University of Cape Town

PROFILES OF ILLNESS AND INJURY AMONG SOUTH AFRICAN ELITE ATHLETES WITH DISABILITY AT THE 2012 SUMMER PARALYMPIC GAMES

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Declaration

I, Demitri Constantinou, declare that this dissertation is my own work. It is being submitted for the degree of Master of Philosophy in Sport and Exercise Medicine at the University of Cape Town. It has not been submitted before for any degree or examination at this or any other university.

Signed by candidate

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Abstract

Epidemiological data is important to better understand injury and illness patterns in para athletes. Medical teams used a web-based injury and illness surveillance system (WEB-IISS system) to all the para-athlete injuries and illnesses during the 2012 London Paralympic games. All team physicians could access the system at any time to log data, providing a vast database for potential research. The relative ease of data collection permits large amounts of data to be analysed, providing important surveillance data on injury and illness. Data on the South African para-athletes, provided by the team's Chief Medical Officer, were assessed and compared to all countries.

This study aimed to describe the illness and injury profiles in South African elite para-athletes who participated in the 2012 Summer Paralympic Games; and compare these profiles to data from the other countries that participated.
A retrospective sub-analysis of the data-set collected from a large prospective study of injury and illness at the London Summer Paralympic Games in 2012 was compared to data collected on all para-athletes from input by team physicians into the WEB-ISS system. In total, 62 South African para-athletes presented with 19 injuries, with an injury rate of 21.9 per 1000 athlete days. Twenty-five para-athletes presented illness, with an illness rate of 28.8 per 1000 athlete days.
The overall injury and illness rate in the South African para-athletes was higher than the injury and illness rate in all para-athlete participants at the London Paralympic Games. The anatomical distribution of injuries (lower limbs, axial and upper limbs) and the nature of illness (respiratory, skin & subcutaneous and digestive systems) were however similar. Causative factors are not evident and need to be further studied. Increased efforts in injury and illness surveillance and preventative programmes should be employed to reduce the incidence of injury and illness, and their severity . Such efforts in para-athlete care should be ongoing with surveillance to monitor and manage trends to ensure the culmination of Paralympic competition does not result in high rates of injury and illness. Education of healthcare providers, para-athletes, coaches and others in the management of para-athletes, is key.

Keywords: injury surveillance; para-athlete illness surveillance multisport event; Paralympic Games, Athletes with disabilities; para-athletes

Chapter 1: Literature review

1.1 Introduction

The history of the modern Paralympic Games has its roots at the Stoke Mandeville hospital in the United Kingdom, where the National Spinal Injuries Centre was founded by Professor Sir Ludwig Guttman in 1944. As a neurologist his intention was to provide a treatment facility for World War II soldiers with spinal cord injuries. Four years later he had the insight to use wheelchair sport as part of the rehabilitation programme (McCann, 1996), and symbolically organised an archery competition at the time of the opening ceremony of the 1948 Summer London Olympic Games (Buckinghashire Trust, 2015). Archery competitions at Stoke Mandeville became an annual event, with the introduction of other events over time and, in 1952, it achieved international standing, as para-athletes from the Netherlands joined the competition. This competition—now known as the World Wheelchair Games—is still held annually, except in the years that the Paralympic Summer Games are held (Ross, 2007).

The international Sports Organization for the Disabled (ISOD) was founded in 1964 and is the International Olympic Committee (IOC) equivalent for disability sports (DePauw & Gavron, 2005). The early disability sport competitions grew into the first Paralympic Games in 1960.

The name "Paralympics" is derived from the Greek prefix "para-" (in this context, "beside" or "alongside") and "Olympics." "Parallel Olympics" approximates the intended meaning. It has nothing to do, as is often the misperception, with "paralysis" or "paraplegia." The motto of the Paralympic Games was "Mind, Body,

Spirit" from 1994 through 2003, and is now "Spirit in Motion" (Ross, 2007). Despite the Paralympic Games having begun over 50 years ago, they are relatively young when compared to the modern Olympic Games, which have, with some disruptions, been held for the past 120 years since 1896; (Olympic.org, 2015).

The first official Paralympic Games took place in Rome, a week after the 1960 Summer Olympic Games were held in the same city. Four hundred para-athletes with spinal cord injuries from 23 countries competed in eight sports, including para-snooker, para-fencing, field events, para-basketball, para-swimming, para-table tennis, para-archery, and the para-pentathlon (McCann, 1996; Blauwet & Willick, 2012). In 1968, Mexico City (home of that year's Summer Olympics) declined to host the Paralympics, and the Games were therefore moved and held in Tel Aviv instead. From then until 1988, the Paralympics continued to be held in locations other than the Summer Olympics, as there were separate organising committees and processes in cities bidding to host the Games. A formal agreement between the International Olympic Committee and the International Paralympic Committee (IPC) that the host city until 2012 would host both events (Ross, 2007). This agreement was then extended to the year 2020 (International Paralympic Committee, 2012).

The 1972 Paralympics included the first competition for quadriplegics, and demonstration events for para-athletes with visual impairment. In 1976, para-athletes with other and various disabilities were included in the Summer Paralympic Games, including para-athletes with visual impairment, amputations and “les autres” (a catchall term embracing many sorts of motor disabilities and

used to denote disabilities not otherwise classified). This led to an expanded number of participating para-athletes (1600) from 40 countries (Canadian Paralympic Committee, 2005).

Paralympic competition grew rapidly; more than 3800 athletes from 100 countries and 4200 athletes from 150 countries participated in the Beijing and London Summer Paralympic Games respectively (Blauwet & Willick, 2012) (Derman, et al., Illness and injury in athletes during the competition period at the London 2012 Paralympic Games: development and implementation of a web-based surveillance system (WEB-IISS) for team medical staff, 2013) (Schwellnus, et al., 2013). This growth in participation meant better preparation, accessibility and closer alignment with the Olympic Games.

The venues, facilities and infrastructure are the same as those for the Olympic Game (Gold & Gold, 2007). This include the medical infrastructure – athlete village polyclinic, (add here competition and training venue medial infrastructure) and referral systems are the same.

1.2 Overview of classification system in the Paralympic games

Para-athletes that compete at the Paralympic Games are classified into one of 10 classes. These are divided into groups with specific functional impairments (Table 1); (1) impaired muscle power, (2) impaired passive range of movement, (3) limb deficiency, (4) leg length difference, (5) short stature, (6) hypertonia, (7) ataxia, (8) athetosis, (9) vision impairment, and (10) intellectual impairment. The Paralympic Movement adopted the definitions for the eligible impairment types as described in the World Health Organisation International Classification of Functioning, Disability and Health (World Health Organisation, 2016).

This complex system of classification is meticulously carried out by international classifiers and is subject to assessments based on functionality of the para-athlete. This includes verifying the impairment, the limitations that are present from a physical and technical point of view, and then allocating a sports class. The para-athlete is then observed whilst competing to confirm the classification, which is sport specific. Although the classification system is measured against certain impairments or disabilities, the system in fact allows for para-athletes of similar function and ability to compete against another para-athlete of similar ability, but not necessarily the same disability. Classification is also sport-specific, as there may be differences when applied to different activities. The imposition of classification is to ensure that there is a fair and equal competitive environment for the participating para-athletes and that winning is based on skill, power, endurance and the other elements are attributable to the success of able-bodied athletes.

Table 1: Impairment classification categories for Paralympic para-athletes

Classification category	Impairment
1. **Impaired muscle power**	Impairments of reduced force generated by the contraction of a muscle or muscle groups (e.g. muscles of one limb, one side of the body, the lower half of the body). Examples of conditions are para and quadriplegia, muscular dystrophy, post poliomyelitis, spina bifida.
2. **Impaired passive range of movement**	Range of movement in one or more joint is reduced in a systematic way. Hypermobility of joints, joint instability (e.g. shoulder dislocation), and acute conditions of reduced range of movement (e.g. arthritis types of impairment) typically will be excluded as 'eligible impairment'
3. **Limb deficiency**	There is a total or partial absence of the bones or joints as a consequence of trauma (e.g. traumatic amputation), illness (e.g. bone cancer) or congenital limb deficiency (e.g. dysmelia)
4. **Leg length difference**	From congenital deficiency or trauma one leg.
5. **Short stature**	Standing height reduced due to aberrant dimensions of bones of upper and lower limbs or trunk (e.g. achondroplasia).
6. **Hypertonia**	Condition marked by abnormal increase in muscle tension and reduced ability of a muscle to stretch. May result from injury, disease, or conditions that involve damage to the central nervous system. When an injury occurs in children under the age of 2, the term cerebral palsy is often used, but may also be due to brain injury (e.g. stroke, traumatic brain injury) or multiple sclerosis.
7. **Ataxia**	Neurological sign and symptom consisting of lack of co-ordination of muscle movements. When injury occurs in children under the age of 2, term cerebral palsy is often used, but may also be due to brain injury (e.g. stroke, traumatic brain injury) or multiple sclerosis.
8. **Athetosis**	Can vary from mild to severe motor dysfunction. Generally characterized by unbalanced, involuntary movements of muscle tone and difficulty maintaining a symmetrical posture. When form an injury occurs in children under age of 2 years, the term cerebral palsy is often used, but may also be due to brain injury (e.g. stroke, traumatic brain injury).
9. **Vision impairment**	From either impairment of the eye structure, optical nerves or optical pathways, or visual cortex of the central brain.
10. **Intellectual impairment**	The Paralympic Movement identifies intellectual impairment as "a disability characterized by significant limitation both in intellectual functioning and in adaptive behaviour as expressed in conceptual, social and practical adaptive skills. This disability originates before the age of 18" (American Association on Intellectual and Developmental Disabilities, 2010). Diagnostics of intellectual functioning and adaptive behaviour must be made using internationally recognized and validated measures recognized by INAS (International Federation for sport for para-athletes with an intellectual disability).

After (World Health Organisation, 2016)

In addition to other criteria, each sports code must define what impairment/s are applicable for their sport. This is based on the classification rules for each sport code. It is such that some sports codes are applicable for all types of impairments (e.g. para-swimming or para-athletics). On the other hand there are sports codes that are specific for an impairment type (e.g. goalball), or for a number of impairments (for example cycling and equestrian).

1.2.1 Injuries in para-athletes

The consistency and accuracy of data from injury studies of para-athletes with disabilities and the Paralympic Games have been difficult to obtain and interpret (Derman, et al., 2013). As with many reports of sports related injuries, adequate surveillance of data collection allowing comparison is fraught with flaws related to different methodologies including differences in injury definitions, reporting mechanisms, compliance in reporting and differences among sports. The need for focused sport specific longitudinal epidemiological studies addressing the health and injury profiles in Paralympic athletes is therefore recognized (Ferrara & Buckley, 1996; Webborn & Emery, 2014). Para-athletes present with unique biomechanical changes and limitations, which may predispose them to subsequent injury. These physical limitations include altered range of motion, muscle strength, sensation and postural balance; increased muscle tone and hyperreflexia. Furthermore, the use of the entire kinetic chain for sports specific tasks and movements may lead to increased risk for tissue overload/overuse injuries (Wilson & Clayton, 2010). Any one or more of these impairments will alter movement of para-athletes through limitations in range of movement; or from non-coordinated movements. This will cause unusual strains and force vectors in the musculoskeletal system, which may often be

uncontrolled. Repetitive type injury and overuse injuries are therefore common in para-athletes (Ramirez, et al., 2009). Physical impairments and neurological disorders may cause lack of coordination in movement and impaired balance which could increase risk of falling and therefore risk of extrinsic traumatic injury.

The winter Paralympic Games present with different exposures and risk for injury when compared to the Summer Paralympic Games. Webborn et al (2005) conducted a prospective injury surveillance study during the 2002 Winter Paralympics on the various types of injuries as well as risk factors of injuries sustained by para-athletes at elite level. They reported 39 injuries involving 9% of the Paralympic athletes. Most were of acute, traumatic onset and involved disciplines of alpine skiing and sledge hockey. They stated that within the same sports codes the pattern of injuries was similar to able bodied athletes. However in para-athletes there are some distinctive risks. They suggested that several of the more severe injuries were potentially preventable. Although injuries and risk of injuries in the Summer Paralympic Games may not be the same, the principle that they may be similar to able-bodied athletes is something that has not been determined. Indeed the notion that many injuries are potentially preventable makes the study of injuries in Summer Paralympic Games all the more important. Most studies have been retrospective in nature and limited to the analysis of data from surveillance recording systems and sample populations. For example, wheelchair para-athletes with spinal-cord injuries present with varying levels of impaired truncal and pelvic instability depending upon the severity and level of injury. This influences and varies risk for acute and/or chronic injuries which have been reported differently in different studies

(Webborn & Emery, 2014). Further, many studies do not report on exposure so rates data are sparse.

There has been only one detailed analysis, from the 2012 Summer Paralympic Games, reporting the injuries as incidence rates (IR) and incidence proportions (IP) (Derman, et al., 2013). Injuries in the context of the London Paralympic Games 2012 was defined as any injury for which the para-athlete sought medical attention, irrespective of whether they could continue participating in training or competition (Derman, et al., 2013). Injuries were further defined as any acute (newly acquired and caused by an acute precipitating traumatic event) or exacerbation of a pre-existing injury during either training or competition in the 14 day period before and during the London Paralympic Games (Derman, et al., 2013). An acute on chronic injury fulfilled the definition of an acute injury, but in the anatomical location of a chronic injury. The latter was an injury that developed over no less than several days and had no acute precipitating event associated with it. The ratio of acute to chronic injuries is usually in the region of 60:40 (Willick, et al., 2013) and in some contact sports as much as 80:20 (Magno e Silva, et al., 2012). At the London Paralympic Games of 2012 the ratio of acute to chronic injuries was similarly reported as 70:30 (Derman et al., 2013).

1.2.1.1 Injury patterns

Injury patterns in para-athletes are not dissimilar to able-bodied athletes (Klenck & Gebke, 2007), however specific injury types have been identified for certain groups of para-athletes : wheelchair para-athletes typically sustain upper

extremity injuries, visually impaired para-athletes lower extremity injuries, and cerebral palsy para-athletes sustain both upper and lower limb injuries (Nyland et al., 2000; Silva et al., 2013). In addition to the expected musculoskeletal stresses an athlete faces, para-athletes may have additional risk related to adaptive or assistive devices (Nyland et al., 2000). This leads to differences in soft tissue injuries as reported by different disabled sports organizations, and Nyland et al (2000). Musculoskeletal injuries may have a bigger impact in a para-athlete than the able-bodied athlete (Blauwet & Willick, 2012). Para-athletes usually adapt and become adept in activities of daily activity, and even more so in participating in their sport. In addition the already strained kinetic chain of these elite para-athletes may be such that it has less reserve to accommodate for changes from injury. Injury management and relative rest may be more awkward or burdensome for these para-athletes to cope with. Injuries may therefore be defined as more severe if considering time to recover (Ferrara & Buckley, 1996). The psychological impact of an injury may be significant, and may have a negative effect on their recovery (Blauwet & Willick, 2012).

Injury rates in Paralympic athletes have been reported ranging from 9.45/1000 athlete exposures (Ferrara & Buckley, 1996) to 12.7/1000 athlete-days with an incidence proportion of 11.6% (Derman, et al., 2013). Ferrara et al (2000) reported injuries in para-athletes from the USA Paralympic trials of the World Games, World Athletic Championships and both the 1992 and 1996 Paralympic Games. Injury proportions were between 1.7 – 27.8% of participants. Of these injuries 79.7% were musculoskeletal. Sobiecka (2005) reported that 46% of the 125 participants of the Polish Paralympic Team of the Summer Paralympic Games of 2000 had presented with injuries; similar to the report of Burnham et

al (1991) with 51% of the Canadian Team at the 1988 Seoul Paralympic Games that presented with musculoskeletal complaints. Richter et al (1991) reported an injury frequency of 36% in the group of para-athletes with cerebral palsy from the 1988 Seoul Paralympics. Such large variations is due to differences in methods of data collection, definitions of injury, different sporting codes with their specific injury risks and methods of reporting results. Although wide ranges of injury rates in para-athletes have been reported, consistently the majority have been of the musculoskeletal system.

1.2.1.2 Anatomical locations

Musculoskeletal injuries are commonly found in para-athletes competing in track and field events as well as 5-a-side football .(Ferrara & Buckley, 1996; Magno e Silva, Morato, Bilzon, & Duarte, 2012) These musculoskeletal injuries' location varies in para-athletes of different disabilities. For example, lower limb injuries predominate in some sports such as athletics as compared to others. During the London 2012 Paralympic Games, the most prevalent injuries incurred were of the upper limbs (35%) followed by lower limbs (32%); the rest were all other anatomical regions (13.7%) (Derman, et al., 2013; Willick, et al., 2013). Earlier research found para-athletes in wheelchairs have a higher incidence of upper limb injuries to the elbow-arm and forearm-wrist areas (Nyland et al., 2000) Similarly, in the events reported by Ferrara et al (2000), most injuries were in the upper body (25% upper limb; 13% thorax/spine). In Ferrara et al's paper (2000), injuries to the shoulder complex comprised 12.8% of all injuries, and were similar to the frequency reported by Nyland et al (2000) in the USA Paralympic team of the 1996 Summer Games (17%). The British Paralympic

Team of the 1992 Barcelona Summer Paralympic Games reported 24% of injuries occurring in the upper limb (Reynolds et al.,1994).

1.2.1.3 Mechanism of injuries

In some Paralympic athletes biomechanical consequences related to their impairment leads to differences to able-bodied athletes with respect to muscle activation, power output, force vectors, neuromuscular integration and other factors. These physiological considerations, combined with use of assistive devices including prostheses, wheelchairs (for both locomotion and sport) and indeed the sport-specific stressors, increase the risk for both acute and chronic injury (Nyland et al., 2000; Webborn & Van de Vliet, 2012; Burnham et al., 1991). The inherent disability not only increases risk of injury due to the increased possibility of falls and abnormal musculoskeletal movements, but also of overuse injury. This is further exacerbated by the addition of these assistive devices. The extension of the kinetic chain with inanimate objects in the form of assistive devises changes mechanics and biomechanics with the intention of providing better stability and ability in daily function and sporting activity (Webborn & Van de Vliet, 2012; Wilson & Clayton, 2010)). However, this is undertaken without additional proprioception and changes in the mechanics that the para-athlete is perhaps adapted to, which may increase acute injury risk. Changing the dynamics of muscle activation and movement could lead to overuse injuries from the repetitive strain in using certain muscle groups. The regular use of these devices adds additional pressure on certain body areas and increases the risk and incidence of overuse injuries as well as complications including pressure sores, calluses, skin irritation and perhaps

subsequent infection. Furthermore, contact injuries from scrapes and falls are not uncommon, which leads to skin abrasions and bruising. More injuries occur during competition than during training (Willick, et al., 2013), which is also found in able-bodied athletes and in all sporting codes (Johnson et al., 2009; Lee & Garraway, 1996). Injury mechanism are therefore mostly acute traumatic injuries which occur with activity, and more so in competition rather than in training; and overuse injuries are due to repetitive movement which may be exacerbated by assistive devices.

1.2.1.4 Severity of injuries

Injury severity is usually based on time loss from sports participation and are variably defined as mild, moderate an severe (Fuller, et al., 2007). This is determined by; absence from and the duration of absebnce from training and competing.. In Paralympic athletes, severity of injuries has been variably reported as 50% being minor (time loss of up to a week) and 20% being severe (more than three weeks' time loss) (Ferrara & Buckley, 1996). Ferrara and Buckley (1996) further reported data from an injury registry of para-athletes in the USA. They reported injury severity in descending order of magnitude as minor (0-7 days off), moderate (8-21 days off) and severe (22 and more days off) (52%, 29%, and 19% respectively). More than half the injuries in their study were minor and varied between 0 - 7 days off. Injury severity is also inconsistently reported in the literature. Fuller et al (2007) suggested that severity be defined and grouped as slight (0–1 days off), minimal (2–3 days off), mild (4–7 days off), moderate (8–28 days off), severe (>28 days off), ''career-ending'' and ''non-fatal catastrophic injuries' (Fuller, et al., 2007). Unless data is

reported this way, many injuries that are slight or minimal could be grouped with injuries that are mild or moderate. No-time off injuries are not being reflected in injury data reports, yet they may have an influence on future injury, or risk of injury recurrence (Hagglund et al., 2006). No data from the 2012 London Paralympic Games have been reported in the literature with respect to severity.

1.3. Illnesses in Paral-athletes

There is a paucity of data on illnesses in competing para-athletes. Data prior to 2005 described mostly minor incidence of fungal skin infection, insect bites, upper respiratory tract infections, headaches, insomnia, diarrhoea & vomiting (Reynolds et al., 1994; Sobiecka, 2005). The collection of data related to illness in the 2012 London Paralympic Games, has been recognized as an important determinant for para-athletes athletes (Webborn & Van de Vliet, 2012 (Derman, et al., 2013). Illness may have direct effects on an athlete and also on fellow athletes. An illness may be mild and cause small but significant effects on an athlete's performance. It may be more severe and exclude them from training or competition for a day or several days. Unlike an injury, which will influence an individual para-athlete, it may also affect other para-athletes if it is contagious, and have an impact on the whole team. At the 2012 London Summer Paralympic Games, illness in para-athletes was defined as a medical condition of any newly acquired illness as well as an exacerbation of a pre-existing illness during the 14 day period before and during the Games (Derman, et al.,2013). Illness information in para-athletes is sparse, with the data from the London 2012 Paralympic Games providing the first large scale systematic analysis of illness. The findings were in keeping with the few other reports on medical problems

amongst Paralympic para-athletes; namely to the respiratory tract system, the gastrointestinal tract and skin problems (Burnham et al.,1991; Schwellnus, et al., 2013; Sobiecka, 2005). The most common illness recorded and reported was of the respiratory system (39.5%), followed by the digestive system (15.8%), skin and subcutaneous tissue (11.8%). Other conditions, affecting genitourinary, nervous, ears, eyes and other systems combined made up had less than ten percentage. The incidence rate (IR) of illness among the 3329 para-athletes' data from the Summer Paralympics was 8.3 per 1000 where 9.2% of para-athletes reported illness (Derman et al., 2014). This was less than reported in previous studies by the authors (12.8 and 13.2 per 1000 athlete days) (Derman, et al., 2013; Schwellnus, et al., 2013), where they speculated the reason could be that their study did not include data from teams without their own medical support personnel (256 para-athletes from 82 participating countries).

It is therefore important to gather such data, in order to better understand and determine injury and illness patterns in competition and reduce their risk and incidence, and the Summer Paralympic Games affords the opportunity for this. It allows for a controlled and standardised environment for data capturing which for individual para-athletes in their respective sport during non-competition times is inconsistent.

2. Setting and Outline

In 1944, Sir Ludwig Guttman considered that athletic competition was useful as part of a rehabilitation programme for patients with spinal cord injuries at the Stoke Mandeville Hospital in the District of Aylesbury Vale, England. (McCann, 1996). The hospital treated spinal injuries after World War II which lead to the establishment of a specialized spinal unit under the directorship of German ex-patriate Sir Guttman. After introducing sport as a tool for rehabilitation, he established the Stoke Mandeville Games in 1948, to encourage the competition element of the Games. The competition between patients with disabilities led to international recognition and growth, and eventually the Paralympic Games were started in 1960. In the first iteration of the Games, four hundred para-athletes and support staff from 23 countries participated, but only in para-wheelchair sports (athletics [field events], fencing, precision javelin, swimming, snooker, table tennis and wheelchair basketball) (McCann, 1996; Blauwet & Willick, 2012).

There has been rapid growth in this competition since its inception. Indeed, over 3800 para-athletes representing over 100 nations participated in the Beijing Summer Games of 2008 (Blauwet & Willick, 2012), and in the London Summer Paralympic Games of 2012, 4,200 para-athletes from 150 countries in over 20 sports participated (Schwellnus, et al., 2013;Derman, et al., 2013). With the growth in participation, strides have been made in the preparation of the Paralympic Games including venue access for para-athletes with disabilities and closer alignment with the Olympic Games (Gold & Gold, 2007).

Physically challenged para-athletes present with unique biomechanical changes and limitations, which may predispose them to subsequent injury. These physical limitations include altered range of motion, muscle strength, sensation and postural balance; increased muscle tone, and hyperreflexia. Furthermore, the use of the entire kinetic chain for sports specific tasks and movements may lead to increased risk for tissue overload/overuse injuries (Wilson & Clayton, 2010; International Paralympic Committee, 2016).

Common problems affecting para-athletes using wheelchairs include autonomic dysreflexia, difficulty with thermoregulation, pressure sores, neurogenic bladder, premature osteoporosis, peripheral nerve entrapment syndromes, and chronic upper extremity injuries. Some of these medical conditions may even influence risk of injury (Neal & Fields, 2010). Para-athletes with amputations experience injuries to the stump, spine, and intact limbs (Wilson & Clayton, 2010).

However, the consistency and accuracy of capturing information on injuries during the Paralympic Games has been difficult to obtain and interpret. As with many reports on sports related injuries, adequate surveillance of data collection allowing comparison, is fraught with flaws related to different methodologies and populations including differences in injury definitions, reporting mechanisms and compliance in reporting. There is also no consistency in reporting of specific sports or disabilities, and therefore specific risks cannot be evaluated (Faqher & Lexell, 2014). Furthermore, there is a paucity of data on illnesses in competing Paralympic para-athletes, with mostly minor incidence of fungal infection, insect bites, upper respiratory tract infections, headaches, insomnia, diarrhoea &

vomiting (Reynolds et al., 1994; Sobiecka, 2005). Therefore the need for focused sport specific longitudinal epidemiological studies addressing the health and injury profiles in Paralympic para-athletes is recognized (Ferrara & Buckley, 1996; Webborn & Emery, 2014).

Using a standardized web-based data-collection tool in the setting of the largest Paralympic Games allowed the opportunity for injury and illness analysis not previously possible (Derman et al., 2013). Whilst injury and illness profiles have been determined for the large cohort of para-athletes who attended the London 2012 Summer Paralympic Games, it was apparent that there was a large variation in rates and proportions of both injury and illness in the various teams participating in the competition (Derman, et al., 2013; Schwellnus, et al., 2013; Willick, et al., 2013). The collection of data related to illness was recognized as an important determinant for Paralympic para-athletes (Webborn & Van de Vliet, 2012), and was studied for the first time at these 2012 London Paralympic Games (Derman, et al., 2013).

The increase in knowledge of injuries and illness will provide knowledge that will assist in the profiling of risk and provide solutions to reducing risk; and injury and illness prevention (Webborn 2012). Yet, sub-analyses of individual countries, different sport types and different disabilities have yet to be conducted. Such an analysis is important to undertake in order to determine the types of injuries and illnesses para-athletes at the Summer Paralympics are at risk for, and to determine if South African para-athletes have similar profiles of injuries and illness when compared to the rest of the world. Furthermore, whist patterns of injury and illness in the South African Olympic team is known (Derman, et al.,

2013), few data exits when considering injury and illness in the South African Paralympic team.

The most commonly cited model of sports injury prevention is Van Mechelen's sequence of prevention model. This follows a four-step approach which is presented as a logical sequence (Van Mechelen et al., 1992). The first step in the model is to establish the incidence of injuries, or the extent of the problem. The same principles would apply to incidence of illness.

This dissertation forms an important link in the model for garnering data of illness and injury in South African Paralympic Athletes. This information would be important for the medical and administrative staff in planning the medical support to and for the teams traveling to future competition, not only in managing but also in providing strategies for the prevention of injuries and illness (Webborn, 2012; Enock & Jacobs, 2008).

3. Purpose of the study

Aim:

The aim of the study was to describe the illness and injury profiles in South African elite para-athletes who participated in the 2012 Summer Paralympic Games.

Specific objectives:

The specific objectives in this study were to study the elite South African para-athletes who participated in the 2012 Summer Paralympic Games, and:

1. Describe details of injuries including the type, location and mechanism of injury in the period immediately prior to and during the Games.
2. Describe the incidence and nature of illnesses in the period immediately prior to and during the Games.
3. Compare rates of injury and illness in the South African para-athletes with other countries who participated at the 2012 Paralympic Games.

4. Study

Methodology

Study design

This study is a retrospective sub-analysis of the data-set collected from a large prospective study of injury and illness at the London Summer Paralympic Games in 2012.

Data source

Data collected on injury and illness surveillance over the course of the two-week period of the 2012 Summer Paralympic Games was analysed. Data of the Games from participating countries was retrieved and published following the provision of information by the medical personnel of participating countries via a password-secured web-based platform (WEB-IIS) (Derman et al., 2014). Data sets completed included age, gender, sport, injury details (type, mechanism), and illness detail (Derman, et al., 2013). The data for the South African Paralympic para-athletes was captured and added to the WEB-IIS by the Chief Medical Officer of the team.

Number of participants

Eighty five percent of all the participating para-athletes' (3565) information was collected during the large prospective study (Schwellnus, et al., 2013). The information retrieved from the online WEB-IIS system reflected data over 46 606

athlete days. The data regarding injury and illness in the South African Team were collected by the Chief Medical Officer and inputted daily into the WEB-IISS system. Following analysis for the 3565 para-athlete data sets post-Games, data specific to the South African Team were extracted and de-identified. There were 62 para-athletes in the South African team, with a total exposure of 868 athlete-days over the 14 day days of competition. The South African para-athletes competed in seven sports codes (para-athletics, para-swimming, para-cycling, para-equestrian, para-rowing, para-wheelchair basketball and para-wheelchair tennis); and were cared for by a medical team comprising nine members (two medical doctors, seven physiotherapists). .

Inclusion and exclusion criteria

All medical data on injuries and illness reported three days before the start of competition, and the 11 days of competition, were included in the analysis.

Study Site

The Paralympic Games in London 2012.

Data analysis

Data was analysed in the form of counts, that is, number of illnesses and/or injuries each para-athlete had or contracted and reported as incident rates, calculated per 1000 athlete-days. Incidence rate is reported as a measure of the frequency with which an injury or an illness occurred in the population over a period of time, namely during the Paralympic Games of London, 2012 (incidence rate = [number of cases occurring over the prescribed time period /

population at risk] * 10^n), where the denominator is the sum of the person-time of the at-risk population. Incidence proportion (IP) (also referred to as cumulative incidence) is the number of new cases within the specified time period divided by the size of the population at risk.

Data were analysed using a statistical software package (SAS) and descriptive data of injuries and illnesses presented as numbers, proportions/percentages (including 95% Confidence Intervals [CI]) and incidences (including 95% CIs). Comparisons were done using t-test and chi-square statistics. Significance was set at $p<0.05$. Statistical analysis was conducted with the assistance of the statisticians of the Medical Research Council of South Africa.

Ethical considerations

Original data collection research was subject to ethical clearance for research by both University of Brighton (FREGS/ES/12/11) and University of Cape Town Health Sciences Research Ethics Committee (HREC/REF436/2012). Prior to the Games, all para-athletes consented to the use of their medical data for research purposes and all information was de-identified and stored on a secure server. The supervisor of this dissertation (Chief Medical Officer of the South African Team at the 2012 Paralympic Games) was a co-investigator of the original research protocol and ethics application and collected the data for Team South Africa. This was done using a daily injury and illness record sheet and data were inputted into the WEB-IISS system. Data were confidential and no individual para-athletes were identified in the results. Ethics committee

approval for the sub-analysis was approved by the University of Cape Town's Human Research Ethics Committee (Ref 346/2015, appendix [pg60])

Para-Athlete profiles

The demographic profiles of the South African team are displayed in Table 1. Most of the team were under the age of 35 (n=47, 76%) and male (n=44, 71%), in keeping with the profile of the London participants (65.8%). This is also in keeping with the overall age of the para-athletes that competed in the London Paralympic Games, where the mean (+SD) age was 30 ± 9 years (range 13-67 years).

The majority of the participating para-athletes competed in athletics and para-swimming (n= 35, 56%). The dispersion of disabilities in the South African team when compared to all countries was similar in some (e.g. spinal cord injury and limb deficiency) and somewhat different in others (e.g. intellectual disability). Athletics had the highest number of participants (25 para-athletes), followed by the para-basketball team (12 para-athletes) and the para-swimming squad (10 para-athletes). There were 6 para-cyclists in the South African team. Thirty two percent of the para-athletes had amputations or limb deficiencies and 24% had cerebral palsy (Table 2).

Table 2:
South African para-athlete demographics for the 2012 Paralympic Games

	n	%
Gender		
Males	44	71
Females	18	29
Age		
13 to 25 yrs	23	37.0
26 to 34 yrs	24	39.0
35 to 67 yrs	15	24.0
Sport		
Para-Athletics	25	40
Para-Cycling (road)	6*	9.7
Para-Cycling (track)	2*	3.2
Para-Equestrian	4	6.5
Para-Rowing	1	1.6
Para-Swimming	10	6.2
Para-Wheelchair basketball	12	19.3
Para-Wheelchair tennis	4	6.5
Total	**62**	**100**

* 2 cyclists competed in both track and road

Disabilities

The athlete disabilities by international classification of the South African Team are displayed in Table 3. Most were classified in the groups of physical disabilities (limb deficiency, spinal cord injury and cerebral palsy; 77.5%).

Table 3:
Demographic of the disabilities in South African Paralympic athletes

Disability	South Africa n (%)	All other countries n (%)	Total n (%)
Intellectual disability	**0**	439 (12.5)	439 (12.3)
Les autres (LA)	5 (8)	183 (5.2)	188 (5.3)
Cerebral palsy	15 (24.2)	524 (15)	539 (15.1)
Amputation/limb deficiency	20 (32.3)	899 (25.7)	919 (25.8)
Spinal cord injury	13 (21)	754 (21.5)	767 (21.5)
Visually impaired	9 (14.5)	704 (20.1)	713 (20)
Total n (%)	**62 (100)**	**3503 (100)**	**3565 (100)**

n para-athlete numbers , % percentage of total para-athletes. Most South African para-athletes were in the category of amputation or limb deficiency, followed by cerebral palsy and spinal cord injury; similar proportions to all country para-athletes. There were 439 para-athletes whom we did not have a disability code for. LA included 'other' (for example dwarfism, multiple sclerosis, and congenital deformities of the limbs).

5. Results

A total of 3565 para-athletes participated in the 2012 London Paralympic Games, of which 62 were South African Paralympic para-athletes. It should be noted that due to the nature of the research, the number of South African para-athletes was relatively small and therefore inferential statistical analysis was not performed. The data presented are therefore descriptive. Reported confidence intervals (CI) were set at 95%. Results of injuries per athlete days are reported as incidence rates and incidence proportion is reported as percentage of para-athletes with injury or with illness.

5.1 Para-Athlete injuries

In the 62 South African (SA) para-athletes, 19 injuries in 17 para-athletes were assessed and treated by the medical team (Table 4). Of the almost one third of para-athletes with an injury (27.4%), the injury proportion in the South African team was 21.9 /1000 athlete days (95%CI: 13.2-34.2) (Table 4). In the SA female para-athletes the injury rate was 31.7/1000 athlete days (95%CI=13.7-62.6) and in SA males 17.9/1000 athlete days (95%CI=8.9-32) (Table 4). All country para-athlete injury rates were similar in male (437 injuries (IR=13.3 injuries/ 1000 athlete-days (95% CI 12.1 to 14.6)) and female para-athletes (IR=11.5 injuries/1000 athlete-days (95% CI 9.9 to 13.2)) (Willick, et al., 2013). Most of the injuries occurred in the lower limb (n=9, 47%) (Table 6). Further detail of the injury rates per disability, age and sport are reported in Table 5 and Figure 1, and anatomical regions affected are reported in Table 6.

Table 4: Incidence rate and percentage of South African and all other countries para-athletes with reported injury

	South Africa				All other countries			
	number	SE*	95% CI		number	SE*	95% CI	
Para-Athletes (n)	62				3503			
INJURIES								
Total injuries reported (n)	19				614			
Injury rate per 1000 athlete days	21.9		13.2	34.2	12.5		11.5	13.6
% of para-athletes with an injury	27.4(n=17)	5.7	16.3	38.5	14.9 (n=92)	0.6	13.7	16.1
IP	30.6	5.9	19.2	42.1	17.5	0.6	16.3	18.8

Abbreviations: SE, standard error; IP, incidence proportion. South African para-athletes had a higher injury rate than all other countries. Incidence time: the times at which new disease occurs among population members. Incidence rate: the occurrence of new disease per unit of person-time=(no of disease onset)/(sum of person@risk)=19/868=21.9. Incidence proportion: proportion of people who develops new disease during a specified period of time=(no of disease onset)/(no of persons initially @ risk)=19/62=30.6. Prevalence: the proportion of people who have disease at a specified time=no of cases/pop size=17/62=27.4

Table 5: Rates of injury for gender, age, disability and sport in the South African Paralympic team

	Number of para-athletes / number of injuries				number of para-athletes	number of injuries	number of para-athletes with injuries	IR injury rate per 1000 athlete days	IP Injury Proportion
	0	1	2	3					
GENDER									
Female	12	5	0	1	18	8	6	31.7 (CI=13.7-62.6)	44.4
Male	33	11	0	0	44	11	11	17.9 (CI=8.9-32)	25.0
AGE									
13 to 25 yrs	18	4	0	1	23	7	5	21.7 (CI=8.7-44.8)	33.3
26 to 34 yrs	16	8	0	0	24	8	8	23.8 (CI=10.3-46.9)	26.7
35 to 67 yrs	11	4	0	0	15	4	4	19.0 (CI=5.2-48.8)	44.4
DISABILITY									
Misc*	5	0	0	0	5	0	0		
Cerebral palsy	13	2	0	0	15	2	2	9.5 (CI=1.2-34.4)	
Amputation / limb deficiency	13	7	0	0	20	7	7	25.0 (CI=10.1-51.5)	
Spinal cord injury	7	6	0	0	13	6	6	33.0 (CI=12.1-71.8)	
Visually Impaired	7	1	0	1	9	4	2	31.7 (CI=13.2-34.2)	
SPORT									
Para-Athletics	18	6	0	1	25	9	7	25.7 (CI=11.8-48.8)	
Para-Swimming	8	2	0	0	10	2	2	14.3 (CI=1.7-51.6)	
TOTAL	**45**	**16**	**0**	**1**	**62**	**19**	**17**	**21.9 (CI= 13.2-34.2)**	

Abbreviations: SE, standard error; IP, incidence proportion. South African para-athletes had a higher injury rate than all other countries. Incidence time: the times at which new disease occurs among population members. Incidence rate: the occurrence of new disease per unit of person-time=(no of disease onset)/(sum of person@risk)=19/868=21.9. Incidence proportion: proportion of people who develops new disease during a specified period of time= (no of disease onset)/(no of persons initially @ risk)=19/62=30.6. Prevalence: the proportion of people who have disease at a specified time=no of cases/pop size=17/62=27.4

Table 6: Injury incidence by anatomical area

	Number of injuries	Incidence (95% CI)	Incidence Proportion (95% CI)	Number of para-athletes with injuries	Percentage of para-athletes with injuries
Upper limb	4	4.6 (CI=1.3-11.8)	6.5 (CI=0.3-12.6)	4	6.5
Lower limb	9	10.4 (CI=4.7-19.7)	14.5 (CI=5.7-23.3)	9	14.5
Axial	6	6.9 (CI=2.5-15.0)	9.7 (CI=2.3-17.0)	5	8.1
Total	**19**	**21.9**		**18**	**29.1**

Abbreviations: CI = confidence interval, IP = Incidence proportion

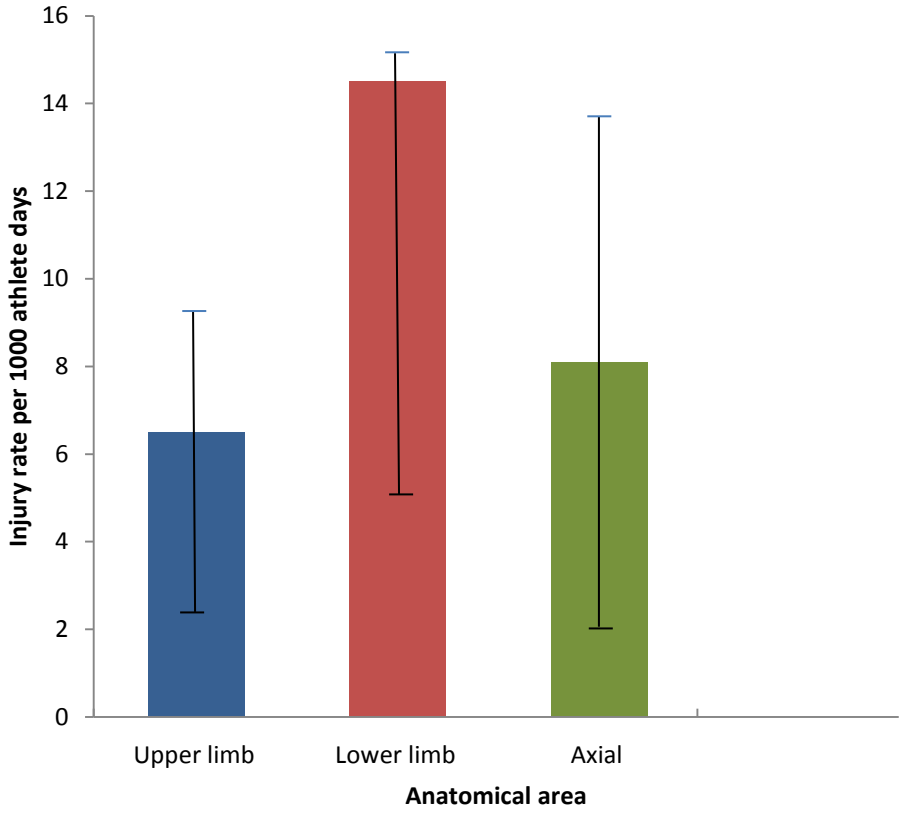

Figure 1: Injury rates by anatomical area of the South African Paralympic athletes

Figure 1 shows that most injuries occurred in the lower limb (n=9), followed by the axial area (n=6), then upper limb (n=4). The incidence rates were however not statistically different.

5.2 Para-Athlete illness

A similar percentage of para-athletes from the South African team presented with illness (27.4%) as they did with injury, but with a higher number of injuries (25 vs 19), making the incidence proportion for illness as high as 40 compared to 31 for injury (Table 7). The illness rate was found to be 28.8 / 1000 (CI=18.6-42.5) (Table 8). This was higher than for other countries (IR=12.9, 95%CI: 11.9-13.9). Illnesses were reported in three main areas, namely the skin/subcutaneous tissue, digestive/gastrointestinal system and respiratory system (Table 9). Details of the illness rates per disability, age and sport are reported in Table 8. The nature of illness in the South African para-athletes was similar to that seen in all countries.

Table 7: Incidence rate and percentage of para-athletes with reported illness

	South Africa			All other countries		
	n	95% CI		n	95% CI	
Para-athletes	62			3503		
ILLNESS						
Total illness reported (n)	25			632		
Illness rate per 1000 athlete days	28.8	18.6	42.5	12.9	11.9	13.9
% of para-athletes with illness	17 (27.4%)	16.3	38.5	88 (13.9%)	12.8	15.1
IP	40.3	28.1	52.5	18.0	16.8	19.3

Abbreviations: CI = confidence interval; IP = Incidence proportion; SA = South Africa; n= number

Table 8: Rates of illness for gender, age, disability and sport in the South African Paralympic team

	Number of para-athletes / number of illness				Number of para-athletes	number of illness	number of para-athletes with illness	Illness rate per 1000 athlete days (95 % CI)	IP
	0	1	2	3					
TOTAL	**45**	**10**	**6**	**1**	**62**	**25**	**17**	**28.8 (18.6-42.5)**	
GENDER									
Female	12	4	2	0	18	8	6	31.7(13.- 62.6)	44.4
Male	33	6	4	1	44	17	11	27.6 (16.1-44.2)	38.6
AGE									
13 to 25 yrs	20	2	1	0	23	4	3	12.4 (3.4-31.8)	58.3
26 to 34 yrs	14	6	4	0	24	14	10	41.7 (22.8-69.9)	46.7
35 to 67 yrs	11	2	1	1	15	7	4	33.3 (13.4-68.7)	44.4
DISABILITY									
Misc*	5	0	0	0	5	0	0		
Cerebral palsy	12	2	1	0	15	4	3	19 (5.2-48.8)	
Amputation / limb deficiency	11	6	2	1	20	13	9	46.4 (24.7-79.4)	
Spinal cord injury	9	2	2	0	13	6	4	33 (12.1-71.8)	
Visually Impaired	8	0	1	0	9	2	1	15.9 (1.9-57.3)	
SPORT									
Para-Athletics	17	5	3	0	25	11	8	31.4 (15.7-56.2)	
Para-Swimming	7	2	1	0	10	4	3	28.6 (7.8-73.2)	

Abbreviations: Misc = intellectual disability and les autres; CI = confidence interval; IP = Incidence proportion; SE = standard error; IP = incidence proportion.

Of the total burden of illness, the highest illness rates occurred in female para-athletes (IR=31.7, 95%CI: 13.7-62.6) and in the age group 26-34 years (IR=41.7, 95%CI:22.8-69.9). For disability categories, the highest illness rates were in para-athletes with amputation/limb deficiency (IR=46.4, 95%CI: 24.7-79.4) followed by spinal cord pathology (IR=33.0, 95%CI: 12.1-71.8).

Table 9: Illnesses by system affected in South African and all other countries para-athletes

Physiological System	All countries illness number n (%)	South Africa illness number n (%)
Respiratory	152 (39.5)	11 (44)
Digestive	61 (15.8)	8 (32)
Skin & subcutaneous	45 (11.8)	4 (16)
All illnesses	**385 (100)**	**25 (100)**

The number and percentages for illness are presented in the table, with incidence rates for respiratory illness being 12.7/1000 (95%CI: 6.3-22.7). The incidence rate for digestive illness of 9.2/1000 (95%CI: 4.0-18.2) and skin of 4.6/1000 (1.3-11.8) were both lower than that of respiratory illness.

6. Discussion

This study set out to describe the nature of injury and illness amongst South African Paralympic athletes at the London 2012 Paralympic Games and to determine whether they are similar to those of other countries. It is important to determine if such profiles differ in a single team and to evaluate what approaches may be taken to change the profile if necessary to reduce the injury and illness rates. This implies preparation of para-athletes; medical team support and general para-athlete support in their home country must be contextualised and optimised.

Data from illness and injury surveillance in the para-athletes competing in the 2012 London Summer Paralympic Games using a web-based surveillance system for medical staff formed the basis of the research presented here. This same database was used to report for the first time comprehensive data on both injury and illness from the Paralympic Games (Derman, et al., 2013); which was also the largest Paralympic event held to date.

The most important finding in this study highlighted an overall higher injury rate in the South African para-athletes, when compared to the injury rate in para-athletes from all the other countries at the London Paralympic Games; where the IR was found to be 21.9 /1000 athlete days (95% CI13.2-34.2) (Table 4). Willick et al (2013) however showed the overall injury rate in the 2012 Paralympics to be 12.7 (95%CI 11.5-13.36).

In the 62 South African para-athletes, there were 19 injuries in 17 para-athletes (27.4% of the para-athletes presented with injuries), with an incidence rate of

21.9 /1000 athlete days representing an incidence proportion of 30.6%. All the other countries showed a lower percentage of para-athletes that presented with injuries (14.9%) and an injury rate of 12.5 / 1000 athlete days (IP of 17.5%).

The second important finding was the illness rate amongst South African Paralympic athletes appeared to be higher than the other countries, where of the 3503 para-athletes, 88 (13.9%) presented with 632 illnesses. Seventeen of the 62 para-athletes in the South African team, with 25 documented illnesses, sought medical treatment for their condition. This presented an illness rate of 28.8 per 1000 athlete days with an incidence proportion of 40.3%. In all countries the incidence rate was lower, with 12.9 illnesses per 1000 athlete days (incidence proportion 18%).

In this research it was found that the incidence rate of injuries in the South African Team was 21.9 /1000 athlete days, which occurred in almost a third of the para-athletes (27.4%). The incidence rate of injuries in all countries was 12.7 injuries per 1000 athlete-days (Willick, et al., 2013). Most of the injuries occurred in the lower limb (n=9, 47%). The illness rate was found to be 28.8 (CI=18.6-42.5) Most reported illnesses were in the three regions comprising the skin/subcutaneous tissue, digestive / gastrointestinal system and respiratory system.

What follows from here is a more detailed discussion of the breakdown of injury and illness data and compared to the existing literature. Comparisons to other teams of a similar size could not be made as their data were not available to the researcher and not published.

6.1 Para-Athlete profiles

Most of the South African team were under the age of 35 (n=47, 76%) and were similar with the overall age of the para-athletes that competed in the London Paralympic Games, and to other Paralympic competitors (Sobiecka, 2005) . As with the other competitors of the London para-athletes, the majority of the South African Team were male and in line with the profile of other Paralympic team participants (Reynolds et al., 1994l; Sobiecka, 2005; Magno e Silva et al., 2012).

6.2 Para-Athlete injuries

The injury rate in the South African Team being higher than the other countries was noted as the most important finding. Injuries in para-athletes have been variably reported. Some have ranged between 14.9% and 27.8% of para-athletes presenting with injuries (Ferrara et al, 2000). Sobiecka (2005) did not report on injury rates, but rather that 45% of the medical team consultations (out of 269 consultations for a team of 114 competitors) were for injuries to the motor system. Similarly Nyland et al (2000) reported 67% acute onset soft tissue injuries in the USA Paralympic team athletes at the 1996 Summer Paralympic Games, and the Canadian Team at the 1988 Seoul Games had 51% of their para-athletes present with musculoskeletal conditions (Burnham et al., 1991).

In the South African Team the injury rate in females was 31.7/1000 athlete days (CI=13.7-62.6) and in males 17.9/1000 athlete days (CI=8.9-32). In all countries the injury rate for females was 11.5/1000 athlete days (CI=9.9-13.2). The reported all para-athlete injury rates were similar in male (437 injuries (IR=13.3 injuries/ 1000 athlete-days (95% CI 12.1 to 14.6)) and female para-athletes

(IR=11.5 injuries/1000 athlete-days (95% CI 9.9 to 13.2)) (Willick, et al., 2013). Considering that the ratio of female and male para-athletes in the South African Team compared to the overall participants was similar, it appears that the South African female Paralympic athletes had a higher injury rate than that in all female Paralympians. In the South African males the injury rate of 17.9/1000 athlete days (CI=8.9-32), was not dissimilar to all countries who had a rate of 13.3 (CI=12.1-14.6).

In the age group 13-25 years the injury rate for the South African Team was 21.7 (CI=8.7-44.8) as compared to the all other countries report of 11.3 (CI=9.7-13) (Willick, et al., 2013). In the age group range of 26-35 years, the South African injury rate of 23.8 (CI=10.3-46.9) was higher than all the other countries (IR 14.5 (CI=12.8-16.4)) (Willick, et al., 2013). In the age group with the least participants (35-67 years), the injury rate for South Africa was 19 (CI=5.2-48.8) and in all other countries 12.1 (CI=10.5-13.9)(Table 8). Despite the small sample of South African para-athletes, in all age groups, the proportion of injuries appeared to be greater than all the other countries.

Injuries to various anatomical areas para-athletes have been variably reported. In a longitudinal study Ferrara (2000) reported upper extremity injuries accounting for 23.3% of injuries and lower extremities for 26.1%. It is to be noted that different sports for para-athletes are likely to result in different injury types and in different anatomical regions (Nyland et al., 2000). For example wheelchair para-athletes are more likely to have injuries related to the elbow-arm and forearm-wrist area (Faqher & Lexell, 2014), whereas lower extremity limb deficient para-athletes are likely to suffer insult to the other ankle area (Nyland ey al., 2000;

Faqher & Lexell, 2014). Indeed the type of sport participation will further influence the injury types, as would be expected for lower limb injury in visually impaired football for example versus shoulder injuries in archery. Most of the injuries in the South African Team occurred in the lower limb (n=9, 47%). The next most common area was the axial skeletal area (n=6, 6.9%, CI=2.5-15.0) and then the upper limb area (n=6, 10.4%; CI=4.7-197). The injured anatomical regions reported for all London Games participants were 40.8% upper limb, 32.5% lower limb and axial skeleton & other at 26.7%. It is difficult to interpret why the South African Team results would differ, and one cannot make any firm conclusions, however factors that may account for the findings include the small number of South African participants, the disability profile and the sports events that the team participated in. Regular and adequate screening of para-athletes with targeted interventions on identified risks and prevalent chronic injuries, which are not routine in South African para-athletes, may have reduced the incidence. Perhaps the access and accessibility of care for South African para-athletes are less than in other teams.

6.3 Para-Athlete illness

There is a conspicuous scarcity of illness data in Paralympic athletes and para-athletes. Burnham (1991) reported that 49% of the Canadian Paralympic Team at the 1988 Seoul Games presented with medical problems. Sobiacki (2005) reported that 53.5% of consultations for the Polish Paralympic team at the 2000 Games were for medical conditions. In the absence of standardized illness definition, data collection and reporting, one cannot compare such information.

What does seem to be the case, however, is that with the information at hand there is the risk of the South African team having a higher incidence of illness than the overall Paralympic athlete population. Why this should be is not clear, but does beg the question as to what the possible reasons could be and is important in determining that in efforts for the alleviation of this in future.

6.4 Gender

The illness rate in the South African females was higher than all other countries at the London Games. In the South African Team the rate of illness in female para-athletes was 31.7/1000 athlete days (95%CI=13.7-62.6) (which was the same for the injury rate) which in all other countries was 14.4(95%CI=12.6-16.3) (Schwellnus, et al., 2013). The respective incidence proportion was 44.4% and 20.1% for SA and all other countries.

In the South African male para-athletes the illness rate was 27.6/1000 athlete days (95%CI=16.1-44.2) with an incidence proportion of 38.6%. The statistics for all other countries have been reported as 12.5/1000 athlete days (95%CI=11.4-13.8) with an incidence proportion of 17.6% (Schwellnus, et al., 2013). It would appear that as in the females, the rate and incidence of illness in the South African male para-athletes were higher than male para-athletes in all other countries at the London Games. The higher incidence of illness in the South African male and female para-athletes would account for the overall higher rate in the South African team compared to all countries. Although both male and female South African para-athletes had a higher illness rate than all countries, females were particularly affected. Exact factors for overall higher rates of illness have not

been determined, but whatever they are, perhaps they are more so in female para-athletes for additional reasons; such as, that female para-athletes do not get the same attention as their male para-athlete counterparts.

6.5 Age

In the age group 13-25 years the illness rate for the South African Team was 12.4 (95%CI=3.4-31.8) with an incidence proportion of 58.36%. In all countries this was 12.4 and 17.3% respectively. In the age group range of 26-35 years, the South African illness rate was 41.7(95%CI=22.8-69.9) and incidence proportion of 46.7% compared to all countries at 12.8 and 19% respectively. And in the age group of least participants (35-67 years) the South African illness rate was 33.3 (95%CI=13.4-68.7) with incidence proportion of 44.4% compared to 14.4 and 20.1% respectively for all countries. Thus in all age groups the illness incidence proportion in the South African Paralympic athletes was higher than in all countries.

6.6 Illness by system affected

A total number of 25 illnesses in the South African Paralympic athletes required medical intervention. Illnesses were reported in three systems, namely the respiratory system, skin/subcutaneous tissue and digestive/gastrointestinal system. The majority were related to the respiratory system (44%) (IR 12.7; 95%CI=6.3-42.5), similar to what was reported in all Paralympic athletes at the 2012 Summer Paralympic Games (27.4%; IR 3.61, 95%CI=3.10-4.17) (Derman,

et al., 2013). This is in keeping with other reports of illness in elite para-athletes (Sobiecka, 2005; Reynolds et al., 1994; Burnham et al., 1991). Derman et al (2014) reported on the illnesses of all para-athletes at the London 2012 Paralympic Games, with data collected and analysed from the WEB-ISS system. They reported 385 illnesses in the 3565 para-athletes over a 14 day time period. The incidence reported as illness per 1000 athlete days was 8.3 per 1000 (95%CI of 95% 7.5-9.1). The majority of illnesses were in the respiratory tract, followed by the digestive system and then skin & subcutaneous tissue. These three areas contributed to 67.1% of all illness presentations in all countries at the London Paralympic Games. Severity of illness, determined as time loss, was not severe for the majority of the para-athletes. However, of importance was that approximately one third (29.3%) of para-athletes had symptoms present the day before they sought medical attention and some delayed their presentation for up to 48 hours. Most illnesses presented in para-athletes with spinal cord injury, who in addition to skin & subcutaneous tissue illness had the highest incidence of urinary tract illness (Derman et al., 2014).

7. Conclusion

The overall injury rate in the South African para-athletes was higher than the injury rate in all para-athlete participants at the London Paralympic Games (21.9/1000). The rate reported for all countries at the London Paralympic Games 2012 was 12.7 injuries per 1000 athlete-days. It also was apparent that the South African female Paralympic athletes had a higher injury rate than all female participants at the Games. The illness rate of South African para-athletes was higher than all countries, and as for injuries, more so in the female para-athletes. In addition to both genders having higher rates of illness and injury than all countries, the same was seen in all age groups.

The supervisor of this dissertation was the chief medical officer of the SA team as well as the principal investigator of the overall injury and illness study. This ensured accuracy in recording of data for illness and injury in the South African Team. It is possible that there might have been under-reporting of the cases of injury and illness in the other countries' medical teams. This is a factor that might account for some of the differences between the rates in the SA team and the other nations. If this is indeed correct, it might be that the figures of the South African team is a more accurate rate of injuries and illnesses in Paralympic athletes in competition.

Causative factors for injuries being higher are not evident and need to be further investigated. Causative factors for illness are mostly infections and may be influenced by environmental conditions, but why this may be more so in South

African para-athletes is not clear. It is possible that South African para-athletes and their families, administrators, medical personnel and others require increased efforts in education and other injury and illness prevention programmes, including a continuous medical support structure that gives input into more of the chronic injury issues.

8. Recommendations

Continued data gathering and analysis in para-athletes with disabilities and the Paralympic Games in South African para-athletes will enhance the understanding of injuries and guide measures to reduce these. With respect to illness, little data exists and with the only comparison of the South African illness data being to the overall Paralympic Games of London 2012, ongoing exposure data gathering over time will allow for better comparisons and understanding. Research into aetiology of injury and illness in South African para-athletes is required to review possible causes of higher rates in these Paralympic athletes. Aspects should include knowledge of causes of injuries and illness, injury and illness prevention, healthcare support. There appears to sufficient medical care at the Paralympic Games but this may need to be improved, and likely to be inadequate at all other times. It is possible that these para-athletes are not amenable to good care between Games, unless they are on high level programmes or self-funded and have access to good care. This must be addressed so para-athletes are given at least the same support in resources and preparation as their able-bodied Olympic athlete counterparts, who have similar injury and illness rates to all countries (Derman W. , 2003).

Annual periodic health assessments and screening of para-athletes should be mandatory. A national database of athletes' injuries and illness could be maintained and used to identify problems early. These could guide interventions and the successes thereof. Specific national policies should be developed for these. Perhaps increased attention should be paid to the female para-athletes, who had higher rates of both injuries and illness as compared to the male para-athletes. Future similar studies could consider a qualitative arm by using post-

event questionnaires to the South African para-athletes, coaches and medical team with individual or focus group interviews to gain insight to possible contributing factors for the higher injury and illness rates

Para-athlete preparation and resources to support these para-athletes must be put in place and used for maximum effect. Measures should be taken to positively influence the outcomes presented in this study. Some of the actions that may be taken and be effective include adequate financial resources to be allocated and used optimally; displaying equity in dealing not only with para-athletes, but with female para-athletes. It seems prudent that periodic screening and interventions for identified risks and disorders/injures of para-athletes is important, and should be carried out by a network of practitioners skilled in the care of para-athletes with disabilities, who could then also provide the necessary interventions and care for the para-athletes. With such an organised network, a national database and registry for illness and injury bioinformatics could be set up. This would provide further opportunity for ongoing research and also identify other aspects that need addressing.

Further, barriers to prepare para-athletes maximally should be eliminated. This implies that matters of financial allocations and support for these identified programmes must be made available. Political and administrative intervention in healthcare and management of para-athletes with disabilities should support theses initiatives. Generalised education programmes for para-athletes, healthcare providers and others in concerted and directed education programmes for the prevention and treatment of injuries and illnesses should be instituted.

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Appendix

Ethics clearance

UNIVERSITY OF CAPE TOWN
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15 June 2015

HREC REF: 346/2015

Prof W Derman
Sport Science Institute
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Newlands

Dear Prof Derman

PROJECT TITLE: PROFILES OF ILLNESS AND INJURY AMONG SOUTH AFRICAN ELITE ATHLETES WITH DISABILITY AT THE 2012 SUMMER PARALYMPIC GAMES - Sub-study linked to 436/2012 (MPhil candidate - Dr D Constantinou)

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee for review.

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

Approval is granted for one year until the 30th June 2016.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

Please quote the HREC REF in all your correspondence.

We acknowledge that the student, Dr Demitri Constantinou will also be involved in this study.

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

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE
Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938
This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical