two provides an overview of the relevant literature on PHE and EIB, and theory underlying the motivation for the research and analysis of the results. Chapter Three gives an account of the methods followed for participant selection, data collection and analysis of this descriptive, cross-sectional study, to fulfil the aims of the research project. Chapter Four presents the results of the study, using graphic and written formats and to present them in terms of statistical relevance. Chapter Five presents an in depth discussion of these results against the backdrop of the current literature in an attempt to establish the place of spirometry in the PHE. The chapter explores the findings of the thesis and compares them to the available literature, identifying the questions that have been addressed and those that have been exposed. The chapter also presents the limitations of the study. In Chapter Six, conclusions are drawn and recommendations made. Topics which require further research are also suggested.

CHAPTER 2

LITERATURE STUDY

2.1 INTRODUCTION

Exercise-induced bronchospasm (EIB) poses a discrete yet silent danger to any athlete, regardless of the level of participation, age or gender of the athlete. Whether the athlete participates to improve general health or athletic performance the risk associated with EIB is real and could be life-threatening if not managed properly. However, it is counterproductive to limit any athlete's participation and will to excel in sports due to a fear of suffering an asthmatic attack. Previous studies have demonstrated a "substantial burden of undiagnosed EIB" and Dickinson *et al.* (2011) proposed that elite athletes should be screened routinely. Failure to diagnose or exclude EIB leads to decreased performance on a physical and emotional level as well as unnecessary exposure to drugs. EIB could decrease the athlete's ability to train and compete; furthermore it could increase hospital admissions in case of the undiagnosed and subsequently untreated athlete.

Symptoms could be mild to moderate in severity and have a negative impact on athletic performance. EIB is not an exclusion to participation on any level of sport as seen with the surprising amount of athletes winning medals in the Olympic Games. Sixty-seven of 597 (11%) American Olympic athletes in the Los Angeles summer Olympic Games in 1984 suffered from exercise-induced asthma (EIA) or asthma. Nevertheless 41 medals were taken home by the 67 athletes (Voy, 1986). On the contrary, in case of severe symptoms, respiratory failure as well as death could occur. In a population-based study in young adults it was found that 61 of 263 (23%) sports-related deaths were caused by asthma exacerbation (Becker *et al.*, 2004). In addition, it was stated that only one of the 61 athletes used inhaled corticosteroids. Rossini *et al.* (2000) reported that 32 of 108 (29.6%) children died suddenly during sports activities. The majority of them were not using any preventative therapy.

Due to improved diagnostic techniques the elite athlete could receive a higher level of care as the false positive athlete's medication could be stopped, and the poorly controlled or un-diagnosed EIB athlete's medication could be optimized.

2.2 DEFINITIONS

Exercise-induced bronchospasm is a transient narrowing of the airways in an athlete who is usually without any asthma symptoms, but show symptoms and signs during and/or after vigorous exercise (Storms, 2009). The bronchospasm is reversible with inhaled β_2-agonists (Dickinson *et al.*, 2006). The condition is divided into two sub-groups: the athlete with chronic asthma in which exercise is a trigger for bronchoconstriction (known as exercise-induced asthma; EIA); and the athlete without chronic asthma which only experiences bronchoconstriction associated with exercise (known as exercise-induced bronchospasm; EIB) (Weiler *et al.*, 2010).

2.3 PATHOLOGY

EIB starts with hyperventilation as experienced during exercise. This process increases water loss from the airway surface epithelial layer with dehydration of the cells and subsequent increased osmolarity. This causes mediator-release from the mast cells and eventually leads to damaged epithelium. This inflammatory reaction causes bronchospasm as seen in EIB. Cooling of the airways during exercise, subside when exercise has been stopped. As the trachea-bronchioli increase in temperature a reactive hyperemia leads to exudation of serum into the interstitial fluid - again with release of mediators and igniting bronchospasm (Storms, 2009). Subsequently EIB is a physiological response rather than a medical disease.

2.4 PREVALENCE

Many cases of EIB are undiagnosed. Exercise-induced bronchospasm occurs in about 10% of the general population who do not have a known history of asthma (Parsons *et al.*, 2012; Parsons and Mastronade, 2005) and EIB found by Gotshall (2002), in up to 10% of individuals who are not known to be asthmatic or atopic. EIB occurs in 5-10% of patients who have no respiratory or allergic disease (Hermansen and Kirchner, 2005). Eleven per cent of the 1984 US Summer Olympic Team athletes had either asthma or EIB (Voy *et al.*, 1984). In the 1996 US Summer Olympic Team Weiler *et al.* (1998) reported that 17% of the US athletes were identified as having asthma. Furthermore Helenius *et al.* (1997) found that 17% of Finnish distance runners and 8% of speed and power athletes had a confirmed

diagnosis of asthma. Weiler and Ryan (2000) did a study on athletes of the 1998 US Winter Olympic Games and found that 22.4% athletes were positive for EIB and the overall incidence of EIB was 23% across seven of the sports and genders evaluated by Wilber *et al.*, 2000.

The variability in prevalence of EIB depends on the season (summer or winter sports), the type of sports (cross-country skiers, endurance type of sports) as well as environmental factors (ice rink or on the grass fields). Noviski *et al.* (1987) indicated that the intensity of exercise as well as the specific temperature and humidity of the inhaled air are modifying factors in the severity of the EIB response. Previous studies have indicated that EIA in patients with seasonal asthma has a significant relation to humidity and temperature. The prevalence was 50% in summer, 86.4% in spring/fall and 84% in winter (Koh and Choi, 2002).

The maximum reduction in FEV_1 post-exercise increases significantly in a cold environment as compared with the same exercise under regular conditions. It was also found that the exercise capacity was decreased as measured by VO_2 peak and peak running speed. The participants reported that their breathing during exercise in such a cold environment was much more difficult and slower as well as that they experienced a shortened time to exhaustion (Stensrud *et al.*, 2007). On the contrary the exercise capacity (as measured by VO_2 peak and peak running speed) improves in humid conditions as indicated by Stensrud *et al.*, 2006. This difference in prevalence at high/low temperatures was demonstrated with a prevalence of 60% in cold (10°C) and 40% in hot (45°C) air in a study on trained adolescent males who did high intensity interval exercise tests with maximal heart rate of 95% under conditions with almost 50% relative humidity (Mohammadizadeh *et al.*, 2012). Another study found that EIB is more likely to occur in dry air (relative humidity of 25% at a temperature of 25-26°C) than humid air (relative humidity of 90% at a temperature of 25-26°C) possibly due to heat loss via evaporation at the airway mucosal layers (Bar-Or *et al*., 1977).

A variable response to pharmacotherapy in animal studies revealed heterogeneous inflammatory response which correlated with EIB, therefore a genetic component probably plays a role (Parsons and Mastronade, 2009).

Multiple studies found that about 35% of school children and 50% of cold weather athletes have EIB when specifically tested with an exercise challenge (Storms, 2009). Other studies found that 10% - 35% of athletes have EIB (Rundell *et al.*, 2001). The prevalence of EIB

was found to be almost 20% in the British Olympic athletes (Dickenson *et al.*, 2005). According to McFadden and Gilbert (1994), up to 90% of athletes with diagnosed asthma also suffer from EIB. Further, Gotshall (2002) found that 12% - 15% of non-asthmatic patients may develop EIB. Evidence provided by the Joint Task Force on Practice Parameters indicates that almost 90% of known asthmatics and 50% of competitive athletes may experience EIB (Weiler *et al.*, 2010). Another study in known asthmatics found 40-90% of them had EIB (McFadden, 2009). Athletes with poorly controlled or more severe asthma are more likely to present with EIB than the less severe or well-controlled asthmatic athlete. Furthermore it has been reported that the prevalence is up to 15% of high school and college athletes without any history of asthma (DiDario and Becker, 2005).

When interpreting the prevalence of EIB, it is important to take in account the environmental factors which could either aid in the development of the condition or in exacerbation thereof. In speed skaters, figure skaters and ice hockey players there are increased airway dysfunction due to the exposure to cold dry air and ice-resurfacing machine pollutants. In case of the elite swimmer chlorine exposure could be a trigger for EIB. Helenius and Haahtela (2000) found a prevalence of EIB in 29% of swimmers.

When looking at specific sports it is clear that the highest incidence of EIB is found in cross-country skiers with 50% in a study by Wilber *et al.* (2000); 78.6% in a study by Larsson *et al.* (1993); and Sue-Chu *et al.* (1996) found the prevalence of asthma in these athletes to be similar with 46% and 51% in Norway and Sweden athletes, respectively. In other cold weather sports an incidence of 35% in figure skaters and 35% in ice hockey players have been reported (Storms, 2003). In the 1996 Summer Olympic Games 50% cyclists, 30% swimmers, 25% rowers and 18% of track and field athletes reported that they had asthma (Weiler *et al.*, 1998).

Sport which require significant aerobic exercise such as endurance sports, basketball, soccer and ice hockey have been referred to as sport with a high asthmogenic potential. Soccer or lacrosse is a high ventilation type of sport, consuming up to more than 280 litres of inhaled air per minute (Anderson and Daviskas, 1992), and has sustained periods of high aerobic and ventilatory demands. Forty eight per cent of the athletes participating in high ventilation sports reported symptoms for EIB and 25% in the low ventilation sports group (Parsons *et al.*, 2007).

On the contrary golf, baseball, bowling, volleyball, weight lifting and martial arts have a low asthmogenic potential. Water sports in a humid environment but high chlorine content of the water have been referred to as intermediate asthmogenic (Hermansen and Kirchner, 2005).

The large variability in the prevalence of EIB is due to a lack of standardized methodology for the diagnosis thereof, the type of exercise, environmental factors and possible underlying respiratory related illnesses such as atopy or allergic conditions and previous history of asthma as well as the diagnostic criteria (Aissa, *et al.*, 2009).

Bronchial provocation tests (BPT's) are indicated if a bronchodilator test is inconclusive and EIB is still expected. These tests are either direct or indirect tests aimed at provoking bronchospasm by inhalation of cold dry air, certain aerosols or by doing an exercise challenge to provoke the symptoms (Constantinou, 2010).

Peak expiratory flow rate (PEFR) is measured during a maximally rapid exhalation with immediate maximal inhalation. PEFR is not particularly sensitive in detecting the presence of limitation of the airflow, therefore the variability among athletes is very large (more than 30%) as it is effort dependant (Enright *et al.*, 1994; Crapo, 1994).

Spirometry is indicated to evaluate and monitor asthma in athletes. The test allows measurement of lung volumes according to forced vital capacity (FVC), the volume exhaled in the first second of expiration (FEV_1) and the ratio of FEV_1/FVC. These measurements are reproducible and much less variability is seen (equal to or less than 5%) (NAEPP 2007).

2.5 RISK FACTORS FOR EIB

Self-reported allergy or atopy is found to be an independent risk factor for EIB (Koh *et al.*, 2002; Helenius *et al.*, 1998). The prevalence of rhinitis is more than 30% (Katelaris *et al.*, 2000), and especially high in the swimming population with a prevalence of almost 74% (Bougault, *et al.*, 2010).

Gender is not necessarily a risk factor but 35.4% of female athletes and 13.2% of male athletes were positive for EIB based on questionnaires (Weiler and Ryan, 2000). When these athletes of the 1998 US Winter Olympic Games were formally tested with a pulmonary function test the prevalence was 26% and 18% for the female and male competitors respectively (Wilber *et al.*, 2000). The trend continues for the 1996 US Summer Olympic

Games' responses on questionnaires with 20% female and 14% male athletes identified as asthmatic (Weiler *et al.*, 1998). Some evidence is suggesting that the role of airway size post-exercise, smooth muscle responsiveness during exercise as well as inflammatory mechanisms associated with hormonal fluctuation could lead to the increased prevalence of EIB in the female population (Iñigo, 2012).

It is clear from the literature that type of sport and certain environmental factors do play an important role as possible risk factors for EIB. High ventilation sport (endurance type) has higher risk than low ventilation sports such as strength-type of sport. It is said that EIB could develop over many years of participating in endurance types of sport due to the long-term chronic airway irritation because of exposure to high volumes of airflow. Furthermore some environmental substances are associated with airway irritation: chlorine for swimmers, certain ice-rink treating chemicals for figure skaters, speed skaters and ice hockey athletes and pollen in athletes with allergies. The risk is also higher in athletes participating in cold/hot dry conditions than their fellow participants in moderate and humid conditions (Schumacher *et al.*, 2011). Seasonal changes could be a reason for the variations in patterns of response in the same athlete with the same sport during the year (Addo-Yobo, *et al.*, 2002).

Environmental factors are being researched more intensively as exposure can trigger EIB or exacerbate the condition in known asthmatic athletes. The focus is on allergens (pollen, mold, animal dander and insect parts) and irritants (smoke, chlorine, dust and gas fumes). High levels of outdoor air pollution in the last several decades have been associated with an increase in asthma morbidity and mortality (Ostro *et al.*, 2001; Tolbert *et al.*, 2000). It has been described that direct contact or by inhalation of latex particles from various types of sporting equipment may cause an allergic response such as bronchospasm (Landwehr and Boguniewicz, 1996). The importance of allergen and irritant exposure as aggravating factors in asthma has been strongly argumented. The findings in certain studies emphasize the importance of identification and proper management of these factors (Nelson, 2000; Simpson and Custovic, 2004).

Exposure to environmental tobacco smoke is a risk factor for exacerbation of airway hyperresponsiveness. Children with asthma whose parents smoke have more frequent asthma attacks (Weitzman *et al.*, 1990; Murray and Morrison, 1993). However, some research have shown there is no significant effect of tobacco smoking exposure on the prevalence of EIB but it certainly can induce EIB-symptoms in susceptible athletes (Lee and Forey, 2007).

Some data confirms that sports-related deaths associated with asthma generally occurred during late summer seasons and fall. It is postulated that this might be due to increased mold and pollen in the air (Becker *et al.*, 2004).

2.6 CLINICAL PRESENTATION OF EIB

The cardinal EIB-related symptoms and signs include a dry cough, wheezing of the chest, chest pain (especially in the younger athlete), shortness of breath or tightness of the chest or excess mucus production (Rundell *et al.*, 2001; Parsons *et al.*, 2007). It has been found that 50% of elite athletes who present with breathlessness and chest tightness during exercise do not have EIB (Rundell *et al.*, 2001). Cough is an extremely common symptom in patients who exercise strenuously. Especially in cross-country skiers with a respiratory symptom prevalence of 86% with cough as the most commonly reported symptom (Heir, 1994). While cough is often associated with EIB more than half of athletes reported this symptom without any evidence of EIB (Rundell *et al.*, 2001).

Clinical entities have been described which could mimic EIB. These include physiological limitation and deconditioned status, obesity, vocal cord abnormalities such as vocal cord dysfunction, gastro-oesophageal reflux disorder, type A personalities and larynchomalacia. Furthermore, anxiety, hyperventilation syndromes, pulmonary hypertension, arrhythmias and hypertrophic cardiomyopathy could also be the underlying cause for the clinical picture associated with EIB. Respiratory illnesses include pulmonary arteriovenous malformations, chest wall or musculoskeletal abnormalities, chronic obstructive pulmonary disease and interstitial lung disease (Weiss and Rundell, 2009). Respiratory tract infections, gastro-esophageal reflux and hyperventilation syndromes should also be considered in the differential diagnosis of EIB and EIA (Schumacher *et al.*, 2011).

2.7 DIAGNOSIS

In case of suspected EIB it is necessary to obtain a history, a physical examination and formal lung function testing. History alone should not be the main indicator for further EIB-testing such as spirometries. Parsons *et al.* (2007) found a prevalence of 36% in athletes *without* symptoms suggestive of EIB and prevalence of 35% in athletes *with* symptoms.

Furthermore, in the group with positive EIB testing there were 25% without any self-reported symptoms.

It seems that elite athletes are poor perceivers of their symptoms and are prone to interpret EIB symptoms as exertional fatigue, poor conditioning or a lack of motivation. It was found by Rundell *et al.* (2001) that 39% of athletes who tested positive to an exercise challenge reported two or more symptoms, while 41% of those who tested negative also reported two or more symptoms. Hallstrand *et al.* (2002) demonstrated that of 39.5% of athletes with either symptoms or history suggestive of EIB only 12.9% were positive on formal testing. As some of the signs are subtle the athletes choose not to report them as it may affect their ability to participate in sport. They regard these vague symptoms as an indication of being out of shape (Parsons and Mastronade, 2005). The diagnosis of EIB based on clinical picture alone is relatively inaccurate

The formal diagnosis of EIB is based on the measured lung function changes due to exercise as a trigger, and not on the presence or absence of clinical symptoms (Parsons *et al.*, 2013). A significant drop in FEV_1 post-exercise is a logical criterion for further evaluation in the symptomatic athlete, but in asymptomatic athletes stronger criteria for the diagnosis of EIB are required. A study done on young soccer players found that 2.1% of them without a history or previous diagnosis of asthma and/or allergic conditions are at risk for developing EIB. This means that a significant percentage of soccer players will develop bronchospasm in the absence of any EIB-related symptoms (Ziaee, *et al.*, 2007).

No EIB-related symptoms were reported in a group of Australian summer sport athletes with 27% of them having a positive challenge test. This implies that the athlete with EIB symptoms could have a normal spirometry. In the same group 71% of participants reported symptoms and had a positive bronchial provocation test (Holzer *et al*., 2002).

Dickinson *et al.* (2006) states that there currently is no gold standard test for EIB, however, the International Olympic Committee-Medical Commission (IOC-MC) is accepting the results of airway challenges including exercise, eucapnic voluntary hyperventilation (EVH), metacholine as well as saline challenges. The IOC-MC regards the exercise or EVH challenge as positive for the diagnosis of EIB when the FEV_1 fall $\geq$ 10% from the baseline value. The direct BPT's such as the saline and metacholine challenges have lower sensitivity and specificity for EIB than indirect challenges such as EVH and exercise challenge tests, therefore an indirect challenge test is preferred (Holzer *et al.*, 2002). EVH is reported to have a high specificity (90% and 100%) for the diagnosis of active asthma when

the FEV_1 fall is measured as ≥ 10%, and ≥ 15% respectively (Hurwitz *et al*., 2005). The major advantage of EVH is that this test can reliably achieve and sustain the minute ventilation that is higher than the minute ventilation which can be elicited by doing an exercise challenge.

On the contrary lung challenge testing such as the exercise test (a physiologic test) is the most commonly available test. EVH is also available but limited to a small number of laboratories and therefore access is generally poor in the primary care settings (Hull *et al.*, 2009).

Pharmacological challenge tests such as the metacholine challenge have low sensitivity for the diagnosis of EIB (Aissa *et al.*, 2009; Holzer & Brukner, 2004; Rundell *et al.*, 2000).

An alternative to EVH is the hyperosmotic challenge test with either hypertonic saline or dry inhaled mannitol powder which both have high sensitivity (96%) and specificity (92%) for EIB (Holzer & Brukner, 2004; Holzer *et al.*, 2003).

2.8 PERIODIC HEALTH EVALUATION (PHE)

The primary goals of the PHE are to detect any factors predisposing injury, disability or even death as well as to meet certain medico-legal requirements. Secondary goals include addressing general health issues, providing patient-specific counselling on certain health-related issues as well as assessment of the level of fitness of the athlete. Again there is no gold standard available for performance of PHE's, but the most important philosophy should be to assist the patient to participate safely in his or her sport, rather than to exclude him or her from the sport (Mick and Dimeff, 2004). It should be clear whether one wants to confirm the prevalence or the diagnosis of a condition with a questionnaire (in this case EIB).

History and baseline physical examination will most often fail to identify the athlete with EIB (Miller *et al.*, 2005). Many athletes subsequently fail to report or even recognize symptoms of EIB themselves (Rundell *et al.*, 2001; Parsons *et al.*, 2012). According to research done by McKenzie *et al.* (2002) and Tan & Spector (2002), the participant's medical history alone can both underdiagnose and overdiagnose the problem. Furthermore Parsons *et al.*, (2007) found that symptoms were not predictors of EIB in their study of college students. It has been found that the reporting of symptoms alone has a very low positive predictive value for EIB as confirmed by a study done by Dickenson *et al.* (2011). In their group of athletes 34%

were positive for EIB with eucapnic voluntary hyperpnoea challenge testing and 73% of these positive challenges did not have a previous diagnosis of EIB.

Self-reported symptoms lack sensitivity and specificity in regards with EIB. Objective measures and standardized tests should be used to confirm EIB (Rundell and Slee, 2008). Rundell *et al.* (2001) found that half of the athletes with EIB-symptoms had a negative formal lung function test and that the other half of the athletes without EIB-symptoms had a positive formal lung function test. Thus self-reported symptoms are not useful in making the correct diagnosis, but it certainly estimates the prevalence similar to the results obtained from formal lung function testing.

2.9 SPIROMETRY

As the history and clinical examination on symptoms of EIB is variable, non-specific and has poor predictive value for EIB, a special tool is necessary to aid in diagnoses and/or excluding of EIB. Spirometry includes measurement of forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC). Baseline spirometry and serial spirometries post-exercise could be of much more value as EIB symptoms are not clear without a specific broncho-provocation test.

Studies using PEFR measurements post-exercise proposed that EIB may be more common than recognized with the medical history and physical examination alone (Johansson *et al.*, 1997). It was also found that PEFR may lead to noteworthy misclassification when compared with serial spirometry post-exercise (Johansson *et al.*, 1997; Randolph *et al.*, 1997), therefore PEFR is an unacceptable method for the diagnosis of EIB.

Eucapnic voluntary hyperventilation (EVH) testing, an indirect challenge test, can be regarded as a substitute for the exercise challenge test. EVH is mainly conducted by academic lung function laboratories (Constantinou, 2010). Furthermore EVH with dry air is the gold standard as recommended by the IOC-MC, to assess EIB in the elite athlete (Holzer *et al.*, 2003). Contrary to the recommendation of EVH testing for EIB, exercise challenge testing has been widely advocated as the most appropriate and accessible provocation test for EIB. This test requires a specific exercise intensity, duration, mode and environment conditions (Rundell and Jenkinson, 2010).

Regarding sensitivity and specificity of spirometry (resting and exercise testing) in detection of EIB, sensitivity is an indication of the percentage of patients recognized by the test and specificity is an indication of the percentage of healthy athletes recognized by the test. Single screening or "once-off" BPT's could easily miss EIB and is therefore inaccurate and inadequeate (Knöpfli *et al.*, 2007). Continuous screening is therefore more appropriate.

The exercise challenge test is clinically useful because the symptoms due to vigorous exercise are similar to the symptoms reported by athletes with EIB. Availability is easy (especially the field test) as it reproduces the athlete's symptoms during his usual field routines. PEFR was commonly used in the past, but it is no longer utilized for EIB-identification as it does not provide repeatable FEV_1 measurements. The ability to perform as vigorously in the laboratory as on the field is dependent on the availability of the equipment needed to do the evaluation. In the laboratory ergometers such as a treadmill and bicycle are used. The limitation of a laboratory exercise challenge is that the exercise protocol sometimes is inadequate to reach the maximum work load, intensity or ventilation rate to provoke EIB symptoms. Other factors affecting the athlete's response to exercise include the temperature and humidity of the inspired air (Anderson, 2011) which is difficult to be controlled in case of a field exercise challenge test.

Eucapnic voluntary hypernoea (EVH) is useful as it requires less equipment and fewer personnel as well as being less stressful for the athlete to perform. It is regarded as the most useful test in identifying EIB and has a low frequency for false negative tests (Mannix *et al*., 1999). A major limitation described by Anderson (2011) is the need to maintain the eucapnia over a fairly wide range of ventilation. Some athletes report this test to be uncomfortable to perform (Stadelman et al., 2011) due to the very dry air and the high ventilation rate.

2.10 EXERCISE CHALLENGE TEST

Challenge tests consist of mainly two groups: direct and indirect challenge testing. During the direct challenge a pharmacological agent is used to induce muscle contraction of the smooth muscle of the airways. Unfortunately it has a low sensitivity for detecting EIB, is laboratory dependant and doesn't measure the outdoor environmental factors to which the athlete is being exposed to. On the positive side this type of bronchoprovocation tests are easily accessible, reproducible, not time consuming, relatively inexpensive and could be used without special equipment such as a treadmill.

Sport specific exercise challenges mimicking the athlete's sport are recorded in athletes taking in account the standardization of both the workload and environmental conditions such as temperature and humidity (Rundell *et al.*, 2000).

The IOC-MC requirements for diagnosis of asthma in 2004 include a positive bronchodilator or bronchoprovocation test. The bronchoprovocation challenge test could consist of either an exercise challenge test or EVH challenge (Dickenson *et al.*, 2005).

The protocol should result in a test duration of 8 minutes in total with an intensity equal to 80% to 90% of the athlete's estimated maximum heart rate. The speed and incline of the treadmill, or resistance of a cycle ergometer should be adjusted to elicit the mentioned heart rate. This should be reached within two minutes and must be maintained for the remaining duration of the challenge. The intensity of the ventilation should be equal to 40% to 60% of the maximum voluntary ventilation (MVV). Because a rapid increase in MVV is required and obtained with this specific exercise protocol, the Bruce Protocol and Jones Progressive Exercise Protocols are inadequate in diagnosing or excluding of EIB (Jones, 1997). The athlete can terminate the exercise at any time during exercise challenge test.

2.11 CONCLUSION

Exercise-induced bronchoconstriction is real and have a negative effect on the athlete. With the alarming amount of deaths related to EIB, it is clear that some precautions need to be set in place. Proper management of EIB include early accurate diagnosis with objective testing, knowledge of possible triggers, sensitivity to warning signs signalling the onset of EIB and the proper use of prescribed medication. Screening for EIB and follow-up are rational considerations for athletes to train at the required intensity and to be able to reach their peak levels of performance. Regular post-exercise screening also decreases the significant morbidity and mortality associated with EIB and optimizes the medical management thereof.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

It is uncertain whether the current periodic health examination (PHE) guidelines as suggested by the International Olympic Committee (IOC), are sensitive enough to detect exercise-induced asthma (EIA) and bronchospasm (EIB) without including a routine lung function test. The aim of the study is to determine whether spirometry increases the sensitivity of the PHE to identify respiratory illnesses such as EIA and EIB, or not.

3.2 STUDY DESIGN

This study is a prospective descriptive study to determine the prevalence of respiratory illnesses in a specific athletic population. Furthermore the study has an analytical cross-sectional part to determine the sensitivity of clinical history, examination and the value of spirometry, as a possible additional screening tool to the current standard PHE.

3.3 STUDY PARTICIPANTS

The participants in this research project were athletes of the University of the Free State (UFS) in Bloemfontein, South Africa. The sample size was determined by the number of athletes who required PHE's at the UFS Sport and Exercise Medicine Clinic for 2012. Thirty-seven athletes were selected by non-randomized, sequential sampling. The inclusion criteria were any male or female athlete, participating competitively in a recognized sport at the University, at the age of 19 to 25 years during the year 2012. Any athlete older than 25 or younger than 19 years of age was excluded.

3.4 MEASUREMENT

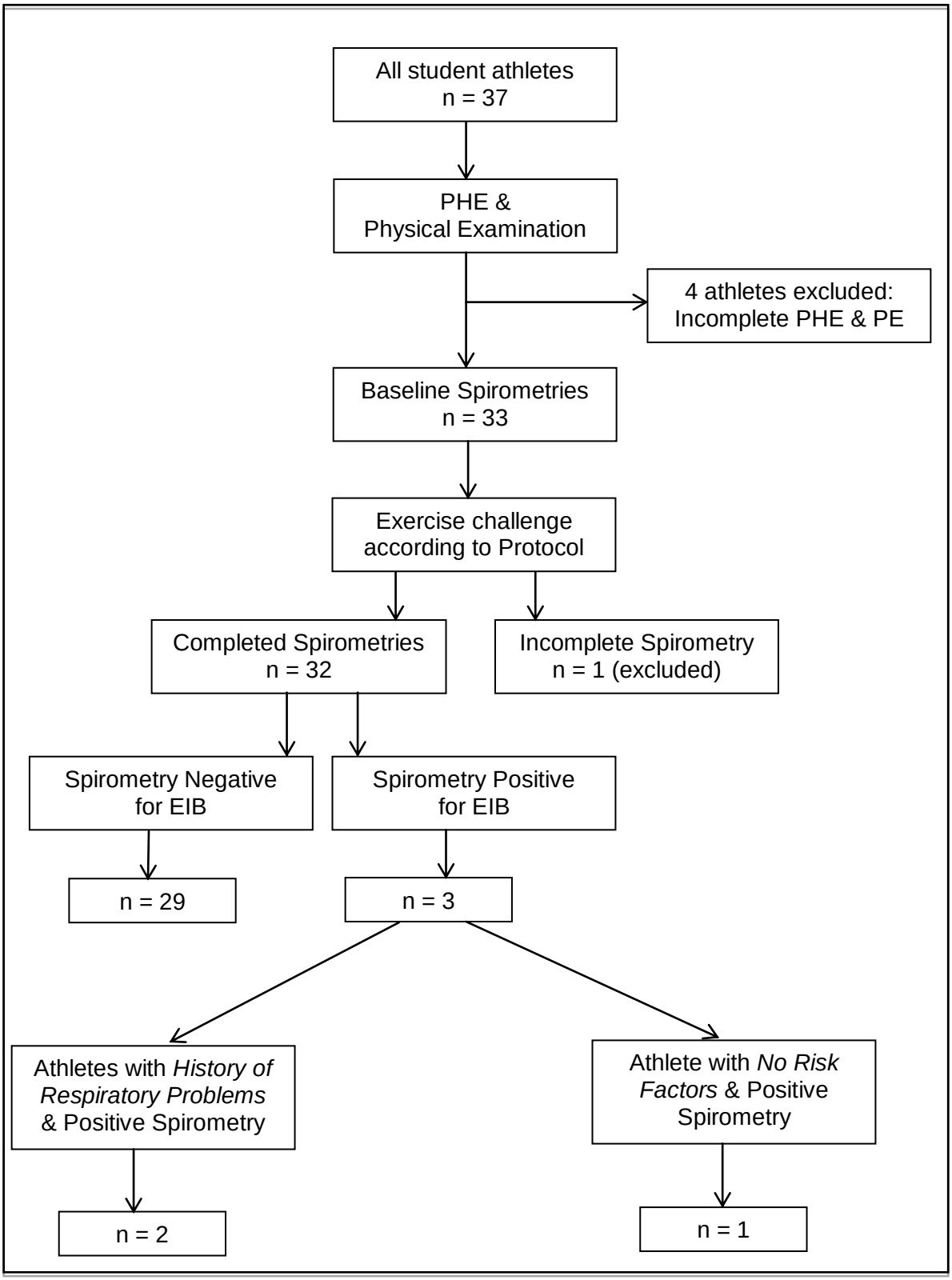

Fig. 3.4.1: Flow diagram of data collection. (PHE = pre-participation health examination; PE = physical examination; EIB = exercise-induced bronchospasm)

3.4.1 *Consent*

Data collection entailed obtaining informed consent from every participant. Each athlete received an information document (Appendix A) explaining the aim and procedures of the research project, as well as a consent form (Appendix B) which was signed before the process of data collection commenced.

3.4.2 *History*

The data collection started with the completion of a standard International Olympic Committee PHE questionnaire (Ljungvist *et al*., 2009) by the athlete. The researcher added some specific respiratory system related questions to the standard paper as well as three spirometry tests after an exercise challenge and bronchodilator, for all participating athletes. The IOC PHE questionnaire is shown in Appendix C. The examiner went through the questionnaire with the participant to fill gaps or to explain some questions that were not understood by the participant.

3.4.3 *Physical examination*

The physical examination, also according to the IOC PHE, included weight, height, body mass index, vital signs and a thorough systemic examination (Appendix D).

3.4.4 *Spirometry*

The spirometry was done on all participants, irrespective of the presence or absence of any risk factors associated with EIB. Baseline spirometry was done with an nSpire KoKo® PFT spirometer (SSEM Mthembu Medical) followed by an exercise challenge. The exercise challenge test was followed by another two spirometries done at three and six minutes after completion of the exercise. Two puffs of a bronchodilator (salbutamol 100µg) were administered after the six minutes spirometry. This was followed by one final spirometry 15 minutes post-bronchodilator.

The technique of performing spirometry was standardised according to the American Thoracic Society (ATS) guidelines (Miller *et al.*, 2005). Every athlete was asked to avoid the following activities prior to testing: no smoking within one hour of testing, no consumption of alcohol for four hours before testing, no vigorous exercise within 30 minutes of the spirometry, wearing clothing that is suitable for exercise on the treadmill and should be non-

constrictive of the chest and abdominal wall, as well as avoidance of large meals within two hours of testing (Miller *et al*., 2005). In addition, athletes taking respiratory tract medicine were asked to stop taking the medication according to the guiedlines in Table 3.1. Such athletes were advised to use medication in the event of exacerbation of symptoms or in an emergency.

Table 3.1: Medications and factors that may decrease bronchial hyperresponsiveness and their required withholding periods (ATS Guidelines, Am J Respir Crit Care Med. 2000. 161 p. 309-329).

Medication	Minimum time interval from last dose to spirometry
INHALED BRONCHODILATORS:	
Short-acting: salbutamol (Ventolin®), terbutalin (Bricanyl®), fenoterol (Berotec®)	8 h
Medium-acting: ipratropium (Atrovent®)	24 h
Long-acting: salmeterol (Serevent®), formoterol (Foradil®), tiotropium bromide (Spiriva®)	48 h 7 days for tiotropium bromide
ORAL BRONCHODILATORS:	
Liquid theophylline	12 h
Intermediate-acting theophylline	24 h
Long-acting theophylline	48 h
Standard $ß_2$-agonist tablets	12 h
Long-acting $ß_2$-agonist tablets	24 h
OTHER:	
Leukotriene modifiers: montelukast (Singulair®), zafirlukast (Accolate®)	24 h
Hydroxyzine (Aterax®), cetirizine (Texa®, Zyrtec®)	72 h
Cromolyn sodium (not in South Africa)	8 h
Nedocromil (not in South Africa)	48 h
Caffeinated foods and drugs	12 h

For optimal lung function results, the method of spirometry should be accurate, repeatable and reproducible (Miller *et al*., 2005). Each athlete performed a baseline test three times and the best result was recorded.

For each test, the athlete was instructed to stand with his or her feet comfortably placed, with a chair available behind the athlete to be able to sit down in case of light headedness. The athlete was told to inhale rapidly and completely, to close the lips around the mouth piece and exhale as hard and rapidly as possible while the nose is pinched to prevent air escaping via the nasal passages. Inspiration had to be full and without hesitation, and expiration had to be continuous, with force and without pause (Sallaoui *et al.*, 2009). During the manoeuvre the technician coached the athlete with enthusiastic encouraging to inhale and exhale with maximal efforts.

The end of test criteria included inability of the athlete to continue further exhalation, no change in the volume for more than one second on the volume-time curve, exhalation for longer than 6 seconds and three acceptable spirograms. To ensure acceptability and a satisfactory result, the following conditions are important: no artefacts should be noticed such as coughing during first second of exhalation, evidence of an additional breath during the manoeuvre, breathing against a closed glottis, too early cut-off of manoeuvre, poor effort, leakage of air and an obstructed mouth piece (Miller *et al*., 2005).

The airflow measured with spirometry is expressed in litre per second (L/sec). The forced expiratory volume in one second (FEV_1) is a measurement of the volume of air the athlete can exhale as quickly as possible during the first second. The diagnosis of EIB should be considered if the FEV_1 is decreased by ≥ 10% from the baseline test, or increased by ≥ 12% after the use of a bronchodilator (ATS Guidelines, Am J Respir Crit Care Med. 2013).

3.4.5 *Exercise Challenge Test*

The exercise challenge involved the athlete to exercise (walking or jogging) for two minutes on a treadmill for warm-up to raise ventilation and heart rate. The desired heart rate (HR) or Target heart rate (THR) was determined to be 80% or higher of the HR reserve method - known as Karvonen's method (ACSM 2014).

Box 3.1: Karvonen's method of determining target heart rate (ACSM 2014).

Karvonen's method
Target HR = [(Max HR - Resting HR) x 80% intensity] + Resting HR

HR = heart rate

The athlete continued running for 6 - 8 minutes at THR and spirometry was done as described in Appendix E. The THR was reached by increasing the incline and/or speed of the motorized treadmill. The exercise was terminated when the THR was reached and maintained for at least 6 - 8 minutes; in case of symptoms of EIB, or when any other adverse events occurred such as dizziness, coughing, nausea, vomiting, vertigo, headache, chest discomfort, pharyngeal of laryngeal pain (Anderson *et al*., 2005).

The spirometry for one participant consisted of a baseline test (before exercise), one test at 3 minutes post-exercise, one test at 6 minutes post-exercise, inhaling two puffs of salbutamol after the 6 minutes lung function test, and the final spirometry done at 15 minutes after inhalation of the bronchodilator. The best of three efforts was recorded for each test.

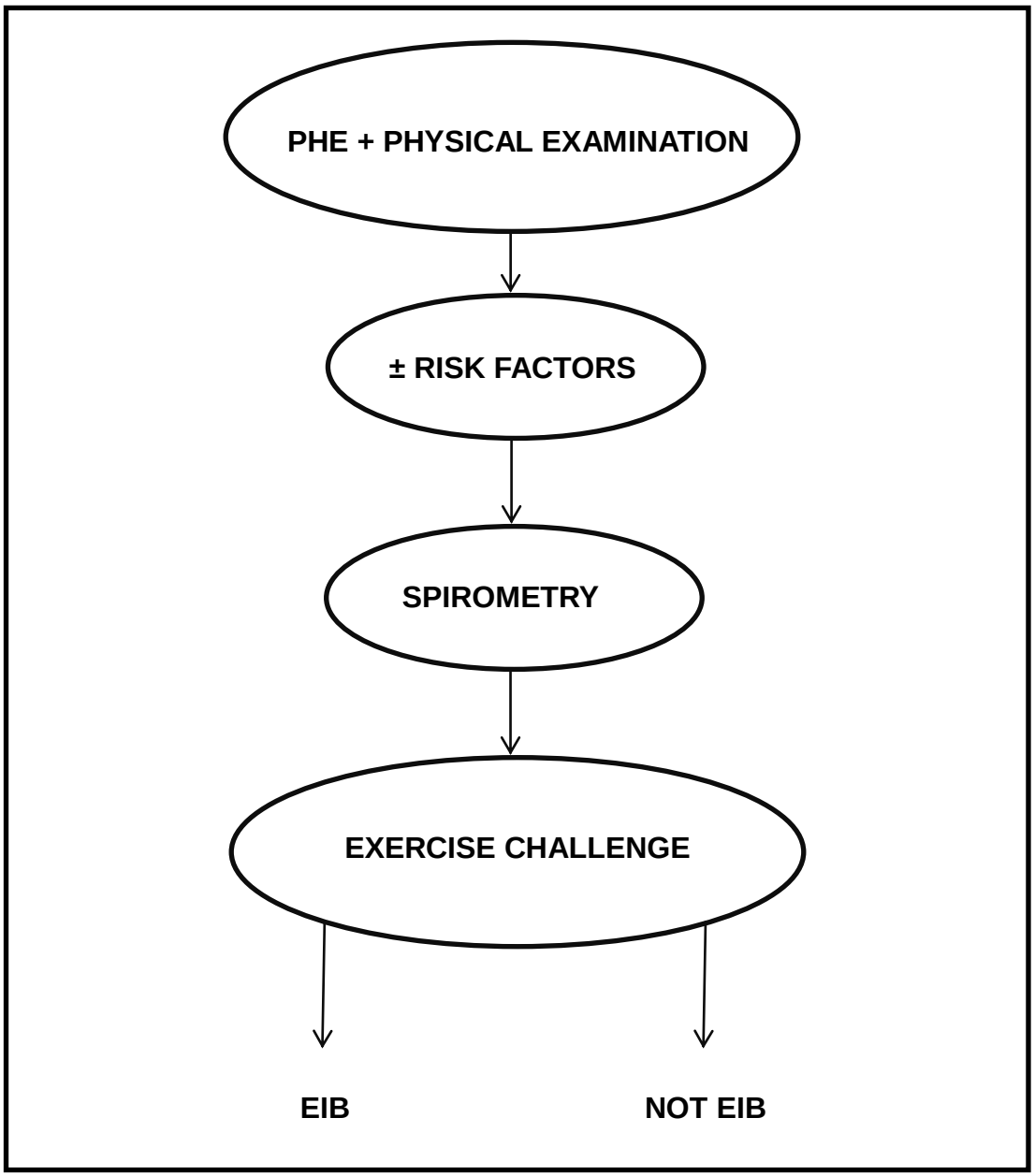

Figure 3.4.2: Approach to data collection - history, physical examination, baseline spirometry as well as exercise challenge followed by spirometry.

3.5 METHODOLOGICAL AND MEASUREMENT ERRORS

Possible errors that could have been included in this study were:

3.5.1 Inter-observer variation

This was minimized by using only two medical doctors to complete the PHE and do the physical examination. All spirometry was done by the same biokineticist, which is experienced in the technique of spirometry testing.

3.5.2 Participant Dropout

Athletes' participation was voluntary. They were informed that they could refuse or terminate participation at any stage. Two athletes did not have the physical examination but did complete the questionnaire as well as the spirometry. Two other athletes did not do the spirometry, but did complete the questionnaire and had the physical examination. One athlete completed the questionnaire, the physical examination but could not complete the spirometry successfully. These five athletes were excluded from the study.

3.5.3 Accurate collection of data

The athletes completed the questionnaire on their own and the examiner went through the answers before the physical examination. This minimized the possibility of questions being misunderstood, or not giving accurate information regarding the use of supplements, medication or smoking habits. During this discussion prior to the physical examination the athlete was reminded not to do any form of exercise on the day before the spirometry and also to withhold his or her usual asthmatic medication (as instructed depending on the type of current medication). In case of an acute exacerbation of asthmatic attack, medical assistance with emergency treatment was available.

3.5.4 Spirometry and Exercise challenge

These components of the data collection were done by a biokineticist at the UFS Sport and Exercise Medicine Clinic. The spirometry technique was explained to each participant, to ensure maximal effort during the tests, with verbal motivation added during the inspiration

and expiration efforts. Spirometry equipment was calibrated prior to commencement of the study to ensure accuracy.

3.6 PILOT STUDY

A pilot study was done on two athletes to evaluate efficacy of the questionnaire, to ensure a proper physical examination, to confirm the correct method in obtaining an accurate, repeatable and reproducible spirometry result as well as deciding on which apparatus to use for the data collection. During the pilot test, the nSpire KoKo® PFT spirometer (SSEM Mthembu Medical) was selected for use in the study, because of its superior repeatability of spirometry results, easier breathing technique and printability of results compared to other available spirometers.

3.7 ANALYSIS OF THE DATA

The information on the questionnaire, the physical examination and the spirometries were transferred to the data collection sheet for each athlete (Appendix F).

Statistical analysis was done by the Department of Biostatistics, University of the Free State, South Africa. The collected data (as completed on the data collection sheet) was forwarded to the Department of Biostatistics for further statistical analyses.

3.8 IMPLEMENTATION OF FINDINGS

The results from the study as well as the prevalence of respiratory illness in athletes at the UFS, will be used to contribute to the current body of knowledge that forms the foundation for the recommendations and guidelines on the PHE as currently implemented by the IOC. Insight into the efficacy and value of adding spirometry as specific tool to the PHE guidelines to increase the sensitivity for detecting respiratory illness, specifically EIB, will be gained. The findings will be put forward for peer review and publication in international and/or national scientific journals and presented at medical conferences such as the Biennial South African Sports Medicine Association Congress.

3.9 ETHICS

Permission to do the study was obtained from Dr. L. Holtzhausen, Head of the Division of Sports Medicine at UFS; the Manager of UFS Sport Performance Unit at UFS as well as Prof. D. Hay, Vice Rector: Academic of the UFS. In addition, the study protocol was submitted for approval to the Ethics Committee of the Faculty of Health Sciences, University of the Free State, South Africa (Ethics approval number ECUFS 197/2011).

Informed consent to participate in the study was obtained voluntarily from all participants. An information document containing all relevant information concerning the study was provided to each participant.

Emergency treatment was available in case of exercise-induced bronchospasm. If any problem was to arise during the examinations, the athlete could have been immediately referred to his own General Practitioner with an information letter discussing his condition/problem.

3.10 CONCLUSION

This chapter presented the study population, methodology of conducting PHE's, and spirometry. Statistical analysis and ethical issues related to the study were explained. The results of the study are discussed in Chapter 4.

CHAPTER 4

RESULTS

4.1 INTRODUCTION

In this chapter, the results of the questionnaire, clinical history, physical examination and the spirometries are presented. Data was captured according to the protocols described in Chapter 3. The collected data was subsequently processed and presented as means and percentages with significance set at 95% confidence intervals where appropriate.

4.2 DEMOGRAPHICS

The participants were sequentially selected from athletes who had to complete PHE's as part of their sport performance programmes at the University of the Free State. Thirty-seven athletes gave consent to participate, but five athletes were excluded. Four athletes were excluded for non-compliance and one athlete for failure to complete the spirometry successfully. Thirty-two participants completed the study, for a response rate of 86.5%. The final thirty-two participants included nineteen male and thirteen female athletes. Demographic characteristics of the study participants are presented in Table 4.1. The median age of the athletes was 21.0 years (range 19 - 25 years). The main types of sport were athletics (n = 10), tennis (n = 7), rugby (n = 5), cricket (n = 5), squash (n = 3), badminton (n = 1) and netball (n = 1).

Table 4.1 Demographic characteristics of the study participants (n = 32)

	n	%
Gender		
Female	13	40.6
Male	19	59.4
Age (years)		
19	4	12.5
20	11	34.4
21	3	9.4
22	6	18.8

23	4	12.5
24	2	6.2
25	2	6.2

4.3 MEDICAL HISTORY

4.3.1 History of past or present asthma

A total of three athletes gave a history of past and/or present asthma (9.4%). One athlete was currently using an inhaler on a daily basis and two other athletes admitted to have been diagnosed with asthma in the past but not using an inhaler at the time of the data collection.

4.3.2 Smoking

Six athletes admitted to smoking of either cigarettes and/or hubbly bubbly (15.6%).

Table 4.2 Prevalence of smoking in the study participants (n = 32)

	n	**%**
Cigarettes 1-10/day	3	9.4
Hubby Bubbly	1	3.1
Both	2	6.2
No smoking	26	81.3
Total	32	100

4.3.3 Respiratory Medication

The use of medication indicated in respiratory illness, specifically for allergic rhinitis and asthmatic conditions, was reported in five athletes (15.6%). They either used it during the preceding six months or at the time of data collection. The different types of medication are presented in Table 4.3. Four athletes used antihistamine tablets; one athlete used a corticosteroid inhaler on a daily basis and one athlete used a saline nasal spray. One athlete used more than one type of medication for respiratory illness. A total of 27 athletes denied using medication for any respiratory conditions (84.4%).

Table 4.3 Prevalence of medicine used for respiratory related illness in study participants (n = 34)

	n	%
Antihistamine tablets	4	11.9
Inhaler	1	2.9
Saline nasal spray	1	2.9
Combination therapy	1	2.9
No medication	27	79.4
Total	34	100

4.3.4 History of Respiratory Illness other than Asthma

Eight athletes had a history of hay fever and/or allergic rhinitis (25%). Only three of these athletes declared the use of antihistamines on a regular basis (38%).

4.3.5 Summary of Risk factors identified from the History

The risk factors for EIB as from the history include *present or past history of asthma*, *symptoms and signs indicative of respiratory illness* (for example hay fever, post nasal drip, coughing or wheezing or difficulty in breathing after exercise); the *use of respiratory medication* and *smoking habits* as presented in Table 4.4. One athlete was diagnosed with current asthma and two athletes gave a history of asthma in the past. Therefore three athletes have either past or current asthma. Six athletes admitted to smoking and five athletes used medication for respiratory illness. Eight athletes admitted having symptoms and signs of respiratory illness such as hay fever and allergic rhinitis. Eighteen of the 32 athletes denied any of the mentioned risk factors in the history (56%).

Table 4.4 Summary of risk factors identified in the history

Risk Factor	Number of athletes	Percentage of Athletes
Current or past asthma	3	7.5
Smoking	6	15
Medication for respiratory illness	5	12.5
Respiratory symptoms	8	20
None	18	45
Total	40	100

The total number of risk factors per athlete as identified during the history is summarized in table 4.5. Eighteen of the athletes had no risk factors. One risk factor is found in eight athletes, two risk factors are identified in four athletes and three risk factors in two other participants.

Table 4.5 Number of risk factors per athlete according to history

Number of Risk Factor	Number of athletes	Percentage of Athletes
No risk factors	18	56
One risk factor	8	25
Two risk factors	4	13
Three risk factors	2	6
Total	32	100

4.4 PHYSICAL EXAMINATION

The pre-exercise physical examination of all 32 participants did not detect any symptoms and signs of bronchospasm, which include abnormal chest wall movement, wheezes and decreased breathing sounds on auscultation.

4.5 SPIROMETRY

The baseline spirometry, exercise challenge and subsequent spirometries were done in each athlete, irrespective of the presence or absence of risk factors associated with EIB.

Table 4.6: Spirometry measurements of FEV_1 at baseline, 3 and 6 minutes after exercise, at 15 minutes post-bronchodilator and the change in FEV_1 from baseline expressed in percentage.

Athlete Number	Baseline FEV_1	FEV_1 at 3 min after exercise	FEV_1% diff at 3 min, from Baseline	FEV_1 at 6 min after exercise	FEV_1% diff at 6 min, from Baseline	FEV_1 at 15 min post BD	FEV_1% diff at 15 min, from Baseline
1	4.32	4.43	2.55	4.59	6.25	4.52	4.63
2	4.98	4.68	-6.02	4.53	-9.04	4.92	-1.2
3	4.64	4.57	-1.51	4.46	-3.88	4.77	2.8
4	5.05	5.12	1.39	5.22	3.37	5.12	1.39
5	4.77	4.52	-5.24	4.7	-1.47	4.83	1.26
6	3.77	3.76	-0.27	3.65	-3.18	3.59	-4.77
7	3.05	2.61	-14.43	2.54	-16.72	2.3	-24.59
8	4.65	4.78	2.8	4.64	-0.22	5.1	9.68
9	5.11	5.2	1.76	5.45	6.65	5.54	8.41
10	3.06	3.05	-0.33	3.01	-1.63	2.97	-2.94
11	4.1	4.31	5.12	4.23	3.17	4.19	2.2
12	4.55	4.6	1.1	4.6	1.1	5	9.9
13	4.59	4.55	-0.87	4.58	-0.22	4.82	5.01
14	4.77	4.87	2.1	4.84	1.47	5.14	7.76
15	3.24	3.19	-1.54	3.22	-0.62	3.11	-4.01
16	4.02	3.96	-1.49	3.17	-21.14	3.15	-21.64
17	3.49	3.57	2.29	3.28	-6.02	3.56	2.01
18	4.36	4.25	-2.52	4.32	-0.92	4.18	-4.13
19	3.76	4	6.38	3.81	1.33	3.51	-6.65
20	4.7	4.57	-2.77	4.58	-2.55	4.84	2.98
21	3.58	3.59	0.28	3.5	-2.23	3.6	0.56
22	4.93	5.11	3.65	5.18	5.07	5.23	6.09
23	2.95	2.86	-3.05	2.9	-1.69	3.17	7.46
24	4.62	4.42	-4.33	4.64	0.43	4.62	0
25	4.43	4.47	0.9	4.46	0.68	4.41	-0.45
26	4.79	4.99	4.18	4.99	4.18	4.99	4.18
27	3.63	3.51	-3.31	3.27	-9.92	3.15	-13.22
28	3.97	4.62	16.37	3.85	-3.02	3.75	-5.54
29	4.59	4.61	0.44	4.56	-0.65	4.47	-2.61
30	4.7	4.12	-12.34	4.81	2.34	4.87	3.62
31	4.07	4.2	3.19	4.02	-1.23	3.94	-3.19
32	3.32	3.41	2.71	3.35	0.9	3.5	5.42
Median	4.43	4.43	0.28	4.46	-0.65	4.47	1.39
Max	5.99	5.64	16.37	5.87	6.65	6.21	9.89
Min	2.95	2.61	-14.43	2.54	-21.14	2.3	-24.59

Three athletes had a fall in their FEV_1 of more than 10% from the baseline spirometry after exercise. Athlete 7 had a fall in FEV_1 of 14.43% at 3 minutes post-exercise as well as a fall of 16.72% at 6 minutes post-exercise; athlete 16 had a fall in FEV_1 of 21.14% at 6 minutes post-exercise and athlete 30 had a fall in FEV_1 of 12.34% at 3 minutes after exercise. One athlete completed the baseline spirometry successfully, but couldn't complete the exercise challenge due to severe dyspnea and therefore didn't do the post-exercise spirometries. The athlete was excluded for technical insufficiency of the data recorded. None of the participants showed an increase in FEV_1 of more than 12% after the use of the bronchodilator.

4.6 CORRELATIONS BETWEEN RISK FACTORS IN HISTORY, PHYSICAL EXAMINATION AND SPIROMETRY

Table 4.7 shows the associated risk factors which could predict EIB.

Table 4.7: Outcome of spirometries and risk factors for EIB

Risk Factor	Spirometry: positive	Spirometry: negative
known asthmatic (n = 1)	1 (100%)	0
athletes with hay fever (n = 8)	2 (25%)	6 (75%)
athletes using respiratory medication (anti-asthmatics and/or anti-histamines (n = 5)	2 (40%)	3 (60%)
athletes not on respiratory medication (n = 27)	2 (7%)	25 (93%)

From the above results, the following correlations are of note:

- **Past history of asthma:** Three patients (9.3%) had a past history of asthma, of which 2 (66% of athletes with past history, 6% of sample population) were reconfirmed as present EIB with spirometry.

- **Present history of asthma:** One athlete (3%) had a history of current asthma. After abstinence from asthma medication for the 24 hours before the lung function testing, two cases of EIA were confirmed (66% of known asthma, 6% of sample population), while 50% of athletes with known asthma were either misdiagnosed before, spirometry was

false negative, or the asthma was well controlled despite a wash-out period of anti-asthmatic medication.

- **History of other respiratory conditions:** Eight athletes (25%) had a history of hay fever/allergic rhinitis. Of these, three (37.5%) had positive spirometry for EIB, and six (62.5%) did not show signs of EIB on examination or spirometry.

- **Taking medication for respiratory conditions:** Six athletes (18.7%) took medication for asthma or allergic rhinitis, of which two cases of EIB were confirmed with spirometry.

- **Smoking:** Six athletes (18.7%) gave a history of smoking. None of them had any other indication of asthma in history, physical examination or spirometry.

4.7 CONCLUSION

The results of detection of EIB with history, physical examination and exercise challenge spirometry were presented in this chapter. The main findings are:

Almost ten per cent (9.4%) of the sample population of university athletes was diagnosed with EIB with spirometry. Of these athletes, 66% (n = 3), or 6.3% (n = 32) of the population were not aware that they currently suffered from the condition. Of the three athletes with known present or past asthma, only one athlete was reconfirmed with spirometry, indicating a poor correlation between history of asthma and spirometry.

Of the three athletes with positive spirometry, 66% had associated allergic rhinitis and one had known asthma. In one athlete (3% of the population), no risk factors were identified and EIB was diagnosed on spirometry only.

None of the athletes with EIB showed any clinical signs of respiratory disease, rendering physical examination at rest a poor predictor of EIB. None of the smokers in the population showed any history, physical sign or positive spirometry for EIB, rendering smoking a poor predictor for EIB.

The results are discussed and interpreted in Chapter 5.

CHAPTER 5

DISCUSSION

5.1 INTRODUCTION

In this chapter the results of the study are discussed according to the available literature, trends identified and recommendations offered to increase the sensitivity of the Periodic Health Evaluation (PHE) in terms of respiratory disease with serial spirometry and an exercise challenge as addition. Most studies focus on identifying EIB in the elite athlete participating on the level of the Olympic Games. Our study focused on the young varsity athlete who participates at a less strenuous level of sport. The proper diagnosis and management of the athlete with unrecognized EIB will ensure successful competition on all levels of participation, and improvement in the athlete's general health and performance - thus objective testing is necessary to confirm the diagnosis.

5.2 METHODOLOGY

The study was a prospective descriptive study to determine the prevalence of respiratory illness in a University athletic population. Furthermore there was an analytical cross study part to determine the sensitivity of clinical history, examination and test the value of spirometry after an exercise challenge as a possible additional screening tool to the current PHE.

On completion of the PHE and PE each participant had a baseline spirometry test at rest which excluded chronic underlying asthma or respiratory illness. Subsequently a challenge test was added to confirm/exclude the diagnosis of EIB as the symptomatology associated with EIB is not always obvious. Our study used a laboratory exercise challenge test on a motorized treadmill. The baseline and post-exercise spirometry were done according to the guidelines provided by the American Thoracic Society (ATS).

The diagnosis of EIB is often problematic due to the various available methods of testing as well as their variation in quality and sensitivity. Two main categories of diagnosis methods include direct and indirect testing. Direct testing, which consists of metacholine, induces EIB by direct contraction of the smooth muscles of the airways. The metacholine challenge is

laboratory dependent, does not measure the exercise in the outdoor environment and has a low sensitivity and specificity for EIB. On the positive side this test is easily accessible, reproducible, inexpensive, not time-consuming and independent of specialized equipment (Holzer and Brukner, 2004).

Indirect testing consists of either laboratory or field exercise challenging by using a cycle ergometer or motorized treadmill. The laboratory exercise challenge is specific for EIB, but not sport specific as it is not performed within the environment of the athlete's sport activities. Field exercise challenge on the other hand, is sport specific as well as EIB-specific. Another indirect method of testing is the eucapnic voluntary hyperpnea (EVH) challenge test where EIB is triggered by hyperventilation of a dry gas. This test has the highest sensitivity for EIB, imitates the event on the sports field and is recommended by the IOC-MC as the gold standard (Holzer *et al*., 2002). Unfortunately EVH challenge testing is only availbale in specialized centers.

Peak expiratory flow rate (PEFR) is not recommended for diagnosis/excluding of EIB (NAEPP, 2007) due to the more significant changes that occur in FEV_1 than in PEFR in the athlete with EIB. PEFR could be used in the emergency departments or for home monitoring in the asthmatic athlete, but is not regarded as an equal alternative for FEV_1 when it comes to EIB.

5.3 POPULATION

The participants were selected by non-randomized sequential sampling. We have included athletes from the University of the Free State irrespective of their gender, medical history, type and level of sport participation. The sample size of 32 was relatively small in comparison with other studies done, e.g. Dickinson *et al*., (2011) who studied 228 elite athletes.

The small number of athletes within each type of sport in our study makes it difficult to obtain accurate information that could confirm the same prevalence as some of the larger studies. None of our participants had swimming or figure ice skating as their main sport, thus we could not confirm that competing in cold conditions has a higher prevalence. Furthermore it is difficult to make a more direct comparison with the participants who indicated athletics (31% of the participants) as their main sport as athletics has various types of events such as long distance running or sprinting which were not clearly specified in the questionnaire. It is

also possible that some athletes specifically did not participate as they feared being excluded from their current sport season. The compliance was moderate as 86.5% of the participants (n = 37) successfully completed the full process of data collection. Assistance at completion of the questionnaire was offered by the researcher to aid in comprehension of some questions and to prevent inability to differentiate between normal exercise breathing patterns and possible symptoms related to EIB.

5.4 INCIDENCE OF EXERCISE-INDUCED BRONCHOSPASM

The incidence of EIB in the general population is 10-15% and it is found to be 80-90% in diagnosed asthmatic patients (Weiss and Rundell, 2009). In general athletes there is a high prevalence, 21-50% in Varsity college or elite athletes depending on their specific sports (Parsons *et al*., 2007).

5.4.1 Types of Sport

Assessing the types of sport of our participants it was clear that the main sports of the EIB-positive participants were from the mildly asthmogenic group of sport: athletics (10%; n = 10), tennis (14.3%; n = 7) and squash (33%; n = 3). Our population did not represent types of sport which are regarded to be highly asthmogenic and this could influence the prevalence of EIB in our study to be less than reported by similar studies. The types of sport were athletics (31%), tennis (22%), rugby and cricket both 16%, squash (10%), badminton and netball both 2.5%.

According to the literature endurance types of sport such as cross-country ski, basketball, cycling, long distance running, swimming and soccer are regarded as highly asthmogenic; with baseball, football, squash, tennis, volleyball, wrestling and golf regarded as sports with low asthmogenic potential (Storms, 1999). With the detection of athletes with unrecognized EIB as shown in our study, it would not be statistically significant to only target the athletes from the highly asthmogenic types of sports. This will lead to both over- and underdiagnosis of EIB.

5.4.2 History of asthma

In our study 9.4% athletes (n = 32) reported that they had been previously diagnosed as being asthmatic. Thirty-three per cent of these known asthmatics tested positive with the

post-exercise spirometry. Thirty-three per cent used an inhaler for control of asthma, 33% used antihistamines and 33% used no treatment at all.

The remaining 66% of athletes had normal post-exercise spirometries. Sixty-six per cent different athletes tested positive for EIB with post-exercise spirometry that did not have asthma in their past history. Therefore the diagnosis of EIB could not be made on the past/present asthma history alone.

5.4.3 Respiratory Medication

Respiratory medication was used by 15.6% of the participants (n = 32) whose indications were either asthma or allergic rhinitis. Twenty per cent of these athletes had a positive post-exercise spirometry and the medication was specified as antihistamines for allergic rhinitis. The remaining 80% athletes had negative post-exercise spirometries. Therefore the diagnosis of EIB could not be made on the history of use of respiratory medication alone.

5.4.4 Spirometry

A resting spirometry was done for every participant. In correlation with most studies our baseline spirometry also did not identify a single positive pre-exercise test for EIB. In our study 9.4% of athletes (n = 32) were positive for EIB as confirmed with serial spirometry after an exercise challenge test. Even though the prevalence of EIB in different populations varies greatly in the literature, the prevalence in this study correlates with the general 10-15% prevalence cited in the literature for the general population.

It is lower than the high prevalence of 21-50% reported in College and Elite athletes (Weiss and Rundell, 2009; Parsons *et al*., 2007). Hull *et al.*, (2007), indicated that EIB has been found to be present in almost all asthmatics and in a “significant proportion of otherwise healthy individuals”. Helenius and Haahtela (2000) reported that the prevalence in summer sports is 3.7-22.8% and Haahtela *et al.*, (2005) found the prevalence of EIB in winter sports to be 2.8-54.8%. This variability may be due to different reporting or methods of diagnosis in the literature, or lack of sensitivity in the methods used in the studies. According to the literature, up to 80% of patients with asthma have some degree of EIB (McFadden, 1994). In our study 33% of the known asthmatic athletes had a positive post-exercise spirometry - which is not in correlation with the high prevalence in known asthmatic athletes as mentioned in the literature.

5.4.5 Gender

The EIB-positive athletes identified in our study were female participants even though the percentage of female participants was 40.6% and the male participants 59.4%. This finding corresponds with studies that found the prevalence of EIB to be higher in female than male athletes (Minov *et al*., 2011). Of the asthmatic athletes in our study 66% were female and the 33% male participants.

5.5 RISK FACTORS FOR EXERCISE-INDUCED BRONCHOSPASM

During the data collection some risk factors related to EIB were identified. These included smoking, past or present asthma, allergic rhinitis and the present use of medication to control underlying conditions of the respiratory system.

5.5.1 Smoking

Almost 19% (18.7%; n = 32) of athletes admitted to smoking. No correlation was found between these athletes that smoked (cigarettes or hubbly bubbly) and those with positive spirometry. According to the literature the exposure to tobacco smoke is worsening asthma in children (Weitzman *et al*., 1990; Murray and Morrison, 1993) but with no significant effect on the adult athlete, unless he or she is susceptible (Lee and Forey, 2007).

5.5.2 History of Respiratory illness

In our study 9.4% athletes had a past history of asthma. Thirty-three per cent of these athletes had two risk factors for EIB (past history of asthma and currently using antihistamines for allergic rhinitis); 33% EIB-positive athletes had only underlying allergy (allergic rhinitis with no current medication used) and 33% EIB-positive athletes had no indicators or risk factors in their history. Assessing the history of the EIB-positive athletes, the risk for EIB does not seem to be much higher when there is underlying allergy in addition to current of past asthma in the history. Twenty-five per cent of (n = 32) athletes reported allergic rhinitis on the questionnaire and only two (25%) of them had a positive post-exercise spirometry with a fall of ≥ 10% on the FEV_1. With this in mind allergic rhinitis could not be regarded as an important factor that warrants an exercise challenge with post-exercise spirometry.

5.5.3 Periodic Health Evaluation

Some studies have shown that the diagnosis of EIB on the basis of clinical symptoms has moderate sensitivity and specificity for EIB (Holzer and Brukner, 2004). Anderson *et al.,* 2005, found that clinical assessment alone is not sufficient to make an accurate diagnosis of EIB therefore symptoms have a poor predictive value which influence the prevalence and incidence of EIB. The use of history as the only indicator for EIB has been shown to both over- and under-diagnose EIB (McKenzie *et al*., 2002; Tan and Spector, 2002). In our study no athlete was diagnosed with asthma/EIB solely on the history and physical examination. A proportion of the athletes only became aware that they had EIB *after* completing the exercise challenge combined with post-exercise spirometries.

5.6 LIMITATIONS OF THE STUDY

The goal was to have a 100% participation of all the athletes of the University of the Free State, but could not occur due to some logistic obstacles. The sample size was too small in comparison with some other studies. Technical challenges were also problematic as some of the athletes did the PHE, the physical examination and the spirometry on three different occasions. Due to the ill-timed collection of data the results could have been influenced by subsequent seasonal changes as bronchospasm could be intermittent or seasonal with different potential triggers e.g. pollens/humidity/temperature. There was limited continuity in collection of data in all the participants. In our study we could not differentiate between summer and winter sport as the data collection was mainly done in the summer months. Our data is also not representative of the entire spectrum of high and low ventilation types of sport as the participants were asked to indicate their main type of sport even though they partake in more than one type of sport.

5.7 CONCLUSIONS

In conclusion, our study found that past/present asthma and allergic diseases of the upper respiratory tract are significant risk factors for the development of EIB in the athlete. Furthermore the results confirm the need of an adequate exercise challenge with serial post-exercise spirometry in elite athletes irrespective of the presence/absence of risk factors as the correlation between risk factors from the history and EIB is very poor. If resting spirometry alone was the only screening tool to identify the athlete at risk for EIB then none

(0%) would have been diagnosed. By adding the exercise challenge and the serial spirometries 9.4% new EIB's were diagnosed and consequently saved from significant mortality as seen in acute cases of bronchospasm. Additionally the study confirms that there is no association of smoking and the diagnosis of EIB with or without spirometry after an exercise challenge.

As the aim of a PHE is to assure safe sports participation, proper identification and treatment of athletes with EIB should be implemented. Hallstrand *et al*., (2002) reported that 32 of 108 (29.6%) children died due to severe asthma during sports activities who were not identified prior to the fatal incidents. Our study confirms that clinical assessment alone is not of significant predictive value (as found by Hull *et al*., 2009) and another tool such as serial post-exercise spirometry is necessary to identify the athletes with unrecognized EIB. The addition of a standardized exercise challenge followed by serial spirometries to all participants will in fact have a very positive impact on the current medical care of the athletes.

CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

Exercise-induced bronchospasm is a condition that could present itself at the most inconvenient of times and places. As general health and exercise as well as different levels and motivation for participation in sport are of increasing importance to our generation, it is of great value to complete a periodic health evaluation before commencement of sport. The aim of the PHE should remain the most important goal - to detect a problem as early as possible with the maximum sensitivity and specificity for the specific diagnosis to assist the athlete in healthy and safe participation.

It is clear from our study that EIB and EIA is underdiagnosed in athletic populations. History and clinical signs during PHE are poor indicators of EIB. With the data of our study we recommend that the current PHE's sensitivity for EIB could be increased with addition of serial spirometries after an exercise challenge, and not only with a resting spirometry. The athletes being diagnosed with our study could prepare themselves to participate safely in their current sports. That could be regarded as making a difference in their quality of life.

On the grounds of our findings, our recommendation is that serial post-exercise spirometry ensure overall effectiveness and increased sensitivity of the PHE to identify unrecognized EIB and should be included for all PHE's of athletes competing in all types of sports taken in account the availability of such evaluation. The focus usually is on the elite athlete, but serial post-exercise spirometries should be implemented on all levels of sports participation as exercise is beneficial for every individual irrespective of their age, gender, underlying respiratory condition and type of sport.

6.2 RECOMMENDATIONS FOR FURTHER RESEARCH

Other research topics to fill the gaps in the literature, include:

- Endurance athletes have increased risk for EIB as they have high volume airflow over long period of time – are more frequent spirometry with exercise challenge tests indicated? If yes, what would be the recommended frequency of formal testing?

- With the Olympic Games held every four years, what would be the best time intervals for BPT's? Only just before registration for the OG or on a more regular basis? What happens with the athlete who was diagnosed with EIB with gold standard techniques after the main competition?

- As children run and play (high intensity and short duration type of activities) much more than the adolescent or adult in general – would that warrant formal testing for EIB?

- When an athlete is diagnosed with EIB and his/her sporting career ends, will the condition subside or evolve into a diagnosis on the Chronic Obstructive Pulmonary Disease spectrum? Are these patients more prone to lower respiratory infections later in life?

- If the athlete experienced EIB in one type of sport, will it be experienced in any/all the other types of sport?

Appendix A (Afrikaans version)

INLIGTINGSDOKUMENT VIR DIE DEELNEMER

Studietitel:

Bepaling van die insidensie van longsiekte in atlete van die Universiteit van die Vrystaat deur ‘n Periodieke Gesondheids-ondersoek met en sonder spirometrie.

Inleiding:

Ek, Dr. I.J. Joubert, doen navorsing oor die voorkoms van longsiekte in jong atlete op universiteitsvlak. Hierdeur wil ek die sensitiwiteit van die huidige periodieke gesondheids-ondersoek, soos tans aanbeveel deur die Internasionale Olimpiese Komitee, verhoog deur ‘n spesiale ondersoek by te voeg. Die ondersoek is ‘n longfunksietoets (ook genoem spirometrie).

Tydens hierdie navorsingsprojek, wil ek die volgende doelwitte bereik en dokumenteer:

a) wat is die insidensie of voorkoms van longsiekte in atlete
b) doen spirometrie met elke deelnemer
c) publiseer hierdie inligting in mediese joernale
d) om die verwerkte inligting voor te dra by mediese kongresse
e) om die sensitiwiteit van die periodieke gesondheis-ondersoek te verhoog

Ek vra jou om deel te neem aan die navorsingsprojek.

Ek, Dr. I.J. Joubert, en sommige van die studente van die Department Sportgeneeskunde sal die studie doen. In hierdie navorsing sal die standaard tegniek gebruik word vir die spirometrie, soos aanbeveel deur die Amerikaanse Toraks Vereniging.

Daar is geen risiko’s verbonde aan deelname nie.

Daar is geen vergoeding van enige aard, indien deelname wel sou plaasvind.

Indien daar wel longsiekte gediagnoseer word, sal die atleet na sy/haar huisdokter verwys word vir verdere hantering. Geen mediese advies of voorskrifte sal deur die navorser of studieleiers gegee word nie.

Daar sal gepoog word om alle persoonlike inligting konfidensieel te hou. Absolute konfidensialiteit kan nie gewaarborg word nie. Persoonlike inligting sal openbaar word, indien die wet dit vereis.

Vir verdere inligting, kontak die navorser Dr. I.J. Joubert, by 082 785 2242.

Vir rapportering van klagtes of probleme, kontak die Sekretariaat van die Etiekkomitee van die Fakulteit van Gesondheidswetenskappe van die Universiteit van die Vrystaat, by 051 405 2812.

Appendix A (English version)

PARTICIPANT INFORMATION DOCUMENT

Study title:
Detection of Respiratory illness in athletes of the University of the Free State through a Periodic Health Evaluation with and without spirometry.

Introduction:

I, Dr. I.J. Joubert, am doing research about the incidence of lung disease in young athletes at university level. By this, I want to improve the sensitivity of the current Periodic Health Examination used by the International Olympic Committee, by doing a special test called spirometry.

In this research project I want to document findings for the following purposes:
a) to determine the incidence of lung disease in athletes
b) to do spirometry on every participant
c) to publish the data in medical journals
d) to present the results of the study at medical congresses
e) to improve the sensitivity of the PHE

I am asking you to participate in this research study.

I, Dr. I.J. Joubert, and some of the students from the Department of Sports Medicine will do the study. In this research study, we will apply the standard techniques for spirometry, as indicated by the American Thoracic Society.

There are no risks being involved in this study.

There are no benefits to the participant and family.

If lung disease is diagnosed that was not known before entering the study, the athlete will be referred to his/her general practitioner for further management. No medical advice or treatment will be given or prescribed by the researcher or study leaders.

Efforts will be made to keep personal information confidential. Absolute confidentiality can not be guaranteed. Personal information may be disclosed if required by law.

For further information, please contact the researcher, Dr. I.J. Joubert at 082 785 2242.

For reporting of complaints or problems, please contact the Secretariat of the Ethics Committee of the Faculty of Health Sciences at UFS: 051 405 2812.

Appendix B (Afrikaans version)

Studietitel:

Bepaling van die insidensie van longsiekte in atlete van die Universiteit van die Vrystaat deur ‘n Periodieke Gesondheids-ondersoek met en sonder spirometrie.

TOESTEMMING TOT DEELNAME AAN NAVORSING

Ek is gevra om aan ‘n navorsing studie deel te neem. Ek is deur Dr. I.J. Joubert ingelig in verband met die studie. Ek is ingelig dat daar geen vorm van vergoeding as gevolg van die studie is nie.

Ek kan Dr. I.J. Joubert enige tyd kontak by 082 785 2242 indien ek vrae het oor die navorsing. Ek kan die Sekretariaat van die Etiek-komitee van die Fakulteit Gesondheidswetenskappe, UV, kontak by telefoonnommer 051 405 2812, indien ek enige vrae het oor my regte as proef-persoon.

My deelname aan hierdie navorsing is vrywillig en ek sal nie gepenaliseer word of voordele verbeur as ek weier om deel te neem of besluit om deelname te staak nie. Indien ek instem om deel te neem, sal ‘n ondertekende kopie van hierdie dokument, sowel as die deelnemer-inligtingsblad, wat ‘n geskrewe opsomming van die navorsing is, aan my gegee word.

Die navorsingstudie, asook bogenoemde inligting, is verbaal aan my verduidelik. Ek begryp wat my betrokkenheid by hierdie studie beteken en ek stem vrywillig in om deel te neem. Ek gee toestemming dat die resultate van die studie publiseer kan word in mediese joernale en voorgedra kan word by mediese kongresse soos die SASMA-kongres.

NAAM VAN PASIËNT	**HANDTEKENING VAN PASIËNT**
NAAM VAN GETUIE	**HANDTEKENING VAN GETUIE**
Dr. I.J. Joubert	**DATUM**

Appendix B (English version)

Title of the study:

Detection of Respiratory illness in athletes of the University of the Free State through a Periodic Health Evaluation with and without spirometry.

CONSENT TO PARTICIPATE IN RESEARCH

I have been asked to participate in a research study. I have been informed about the study by Dr. I.J. Joubert. I have been informed that there is no form of compensation as a result of the study.

I may contact Dr. I.J. Joubert at 082 785 2242 at any time if I have questions about the research. I may contact the Secretariat of the Ethics committee of the Faculty of Health Sciences, UFS at telephone number 051 405 2812 if I have questions about my rights as a research participant.

My participation in this research is voluntary and I will not be penalised if I refuse to participate or decide to terminate participation. If I agree to participate I will be given a signed copy of this document as well as the participant information sheet, which is a written summary of the research.

The research study, including the above information has been verbally described to my. I understand what my involvement in the study means and I voluntarily agree to participate. I give consent that the results of the study can be published in medical journals and can be presented at medical congresses like the SASMA-conference.

NAME OF PATIENT	**SIGNATURE OF PATIENT**
NAME OF WITNESS	**SIGNATURE OF WITNESS**

Dr. I.J. Joubert	**DATE**

Appendix C

UFS SPORT AND EXERCISE MEDICINE CLINIC

Periodic Health Evaluation for Elite Athletes

MEDICAL HISTORY

Demographic

Personal Information Research participant no:_____

Last name _____ First name _____

Address: Street _____ City_____ Region_____

Postal Code_____ Country_____

Preferred Language: _____

Birth date: yyyy_____/mm_____/dd_____

Sex (M/F):_____

Phone: Home_____ mobile_____

Emergency Contact 1: Name_____ Relationship _____ Phone _____

Emergency Contact 2: Name_____ Relationship _____ Phone _____

Medical Aid and nr: _____

Family physician (name, phone number): _____

Background

The following questions ask for information regarding your personal background

What is your main sport? (sport, event/position): _____

Have you participated in other sports in the past? (Include those sports you have done competitively) No ☐ Yes ☐

_____

What is your ethnic origin? _____

Do you have any religious convictions that could affect your medical treatment? No ☐ Yes ☐

When was the last time you had a complete physical examination? _____

Have you ever failed a pre-participation examination for sports, or has your doctor ever stopped you from participating in sports No ☐ Yes ☐

In total, how many days have you missed practice or competition in the past year because of injury or illness? _____

Heart

Have you ever had any of the following **heart or circulation related** problems

Chest pain, discomfort, tightness or pressure with exercise? No ☐ Yes ☐

Unexplained fainting or near fainting or passed out for no reason DURING or AFTER exercise? No ☐ Yes ☐

Excessive or unexplained shortness of breath, lightheaded, or fatigue with exercise? No ☐ Yes ☐

Do you get more tired or short of breath more quickly than your friends during exercise? No ☐ Yes ☐

Does your heart race or skip beats (irregular beats) during exercise? No ☐ Yes ☐

Heart murmur, high blood pressure, high cholesterol, heart infection or inflammation, rheumatic fever, ☐ ☐

heart valve problems, or any other heart related problem? No ☐ Yes ☐

Have you ever had an unexplained seizure? No ☐ Yes ☐

Any tests for your heart (for example, ECG or EKG, echocardiogram)? No ☐ Yes ☐

Breathing

Have you ever had any of the following **respiratory or breathing** problems?

Do you have asthma? No ☐ Yes ☐

Do you have any other symptoms of respiratory (lung) disease including, wheezing, cough, postnasal drip, hay fever, or repeated flu-like illness? No ☐ Yes ☐

Do you cough, wheeze or have more difficulty breathing than you should during or after exercise? No ☐ Yes ☐

Have you ever used asthma medication (such as an inhaler)? No ☐ Yes ☐

Have you ever had bronchitis, pneumonia, tuberculosis, cystic fibrosis or other respiratory or other breathing problem? No ☐ Yes ☐

If asthma, when diagnosed? _____

Current treatment? _____

Do you currently smoke? ☐ Yes ☐ No

What do you smoke? _____

How much do you smoke per day? _____

Have you smoked in the past, but stopped? _____

When did you stop smoking? _____

Heat

The following questions are about exercise in the **heat**:

Have you ever become ill while exercising in the heat? No ☐ Yes ☐

Have you ever been diagnosed with heat exhaustion, heat stroke or hyperthermia? No ☐ Yes ☐

Do you get frequent muscle cramps while exercising No ☐ Yes ☐

Have you ever had electrolyte (salt) or fluid imbalance? No ☐ Yes ☐

Medical

Do you have any **ongoing medical conditions or illness**? No ☐ Yes ☐

Do you have, or have you ever had any symptoms of **medical problems** such as:

Infective mononucleosis (**mono**), flu-like symptoms or viral illness within the past month? No ☐ Yes ☐

Disease of the **ears** (infections, hearing loss, pain), **nose** (sneezing, itchy nose, sinusitis, blocked nose) or **throat** (sore throat, hoarse voice, swollen glands in the neck)? No ☐ Yes ☐

Blood disorders such as anemia, low iron stores, sickle cell trait or sickle cell disease, abnormal bleeding or clotting disorder, blood clot (embolus), or other blood disorder? No ☐ Yes ☐

Immune system including current infections, recurrent infections, HIV/AIDS, leukemia, or are you using any immune suppressive medication? No ☐ Yes ☐

Skin problems such as rashes, infections (fungus, herpes, MRSA) or other skin problems? No ☐ Yes ☐

Kidney or bladder disease, blood in the urine, loin pain, kidney stones, frequent urination, or burning during urination? No ☐ Yes ☐

Gastrointestinal disease including heartburn, nausea, vomiting, abdominal pain, weight loss or gain (> 5kg), a change in bowel habits, chronic diarrhea, blood in the stools, or past history of liver, pancreatic or gallbladder disease? No ☐ Yes ☐

Nervous system including past history of stroke or transient ischaemic attack (TIA), frequent or severe headaches, dizziness, blackouts, epilepsy, depression, anxiety attacks, muscle weakness, nerve tingling, loss of sensation, muscle cramps, or chronic fatigue? No ☐ Yes ☐

Metabolic or hormonal disease including diabetes mellitus, thyroid gland disorders, or hypoglycemia (low blood sugar) No ☐ Yes ☐

Infections such as meningitis, hepatitis (jaundice), or chicken pox No ☐ Yes ☐

Arthritis or joint pain, swelling and redness not related to injury? No ☐ Yes ☐

Were you born without, or are you **missing** a kidney, an eye or any other organ? No Yes

An **injury** to any internal organs such as your liver, spleen, kidney(s) or lung? No Yes

Have you ever had **surgery**? (explain) No Yes

Do you get motion sickness (car, air or sea sickness)? No Yes

Do you have any other medical problems? No Yes

Family

Do any of your **family** members have a history of any of the following conditions (in male relatives < 55 years, female relatives < 65 years):

Sudden death for no apparent reason (including drowning, unexplained car accident, or sudden infant death syndrome)? No Yes

Unexplained fainting, seizures, or near drowning? No Yes

Died before age 50 due to heart disease No Yes

Disability or symptoms from heart disease before age 50 No Yes

Other heart problems including electrical problems (arrhythmia) or heart enlargement, cardiomyopathy, heart surgery, pacemaker or defibulator? No Yes

High blood pressure or high blood cholesterol No Yes

Marfan's Syndrome No Yes

Bleeding disorder, sickle cell trait or sickle cell disease No Yes

Tuberculosis or Hepatitis No Yes

Anaesthetic reaction or problem? No Yes

Other condition such as stroke, diabetes, cancer, arthritis (describe) No Yes

Are you unsure of your family history? No Yes

Medications

The following questions are about medications and supplements you are taking, or have taken in the past month:

Medications that have been prescribed by a doctor (include insulin, allergy shots or pills, sleeping pills, anti-inflammatory medications, etc.) No Yes

Non-prescription medications? (include pain killers, anti-inflammatories, etc.). No Yes

Vitamin or mineral **supplements** or herbal medicines? No Yes

Other substance to improve your athletic performance? (Include substances like creatine, weight gain products, amino acids, etc.) No Yes

Have you ever been offered or encouraged to use **banned performance enhancing drugs**? No Yes

Did you take any medication today? **Yes** **No** **If yes: What, how much and when?**

If yes: What, how much and when? _____

Did you take any of the following:

Asthma pump (inhaler) i.e. Asthavent, Ventolin, Atrovent, Combivent, Serevent, or

Asthma tablets i.e. Theophyllin, Nuelin or corticosteroids i.e. prednisone or pulmison,

Any other medication i.e. antihistamines, nasal steroid sprays, singulair, beta-blockers.

Did you take any of the following –

coffee **Yes** **No**

tea, **Yes** **No**

cola drinks, **Yes** **No**

chocolate or any other caffeinated foods? **Yes** **No** **If yes:**

State_____

Did you smoke today? **Yes** **No**

Allergies

Do you have any **allergies** to?

Medication? No Yes

Anything else, such as foods, pollens, stinging insects, any plant material or any animal material? No Yes

Immunization

Indicate which **immunizations** you have received:

Tetanus/Diphtheria (Td or Tdap)?	No ☐	Yes ☐	Last shot? _____
Measles/Mumps/Rubella (2 shots)?	No ☐	Yes ☐	
Chicken Pox (Varicella)?	No ☐	Yes ☐	
Meningitis (Menimune or Menactra)?	No ☐	Yes ☐	
Hepatitis A (2 shots)?	No ☐	Yes ☐	
Hepatitis B (3 shots)?	No ☐	Yes ☐	
Malaria?	No ☐	Yes ☐	
Have you had a TB Test (PPD)?	No ☐	Yes ☐	Result? _____
Have you had any other immunizations?	No ☐	Yes ☐	Explain: _____

Female

These questions are for females only:

Have you ever had a menstrual period?	No ☐ Yes ☐
What was your age at your first menstrual period? : _____	
Do you have regular menstrual cycles?	No ☐ Yes ☐
How many menstrual cycles did you have in the last year? : _____	
When was your most recent menstrual period? : _____	
Have you had a stress fracture in the past?	No ☐ Yes ☐
Have you ever been identified as having a problem with your bones such as low bone density (osteopenia or osteoporosis)?	No ☐ Yes ☐
Are you presently taking any female hormones (estrogen, progesterone, birth control pills)?	No ☐ Yes ☐
Have you ever had a sexually transmitted disease such as gonorrhea, syphilis, venereal warts, chlamydia or other infection?	No ☐ Yes ☐

Male

These questions are for males only

Do you have two normal testicles	No ☐ Yes ☐
Have you ever had a hernia or swelling around the testicle (varicocele, hydrocele)?	No ☐ Yes ☐
Have you ever had an injury to a testicle?	No ☐ Yes ☐
Have you ever had surgery for an undescended testicle, testicular injury or problem?	No ☐ Yes ☐
Have you ever had a sexually transmitted disease such as gonorrhea, syphilis, venereal warts, chlamydia or other infection?	No ☐ Yes ☐

Head & Neck

Have you ever had any of the following problems related to your **head or neck**?

Eye injury, or other problems with your vision?	No ☐ Yes ☐
Headaches with exercise?	No ☐ Yes ☐
Have you ever had numbness, tingling or weakness in your arms and legs or been unable to move your arms or legs after being hit or falling?	No ☐ Yes ☐
Do you have, or have you been x-rayed for, neck (atlantoaxial) instability?	No ☐ Yes ☐

Have you had an injury to your teeth? No Yes

Do you have any other decayed, missing or filled teeth? No Yes

Do you have a dental prosthesis or appliance? No Yes

Have you had your wisdom teeth removed? No Yes

Injury

Have you ever had an **injury** to your **face, head, skull or brain** (including a concussion, confusion, memory loss or headache from a hit to your head, having your "bell rung" or getting "dinged")? No Yes

Have you had a problem or an **injury** like a sprain, strain, muscle or ligament tear, or tendonitis, broken bone, stress fracture or joint injury (**that caused you to miss a practice or competition**) to any of the following **areas of your body**?

Neck or spine (including a "stinger," or "whiplash,") No Yes

Upper back (thoracic spine) No Yes

Lower back (lumbar spine) No Yes

Chest and ribs No Yes

Shoulder area (including collar bone) No Yes

Upper arm No Yes

Elbow No Yes

Lower arm (forearm) No Yes

Wrist No Yes

Hand or fingers No Yes

Pelvis, groin or hip (including sports hernia) No Yes

Thigh (including hamstrings and quadriceps) No Yes

Knee No Yes

Lower leg (calf or shin) No Yes

Ankle No Yes

Foot, heel or toes No Yes

Other

Tests - **If not already mentioned above**, have you had any other tests, for any injury or condition including blood tests, X-rays, MRI, CT scan, Bone scan, Ultrasound, Electroencephalogram (EEG), Electromyogram (EMG), nerve conduction studies (NCS), Electrocardiogram (ECG/EKG), Echocardiogram (Echo), exercise stress test or other tests? No Yes

Treatment - If not already mentioned above, have you ever received any of the following treatments for any condition?

Surgery?

No Yes

Been prescribed a **brace, sling, cast, walking boot, orthotic**, **crutches** or other appliance? No Yes

Cortisone injection? No Yes

Been prescribed other **rehabilitation or therapy**? No Yes

Have you ever spent the night **in a hospital** or been admitted to a hospital as an inpatient or outpatient? No Yes

Been referred to a **medical specialist** (cardiologist, neurologist or other medical person) for any condition not already mentioned? No Yes

Equipment

Do you wear eye glasses or contact lenses? No Yes

Are you **currently** using any of the following protective equipment? No Yes

Do you use protective eyewear? No Yes

Special equipment (pads, braces, etc.)? No Yes

Mouth guard for sports? No Yes

If you wear a **helmet** for sports, how old is it? No Yes

Nutrition

The following questions are about nutrition:

Do you worry about your weight or body composition?	No ☐	Yes ☐
Are you satisfied with your eating pattern?	No ☐	Yes ☐
Are you a vegetarian?	No ☐	Yes ☐
Do you lose weight to meet weight requirements for your sport?	No ☐	Yes ☐
Does your weight affect the way that you feel about yourself?	No ☐	Yes ☐
Do you worry that you have lost control over how much you eat?	No ☐	Yes ☐
Do you make yourself sick when you are uncomfortably full?	No ☐	Yes ☐
Do you ever eat in secret?	No ☐	Yes ☐
Do you currently suffer or have you ever suffered in the past with an eating disorder?	No ☐	Yes ☐

What is your current weight? _____

How tall are you without shoes? _____

Discuss

Do you have any **other concerns** that you would like to discuss with a doctor? No ☐ Yes ☐

Explain "YES" answers here:

I hereby state that, to the best of my knowledge, my answers to the above questions are complete and correct.

Signature of athlete: _____

Signature of parent/guardian (if under 18 years of age): _____

Date _____

Appendix D

PHYSICAL EXAMINATION

(OFFICE USE ONLY)

Date of Examination: _____

MASS	
HEIGHT	
BMI	
TEMPERATURE	
SYSTOLIC BP	
DIASTOLIC BP	

Medical

	NORMAL	ABNORMAL
(specify)		
Appearance		
Eyes/ears/nose/throat		
Hearing		
Lymph nodes		

Heart

Rhythm		
Heart sounds/murmurs in supine and standing		
Peripheral oedema		
Physical stigmata of Marfan's Syndrome		

Blood vessels

Peripheral pulses		
Delay in femoral pulses		
Vascular bruits (femoral)		
Varicose veins		
Blood Pressure in Sitting Position		

(after 5 minutes rest)

Right arm		
Left arm		
Heart rate (after 5 minutes rest)		
Lungs - percussion and auscultation		
Abdomen		
Genitourinary (males only)		
Skin		

Eyes

Visual acuity (corrected/uncorrected)		
Equal pupils		

Dental

DMF Index = Number of decayed, missing or filled teeth:

_____

Oral Hygiene assessment: ☐ Good ☐ Fair ☐ Poor

Visible Oral Infection: No ☐ Yes ☐

Presence of Worn, Broken or Loose/Mobile teeth: No ☐ Yes ☐

Dental appliances (bridge, plate, braces or orthodontic appliance): No ☐ Yes ☐

Musculoskeletal

Neck		
Back		
Shoulder/arm		
Elbow/forearm		
Wrist/hand/fingers		
Hip/thigh		
Knee		
Leg/ankle		
Foot/toes		

Investigations:

12 Lead ECG Details:

- Normal/no changes
- Common and training-related ECG changes
- Uncommon training-unrelated ECG changes

SPIROMETRY BASELINE

_____

_____

_____

_____

Blood Tests

Haemoglobin _____
Haematocrit _____
Erythrocytes _____
Thrombocytes _____
Leukocytes _____
Ferritin _____
Sodium _____
Potassium _____
Creatinine _____
Cholesterol (total) _____
LDL Cholesterol _____
HDL Cholesterol _____
Triglycerides _____
Glucose _____
C-reactive Protein _____

OTHER:

PROBLEM LIST

Active problems:

_____

_____

_____

_____

Passive problems:

_____

_____

_____

_____

Recommendations:

_____

_____

_____

_____

OUTCOME

CLEARED TO PARTICIPATE WITH:

☐ No restrictions

further

☐ The following restrictions (explain):

NOT CLEARED TO PARTICIPATE:

☐ Deferred – may be reconsidered after evaluation (explain):

☐ Not fit (give reason):

Examining physician:

Name: _____ Phone Number: _____

Address: _____ Email _____

_____

_____

Signature of Examiner: _____ Date: _____

Appendix E

SPIROMETRY:

A. Patient Preparation:

- explain test to the athlete: he or she may experience some minor symptoms (including cough or chest tightness) or no symptoms at all
- (avoid stating that the test could induce an asthma attack as the test description should not bias the result)
- the athlete should empty the urinary bladder before participation, as possible stress incontinence could be precipitated, especially in female athletes
- make sure that the informed consent is signed
- the athlete should be seated comfortably while doing the test - with the correct posture with the head slightly elevated

B. Possible reasons for exclusion to do spirometry:

- can not perform spirometry
- inadequate spirometry
- baseline spirometry < 70% FEV_1
- withdrew consent
- adverse events - dizziness, nausea, cough, feeling jittery, headache, dyspnoea, chest discomfort, pharyngeal or laryngeal pain, reversible airway obstruction, wheezing, rhinitis (if recorded as severe at the time of testing, and if it prevented the exercise challenge to be completed)
- the athlete used the prohibited drugs

C. Measuring FEV_1/FVC:

- use a clean disposable one-way mouth piece for every participant, to attach to the spirometer
- ask the athlete to breathe in as deep as possible (complete full inspiration)
- he or she should hold the breath just long enough to seal their lips
- the participant should blow out the air in the lungs as hard and fast as possible until there is nothing left to expel (exhale with maximal force)
- repeat manoeuvre twice - to have 3 completed readings

D. End point measures include:

- change in FEV_1 is primary outcome measure
- spirometry should meet ATS guidelines
- try to obtain high quality baseline spirometry to prevent false positive or false negative results

E. Acceptable spirograms:

- free from artefacts -
  - cough during first second of exhalation
  - glottis closure that could influence the measurement
  - early termination or cut-off
  - effort that is not maximal throughout
  - leak
  - obstructed mouthpiece

- they have good starts -
  - extrapolated volume < 5% of FVC or 0.15L, whichever is greater

- satisfactory exhalation -
  - duration of > 6 seconds
  - a plateau in the volume time curve
  - the athlete cannot or should not continue to exhale

- acceptable repeatability -

  apply the following tests:
  - the 2 largest values of FVC must be within 0.150L of each other, the 2 largest values of FEV_1 must be within 0.150L of each other
  - If both of these criteria are met, the session may be concluded
  - If both criteria are not met, continue testing until both criteria are met, total of 8 tests have been performed, or the athlete can not or should not continue

F. Factors taken into consideration when interpreting:

- pre-test probability of asthma - including current asthma-like symptoms
- presence or degree of baseline airway obstruction
- quality of athlete's spirometry manoeuvres
- pre-test questionnaire results
- symptoms reported by athlete at end of the test
- degree of recovery after bronchodilator administration
- mild intermittent asthma - athlete has poor perception of symptoms
- he or she experience chest tightness, but does not recognise it as abnormal
- athlete experiences environmental triggers for bronchospasm
- mild broncho-hyperresponsiveness is due to other causes (not asthma) - post-viral upper respiratory tract infection or smoking
- subclinical or asymptomatic asthma that will become clinically significant in future

The difference in pre-test probability of the athlete having EIB and the post-test results, is due to the contribution of exercise.

G. Exercise challenge protocol

- Group: athletes aged 19 - 25 year old in 2012
- Measurement:
    - FEV_1 at baseline, at 3, 6 post-exercise as well as a spirometry 15 minutes post-bronchodilator
- Mode of exercise:
    - start by walking for 2 minutes to raise ventilation and heart rate close to desired value within 2 minutes of exercise, then running to maintain ventilation and elevated heart rate for at least 6 minutes, on a motorized treadmill at speed approximately 10-14km/h and a 2-3 met inclination
- Duration:
    - 8 minutes, challenge could be stopped at any time
- Index of Intensity:
    - 95 - 100% of predicted maximum heart rate (220 minus age) according to Karvonen's method
- Inspired air:
    - dry air at room temperature (20 - 25°C)
- Positive response:

- fall in FEV_1 of ≥ 10% (change in % from baseline spirometry to post-exercise spirometry)

Appendix F

DATA COLLECTION SHEET: DR IJ JOUBERT - 2012

For Office Use

MEDICAL HISTORY:

Research participant number 1-3

1. Date questionnaire is completed: (dd/mm/yy) 4-9
2. What is your gender? (1) male / (2) female 10
3. What is your date of birth? (dd/mm/yy) 11-16
4. What is your age in years? 17-18
5. What is your main sport? 19
   1. cricket
   2. rugby
   3. athletics
   4. swimming
   5. netball
   6. hockey
   7. other
6. Do you have asthma? (1) yes / (2) no 20
7. When was it diagnosed? (mm/yy) 21-24
8. Have you ever been admitted to hospital for management of asthma? (1) yes / (2) no 25
9. Do you have other symptoms of airway disease?
   1. wheezing (1) yes / (2) no 26
   2. cough (1) yes / (2) no 27
   3. post nasal drip (1) yes / (2) no 28
   4. hay fever (1) yes / (2) no 29
   5. repeated flu-like illness (1) yes / (2) no 30
10. Do you experience any of the following symptoms during or after exercise?
    1. cough (1) yes / (2) no 31
    2. wheezing (1) yes / (2) no 32
    3. difficulty in breathing (1) yes / (2) no 33
11. Have you ever used asthma treatment? (1) yes / (2) no 34

12. Do you currently smoke? (1) yes / (2) no ☐ 35

13. If yes, what do you currently smoke?

1. cigarettes (1) yes / (2) no ☐ 36
2. hubbly bubbly (1) yes / (2) no ☐ 37
3. other (1) yes / (2) no ☐ 38

14. How many cigarettes do you smoke per day? ☐ 39

1. Non-smoker
2. 1 - 10
3. 11 - 20
4. 21 - 30
5. >30

15. Medications that previously have been prescribed by a doctor that you CURRENTLY USE:

1. allergy injections (1) yes / (2) no ☐ 40
2. asthma pump or inhaler (1) yes / (2) no ☐ 41
3. asthma tablets (1) yes / (2) no ☐ 42
4. antihistamines (1) yes / (2) no ☐ 43
5. nasal steroid sprays (1) yes / (2) no ☐ 44
6. Singulair®/Acculate®/Topraz® (1) yes / (2) no ☐ 45
7. blood pressure tablets (1) yes / (2) no ☐ 46
8. glaucoma treatment (1) yes / (2) no ☐ 47
9. other (1) yes / (2) no ☐ 48

16. Medications that have been prescribed by a doctor, that you USED PREVIOUSLY:

1. allergy injections (1) yes / (2) no ☐ 49
2. asthma pump or inhaler (1) yes / (2) no ☐ 50
3. asthma tablets (1) yes / (2) no ☐ 51
4. antihistamines (1) yes / (2) no ☐ 52
5. nasal steroid sprays (1) yes / (2) no ☐ 53
6. Singulair®/Acculate®/Topraz® (1) yes / (2) no ☐ 54
7. blood pressure tablets (1) yes / (2) no ☐ 55
8. glaucoma treatment (1) yes / (2) no ☐ 56
9. other (1) yes / (2) no ☐ 57

17. Do you have any allergies? (1) yes / (2) no [ ] 58

1.

2.

3.

PHYSICAL EXAMINATION:

18. Date examination is done: (dd/mm/yy) [ ][ ][ ][ ][ ][ ] 59-64
19. Weight (kg): [ ][ ][ ] 65-67
20. Height (cm): [ ][ ][ ] 68-70
21. Body Mass Index: [ ][ ] 71-72
22. Systolic blood pressure (mmHg) [ ][ ][ ] 73-75
23. Diastolic blood pressure (mmHg) [ ][ ][ ] 76-78
24. Respiratory system: any abnormalities detected?
    1. abnormal chest wall movement (1) yes / (2) no [ ] 79
    2. wheezes (1) yes / (2) no [ ] 80
    3. decreased breathing sounds (1) yes / (2) no [ ] 81

SPIROMETRY:

25. Date examination is done: (dd/mm/yy) [ ][ ][ ][ ][ ][ ] 1-6
26. **Baseline value**
    - FEV_1 [ ][ ].[ ][ ] 7-10
    - FVC [ ][ ].[ ][ ] 11-14
    - FEV_1/FVC in % [ ][ ][ ].[ ] 15-19

27. **Post Ex 3 min**
    - FEV_1 [ ][ ].[ ][ ] 20-23
    - FVC [ ][ ].[ ][ ] 24-27
    - FEV_1/FVC in % [ ][ ][ ].[ ] 28-32
    - % change in FEV_1 from Baseline [ ][ ].[ ] 33-36

28. **Post Ex 6 min**
    - FEV_1 [ ][ ].[ ][ ] 37-40
    - FVC [ ][ ].[ ][ ] 41-44
    - FEV_1/FVC in % [ ][ ][ ].[ ] 45-49

% change in FEV_1 from Baseline | | | | . | | 50-53

29. **15 min post bronchodilator**

FEV_1 | | | . | | | 54-57

FVC | | | . | | | 58-61

FEV_1/FVC in % | | | | . | | 62-66

% change in FEV_1 from Baseline | | | | . | | 67-70

Diagnosis of EIB on

30. History (1) yes / (2) no | | 71

31. Physical examination (1) yes / (2) no | | 72

32. Spirometry (1) yes / (2) no | | 73

33. Risk factors identified:

(a) 0 (1) yes / (2) no | | 74

(b) 1 (1) yes / (2) no | | 75

(c) 2 (1) yes / (2) no | | 76

34. EIB diagnosed in this athlete: (1) yes / (2) no | | 77

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Request permission to conduct a study: Attention Prof Hay

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YUNIVESITHI YA FREISTATA

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GESONDHEIDSWETENSKAPPE

Division Sport and Exercise Medicine
Afdeling Sport- en Oefeningsgeneeskunde

16 Kamp street
Hoopstad
9479

5 January 2012

Prof D Hay
Vice Rector (Academic)
University of Free State

Professor Hay

RE: PERMISSION TO CONDUCT A STUDY – MAGISTER IN SPORTS MEDICINE

I kindly request your permission to do a study on the sports teams of the University of the Free State, in Bloemfontein. Since it is uncertain whether the current Periodic Health Evaluation (PHE) guidelines, as it is suggested by the International Olympic Committee (IOC), is sensitive enough to detect Exercise Induced Bronchospasm (EIB) without including a routine lung function test, the primary aim of the study is to determine whether spirometry increases the sensitivity of the PHE to identify subclinical airway disease.

Spirometry will be added to the PHE, irrespective of what the history and examination reveals. With this study, I aim to prove, that by adding a special test (spirometry) routinely to the PHE, the sensitivity of the PHE will be improved. The secondary aim of the proposed study is to determine the prevalence of respiratory illnesses in a group of university athletes.

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Division Sport and Exercise Medicine
Afdeling Sport- en Oefeningsgeneeskunde

I have already obtained permission from the manager of the UFS Sport Performance Unit and the Head of the Sports Medicine Clinic, provided that you allow the study to proceed.

I am looking forward to hear from you.

Yours sincerely

Dr IJ Joubert,
Hoopstad
082 785 2242

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Request permission to conduct a study: Attention The Manager UFS Sport Performance Unit

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5 January 2012

The Manager
UFS Sport Performance Unit
University of Free State

Dear Manager

RE: PERMISSION TO CONDUCT A STUDY – MAGISTER IN SPORTS MEDICINE

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Spirometry will be added, irrespective of what the history and examination brings forward. With this study, I aim to prove, that by adding a special test (spirometry) routinely to the PHE, the sensitivity of the PHE will be improved. The secondary aim of the proposed study is to determine the prevalence of respiratory illnesses in a group of university athletes.

I therefore request that exercise flow-volume testing is introduced into the PHE protocol of University athletes and the research is conducted on university high performance athletes during routine PHEs.

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Division Sport and Exercise Medicine
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I am looking forward to hear from you.

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SUMMARY IN LAY TERMS

A research study will be done at the Division of Sports Medicine at the University of Free State.

Current athletes of the University of the Free State, age 19 to 25, of different sports teams, will be attended to by means of medical history taking, physical examination focused on the lungs, and by doing some special investigation - spirometry (lung function test).

If the athlete agrees, he or she will be included in the study. Participation is completely voluntary and the participant will be able to withdraw from the study at any stage, without providing reasons. It involves the following: When consent is given, a history and examination of the athlete will be done. Spirometry will be done by a technician and the findings will be documented. Finally the findings and the outcome of the athlete's participation, will be documented.

In short, the study will aim to determine the incidence of lung disease in young athletes at university level. By adding a special investigation routinely (spirometry), the current proposed method of picking up lung disease, will be more sensitive.

When the study is completed, I would like to publish the results in a medical journal and present it at a medical congress.

The study will be done under the supervision of Dr Louis Holtzhausen and Dr Michiel Prins.

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Kantoor van die Viserektor: Akademies
Office of the Vice-Rector: Academic

26 January 2012

Dr IJ Joubert
16 Kamp Street
Hoopstad
9479

Dear Dr Joubert

PERMISSION TO CONDUCT A RESEARCH STUDY: MAGISTER IN SPORTS MEDICINE

Following your written request dated 5 January 2012, I hereby grant permission for the research on the topic *Detection of respiratory illness in athletes of the University of the Free State through a periodic health evaluation with and without Spirometry,* according to the guiding principles described in the Protocol dated November 2011.

I wish you well with the research and the finalisation of the study.

Yours sincerely

Prof. HR Hay
Vice-Rector: Academic

Copy: Louis Holtzhausen

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Ms H Strauss

2011-12-02

REC Reference nr 230408-011
IRB nr 00006240

DR IJ JOUBERT
3 MAREE STREET
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Dear Dr Joubert

ECUFS NR 197/2011
PROJECT TITLE: DETECTION OF RESPIRATORY ILLNESS IN ATHLETES OF THE UNIVERSITY OF THE FREE STATE THROUGH A PERIODIC HEALTH EVALUATION WITH AND WITHOUT SPIROMETRY.

- You are hereby kindly informed that the Ethics Committee approved the above project at the meeting held on 29 November 2011 on condition that the permission letters from the authorities have to be submitted to the Ethics Committee before the study may be conducted.
- Committee guidance documents: Declaration of Helsinki, ICH, GCP and MRC Guidelines on Bio Medical Research. Clinical Trial Guidelines 2000 Department of Health RSA; Ethics in Health Research: Principles Structure and Processes Department of Health RSA 2004; Guidelines for Good Practice in the Conduct of Clinical Trials with Human Participants in South Africa, Second Edition (2006); the Constitution of the Ethics Committee of the Faculty of Health Sciences and the Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines.
- Any amendment, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.
- The Committee must be informed of any serious adverse event and/or termination of the study.
- A progress report should be submitted within one year of approval of long term studies and a final report at completion of both short term and long term studies.
- Kindly refer to the ECUFS reference number in correspondence to the Ethics Committee secretariat.

Yours faithfully

.....
CHAIR: ETHICS COMMITTEE

Cc Dr M Schoeman

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