The prevalence and selected risk factors of musculoskeletal injuries affecting working canines in Kwa-Zulu Natal.

By

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I, Storm Radtke, do declare that this dissertation is representative of my own work in both conception an execution (except where acknowledgements indicate to the contrary).

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DEDICATION

I dedicate this dissertation to my parents, Wayne Radtke and Lynn Radtke, and to my husband, Luca Grobler. Thank you for your unconditional love and support through the many trials and challenges during my student years. Without you, this achievement would not have been possible.

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To Tanner, my brother bear. Thank you for your patience in coping with numerous pieces of paper floating around the house, the skew keyboard, the pushed out chair. I know your OCD tendencies were challenged during those times.

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ABSTRACT

Background

Dog agility has become one of the most popular canine sport disciplines, growing annually with many owners enrolling their canines without an educated understanding of what the sport of agility entails. Various factors have been identified that can contribute to the injury of the agility dog, these include coming into contact with the agility equipment, the experience of the dog, nutrition, supplementation, handler training in warm up technique and participation in additional sporting activities such as flyball, and risk factors such as breed, sex and age of the dog have been shown to have an impact on the prevalence and type of injury that sporting dogs are at risk for, most commonly, injuries to the shoulder, wrists, hip and an extensive range of soft tissue injuries.

There is a significant knowledge gap in the literature that describes injury prevalence, profiles and the potential risks facing the sporting canine participants in a South African context and that, as more and more owners are seeking out CAM therapies such as chiropractic, literature is needed in order to enable these owners and veterinary chiropractors to better understand the risk that the sport of agility entails. Chiropractic treatment can offer both treatment and prevention, from enhancing the performance of the canine athlete, allowing them to compete more effectively and for a longer period at national and international level, to improving the quality of life of the geriatric canine patient.

Aim

The aim of this study is to determine the prevalence and selected risk factors of musculoskeletal conditions affecting working canines registered in the herding breed category in Kwa-Zulu Natal.

Study design

This study was a cross sectional, prospective survey of sporting canine owners registered with the KZNDAA. The study employed a quantitative descriptive design.

Participants

The study comprised of 70 dogs registered to 38 owners who are affiliated with the KZNDAA.

Methodology

Potential participants were identified on the KZNDAA membership list. These members were approached by the researcher at registered agility shows and invited to participate in the study. Once it has been established that the owners and the canines met the inclusion and exclusion criteria of the study, participants were required to sign a letter of information and confidentiality and a consent form and were included as participants in the study. The research questionnaire was then given to participants, who then completed the questionnaire on site and returned it by hand to the researcher. Data was captured on excel and transferred to IBM SPSS version 23. A p value of <0.05 was considered statistically significant. Descriptive statistics such as mean, standard deviation and range were used to describe continuous variables which were normally distributed, while median and inter-quartile range were used for skew variables. Categorical variables were summarized using frequency tables. Associations between lifetime prevalence and risk factors were tested using Pearson's chi square tests for categorical risk factors, or Fischer's Exact tests for continuous variables.

Results

The period prevalence of MS conditions was found to be 8.5% and the lifetime prevalence 45.8%.

Injuries were found to occur most often during play, followed by injury during agility competition, a very small percentage of the injuries incurred were due to direct contact with agility equipment.

Shoulders and hips were the areas most commonly affected, with arthritis and DJD being the most prevalent type of conditions and muscular strains being the most prevalent type of injury. The breed with the highest prevalence of injury was the Border Collie(63%). Neutered males had the highest prevalence of injury (52%), followed by spayed females (30%). The 8-10 year old category had the highest prevalence of injury (30%), followed by the 2-4 year old category (22%). Large breed dogs in the 15-20kg weight category had the highest prevalence of MS injury (40%).

Dogs participating in dog jumping showed a decreased risk of MS injury, while dogs participating in flyball showed an increased risk of developing MS injuries. Handlers with training in specific warm up techniques showed a decreased risk of having dogs developing MS injury.

Reverse casualty associations were found between the increased risk of MS injury and dogs fed on Hills specific diets, dogs supplemented with glucosamine and chondroitin, and dogs currently receiving anti-inflammatories.

Conclusion

The prevalence of musculoskeletal (MS) injuries in agility dogs in KZN is low when compared to studies done outside of South Africa. Factors such as breed, age, sex, and weight of the dog influence the prevalence of MS conditions. Risk factors influencing the development of MS conditions include contact with the equipment, nutrition, participation in other sporting activities and whether warm up periods are allowed. A larger population is needed in order to further analyse the risk of injury in sporting dogs in a South African context.

Key words

Agility, musculoskeletal injury

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LIST OF SYMBOLS AND ABBREVIATIONS

>: Refers to a value or figure greater than the value or figure shown.

<: Refers to a value or figure less than the value or figure shown.

DUT: Durban University of Technology

CAM: Complimentary and alternative medicine

CCL: Cranial Cruciate Ligament

FCI: Federation Cynologique Internationale

FCP: Fragmented coronoid process

FCUT: Flexor carpi ulnaris tendinopathy

GMS: General muscle stiffness

GSD: German shepherd dog

IREC: Institutional Research and Ethics committee

KUSA: Kennel Union of Southern Africa

KZN: Kwa-Zulu Natal

KZNDAA: Kwa-Zulu Natal Dog Athletics Association

MS: Musculoskeletal

MSI: Medial shoulder instability

n: Population size

OA: Osteoarthritis

OCD: Osteochondritis Dessicans

***p*:** *p*-Value indicates the statistical significance of the data. The lower the p-value, the less likely the finding would occur by chance alone (Mosby, 2012).

PVC: Polyvinyl Chloride plastic

SADAA: South African Dog Agility Association

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LIST OF DEFINITIONS

A-Frame: Two ramps connected at the apex in an "A" shape (Federation Cynologique Internationale, 2016).

Aerial phase: One of 5 phases of jumping in which the dog is airborne in order to clear an obstacle (Pfau et al., 2011).

Agility: A sport designed to test a handler's skills and a dog's willingness to negotiate a course of obstacles against the clock (American Kennel Club, 2014). The course involves hurdles, weaving poles, ramps, see-saws and tunnels.

Brachycephalic: A flat, wide skull shape which appears to have been severely compressed from front to back, for example, seen in breeds such as the Boxer or Bull Dog (McAlinden, 2012).

Breed show: A competition where a "blueprint" of the ideal specimen in each breed are assessed and judged according to standards approved by a governing body (Kennel Union of Southern Africa, 2016).

Canine: An animal of the family Canidae, especially a dog, (The Free Dictionary, 2016). This term is interchangeably used with the word dog.

Carting: A sport in which a dog is required to pull a cart and perform a range of activities in a sequence, such as turning, proceeding through a mock gate opening and delivering mock supplies to and from a designated area whilst being judged for accuracy and obedience (Kennel Union of Southern Africa, 2016).

Contacts: The dog walk, A-Frame and see-saw obstacles are referred to as "contacts" or "contact equipment" (Kennel Union of Southern Africa, 2016).

Contact zone: This zone defines the last 90 centimeters of the ramps of a dog walk, an A-Frame and the See-saw obstacles. The area is required to be a different colour to the rest of the obstacle but may not be white, brown or black. The dog is required to touch this area with at least one foot otherwise course faults are incurred (Federation Cynologique Internationale, 2016).

Cross bar: A straight piece of either wood or PVC piping that is held between two sides or "wings" of a hurdle (South African Dog Agility Association, 2015). If the bar is displaced by the dog, course faults are incurred (Federation Cynologique Internationale, 2016).

Dog Jumping: A uniquely South African dog sport, based on horse showjumping. Dog jumping differs to agility as contact equipment is not used (KZN Dog Athletics Association, 2016).

Dog walk: An obstacle consisting of one horizontal plank and a ramp plank on either side of the horizontal plank (South African Dog Athletics Association, 2015).

Drive: A motivational characteristic defined as the propensity of a dog to exhibit a particular pattern of behaviors when faced with particular stimuli (Cobb *et al.,* 2015).

Field trials: A sport designed to resemble a days' shooting in the field where dogs are required to retrieve game animal decoys and track scent trails under competitive conditions (The kennel club, 2016).

Flyball: A dog sport where two teams consisting of four dogs race each other over low wooden hurdles to a box that releases a tennis ball when the dog presses the platform. The dog performs a fluid turn and then races back over the hurdles to its handler. Each dog in the team runs in succession and the first team to finish, wins (Dogtime, 2016).

Handler: An individual who is responsible for a dog at an event, who exhibits or competes with the dog (Dogtime, 2016).

Hurdle: Two uprights with sides, separated by a displaceable cross bar, over which a dog is required to jump (South African Dog Athletics Association, 2015).

Lameness: A clinical sign of a more serious disorder that results in a disturbance of gait and the ability to move the body fluidly, typically in response to pain, injury or abnormal anatomy (Petmd, 2016).

Long Jump: An obstacle consisting of 5 separate raised planks, of which 2-5 separate units must be used for small, medium and large height categories respectively, in order to increase the width of the obstacle (South African Dog Athletics Association, 2015).

Luxation: Also called dislocation. The displacement of a bone or joint (Thefreedictionary.com, 2016), usually caused by a direct blow, a fall or poor conformation (Bongartz et al., 2008).

Musculoskeletal injury: Injuries affecting the body's movement or musculoskeletal system, that is: injury to muscle, tendon, ligament, nerves (Middlesworth, 2015).

Obedience (show): A competitive event where dog and handler are judged by their ability to execute a predetermined set of exercises, including heel work, sit-stays and retrieval of an object (Dogtime, 2016).

See-saw: A straight plank secured onto a central bracket which allows the plank to drop on either side when weight is put upon it (South African Dog Athletics Association, 2015).

Sporting Dog: Any dog that is operational in a sporting context, independently of whether it also performs a role as a human companion (Cobb et al., 2015). For this study, also interchangeable with "Working dog".

Stress: The state of an organism under the influence of certain external or internal conditions or "stressors" which threaten to alter its homeostasis (Pastore et al., 2011).

Swimmer's Turn: A turn style taught to flyball dogs in order to prevent hyperextension injuries to the forelimbs. When executing a swimmer's turn, the dog will hit the platform with its fore limbs then turn and push off the platform with its hind limbs in order to reverse direction in one fluid motion. This technique replaced teaching the dog to turn with its forelimbs, after touching hitting the platform, then stopping and only then performing a turn on the ground (Baltzer, 2012a).

Take off: The phase of jumping when the dogs' feet leave the ground (Pfau et al., 2011).

Tyre Jump: A tyre-like hoop suspended within a sturdy frame by chains or ropes (South African Dog Athletics Association, 2015).

Weave poles: 12 poles erected upright and in a straight line, secured to a base and separated by a distance of 60cm, through which a dog is required to "weave" through each pole or "gate", beginning with the first pole at the dog's left shoulder (South African Dog Athletics Association, 2015).

Wings: Vertical ends of a hurdle that have cups to hold up crossbars (Bud Houston's blog, 2009).

Withers: The highest point of a dog's shoulder. This point of measurement is used to determine which height category the dog will compete in (Bud Houston's blog, 2009).

Working dog: A dog of suitable breed or training kept for its practical use, such as herding and protecting livestock (Collins Dictionary, 2016).

CHAPTER ONE

Introduction

1.1 Introduction

The purpose of this chapter is to introduce a sport of working dogs, that is, the sport of dog agility. This chapter will describe this sport and how because of its physicality, many dogs are at risk for musculoskeletal injuries. These risk factors will be highlighted and further reviewed in Chapter Two. Furthermore, this chapter will present the aims, objectives and rationale of this study as well as outline the forth coming chapters.

1.2 Background

Dog agility has become one of the most popular canine sport disciplines (Birch and Lesniak, 2013). Its popularity has grown annually ever since this sport was first demonstrated in England in 1978 (Siniscalchi *et al.,* 2013). Agility is a sport designed to test a handler's skills and a dog's willingness to negotiate a course of obstacles against the clock (American Kennel Club, 2014). These obstacles include hurdles, weaving poles, ramps, see-saws and tunnels; therefore, resulting in twisting, hard landings, abrupt high speed turns and stops (Usdaa, 2014) which puts the dog at risk for certain injuries such as cruciate tears, an increased prevalence of hip dysplasia and soft tissue injuries which may lead to a reduced lifespan (Witsberger *et al.,* 2008).

Various risk factors have been identified that may contribute to an agility dog's injury, these include: its breed, sex and age, the dog coming into direct contact with the agility equipment, and the experience of the dog (Levy *et al.,* 2009; Cullen *et al.,* 2013).

In a study done by Levy *et al.,* (2009), it was determined that contact with the agility equipment is a major contributor injury risk. The study determined that the A-frame, dog walk and hurdles were responsible for nearly two thirds of injuries that resulted from contact with the obstacle. In addition, Cullen *et al.,* (2013) reported that the amount of agility experience that sporting canines have is also a risk factor for injury, specifically, dogs with less than four years of agility experience.

There is a significant knowledge gap in the literature that describes injury prevalence, injury profiles and the potential risks facing the sporting canine participants and that, as more and more owners are seeking out complementary and alternative medicine (CAM) therapies and animal chiropractic in particular (Maurer, 2000), literature is needed to enable these owners and veterinary chiropractors to improve their understanding of the risk that this sport entails (Levy *et al.,* 2009).

1.3 Research aims

The aim of this study is to determine the prevalence and selected risk factors of musculoskeletal injuries affecting working canines registered in the herding breed category in Kwa-Zulu Natal.

1.4 Research objectives

The first objective is to determine the demographic profile of herding breeds affected by musculoskeletal conditions.

The second objective is to determine the point, period and lifetime prevalence of musculoskeletal injuries in herding breeds.

The third objective is to determine the selected risk factors associated with the development of musculoskeletal injuries in herding breeds.

1.5 Rationale and benefits of the study

Dog agility has become one of the most popular canine sport disciplines worldwide (Siniscalchi *et al.,* 2013), and many more dog owners are seeking CAM therapy treatment for these canine athletes, especially animal chiropractic (Maurer, 2000).

Animal chiropractic is fast gaining recognition, not only in the veterinary and chiropractic fields, but in the public sector as well (Roecker, 2011). Complementary and alternative medicine (CAM) therapies, such as Chiropractic, are those therapies which are a part of a countries principal health care system (Bosman, 2012). These different forms of therapies have developed and gained recognition throughout the years, and are well established in many countries worldwide, but, animal chiropractic is not yet recognized as a standalone profession in South Africa (Bosman, 2012; Maurer, 2000).

However, there has been limited research on animal chiropractic conducted in South Africa, (Taverner, 2011). More research investigating the epidemiology of agility related injuries in a South African context should assist in supplementing the limited literature available to allied health professionals working with animals, such as Chiropractors.

As agility dogs undertake added stressors to their musculoskeletal system which increases their possible predisposition to injury, there is a need for additional information regarding the profile of canines at risk and the common types of injuries these agility dogs face in order to further prevent them from occurring (Baltzer, 2012b).

This study would be the first step in building on the literature available to allied health care members. This would enable these practitioners to better understand the risks involved in the sport of dog agility as well as enlighten canine owners who may have enrolled their dog in agility sport without prior knowledge of what the sport entails and the possible injuries involved (Baltzer, 2012a).

Chiropractic treatment can offer both treatment and prevention, from enhancing the performance of the canine athlete, allowing them to compete more effectively and for a longer period at national and international level, to improving the quality of life of the geriatric canine patient (Baltzer, 2012b).

1.6 Outline of chapters

This chapter provided an introduction to the study, presenting the study's aims, objectives and benefits. Chapter Two provides detail on the current literature in order to expand the reader's understanding of the rationale behind the study. Chapter Three is a detailed description of the study design, which includes the methodology. Chapter Four presents the results obtained via statistical testing of the acquired data. Chapter Five presents the discussion of the results after statistical analysis and includes comparative findings in the available literature. Chapter Six presents the conclusion of the study, recommendations for future studies and the limitations of this study.

CHAPTER TWO

Literature Review

2.1 Introduction

Chapter Two provides an overview of the current literature surrounding the prevalence and type of common injuries experienced by agility dogs. This chapter also discusses risk factors which have been identified in the literature that predispose agility dogs to injury, and the profile of working canines most commonly affected by these injuries.

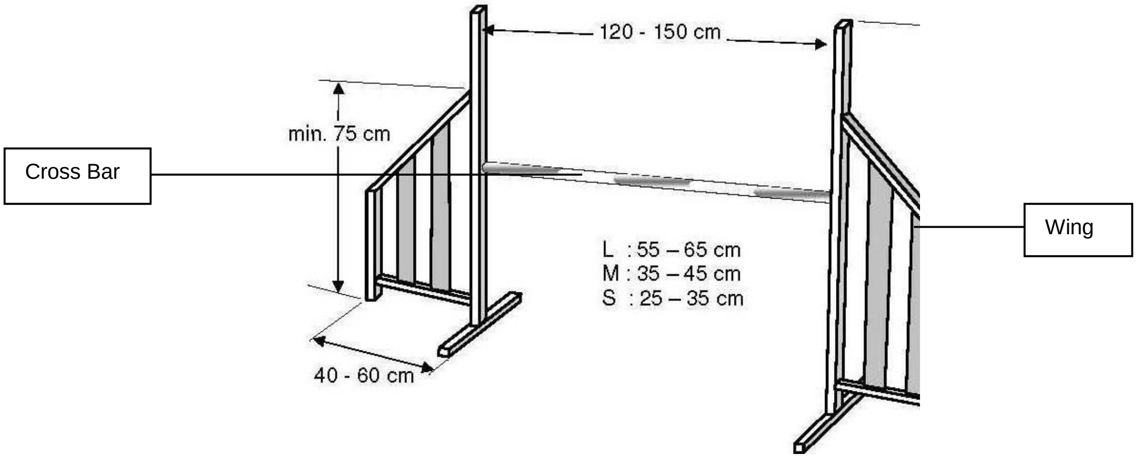
2.2 Agility

The canine sport discipline of agility involves jumping activities where running and jumping at high speed together with rapid directional changes are vital to success (Pfau *et al.,* 2011). Handlers must navigate their dogs around a set course, and are required to compete for the fastest time without faults (Birch *et al.,* 2015). Levy *et al.,* (2009) stated that the most common sites of injury in agility dogs are the shoulders, lumbar spine and toes and that a large portion of these injuries were sustained by direct contact with a hurdle, the A-Frame or the dog walk obstacles. Similarly, Birch and Lesniak, (2013) also found in their study that these injuries were the most common and that such obstacles were to blame. The following sections will expand on agility equipment and the related injury risk facing these canine athletes.

2.2.1 Agility equipment and related risk

2.2.1.1 Hurdles

Hurdles are at a pre-determined height in relation to the dog's height at the withers, or highest point between the shoulder blades. Hurdles constitute the majority of obstacles in an agility course (Birch *et al.,* 2015). According to the Federation Cynologique Internationale (FCI) rules and regulations, which apply to agility competition equipment worldwide, hurdle bars must be easily displaced and made out of either wood or synthetic materials such as PVC (Federation Cynologique Internationale, 2016).



AGILITY OBSTACLES

Regulations of the Féderation Cynologique Internationale, (2016)

Figure 2.1 Hurdle specifications

The dogs' height measurement places them into a category of either small (<35 cm), medium (35-43 cm), or large (>43 cm) and the hurdle heights are set at 25-35 cm, 35-45 cm, and 55-65 cm respectively with a standard width of a single bar being 1,20 to 1.50 metres (Kusa.co.za, 2015).

The potential risk of being limited to three height categories presents itself when looking at dogs that are on the borderline of a particular height threshold (Birch and Lesniak, 2013). Dogs measuring 35-43 cm in the medium category will jump a maximum height of 45cm, however, a dog measuring one millimetre more (i.e. 43,1 cm) must jump at the full height of 65cm (Birch and Lesniak, 2013).

This potentially puts the dog at greater risk of injury due to the greater size of the jump in relation to its body height, as it was found to cause a significant increase in extension of the sacroiliac region as well as simultaneous and significant flexion or 'tucking up' of the forelimbs, particularly the scapulohumeral and radiohumeral joints, to enable it to clear the hurdle (Birch and Lesniak, 2013). This leads to significant, repetitive strain on the tendinous Biceps Brachi, which has been shown to result in bicipital tenosynovitis, a common injury seen in agility dogs (Canapp, 2007).

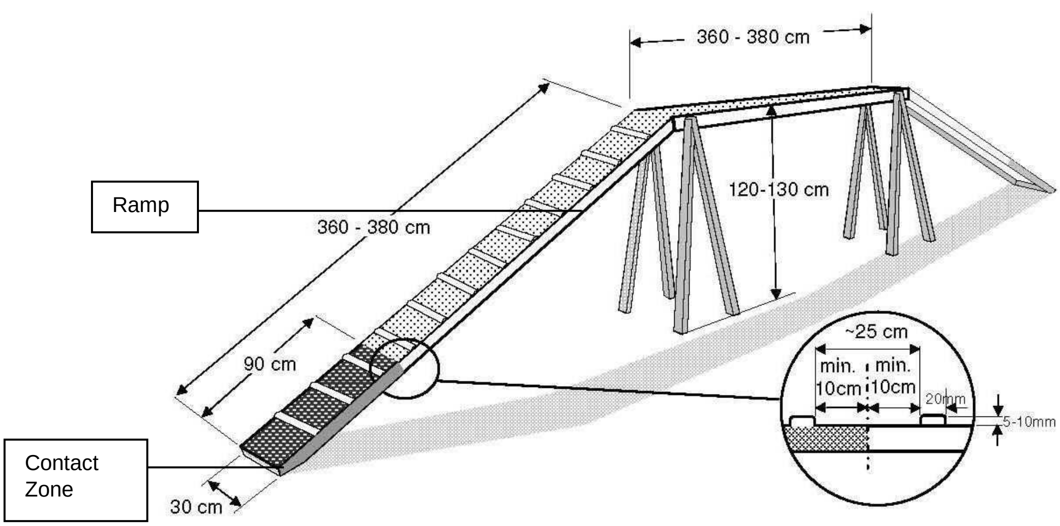
Height is not the only factor increasing potential injury risk to canine agility athletes. The distance between two consecutive hurdles, is ruled at between four and seven meters for the small category and between five and seven meters for the medium and large category (KUSA, 2015). Birch *et al.,* (2015) concluded that altered hurdle distance contributed to the less experienced or skilled dogs' injuries because skilled dogs were more adept at judging optimum jump technique in terms of takeoff and landing points between distances than less skilled dogs. It was shown that as the distance between hurdles increases, the difference seen between the jump technique of skilled dogs and beginner dogs' decreases (Birch *et al.,* 2015). This suggests that reduced obstacle distances should be utilized for more experienced dogs only, in order to minimize injury risk to less skilled dogs that are still developing their jumping technique (Birch *et al.,* 2015).

During a jump approach, the dog has to 'decide' on an appropriate combination of forward velocity and distance to the obstacle in order to clear the obstacle during the aerial phase (Pfau *et al.,* 2011). In some cases, a tight turn after a jump results in a dog colliding with the wing, or side of the jump, if the dog has not adequately collected itself enough before takeoff.

Therefore, for dogs with less experience, there is a risk of injury due to direct contact with the hurdle and bar (Cullen *et al.,* 2013).

2.2.1.2 A-Frame and Dog Walk

According to the FCI rules and regulations, the height of the dog walk must be set at between 1.2 meters and 1.3 metres and all height categories complete the dog walk obstacle at the same setting. The planks that make up the dog walk should be a between a minimum of 3.6 metres and a maximum of 3.8 metres in length and 30 cm in width. The last 90 cm from the bottom of each ramp should have a different colour to indicate the contact zone (Federation Cynologique Internationale, 2016).

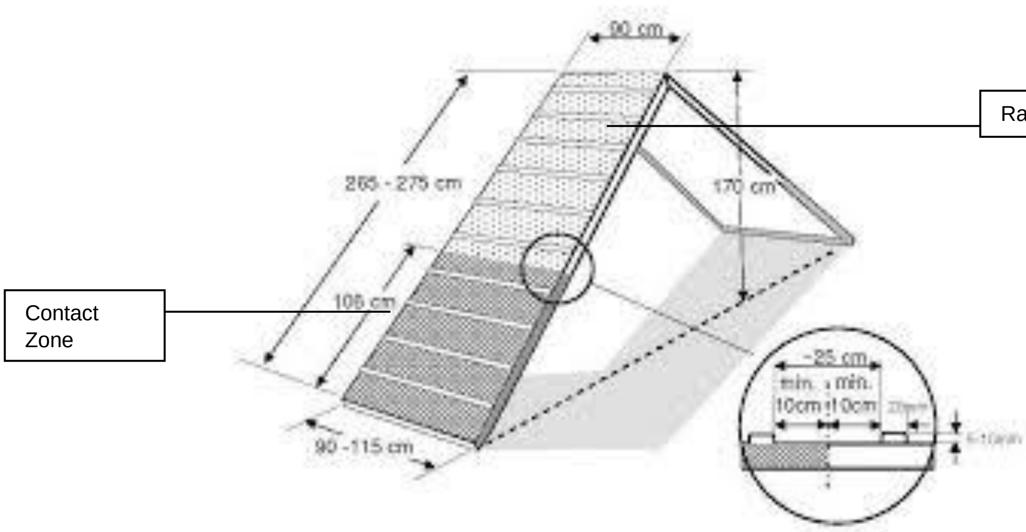


AGILITY OBSTACLES

Regulations of the Féderation Cynologique Internationale, (2016)

Figure 2.2 Dog walk specifications

The specifications for the A-Frame include: 90 metres minimum width which may be increased at the bottom to 1,15 metres. The frame when opened stands 1,70 metres high from the ground for all dogs. The length of the ramps should be between 2,65 and 2,75 metres. The last 1,06 metres from the bottom of each ramp should have a different colour to indicate the contact zone (Federation Cynologique Internationale, 2016).



AGILITY OBSTACLES

Regulations of the Féderation Cynologique Internationale, (2016)

Figure 2.3 A-Frame specifications

The surface of both the dog walk and A-frame obstacles must be of a non-slip material and should be rubberized or sand painted. Each ramp should have anti-slip slats at regular intervals (about every 25 cm) to avoid slipping, but not within 10 cm of the start of a contact area. These slates must be 20 mm wide and 5 -10 mm thick. These specifications are set in accordance of current international standards and are applicable to agility equipment used in competition in South Africa (Federation Cynologique Internationale, 2016).

There have been no studies conducted that are specific to the A-Frame or the dog walk obstacles. However, these obstacles and the hurdle have been found to contribute nearly two-thirds of all injuries resulting from direct contact with an obstacle (Levy *et al.,* 2009).

2.3 Common musculoskeletal injuries

There is a paucity of research literature regarding injuries seen in dogs participating in sports such as agility and the effect that these sports have on the dogs (Baltzer, 2012b), this is true in a South African context. Unlike their human counterparts, such as Olympic athletes, these dogs are not required to undergo pre-participation veterinary examinations or periodic health examinations in order to screen for injuries or underlying serious medical conditions (International Olympic Committee, 2009). The following sections will discuss some of the injuries found to be prevalent in sporting canines.

2.3.1 Foot pad laceration

In a study done by Baltzer (2012b), it was found that foot pad laceration and nail trauma were the most common injuries seen in sporting dogs. Full thickness laceration through the dermis was found to require sutures and splinting to prevent weight bearing during healing and to avoid tearing of the sutures due to undue pressure. Along with lacerations, puncture wounds on the palmar or plantar surface of the paw due to poor surface conditions may put the dog at risk of developing deep digital flexor tendonitis, a possible career ending complication (Baltzer, 2012b). In a survey done on 431 dogs, foot injury constituted 23.7% of all injuries seen (University of Guelph, 2014), highlighting the importance of even and smooth terrain, particularly in outdoor agility competition.

2.3.2 Forelimb injury

2.3.2.1 Shoulder injury

Tendon or ligament related shoulder pathology is one of the most common causes of lameness in dogs (Silva *et al.,* 2013); this is especially true for agility dogs (Baltzer, 2012b). Shoulder trauma can result in fracture, osteoarthritis or luxation (Baltzer, 2012b).

Birch *et al., (*2015) stated that the majority of repetitive strain injuries, such as shoulder injuries are as a result of altered distances between hurdles and varied high speed approaches required to jump over these hurdles. Studies undertaken by Pfau *et al.,* (2011) and Baltzer, (2012b) highlighted the extremely high peak vertical force in the forelimbs of agility dogs when landing after jumping a hurdle, 45 newton s/kg body weight as compared to 25 newtons/kg sustained while running (1 newton = the force required to accelerate 1 kg of mass 1 m/s2). These dogs always land on the same forelimb, potentially predisposing these dogs to chronic overload injuries of the dominant limb (Baltzer, 2012b). Prevalent shoulder injuries will be discussed briefly in the following sections.

2.3.2.1.1 Biceps brachii tenosynovitis

The biceps brachii muscle is responsible for extending the shoulder, passive stabilization the shoulder in both neutral and flexed positions, as well as for flexing the elbow (Baltzer, 2012b). Due to high impact sporting activities, the tendon slowly tears, and over time develops into a chronic injury (Baltzer, 2012b). It is common in middle-aged large breed dogs, and is the most prevalent clinical condition affecting the shoulder of the canine athlete (Marcellin-Little *et al.,* 2007) and symptomatically, the resulting lameness is widely varied from mild weight baring lameness to severe limb disuse and is treated either with corticosteroid injection and rehabilitation or surgically (Marcellin-Little *et al.,* 2007). Both Baltzer, (2012b) and Marcellin *et al., (*2007) state that the prognosis is good for those cases treated surgically, although their level of athletic performance post-surgery has not been scientifically evaluated.

2.3.2.1.2 Medial shoulder instability

Medial shoulder instability (MSI) results from chronic repetitive activity, leading to overuse injury rather than a traumatic injury (Marcellin-Little *et al.,* 2007). MSI results in degeneration of the tissues and a loss of tensile strength, predisposing them to fraying and eventually, complete breakdown (Marcellin-Little *et al.,* 2007). Agility dogs notoriously partake in repetitive tasks such as the weave poles and jump-turn combinations performed both in training and competition. Marcellin-Little *et al.,* (2007) stated that over time, accumulative microtrauma as a result of weave pole repetition, jump-turns and possibly slipping on obstacles such as the A-Frame, causes the dog's performance to deteriorate. The dog may refuse to do tight turns and exhibit unilateral forelimb lameness. Affected dogs may also have a notable difference in the circumference of their forelimbs due to muscle atrophy and when the affected limb is stretched, intense spasm is likely to occur (Baltzer, 2012b).

Conservative treatment of MSI has shown excellent results in 25% of cases and surgical treatment has shown improved condition in 85% of cases. However, after surgery, some dogs have had continued lameness and all dogs affected are unable to return to their previous level of competition (Baltzer, 2012b).

2.3.2.1.3 Osteochondritis Dissecans

Osteochondritis Dissecans (OCD) is a developmental problem of the humeral head, or ball joint of the shoulder that results in cracks and fragmentation of the cartilage surface. It forms a cartilaginous flap or free floating fragments within the shoulder joint (Beizynski *et al.,* 2012; Marcellin-Little *et al.,* 2007). OCD has also been found to frequently affect the elbow in large breed working dogs (Gemmill and Clements, 2007). The development of OCD can be due to heredity, conformation, rapid growth, injury, poor nutrition or a combination of these, affecting mainly large breed male dogs between 4-10 months of age (Beizynski *et al.,* 2012; Marcellin-Little *et al.,* 2007). OCD has been found to occur bilaterally in 27-68% of cases, resulting in pain, lameness and tenosynovitis (Marcellin-Little *et al.,* 2007). Treatment is usually surgical although mild cases respond well to conservative care (Marcellin-Little *et al.,* 2007).

2.3.2.1.4 Osteoarthritis

Shoulder Osteoarthritis(OA) may develop as a result of repetitive trauma, bicipital tenosynovitis, MSI and OCD. However, it does not lead to large losses of movement and is usually an incidental finding (Marcellin-Little *et al.,* 2007).

2.3.2.1.5 Infraspinatus tendon contractions

The infraspinatus muscle is responsible for flexion, extension, passive stability and rotation of the canine forelimb. It is a condition that affects highly active dogs, especially working dogs. This injury results from the contracture of the tendon of the infraspinatus muscle (Marcellin-Little *et al.,* 2007) which commonly occurs along with other conditions such a bicipital tenosynovitis (Baltzer, 2012b). Due to repetitive microtrauma, the muscle contracts and nearly all internal rotation of the forelimb is lost and progressive lameness may be seen (Marcellin-Little *et al.,* 2007). Treatment is either conservative or surgical although studies show that 50% of dogs may not recover from the condition (Baltzer, 2012b)

2.3.2.2 Elbow injury

Prevalent elbow injuries will be discussed in the following section.

2.3.2.2.1 Luxation

Mitchell (2011) reported that elbow luxation in dogs occurs infrequently due to the joint being inherently stable. Conversely, Bongartz *et al.,* (2008) reported that elbow luxation is the second most common luxation in small dogs after luxation of the hip. Strong collateral ligaments and an interlocking joint provide stability, but for this condition, medial collateral ligament is weaker than the lateral ligament, and this results in lateral luxation occurring more often than medial luxation (Mitchell, 2011 and Bongartz *et al.,* 2008). Elbow luxations tend to occur due to indirect rotational forces, such as tight turns in agility, rather than due to direct traumatic forces (Mitchell, 2011). Prompt reduction or re-alignment of the luxation results in an excellent prognosis, if the joint remains stable, however, if the joint cannot be reduced, an open reduction surgery is the standard procedure (Mitchell, 2011).

2.3.2.2.2 Fragmentation of the coronoid process

Fragmentation of the coronoid process (FCP) is the most frequently diagnosed form of elbow dysplasia, typically affecting medium to large breed dogs at the age of 4-8 months and even presenting as late as 6 years of age (Temwichitr *et al.,* 2010). Gemmill and Clements, (2007) reported that male dogs and in particular, working dogs, are more likely to be affected. FCP occurs due to incongruency in the elbow joint, and is commonly associated with OCD (Gemmill and Clements, 2007). FCP is a hereditary condition which presents with forelimb lameness and a decreased range of motion. Osteoarthritis develops in the joint due to chronic irritation and medial joint instability (Temwichitr *et al.,* 2010). Conservative treatment with physical therapy, joint supplementation and the use of non-steroidal anti-inflammatories (NSAIDs) has been found to yield the best possible outcome of slowing the progression of the condition as surgical treatment has shown poor results, with many dogs exhibiting lameness shortly after surgery. (Gemmill and Clements, 2007).

2.3.2.3 Wrist injury

The carpus or wrist joint has the greatest range of motion of all joints in the dog and is commonly injured, especially in large breed dogs during athletic activity such as running or jumping (Jerram *et al.,* 2009). Injury results in pain, instability, lameness and often degenerative osteoarthritis (Worth and Bruce, 2008). During running and jumping activities, the wrist is subject to high impact forces, especially during deceleration, such as before takeoff, on a turn or at the end of a contact zone. Due to the athletic nature of sporting activities such as agility, working and herding breeds are more prone to carpal injury than sedentary dogs (Jerram *et al.,* 2009).

2.3.2.3.1 Fractures

The radial carpal bone and the metacarpal bone are the most prevalent sites of wrist fracture in the dog, especially sporting dogs such as the racing greyhound and flyball dogs who often suffer hyperextension injuries (Houlton, 2011; Baltzer, 2012b). These fractures often occur due to avulsion of the collateral and palmar ligaments respectively, and result in small boney fragmentations within the joint, requiring surgical treatment (Houlton, 2011).

2.3.2.3.2 Flexor carpi ulnaris tendinopathy

Flexor carpi ulnaris tendinopathy (FCUT) is a common injury in agility dogs and racing greyhounds due to the repetitive nature of the sports and due to the dogs working on uneven terrain and hard surfaces (Baltzer, 2012b; Kuan *et al.,* 2007). The flexor carpi ulnaris muscle consists of two muscle bellies located on the humeral and ulnar head, and has a tendon that inserts into the accessory carpal bone. It is this muscle that is responsible for flexing the wrist (Kuan *et al.,* 2007). Injury and the development of FCUT is associated with repetitive stresses leading to chronic strains and a weak, thickened, fibrotic tendon (Kuan *et al.,* 2007). Dogs usually exhibit mild to moderate weight bearing lameness and are best treated with rest and immobilization of the joint for a period of 3 weeks (Kuan *et al.,* 2007). During rehab and return to activity, exercise must be severely limited and increase in gradual increments with the limb remaining splinted for stability (Baltzer, 2012b; Kuan *et al.,* 2007). In severe cases where avulsion of the tendon along with a bone fragment may have occurred, surgery is required (Baltzer, 2012b).

2.3.2.4 Tarsal Degeneration

Tarsal degeneration, or degeneration of the bones of the feet in sporting dogs, especially Border Collies, occurs as a result of repetitive, compressive trauma (Guilliard, 2007). This results in an increased risk of fracture of the central tarsal bone (Guilliard, 2007). Guilliard, (2007) stated that on turning, there are excessive dorsomedial compressive and torsional forces acting on the tarsus and since agility dogs negotiate multiple high speed turns during a course, it is assumed that this would likely increase the risk of degeneration in the tarsus of a breed that is naturally predisposed to this condition.

2.3.3 Hind limb injury

2.3.3.1 Hip Injury

2.3.3.1.1 Iliopsoas strain

Iliopsoas strains are the most common form of hind limb muscular injury seen in working dogs (Canapp, 2010). The psoas major arises from the transverse processes of the second and third lumbar vertebrae and the bodies of the fourth through seventh lumbar vertebrae. It then joins the Iliacus muscle to become the Illiopsoas with a common insertion on the lesser trochanter of the femur (Baltzer, 2012b; Canapp, 2010). The iliopsoas muscle primarily moves the pelvic hind limb forward and strains occur as a result of excessive force acting on this muscle, for example, seen in jumping and high-speed turns in agility (Canapp, 2010).

Illiopsoas injury may not present as lameness but the dog will show a decline in performance with slower completion of the weave poles and by knocking hurdle bars (Canapp, 2010), a stiff legged gait in the hindlimbs will be observed and the dog will be tender on direct palpation (Baltzer, 2012b). In extreme cases, haemorrhage due to a severe sprain of the iliopsoas muscle may result in femoral nerve paralysis, due to the close proximity of the femoral nerve to the inflamed muscle (Worth *et al.,* 2004).

2.3.3.1.2 Canine hip dysplasia

Canine hip dysplasia is a common unilateral or bilateral developmental condition where the dog has ill-fitting or loosely fitting hip joints (Witsberger *et al.,* 2008). It affects medium to large breed dogs and results in mild to intermittent lameness, difficulty rising after rest and exercise intolerance (Krontveit *et al.,* 2012). Hip dysplasia is considered hereditary with the severity of the condition influenced by environmental factors such as overfeeding and vigorous prolonged play activity during puppyhood (Krontveit *et al.,* 2012). The condition can be reliably detected in dogs as young as four months old (Innes and Clegg, 2010), and has been found to have a higher prevalence in castrated male dogs (Witsberger *et al.,* 2008). Osteoarthritis of the hip has been found to develop in dogs with hip dysplasia due to joint laxity, dislocation of the femoral head during weight bearing and alteration of the normal forces acting on the hip joint (Krontveit *et al.,* 2012). Often osteoarthritis of the shoulder and knee is a common finding in dogs with hip dysplasia (Krontveit *et al.,* 2012).

2.3.3.1.3 Hyperextension injuries

Birch and Lesniak, (2013) found a significant increase in extension of the sacroiliac region and the vertebral column in agility dogs when jumping increased height ranges, leading to injury of the region over prolonged periods. This finding accounts for the high prevalence of musculoskeletal injury in the back and hip regions of agility dogs.

2.3.3.2 Knee injuries

2.3.3.2.1 Cruciate ligament injury

Cranial cruciate ligament (CCL) injury has become one of the most common orthopaedic conditions seen in dogs and has a huge economical impact in the veterinary industry (Christopher *et al.,* 2011). Baltzer, (2012b) identified cruciate ligament tears among the most prevalent of hind limb injuries in agility dogs. This condition has been identified as a potentially career-ending injury if not surgically corrected and properly rehabilitated.

The CCL is responsible for stabilizing the tibia on the femur, and is responsible for resisting forces that cause the tibia to translate and rotate on the femur. The CCL originates on the axial aspect of the lateral femoral condyle and extends diagonally across the joint space attaching the femur to the tibia via the intercondyloid area. The ligament is narrowest in its mid-region and fans out proximally and distally (De Rooster *et al.,* 2006).

Minor CCL injuries generally occur as a result of over-exertion activity. Incomplete ligament tears were found to occur as a result of running, chasing or slipping (Worth *et al.,* 2004). Not only are the structural properties of the CCL affected by age but the risk of CCL injury increases in large, heavier breed dogs such as the German Shepherd, without the presence of obesity, and in young, highly active dogs, where the onset of degenerative changes have been found to occur earlier (De Rooster *et al.,* 2006).

Dogs with a high tibial plateau angle have a higher amount of stress placed directly on the cranial cruciate ligament, possibly causing it to tear incrementally. These dogs may also experience full rupture due to the increased thrust when jumping exceeding the strength of the CCL (Canapp, 2010).

Furthermore, partial or complete disruption of the CCL causes instability of the knee joint. This may lead to inflammatory changes which result in synovitis, osteoarthritis, meniscal injury and therefore, altered knee kinematics predisposing the dog for further injury (Canapp, 2007).

Dogs that have ruptured the CCL in one knee have shown a 50-70% increased risk of rupturing their CCL on the opposite side as a result of extra stress placed on the opposite side when the dog favours the injured leg (Canapp, 2010). This highlights the importance of prompt surgical correction of the ruptured CCL in order to reduce the stress placed on the opposite CCL (Canapp, 2010). De Rooster *et al.,* (2006) suggested that CCL injury is likely to be multifactorial: heavier breeds, overweight dogs, senior age and steep tibial plateau angles all predisposing dogs to the possibility of CCL injury.

2.3.3.2.2 Medial Patella Luxation

Fujii *et al.,* (2013) states that medial patella luxation, or knee cap dislocation, is a common orthopaedic condition affecting small breed dogs. Towle *et al.,* (2005) stated that medial patella luxation is 12 times more common in small breed dogs than large breed dogs and occurs bilaterally in 52-65% of reported cases. According to La Fond, Breur and Austin (2002) and Towle *et al.,* (2005) this condition is prevalent in miniature poodles, a breed often seen in the agility ring, and is usually due to developmental misalignment. Dogs affected by medial patella luxation present with chronic lameness and surgery is required to stabilize the area. Following surgery, repeat dislocation has been found to occur in 48% of cases along with the progressive development of degenerative joint disease (Towle *et al.,* 2005).

2.3.3.3 Foot injuries

2.3.3.3.1 Superficial digital flexor tendon luxation

The superficial digital flexor tendon crosses the knee joint and continues distally to attach to the second phalange, or toe of the hind limb. This condition is common in Border Collies and Shetland Sheepdogs, both popular breeds in agility (Baltzer, 2012b). When luxation occurs, the dog will exhibit pain and lameness and the toes may appear to be elevated off the floor when the dog bares weight on the affected limb. Surgical repair is needed to stitch the sheath over the tendon to allow it to guide smoothly over the calcaneal bone, after which, a gradual return to normal daily activity is recommended (Baltzer, 2012b).

2.3.3.4 Rupture and avulsions

Rupture and avulsions of the gastrocnemius and popliteal muscles and their tendons are a common occurrence in sporting dogs due to explosive contractions of the muscles when jumping (Baltzer, 2012b). Both muscles flex the knee of the dog and rupture results in weight-bearing lameness, while avulsion results in non-weight baring lameness in the affected hind limb (Baltzer, 2012b). According to Baltzer (2012b), a dog's ability to return to peak physical performance after a case of avulsion is unlikely even after surgical repair.

2.3 General risk factors

2.3.1 Breed

Through selective breeding, over three hundred breeds of dogs exist, showcasing the highest degree of physical and behavioral differences seen within a species (Innes and Clegg, 2010). Certain breeds have predispositions for certain diseases or musculoskeletal conditions, as pedigree dogs are bred to conform to strict aesthetic standards (Asher *et al.,* 2009). Certain articular conditions have been shown to have a definite inherited component, namely hip dysplasia, elbow osteoarthritis and cruciate ligament failure (Innes and Clegg, 2010).

In a study undertaken by Asher *et al.,* (2009), the German Shepherd breed was shown to be predisposed to the largest number of inherited disorders overall, some of these disorders being musculoskeletal, namely: canine hip dysplasia and osteochondrosis of the elbow, shoulder and stifle (LaFond, Breur and Austin, 2002).

According to La Fond, Breur and Austin (2002), neuro-sensory, cardio-vascular and respiratory conditions are also shown to be common afflictions in the German Shepherd dog which reduce its success in agility. The study also indicated that Miniature Poodles, a popular breed in the small agility category, are predisposed to the most conformational related disorders and are at high risk for patella luxation (LaFond, Breur and Austin, 2002).

In a key study done by LaFond, Breur and Austin, (2002), other herding breeds commonly seen competing in dog agility were found to be at risk for orthopaedic disease. The Border Collie showed susceptibility to osteochondrosis of the shoulder and the Bearded Collie showed an increased risk of canine hip dysplasia.

The taller, heavier breeds are shown to have the most associated musculoskeletal and cardiovascular disorders, while the smaller, lighter breeds are more predisposed to respiratory, neuro-sensory and endocrine disorders (Asher *et al.,* 2009).In general, the large breed dogs are predisposed to elbow and hip dysplasia as a consequence of their size or fast growth rate, while the smaller breed dogs are predisposed to patella luxation and shoulder dysplasia due to their small leg size (Asher *et al.,* 2009).The frequency of death due to musculoskeletal disease as well as neoplastic disease has been found to increase as the breed size gets larger (Fleming *et al.,* 2011).

Certain breeds also have a higher predisposition to fractures. Brianza *et al.,* (2006) found that fractures of the distal radius and ulnar are one of the most common fractures in dogs, with small breeds tending to developing these fractures after falling or jumping, while larger breeds tend to sustain hyperextension injuries to the wrist. In addition, Brianza *et al.,* (2006) highlights that breed related changes in bone mineral, density and geometry were suggested as etiological factors that also reduce a sporting dog's ability to continue in the agility ring.

The Border Collie, the most popular large breed agility dog, has been found to be predisposed to degenerative changes in the tarsus, which then increases the risk of fracture of the central tarsal bone (Guilliard, 2007). This condition has also been found to have a high prevalence in racing greyhounds due to racing anticlockwise around bends resulting in repetitive, unilateral compressive trauma on the medial and dorsal aspect of the tarsus on the right hand side. However, exercise induced fracture was not highlighted as the mechanism of injury in Border Collies (Guilliard, 2007). Instead, the nature of high intensity play was stated as the predisposing factor for this condition (Guilliard, 2007). Guilliard, (2007) also stated that on turning, there are excessive dorsomedial compressive and torsional forces acting on the tarsus and therefore, since agility dogs negotiate multiple high speed turns during a course, it is assumed that this would likely increase the risk of degeneration in the tarsus of a breed that is naturally predisposed to this condition, such as the Border Collie.

2.3.2 The sex of the dog

Gonadectomy, or sterilization of dogs is normally recommended by veterinary practitioners at the age of six to nine months, or in the case of female dogs, before the first oestrus cycle (Kustritz, 2007). Growth of the animal has been documented as being unaffected by gonadectomy, however, a delay in physeal closure has been noted (Reichler, 2009), possibly predisposing the dog to an increased risk of fracture upon vigorous activity at a young age. Baltzer (2012) agreed, stating that early sterilization may result in longer leg development and an increased risk of stress fracture in highly active young dogs.

Spaying of female dogs is positively correlated with an increase in its weight due to an increase in indiscriminate appetite related to a lack of oestrogen influencing satiety (Kustritz, 2007). This highlights the importance of correct feeding (Kustritz, 2007). In contrast, neutering of male dogs before the age of six months has shown to lower the rate of obesity as compared to neutering after the age of six months (Reichler, 2009).

Several orthopaedic conditions can be impacted by gonadectomy (Kustritz, 2007). An increased risk of canine hip dysplasia has been observed in male and female dogs sterilized before five months of age, however, the condition is not as severe (Reichler, 2009). This finding was supported by Baltzer (2012b) who stated that although controversial, early sterilization may result an increased risk of the development of hip dysplasia and CCL rupture. An increased incidence of CCL rupture has been recorded in both spayed and castrated dogs, with increased risk of rupture seen in neutered males, followed by spayed females. In contrast, Reichler (2009) reported that intact dogs' risk of contracting these conditions is only half that of sterilized dogs.

Closure of the growth plates of long bones in dogs, such as the femur or thigh bone, is partially controlled by sex hormones (Kustritz, 2007). Sterilization before the closure of these growth plates has been associated with statistically significant lengthening of long bones (Kustritz, 2007). However, no specific correlation has been found between that and growth plate fractures (Kustritz, 2007), but it should be noted that this increased growth in length could potentially increase disposition to certain MS conditions.

Although necessity and timing is still controversial, there are arguments for both the benefits as well as the adverse effects of sterilizing working dogs and the optimal age to do so. It has been recommended that sterilization of working dogs be delayed until 10-12 months of age (Baltzer, 2012b) to minimize the risk of development of orthopaedic conditions.

2.3.3 Nutrition and Obesity

Nutrition plays a vital role in preventing injury in sporting dogs. Not only in supplying adequate nutrients to maintain a healthy system but conversely, adding to a possible increased risk of injury. The timing of feeding is vitally important as feeding within two hours of strenuous exercise not only results in discomfort as a result of a full, heavy stomach and decreased speed, but also in poor balance, which when running and balancing on contact equipment at speed could result in a fall or slip which puts the dog at risk of musculoskeletal injury (Baltzer, 2012b).

An optimal diet for sporting dogs is considered to be food that is highly digestible and energy dense in order to maintain healthy immune function, minimise injury and optimise performance (Hill, 2010). Hill (2010) found that ideally, a sporting dogs' diet should be high protein, high fat and low carbohydrate as this should maintain consistent glycemic control and increase its fuel utilization, which in turn would help the dog perform optimally and promote endurance.

Baltzer, (2012b) and Fascetti, (2006) reported that excess caloric intake predisposes certain breeds to the development of certain orthopaedic conditions while conversely, dogs on a calorie controlled diet have a lower risk of developing musculoskeletal conditions. They highlighted that free choice feeding resulted in accelerated growth and/or obesity and developed a miss match between bone development and body mass. Thus, requiring an immature skeleton to bare more weight than is optimal during the different developmental stages, leading to biomechanical stress and a marked increase in the risk of developing musculoskeletal conditions.

Other than feeding a calorie controlled diet fortified with essential nutrients and vitamins, supplementation is also commonly provided for these canine athletes. Whether as a preventative measure, aiding in the optimal growth of a puppy, for the maintenance of musculoskeletal health in a competition dog or due to previous injury, daily joint supplementation is often provided (Matzke, 2009). These supplements generally contain Chondroitin, Glucosamine or Green Lipped Muscle extract. Known for their anti-inflammatory and anti-oxidant effects, when combined, these dietary supplements are reported to have disease modifying potential in the symptomatic treatment of osteoarthritis and for the healthy maintenance of joint cartilage (Henrotin and Lambert, 2013). Another common daily supplement is Omega 3 fatty acids in the form of fish oils, which have been shown to decrease the clinical signs of osteoarthritis (Baltzer, 2012b).

Although growth follows a genetically predetermined timeframe, it is influenced by nutrition as well as environmental factors. Fascetti, (2006), discovered that large breed puppies who have been fed a diet excessively high in calcium developed bone abnormalities such as retained cartilaginous cores in the radius and ulnar, abnormal endochondral ossification and delayed skeletal maturation due to direct competition with other minerals or the stimulation of hormones such as parathyroid hormone and calcitionin. This may possibly predispose them to an increased risk of stress fractures and developmental defects such as OCD (Baltzer, 2012b).

Canine obesity is a multifactorial event in which breed disposition, age, sterilization and medication such as corticosteroids all play a contributing role. A dog is considered over weight when the weight of the animal is above 15% of the ideal weight for that particular breed and considered obese when the dogs weight is above 30% of the ideal weight (Byers *et al.,* 2011).

Certain breeds such as the Shetland Sheepdog and the Beagle, two breeds commonly seen in the agility ring, are predisposed to becoming obese, while certain breeds such as the sight hound breeds are protected against obesity although it remains unclear why (Byers *et al.,* 2011; Kustritz, 2007). Perez-Sanchez (2015) noted that breed show dogs are more likely to be obese than sporting dogs because breed show dogs do not take part in any physical tasks and purely are on show, or in some cases, a slightly overweight dog is the actual breed requirement according to the breed's original purpose, such as in breeds required to work in cold climates where extra energy and fuel stores are needed (Corbee, 2013).

Advanced age results in a decrease in lean body mass and a decrease in the total daily energy needs, if the amount of food offered does not alter as the dog becomes older and less active, there is an increased risk of obesity, particularly between the ages of 6-10 years (Perez-Sanchez *et al.,* 2015)

As previously mentioned in section 2.3.2, sterilization predisposes certain breeds to obesity due to a net loss in circulating sex hormones, slowing the metabolism and directly affecting the satiety centre. This is especially true in dogs that have unrestricted access to food (Kustritz, 2007; Byers *et al.,* 2011) and in particular, female dogs (Perez-Sanchez *et al.,* 2007).

Fascetti, (2006) stated that obesity has been demonstrated to increase the production of inflammatory cytokines, providing a connection between over nutrition and/or obesity and the development of osteoarthritis and other orthopaedic conditions, with obese large dogs particularly at higher risk of developing musculoskeletal conditions.

This finding is supported by Byers *et al.,* (2011), in who stated that obesity is a state of chronic inflammation leading to the increased risk of the development of orthopaedic conditions including osteoarthritis and osteochondritis Dissecans as well as a plethora of other conditions including Diabetis Mellitus, Cardiopulmonary conditions, Hypothyroidism, Neoplasia and in small breed dogs, Tracheal collapse. The study also found that longevity is ultimately affected with obese dogs living 1.8 fewer years than dogs with an ideal weight.

2.3.4 Conditioning

Agility training and competition places a large amount of physical and mental strain on the dogs involved (Pierce, 2009). To obtain optimal performance from these canine athletes, they need to be properly conditioned, well trained for their task and importantly, free from any musculoskeletal conditions that might impede their performance (Pierce, 2009).

Handlers place significant importance in the selection of a prospective future agility dog. Parents of the puppies are carefully selected for conformation, ability, achievement and high drive (Cobb *et al.,* 2015). Along with genetic selection, health, rearing, housing, handling, training techniques and handler education all affect the quality of the end product: The optimal agility dog.

Studies have shown that a dog's early environment has a direct impact on their coping mechanism and adaptability to stressful situations, and that structured socialization and training, exposure to different environments and situations are all related to their end goal of becoming a successful agility dog (Cobb *et al.,* 2015).

When considering the agility competition itself, although clearly enjoyed by the dogs, agility is a potentially stressful event. Studies have shown that factors, such as time travelling to events, a constant loud environment, waiting in cages for runs and handler related stress spikes the dogs' cortisol levels (Pastore *et al.,* 2011). High levels of cortisol are considered indicative of a response to stressful stimuli, for example: the factors leading up to an event. This was shown in a study in which salivary concentrations were measured on dogs participating in agility events and they showed marked increases in cortisol levels, indicating a stress response (Pastore *et al.,* 2011). The behaviours associated with the response were restlessness, anxiety, increased panting, salivation and body shaking. However, slight increases in cortisol are also seen in situations of eustress and the exhibited behaviours are identical (Pastore *et al.,* 2011).

Agility dogs need to be conditioned for their sport from an early age and many pet owners lack sufficient knowledge of what injuries may occur as a result of poor conditioning and what is required to prevent those injuries (Baltzer, 2012a). Many agility dogs are in less than optimal physical shape, markedly increasing the risk of musculoskeletal injury (Pierce, 2009). Studies have indicated that the optimal combination of the effect of duration of training, frequency and length of individual sessions vary between breeds (Cobb *et al.,* 2015), for example, brachycephalic or flat faced breeds do not have as much cardiopulmonary capacity as other dogs and are more prone to heat stroke (Baltzer, 2012a). These differences need to be taken into account when formulating a conditioning programme in order to keep the risk of injury or the development of life threatening conditions to an absolute minimum.

Ideally, a competing agility dog needs fitness maintenance of at least 3-4 sessions a week with a combination of skills training and general aerobic fitness (Matzke, 2009) to maximise the dogs physical potential to best carry out their expected duty (Pierce, 2009). But realistically, not many handlers can achieve this in combination with their general work day demands; this means that their dogs' sport specific conditioning is often neglected and such inconsistent training increases the risk of injury (Baltzer, 2012a).

Conditioning not only encompasses exercise, but also includes a proper warm-up and cool-down before and after a training session and/or competition event (Matzke, 2009). A sufficient warm-up and cool-down period is often neglected as many handlers run multiple dogs and therefore, dogs are immediately crated after a run in order to allow the handler to run the next dog or purely to socialize and discuss the round with fellow competitors (Matzke, 2009). Such neglect of an important part of an exercise portfolio significantly increases the risk of their dogs developing a musculoskeletal injury (Matzke, 2009). This finding is supported by Baltzer (2012a), in which it is stated that an adequate warm up of 10 minutes including activities such as walking, trotting, and a few practice jumps before an athletic event such as agility has been shown to reduce the incidence of injury. However, it was stated that this is only effective if the competition happens within minutes after the warm-up activity.

Conversely, Baltzer (2012a) also stated that an excessive warm-up lasting in excess of 15 minutes before sporting activities increases lactate levels. This results in muscle fatigue and increased rates of injury as well as an increased predisposition to stress fracture. Such problems suggest that conditioning programmes are not only vital, but that it is imperative for the routine to be tailored to each dog's specific level of fitness (Pierce, 2009). In addition, some degree of handler education is needed to prevent the risk of injury through excessive practice of an activity meant to aid in the conditioning of the dog.

Strenuous conditioning programmes performed to early in puppyhood have been shown to lead to growth plate trauma as closure of these plates only take place between the ages of 9-18 months, depending on the breed of dog, with larger dogs reaching skeletal maturity at a more advanced age (Baltzer, 2012a). Conditioning in pubertal dogs must be strictly supervised as young, high drive dogs are highly motivated to perform until exhaustion and may not have a developed sense of proprioception to prevent strain on ligaments and tendons and undue strain on articular cartilage (Baltzer, 2012a). This, again, highlights the importance of tailoring conditioning programmes to the age specific needs and capabilities of each dog (Pierce, 2009; Baltzer, 2012a).

Kerr, (2014), discovered that injury in sporting dogs is positively associated with age, as such injuries seem to be more 'wear and tear' related. Proprioception is known to decrease with age and this highlights the importance of the inclusion of proprioceptive exercises in the agility dogs conditioning program, throughout their lifetime. Balance and proprioceptive conditioning may include exercises on a wobble board, sit to stand and down to sit exercises (Baltzer, 2012a).

For dogs that have had rest periods after injuries or surgeries, reconditioning is vital for the dog to return to competitions without an increased risk or re-injury (Baltzer, 2012a). Studies have shown that an activity restriction of 8 weeks leads to a 41% loss of endurance and requires a further 8 weeks recovery to regain the original fitness level (Baltzer, 2012a). If that dog is given one or two weeks of training, with the usual twice per week sessions post rest period, and sent straight back into competition, it can be assumed that the dog will suffer from repeated strain injuries or at least only be able to offer sub-optimal performances (Baltzer, 2012a).

For all agility dogs, not only those suffering from repeated strain injuries, pre and post training and competition stretching and massage is important to decrease oedema and stiffness in previously injured tissues and to prevent injury in normal tissues (Baltzer, 2012a).

2.4 Animal chiropractic

In South Africa, there are only a few chiropractic studies which have been conducted on animals due to ethical and legal issues, as well as a lack of educational infrastructure related to animal chiropractic in South Africa (Taverner, 2011).

Animal chiropractic provides a natural, drug-free adjunct to an animals' overall health care (Taverner, 2011). It is commonly prescribed by veterinarians for the treatment of musculoskeletal conditions, non-steroidal anti inflammatories (NSAIDs) have been shown to weaken cartilage in canines, among many other detrimental side effects such as gastric ulceration and nephrotoxicity when utilized over long periods of time or with high frequency (Taverner, 2011; Mathews, 1996). This is detrimental to agility dogs who are already contending with an increased risk of overuse injuries due to the physical demands of the sport. Working alongside veterinarians, chiropractic care can provide a valuable tool in the treatment of agility dogs, by reducing the need for the use of NSAIDs and by ensuring the dogs perform to their best possible ability.

Maurer (2000), stated that the chiropractic profession is ready to grow and expand into the world of treatment for animals. Animal chiropractic is well established in some countries outside of South Africa, but has shown tremendous progress in South Africa in becoming more widely recognised by private health care providers, and, with a growing public interest in the application of chiropractic in the animal industry (Bosman, 2012).

2.5 Conclusion

As the sport of dog agility grows and gains popularity along with the growth of the awareness and utilization of CAM therapies, the public are keenly searching for alternative forms of therapy for their canine athletes Maurer (2000). By increasing the knowledge of the profile of working canines at risk for injury and the most common injuries seen, it could potentially assist in supplementing the limited literature available to allied health professionals working with canines, such as Chiropractors.

CHAPTER THREE

Methodology

3.1 Introduction

This chapter explains the research methodology and procedure used to conduct the study and collect data. Topics discussed within this chapter include the study design, sampling method, research procedures and the research tool as well as ethical considerations and the statistical methodology used.

3.2 Research study design

This study was a cross sectional, prospective survey of sporting canine owners registered with the Kwa-Zulu Natal Dog Agility Association (KZNDAA) in order to determine the prevalence and selected risk factors of musculoskeletal conditions affecting canine athletes in Kwa-Zulu Natal (KZN). The study employed a quantitative descriptive design. The researcher developed the questionnaire. Questionnaire based studies have been shown to be reliable and valid, and allow for data to be collected from a large diverse population, resulting in descriptive and statistical information which can then be analyzed (Mouton, 2002).

3.3 Ethical consideration

The research design was approved by the Durban University of Technology (DUT) Institutional Research and Ethics Committee (IREC) (Appendix K).

Participation was voluntary and all participants received a Letter of Information and Consent (Appendix M). All completed questionnaires were inserted into a sealed box which was only opened by the researcher once the minimum response rate had been achieved. This helped to ensure the participants' confidentiality.

3.4 Permission and recruitment

Permission was granted by the KZNDAA to conduct this survey at championship and open level shows (Appendix Q). As a result, no formal advertising was required. The researcher approached the participants directly.

3.5 Sampling

3.5.1 Population

Owners of dogs classified and registered under the KUSA herding breed subcategory qualified for the study (Appendix O). Owners with more than one qualifying dog completed one questionnaire per dog.

3.5.2 Sample size

83 dog owners were registered as members of the KZNDAA at the time of ethics clearance with IREC. Therefore, the total population size was 83 members. After the inclusion and exclusion criteria had been applied, the total sample size of the study included 70 dogs who are registered to 38 owners. A minimum response rate of 70% was required for this study to reach statistical significance (Esterhuizen, 2015).

3.6 Sample characteristics

All participants had to comply with the following criteria.

3.6.1 Inclusion criteria - Canines

- All dogs had to be classified under the Herding breed category according to standards listed by the Kennel Union of Southern Africa. (Appendix O).
- All qualifying breeds that are also registered with the KZNDAA.
- Any age of dog.
- Any sex of dog (Intact or Castrated).

3.6.2 Exclusion criteria - Canines

- Mixed breed dogs.
- Any dog with a final diagnosis of "lameness" as this is not a definitive diagnosis.
- Any dog not registered with the KZNDAA.

3.6.3 Inclusion criteria - Owners

- The person completing the questionnaire was required to be the registered owner of the dog.
- The owner was required to be English speaking and literate.

3.6.4 Exclusion criteria - Owners

- Any owner that participated in the expert group or pilot study.

3.7 Measurement tools

3.7.1 Questionnaire development

For this study, a questionnaire was used to gather data. As no questionnaire specific to the research problem could be found from the available literature, a questionnaire was drafted by the researcher. The style of questioning varied from open-ended, multiple choice and yes or no type questions. This lead to the development of the pre-expert group questionnaire (Appendix D).

3.7.2 Pre-expert group questionnaire

The questionnaire was constructed in English and consisted of three main sections addressing demographics, prevalence and risk.

The demographic section was to retrieve information about the sporting canines breed, age, sex, weight and type of food the owners are feeding the dogs. This section also determined what height category the sporting canine is affiliated for and whether the dog currently competes in any other discipline other than agility, such as Dog Jumping.

The prevalence section gathered information regarding whether the sporting canine in question had ever sustained an injury during agility training or competition. Questions specific to the injury were also asked, such as whether a veterinary diagnosis was made and/or if the injury was caused by any specific agility equipment.

The risk section addressed whether the owners put their sporting canines through a warm-up regime before training or competition, how long the canine in question has been competing in agility and the age of the canine before first beginning training and competition. This section also covered how many training sessions are performed in a week and the duration of the sessions.

3.7.3 Expert group

The expert group allowed the facilitation of a group of professionals to openly discuss and critically assess the relevance of questions presented in the questionnaire according to the research objectives. They were also asked to ensure the questions followed a format that could be easily understood. The feedback gained from the expert group meeting ultimately aided in strengthening the face validity of the questionnaire (Appendix E).

Potential participants meeting the inclusion criteria were contacted telephonically to establish whether they would be interested in participating in the proposed expert group. Once the members of the expert group had been established, arrangements went ahead to finalize the meeting.

The expert group consisted of the following people:

- Two owners of working canines who meet the inclusion and exclusion criteria for the study.
- One chiropractic student who is currently completing a questionnaire based research study at DUT.
- One qualified veterinary practitioner.
- One DUT supervisor who is knowledgeable in DUT research protocol and procedure.
- The researcher.
- The researcher’s supervisor.
- The researcher’s co-supervisor.

The researcher opened the meeting by welcoming the participants, explaining the procedure and providing the participants an opportunity to ask questions before the discussion began.

It was required that all members of the expert group read and sign a Confidentiality Statement and Code of Conduct (Appendix A). A Letter of Information and Informed Consent (Appendix C) was then handed to the participants to read and sign. Failure to sign the informed consent meant exclusion from the expert group. Each member of the expert group was then given a pre-expert group questionnaire (Appendix D). The questionnaire was then discussed question by question in sequential order, allowing for suggestions or additions, omissions or alterations to questions to be recorded, based on the general consensus of all members in attendance. The relevance and clarity of the questions was also discussed. An audiovisual recording was taken for record keeping, available only to the researcher and examiners in order to protect the confidentiality of the participants.

All changes that were made to the questionnaire are documented in Appendix E.

The changes suggested during the expert group to the pre-expert questionnaire lead to the development of the post-expert group questionnaire (Appendix F).

3.7.4 Pilot study

The post expert group questionnaire was subjected to a pilot study in order to establish the participants understanding of the questionnaire and to eliminate any confusion or ambiguity that any questions might have raised. The questionnaire was administered by hand at a championship agility show and collected by placement into sealed boxes on the same day by the researcher. This method of distribution and collection was the same for the main study.

The pilot study consisted of the following persons:

- Three agility handlers who
  -are registered with the KZNDAA.
  -own canines registered under the herding breed category listed under the KUSA regulations.

No changes were suggested by the pilot study participants; therefore, the post expert group questionnaire became the research questionnaire (Appendix L) which was to be used in this study for data collection.

3.8 Data collection procedure

- Once approval was obtained from the DUT IREC (Appendix K), the study commenced.
- Potential participants were identified on the KZNDAA membership list. These members were approached by the researcher at registered agility shows (Appendix P) and invited to participate in the study.
- Once it had been established that the owners and the canines met the inclusion and exclusion criteria of the study, participants were then given a Letter of Information and Confidentiality (Appendix M) and an Informed Consent form (Appendix N).
- Once the owners had signed the required documentation, they were included as participants in the study.
- The research questionnaire was then given to participants, who then completed the questionnaire on site and returned it by hand to the researcher.
- To preserve the confidentiality of the participants, completed questionnaires were slotted into a sealed box which was only opened upon completion of data collection for the study.
- The sealed boxes were then opened by the researcher who captured the data onto an excel spreadsheet to give to the statistician for statistical analysis.

- All data and informed consent forms were then securely stored in a locked cabinet at the Durban University of Technology: Department of Chiropractic and Somatology. These documents will remain so for a period of 5 years before being destroyed.

3.9 Statistical analysis

Data was captured on an excel spreadsheet and was sent to the statistician who transferred the information to IBM SPSS version 23 (Esterhuizen, 2015). A *p*-value of <0.05 was considered statistically significant. Descriptive statistics such as mean, standard deviation and range were used to describe continuous variables which were normally distributed, while median and inter-quartile range were used for skew variables. Categorical variables were summarized using frequency tables. Associations between lifetime prevalence and risk factors were tested using Pearson's chi square tests for categorical risk factors, or Fischer's Exact tests for continuous variables.

CHAPTER FOUR

Results

4.1 Introduction

This chapter presents the results obtained from the data collection process.

4.2 Data

The primary data for this study was provided by the participants of the study following the completion of a questionnaire (Appendix L) which was used to collect the data.

The secondary data was compiled using information gathered through literature review, as depicted in chapter two, through the use of research dissertations, journal articles, internet sources, library books and through communication with a statistical analyst (Esterhuizen, 2015).

4.3 Abbreviations specific to this chapter

%: Percent

CI: Confidence Interval

FCI: Federation Cynologique Internationale

GMS: General muscle stiffness

GSD: German Shepherd Dog

MS: Musculoskeletal

n: Population size

OCD: Osteochondritis Dessicans

***p*:** *p*-Value indicates the statistical significance of the data. The lower the p-value, the less likely the finding would occur by chance alone (Mosby, 2012).

4.4 Response rate

A total of 83 dog owners were registered as members of the KZNDAA at the time of ethical clearance with IREC, therefore, the total population size was 83 members. After the inclusion and exclusion criteria had been applied, the total sample size of the study was 70 dogs registered to 38 owners. A minimum response rate of 70% was required for this study to reach statistical significance (Esterhuizen, 2015).

A total of 63 questionnaires were distributed to a total of 34 owners. They were instructed to complete one questionnaire per dog as per the inclusion criteria for participation in the study (Section 3.6.1).

Of the returned questionnaires, 2 had to be excluded as a result of the breed of dog not meeting the inclusion criteria, and 2 were excluded as a result of failure to complete the questionnaire to an acceptable state. This produced 59 questionnaires eligible for statistical analysis. The number of participants are revealed in the following consort diagram (Figure 4.1).

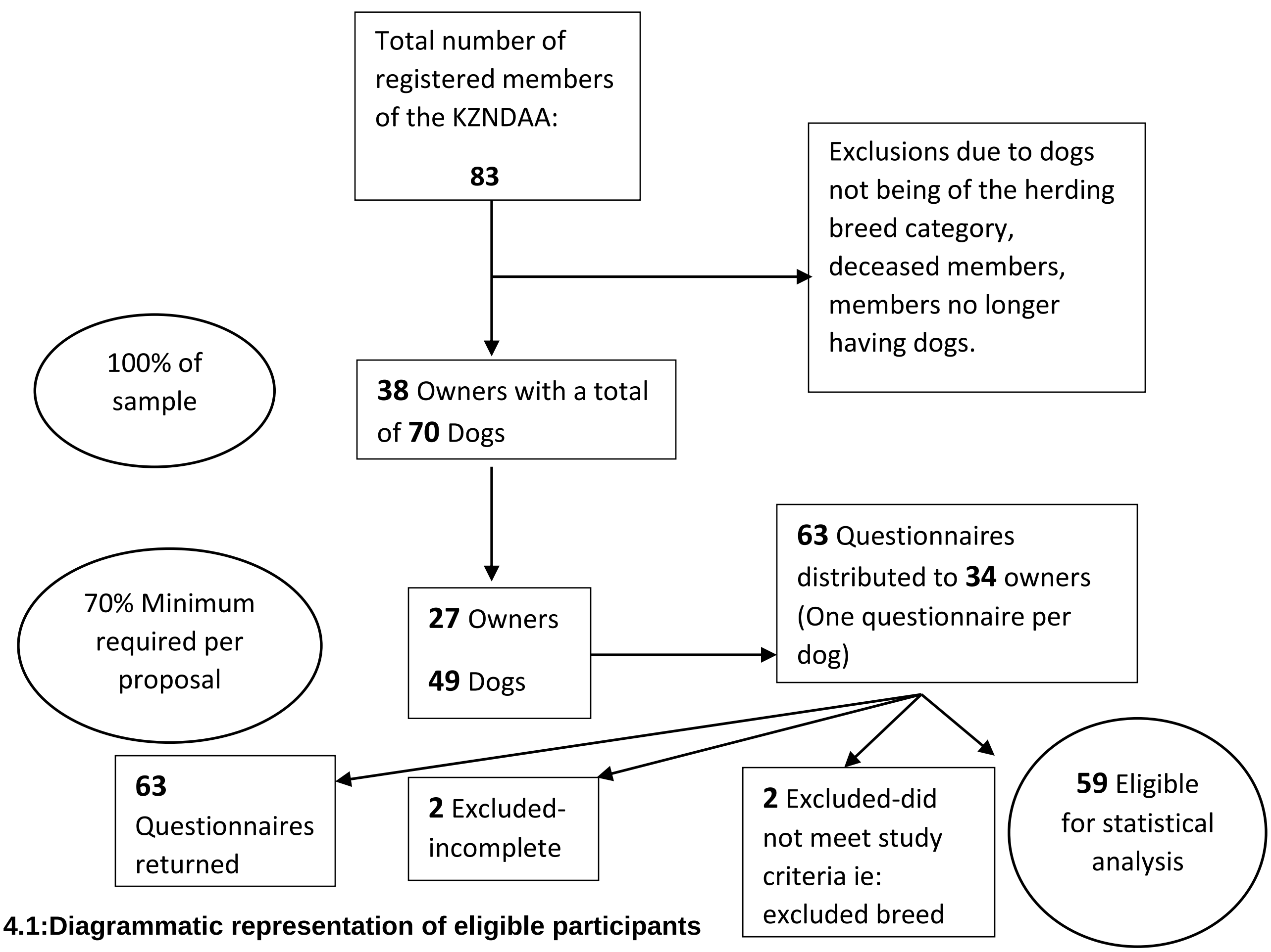


Figure 4.1:Diagrammatic representation of eligible participants

4.5 Results

4.5.1 Objective One: Demographics

To determine the demographic profile of herding breeds affected by musculoskeletal conditions (MS) in Kwa-Zulu Natal (KZN).

Table 4.1 Demographics of the sample as a whole

		Count	Column N %
Breed	Australian Kelpie	2	3.4%
	Australian Shepherd	9	15.3%
	Belgian Shepherd Groenendael	2	3.4%
	Belgian Shepherd Malinois	3	5.1%
	Belgian Shepherd Tervuren	1	1.7%
	Border Collie	34	57.6%
	German Shepherd	4	6.8%
	Pembroke Welsh Corgie	1	1.7%
	Schipperke	2	3.4%
	White Swiss Shepherd	1	1.7%
Sex	Female (Intact)	2	3.4%
	Female (Spayed)	25	42.4%
	Male (Intact)	9	15.3%
	Male (Neutered)	23	39.0%
Age	1-2 Years	9	15.3%
	2-4 Years	15	25.4%
	4-6 Years	13	22.0%
	6-8 Years	6	10.2%
	8-10 Years	10	16.9%
	10+ Years	6	10.2%

		Count	Column N %
Height	Small	3	5.1%
	Medium	5	8.5%
	Large	51	86.4%
Weight	5-10 Kg	3	5.1%
	10-15 Kg	4	6.8%
	15-20 Kg	31	52.5%
	20-25 Kg	12	20.3%
	25+ Kg	9	15.3%

Table 4.1 illustrates that the majority of the sample were Border Collies (58%). The vast majority of participants were in the large category (86%), with the most prevalent weight category being 15-20Kg (53%). In contrast, the small dog category was not as well represented (5%), with the Schipperke being the most popular breed (3%).

Dogs in the age category of 2-4 years made up 25% of the population, closely followed by dogs in the 4-6 year category (22%).

Spayed females were predominant (42%), followed by neutered males (39%). Intact males (15%) were more prevalent than intact females (3%)

The following table illustrates the demographic profile of the lifetime prevalence of dogs affected by MS conditions.

Table 4.2 The Demographic profile of dogs affected by MS conditions (Lifetime Prevalence)

		Count	Column %
Breed	Australian Shepherd	2	7.4%
	Belgian Shepherd Groenendael	1	3.7%
	Belgian Shepherd Malinois	2	7.4%
	Border Collie	17	63.0%
	German Shepherd	3	11.1%
	Pembroke Welsh Corgie	1	3.7%
	Schipperke	1	3.7%
Sex	Female (Intact)	1	3.7%
	Female (Spayed)	8	29.6%
	Male (Intact)	4	14.8%
	Male (Neutered)	14	51.9%
Age	1-2 Years	3	11.1%
	2-4 Years	6	22.2%
	4-6 Years	5	18.5%
	6-8 Years	2	7.4%
	8-10 Years	7	25.9%
	10+ Years	4	14.8%
Height	Small	2	7.4%
	Medium	2	7.4%
	Large	23	85.2%
Weight	5-10 Kg	2	7.4%
	10-15 Kg	2	7.4%
	15-20 Kg	11	40.7%
	20-25 Kg	7	25.9%

25+ Kg	5	18.5%

Border Collies have the highest lifetime prevalence of MS injury (63%), with the other breeds in the lower percentages.

Neutered males were shown to have the highest lifetime prevalence for MS conditions (52%), followed by spayed females (30%). Intact females had the lowest prevalence for MS conditions (3.7%), followed by intact males (15%).

The most common ages affected by these injuries are dogs in the 8-10 year old category (30%), followed by the 2-4 year old category (22%).

Dogs in the large breed category represented the vast majority of those affected by MS conditions (85%). This is representative of the population as small dogs make up the minority of the sample population for this study. The middle to higher weight categories were shown to be the most affected by MS conditions with the 15-20Kg category being the majority at 40% and the 20-25Kg category at 26%.

4.5.2 Objective Two: Period and lifetime prevalence

To determine the period and lifetime prevalence of musculoskeletal injuries in herding breeds in Kwa-Zulu Natal.

Period prevalence was defined as those dogs whose age of injury was in the same two year age bracket as the current age of the dog.

Table 4.3: Period and lifetime prevalence of MS injuries in herding breeds in KZN.

	Injury	Count	Column %	95% CI
Period Prevalence	No	54	91.5%	
	Yes	5	8.5%	[3.16, 19.42]
Lifetime Prevalence	No	32	54.2%	
	Yes	27	45.8%	[32.92, 59.15]

The estimated period prevalence of MS conditions was 8.5%, once the 95% confidence interval was applied, true period prevalence was shown to be between 3.16% and 19.42%.

The lifetime prevalence of MS conditions was estimated to be 45.8%, the confidence interval was shown to be between 32.92% and 59.15%.

4.5.2.1 Characteristics of the cases

The following section is based on lifetime prevalence.

A total of 27 dogs were recorded as having had one injury, a total of 8 as having had two injuries and 5 as having had three injuries.

4.5.2.1.1 Age of injury

Age at the time of injury was recorded in months during the data collection process and then grouped into specific age group categories for ease of statistical analysis and comparison. Injury one was described as the most severe, injury two as the second most severe and injury three as any additional injury.

Table 4.4 Age at injury one (most severe injury)

Section B Q2	Frequency	Percent	Valid Percent	Cumulative percent
0-1 Year	7	11.9	25.9	25.9
1-2 Year	5	8.5	18.5	44.4
2-4 Year	5	8.5	18.5	63.0
4-6 Year	5	8.5	18.5	81.5
6-8 Year	3	5.1	11.1	92.6
8-10 Year	1	1.7	3.7	96.3
10+ Years	1	1.7	3.7	100.0
Total	**27**	**45.8**	**100.00**	
System	**32**	**54.2**		
Total	**59**	**100.00**		

The 0-1 year category had the highest prevalence of MS injury (25.9%), the 1-2 year, 2-4 year and 4-6 year followed that with an equal result (18.5%), the 6-8 year category had a prevalence of 11% and the least affected category was the 8-10 and 10+ categories (3.7%)

Table 4.5 Age at injury two (second most severe injury)				
Section B Q2	Frequency	Percent	Valid Percent	Cumulative percent
0-1 Year	1	1.7	12.5	12.5
1-2 Year	1	1.7	12.5	25.0
2-4 Year	1	1.7	12.5	37.5
4-6 Year	3	5.1	37.5	75.0
6-8 Year	2	3.4	25.0	100.0
Total	**8**	**13.6**	**100.00**	
System	**51**	**86.4**		
Total	**59**	**100.00**		

The age of the second injury excluded some categories as there were no affected dogs in that age category. However, the 4-6 year old category held the highest prevalence of MS injury (37.5%), followed by the 6-8 year category (25.0%) and then the 0-1 year, 1-2 year and the 2-4 year (12.5% each).

Table 4.6 Age at injury three (additional injuries)				
Section B Q2	Frequency	Percent	Valid Percent	Cumulative percent
1-2 Year	1	1.7	20.0	20.0
2-4 Year	1	1.7	20.0	40.0
6-8 Year	1	1.7	20.0	60.0
8-10 Year	2	3.4	40.0	100.0
Total	**5**	**8.5**	**100.00**	
System	**32**	**54.2**		
Total	**59**	**100.00**		

Only 5 dogs were reported to have had three injuries each. The majority of the population either having had no MS injuries or only as having had one, and a few having sustained two injuries. The 8-10 year old category had the highest prevalence of a third or additional MS injury occurring (40%) followed by the 1-2 year, 2-4 year and 6-8 year olds with a result of 20% in each category.

4.5.2.1.2 The activity in which the injury occurred

Section B Q3

Figure 4.2 Illustrates the activity in which the most severe injury (injury one) occurred.

Play dominated the cause of injury (48%), followed by other (26%). Injury during competition accounted for 19% and finally, injury during training accounted for 7%. There were no injuries during warm-up.

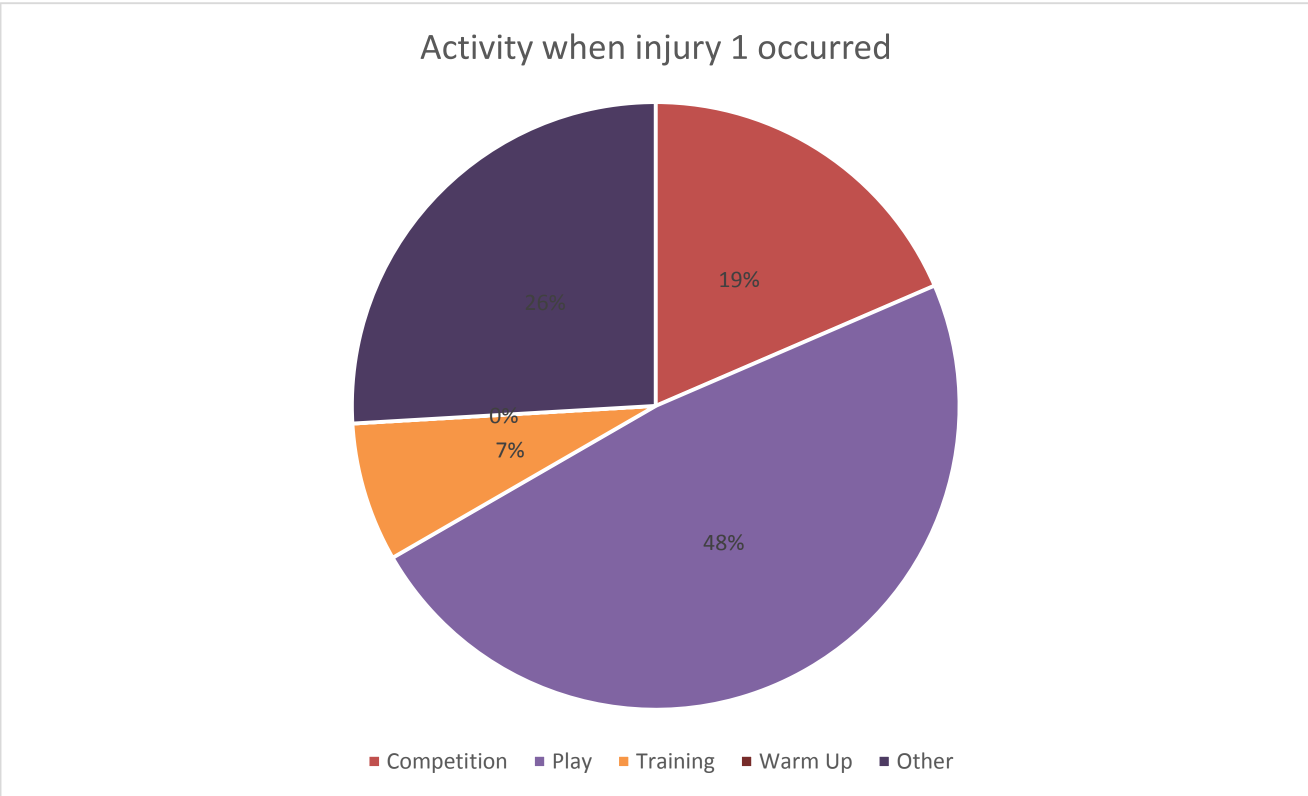


Figure 4.2 Activity during which the most severe injury occurred

Figure 4.3 Illustrates the activity in which the second most severe injury (injury two) occurred.

Injury during competition was the predominant activity for the second most severe injury sustained (50%) followed by injury during play (37%) and other (13%). There were no injuries during warm-up or training in this category.

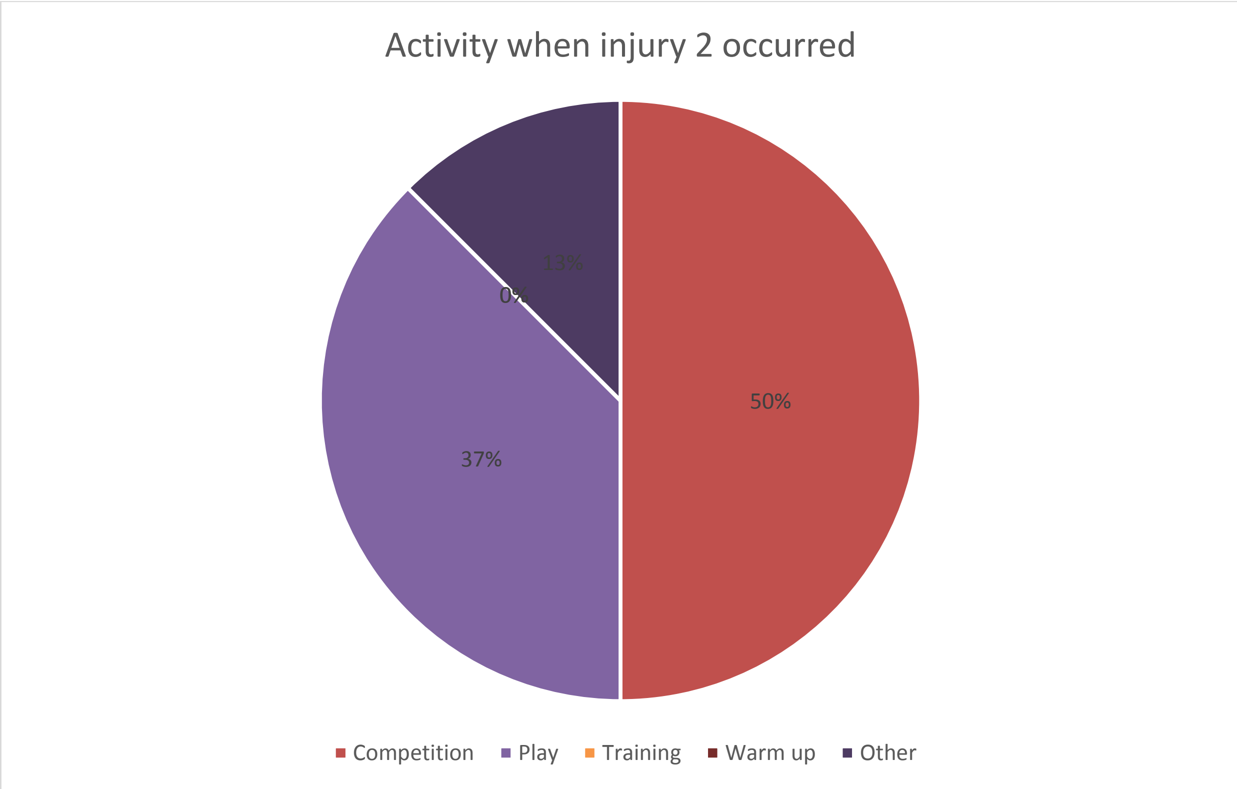


Figure 4.3 Activity during which the second most severe injury occurred

Figure 4.4 illustrates the activity in which any additional injury (injury 3) occurred.

Injury during play accounted for 60% followed by injury during competition (40%). There were no injuries sustained during warm up, training or other.

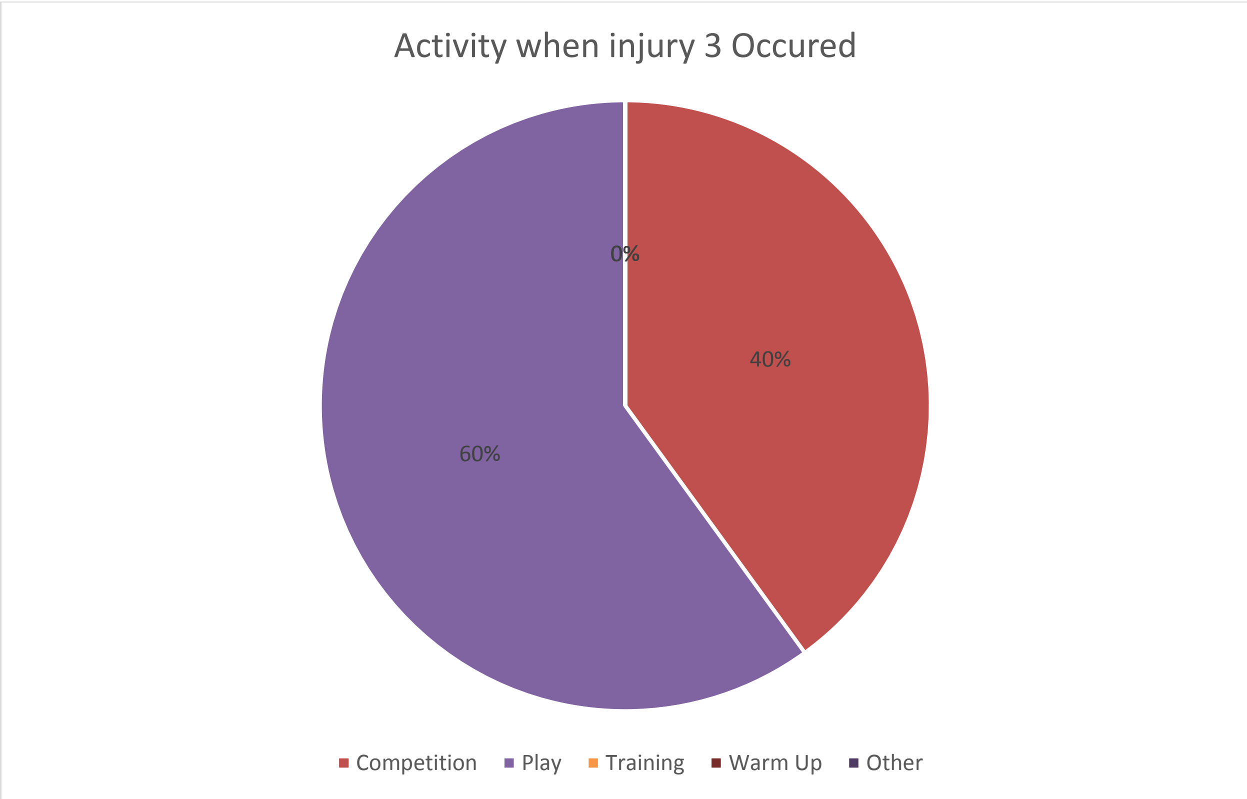


Figure 4.4 Activity during which any additional injury occurred

4.5.2.1.3 Discipline in which the injury occurred

Section B Q4- This question was only answered if the dog's injury was sustained during competition or training.

Injury during training or competition applied to 14 dogs for injury one, a total of eight dogs for injury two and three dogs for injury three.

Table 4.7 Discipline in which the injury occurred

Injury	Discipline	Frequency	Percent
Injury 1	Agility	7	11.9%
	Dog Jumping	5	8.5%
	Other	2	3.4%
Total: 14 Injuries occurred during participation in these events.			
Injury 2	Agility	5	8.5%
	Flyball	2	3.4%
	Dog Jumping	1	1.7%
Total: 8 Injuries occurred during participation in these events.			
Injury 3	Agility	2	3.4%
	Dog Jumping	1	1.7%
Total: 3 Injuries occurred during participation in these events.			
Not Applicable		19	32.2%

Agility was the most frequent discipline in which injury one (most severe) (11.9%), injury two (second most severe) (8,5%) and injury three (additional injury) (3.4%) occurred, followed by Dog Jumping for injury one (8.5%), Flyball for injury two (3.4%) and Dog Jumping for injury three (1.7%).

4.5.2.1.4 General body region injured

Section B Q5

Participants were first asked to select the general region injured, that is: forelimb, hind limb or other. The specific region was then selected and will be illustrated in the next section along with a combined discussion.

Table 4.8 General body region injured

Injury	Region	Frequency	Percent
Injury 1	Forelimb	15	25.4%
	Hind limb	9	15.3%
	Other	4	6.8%
	(n=28)		
Injury 2	Forelimb	3	5.1%
	Hindlimb	5	8.5%
	Other	2	3.4%
	(n=10)		
Injury 3	Forelimb	2	3.4%
	Hindlimb	2	3.4%
	Other	2	3.4%
	(n=6)		

Forelimb injuries for injury one accounted for 25%, hindlimb 15% and other, 7% with a total of 28 injuries. Forelimb injuries for injury two accounted for 5%, hindlimb 9% and other, 3% with a total of 10 injuries. Forelimb injuries for injury three accounted for 3%, hindlimb 3% and other, 3% with a total of 6 injuries.

Table 4.9 Specific body region injured

Injury	Region	Frequency	Percent
Injury 1	Elbow	2	3.4%
	Hip	6	10.2%
	Knee	2	3.4%
	Nail	1	1.7%
	Shoulder	7	11.9%
	Toe	2	3.4%
	Wrist	4	6.8%
	(n=24)		
Injury 2	Hip	2	3.4%
	Knee	2	3.4%
	Shoulder	2	3.4%
	Toe	1	1.7%
	(n=7)		
Injury 3	Hip	1	1.7%
	Knee	2	3.4%
	Shoulder	1	1.7%
	Wrist	1	1.7%
	(n=5)		

The shoulder was the most commonly injured region (n=10), followed by the hip (n=9), other (n=8), the knee (n=6), wrist (n=5), toe (n=3) and finally the elbow (n=2) and the nail (n=1).

4.5.2.1.5 Injury Description

Section B Q6

Participants often had multiple descriptions due to some injuries being multifactorial or because the dog had concomitant injuries, therefore this table is structured: Injury one, a and b, injury two a and b, injury three a and b. For example: Dog's injury 1 was (a) partial cruciate rupture and (b) iliopsoas strain.

Table 4.10 Injury description

Condition 1a	Frequency	Percent	Valid Percent	Cumulative Percent
Arthritis	1	1.7	3.8	3.8
Biceps Brachii-Rupture	1	1.7	3.8	7.6
Congenital deformity	1	1.7	3.8	11.4
Cruciate-Partial rupture	1	1.7	3.8	15.2
Degenerative Joint Disease	1	1.7	3.8	19.0
Elbow Dislocation	1	1.7	3.8	22.8
Fracture-Carpal	1	1.7	3.8	26.6
Fracture-Greater Trochanter	1	1.7	3.8	30.4
Fracture-Metatarsal	1	1.7	3.8	34.2
Fracture-Patella	1	1.7	3.8	38.0
General Bruising-Spine	1	1.7	3.8	41.8
General Bruising- Tail	1	1.7	3.8	45.6
General Bruising-Toes	1	1.7	3.8	49.4
General MS injury	1	1.7	3.8	53.2
General Muscle Stiffness(GMS):				
GMS- Hip	2	3.4	7.7	60.9
GMS- Shoulder	1	1.7	3.8	64.7
Infected nail bed	1	1.7	3.8	68.5
Osteochondritis Dessicans (OCD)	1	1.7	3.8	72.3
Sprain-Wrist	1	1.7	3.8	76.1
Strain-General muscle	1	1.7	3.8	79.9

Strain-Hamstring	1	1.7	3.8	83.7
Strain-Iliopsoas	1	1.7	3.8	87.5
Strain-Shoulder musculature	2	3.4	7.7	95.2
United Anconeal Process	1	1.7	3.8	100.0
Total	26	44.1	100.0	
Missing/System	33	55.9		
Total	59	100.0		

Condition 1b	Frequency	Percent	Valid Percent	Cumulative Percent
Arthritis	2	3.4	28.6	28.6
Degenerative joint disease	1	1.7	14.3	42.9
GMS	1	1.7	14.3	57.2
GMS-Iliopsoas	1	1.7	14.3	71.5
GMS-Spine	1	1.7	14.3	85.8
Patella Ligament tear	1	1.7	14.3	100.0
Total	7	11.9	100.0	
Missing/System	52	88.1		
Total	59	100.0		

Condition 2a	Frequency	Percent	Valid Percent	Cumulative Percent
Arthritis	1	1.7	12.5	12.5
Cruciate-Full Rupture	1	1.7	12.5	25.0
Cruciate-Partial Rupture	1	1.7	12.5	37.5
OCD	1	1.7	12.5	50.0
Strain-Hamstring	1	1.7	12.5	62.5
Strain-Iliopsoas	2	3.4	25.0	83.0
Torn toe nail	1	1.7	12.5	100
Total	8	13.6	100.0	

Missing/System	51	86.4		
Total	59	100.0		

Condition 2b	Frequency	Percent	Valid Percent	Cumulative Percent
Infected nail bed	1	1.7	33.3	33.3
GMS-Iliopsoas	1	1.7	33.3	66.7
GMS-Spine	1	1.7	33.3	100.0
Total	3	5.1	100.0	
Missing/System	56	94.9		
Total	59	100.0		

Condition 3a	Frequency	Percent	Valid Percent	Cumulative Percent
Cruciate-Full	1	1.7	20.0	20.0
Cruciate-Partial	1	1.7	20.0	40.0
GMS-Shoulder	1	1.7	20.0	60.0
Sprain-Wrist	1	1.7	20.0	80.0
Strain-Hamstring	1	1.7	20.0	100.0
Total	5	8.5	100.0	
Missing/System	54	91.5		
Total	59	100.0		

Condition 3b	Frequency	Percent	Valid Percent	Cumulative Percent
GMS-Hip	1	1.7	100.00	100.0
Missing/System	58	98.3		
Total	59	100.00		

In total there were 28 dogs and a total of 50 injuries. Therefore, 47% of the total study population had sustained one or more musculoskeletal injuries (see **Table 4.2** for the prevalence of those affected by MS conditions).

4.5.2.1.6 Veterinary diagnosis and rest periods

Section B Q7: Was a diagnosis made by a vet. A yes or no answer was selected for injury one, two and three. The question was omitted for those dogs who have not sustained an injury in their careers.

Table 4.11 Veterinary diagnosis

Injury 1	Percent	Valid Percent	Cumulative Percent
Yes 23	39.0	85.2	85.2
No 4	6.8	14.8	100.0
No Answer 0			
Injury 2			
Yes 5	8.5	83.3	83.3
No 0			
No Answer 1	1.7	16.7	100.0
Injury 3			
Yes 3	5.1	60.0	60.0
No 1	1.7	20.0	80.0
No Answer 1	1.7	20.0	100.0

A total of 31 of the recorded injuries and conditions were diagnosed by a veterinarian. 5 were not formally diagnosed and 2 were left unanswered.

The following table depicts the length of time the dogs were rested for after sustaining an injury, or in certain cases, whether they were retired due to the injury.

Section B Q8- The length of the rest period was recorded in weeks.

Table 4.12 Rest period following injury

		Frequency	Percent	Valid Percent	Cumulative Percent
Injury 1					
Weeks	0.4	1	1.7	4.3	4.3
	1.0	2	3.4	8.7	13.0
	2.0	2	3.4	8.7	21.7
	3.0	3	5.1	13.0	34.8
	4.0	3	5.1	13.0	47.8
	6.0	3	5.1	13.0	60.9
	7.0	1	1.7	4.3	65.2
	8.0	2	3.4	8.7	73.9
	10.0	1	1.7	4.3	78.3
	12.0	1	1.7	4.3	82.6
	24.0	3	5.1	13.0	95.7
	48.0	1	1.7	4.3	100.0
	Total	23	39.0	100.0	

Injury 2					
Weeks	2.0	2	3.4	28.6	28.6
	3.0	1	1.7	14.3	42.9
	4.0	1	1.7	14.3	57.1
	6.0	2	3.4	28.6	85.7
	8.0	1	1.7	14.3	100.0
	Total	7	11.9	100.0	

		Frequency	Percent	Valid Percent	Cumulative Percent
Injury 3					
Weeks	1.0	1	1.7	25.0	25.0
	3.0	1	1.7	25.0	50.0
	6.0	1	1.7	25.0	75.0
	8.0	1	1.7	25.0	100.0
	Total	4	6.8	100.0	
Immediate retirement due to injury					
		3	5.1	100.0	100.0
Retired due to reoccurring injury					
		1	1.7	100.0	100.0
Unsure		1	1.7	100.0	100.0

Duration of rest periods were widely varied. The majority of injury one cases were rested for 3,4 and 6 weeks (13% in each category). Injury two cases were rested for 2 and 6 weeks predominantly (28.6% in each category) and injury three cases had an even split between 1, 3,6 and 8 weeks (25% in each category).

Immediate retirement due to injury was recorded in three cases, while retirement due to reoccurring injury was reported in one case.

4.5.2.1.7 Injury related to agility contact equipment and surface type

Section B Q9 establishes whether injuries sustained were equipment related and which equipment is most related to injury. This question was only answered if an injury occurred during training or competition and if it was as a result of equipment.

Table 4.13 Injury relating to agility equipment

Equipment Related		Frequency	Percent
Injury 1			
	Yes	2	3.4
	No	24	40.7
	Unsure	1	1.7
Injury 2			
	No	7	11.9
	Unsure	1	1.7
Injury 3			
	No	4	6.8
	No Answer	1	1.7

Equipment	Frequency	Percent	Valid Percent
Injury 1			
A-Frame	1	1.7	4.0
Hurdles	1	1.7	4.0
Not Applicable	23	39.0	92.0
Injury 2			
Not Applicable	6	10.2	100.0
Injury 3			
Not Applicable	4	6.8	100.0

Surface type	Frequency	Percent	Valid percent
Injury 1			
Sand Painted	1	1.7	4.3
Not Applicable	22	37.3	95.7
Injury 2			
Not Applicable	5	8.5	100.0
Injury 3			
Not Applicable	3	5.1	100.0

Injury due to agility equipment only represented 2 cases (3.4%) for injury 1. One of the cases was due to direct contact with the A-Frame with a sand painted surface and one due to a hurdle. Majority of the study population marked the question as not applicable (56%) for equipment related injury and not applicable for surface type (51%). There were no reported cases of injury as a result of the agility equipment that could be categorized under injury 2 and 3.

4.5.2.1.8 Weather condition and floor surface at time of injury

The weather and floor surface were split into options for injury 1, 2 and 3. If there were no results for a particular option, it was excluded from the table.

Table 4.14 Weather and floor surface at time of injury

Section B Q11 Weather		Frequency	Percent	Valid percent
Injury 1				
	Clear	8	13.6	44.4
	Rain	1	1.7	5.6
	Unknown	9	15.3	50.0
Injury 2				
	Clear	2	3.4	100.0
Section B Q12 Surface		**Frequency**	**Percent**	**Valid percent**
Injury 1				
	Grass	12	20.3	63.2
	Sand	5	8.5	26.3
	Indoor	1	1.7	5.3
	Other	1	1.7	5.3
Injury 2				
	Grass	4	6.8	80.0
	Sand	1	1.7	20.0
Injury 3				
	Grass	2	3.4	60.7
	Sand	1	1.7	33.3
Section B Q12 Condition		**Frequency**	**Percent**	**Valid percent**
Injury 1				
	Dry	11	18.6	52.3
	Wet	1	1.7	4.3
	Hard	2	3.4	9.5

Short Grass	7	11.9	33.3
Injury 2			
Dry	4	6.8	100.0
Injury 3			
Dry	2	3.4	100.0

Weather conditions reported at the time of injury one were predominantly clear (n=8) or unknown (n=9) with one record of there being rain. For injury two, weather conditions were reported as clear (n=2) and there were no reports for weather conditions at the time of injury three.

The majority of injuries occurred on grass surface (n=18 with 12 cases for injury one, 4 cases for injury two and 2 cases for injury 3), followed by sand (n=7 with 5 cases for injury one, 1 case for injury two and 1 case for injury three). Indoor and other each accounted for one case respectively.

Surface conditions at the time of injury were predominantly dry (n=17 with 11 cases for injury one, 4 cases for injury two and 2 cases for injury three), 7 participants selected short grass specifically but there were no indications for long grass. Hard ground (n=2) and wet ground (n=1) described the remaining two surface conditions at time of injury and only affected cases in injury one.

4.5.3 Summary of Objective Two

The prevalence of musculoskeletal injury in herding breeds in KZN display a lifetime prevalence of 45.8% and a period prevalence of 8.5%. The characteristics of these injuries were widely varied with small margins separating the frequencies of each characteristic. There were a total of 27 dogs with one injury, 8 dogs with two injuries and 5 dogs with three injuries out of a population of 59 dogs. The most prevalent age of dogs affected by injury 1 was the 0-1 year category, injury two was the 4-6 year category and the 8-10 year category were the age group most affected by injury 3.

Injuries were shown to occur most often during play, followed by injury during agility competition. Shoulders and hips were the areas most commonly affected, with arthritis and DJD being the most prevalent type of conditions and muscular strains being the most prevalent type of injury. The majority of injuries documented were formerly diagnosed by a veterinarian.

However, a very small percentage of the injuries incurred were due to direct contact with agility equipment.

4.5.4 Objective Three: Risk factors

To determine the selected risk factors associated with the development of musculoskeletal injuries in herding breeds in Kwa-Zulu Natal.

The following section will discuss those results that are of statistical significance; all remaining statistical insignificant results will be briefly mentioned with regards to *p*-value and can be referred to in full in Appendix R.

The following data was calculated based on lifetime prevalence.

4.5.4.1 Disciplines and the risk of MS injury

4.5.4.1.1 Dog Jumping

Table 4.15 Dog Jumping cross-tabulation results

			lifetimeprevalence		
			no	yes	Total
Dog Jumping	no	Count	3	8	11
		% within Jumping	27.3%	72.7%	100.0%
	yes	Count	29	19	48
		% within Jumping	60.4%	39.6%	100.0%
Total		Count	32	27	59
		% within Jumping	54.2%	45.8%	100.0%

Dogs who participated in dog jumping as well as agility showed a significant decrease in the risk of the development of MS conditions (p=0.047). There is no literature available in order to compare these findings.

4.5.4.1.2 Flyball

Table 4.16 Flyball cross-tabulation results

			lifetimeprevalence		
			no	yes	Total
Flyball	no	Count	31	22	53
		% within Flyball	58.5%	41.5%	100.0%
	yes	Count	1	5	6
		% within Flyball	16.7%	83.3%	100.0%
Total		Count	32	27	59
		% within Flyball	54.2%	45.8%	100.0%

The risk of developing a MS injury in the flyball discipline was not significant for this study with *p*=0.084. Those dogs participating in flyball were however, found to be more at risk of MS problems.

4.5.4.2 Diet and the risk of MS injury

4.5.4.2.1 Hills specific diet

Table 4.17 Hills specific diet cross-tabulation results

			lifetimeprevalence		
			no	yes	Total
Hills specific	no	Count	28	15	43
		% within Hills specific	65.1%	34.9%	100.0%
	yes	Count	4	12	16
		% within Hills specific	25.0%	75.0%	100.0%
Total		Count	32	27	59
		% within Hills specific	54.2%	45.8%	100.0%

The owners who fed their dogs Hills Specific Diet were found to be more at risk of MS injury (*p*=0.008). The other food brands included in this study yielded insignificant results and have been displayed in section 4.6.6. Due to the cross-sectional nature of the study and the fact that information regarding potential risk factors was collected after the injury had occurred (instead of before), the associations may have been due to reverse causality rather than true causality and the owners may be feeding specific joint foods as a result of previous injuries and not only as a preventative measure.

4.5.4.3 Joint supplementation and the risk of MS injury

Overall, there was no association found between joint supplementation and MS problems (*p*=0.290). However, specific supplements yielded significant results. Refer to Appendix Q for insignificant statistical results.

4.5.3.3.1 Chondroitin and Glucosamine supplementation

Table 4.18a Chondroitin supplementation cross-tabulation results

			lifetimeprevalence		
			no	yes	Total
Chondroitin	no	Count	26	16	42
		% within chondroitin	61.9%	38.1%	100.0%
	yes	Count	6	11	17
		% within chondroitin	35.3%	64.7%	100.0%
Total		Count	32	27	59
		% within chondroitin	54.2%	45.8%	100.0%

Table 4.18b Glucosamine supplementation cross-tabulation results

			lifetimeprevalence		
			no	yes	Total
Glucosamine	no	Count	26	16	42
		% within glucosamine	61.9%	38.1%	100.0%
	yes	Count	6	11	17
		% within glucosamine	35.3%	64.7%	100.0%
Total		Count	32	27	59
		% within glucosamine	54.2%	45.8%	100.0%

Dogs given chondroitin and glucosamine with their food were shown to be more at risk for MS injury (*p*=0.086 respectively). This was not statistically significant, however, it may be the case where dogs are given the chondroitin and glucosamine as a supplement after injury in order to aid in protection and maintenance of joints from further injury and therefore, association with injury in this study is not likely as a result of the supplements being a causative factor but just an association as a result of the dog being treated for a current injury.

4.5.4.4 Additional Supplementation

4.5.4.4.1 Anti-inflammatories

Table 4.19 Anti-inflammatory supplementation cross-tabulation results

			lifetimeprevalence		
			no	yes	Total
Anti-inflammatory	no	Count	32	21	53
		% within Anti-inflammatory	60.4%	39.6%	100.0%
	yes	Count	0	6	6
		% within Anti-inflammatory	0.0%	100.0%	100.0%
Total		Count	32	27	59
		% within Anti-inflammatory	54.2%	45.8%	100.0%

Treatment of pre-existing MS conditions with anti-inflammatories yielded a significant result of p=0.007. Six dogs' diets were being supplemented with anti-inflammatories at the time of participation in the study.

Non-steroidal anti inflammatories (NSAIDs) are commonly prescribed by veterinarians for the treatment of musculoskeletal conditions, however, studies have shown that they are responsible for weakening cartilage in canines when utilized over long periods of time or used with high frequency (Taverner, 2011; Mathews, 1996). As such, this is detrimental to agility dogs who are already predisposed to risk of overuse injuries due to the physical demands of the sport. However, the association with injury in this study is not likely as a result of the anti-inflammatories being a causative factor for injury but just an association as a result of the dog being treated for a current injury.

4.5.4.5 Show specific results

4.5.4.5.1 Warm-up technique training

Table 4.20 Warm up technique training cross-tabulation results

			lifetimeprevalence		Total
			no	yes	
Technique training	yes	Count	10	13	23
		% within Technique training	43.5%	56.5%	100.0%
	no	Count	16	6	22
		% within Technique training	72.7%	27.3%	100.0%
Total		Count	26	19	45
		% within Technique training	57.8%	42.2%	100.0%

Handler training in specific warm-up techniques was shown to have a marginally significant protective effect (p=0.047) against dogs developing MS conditions and injuries.

4.6 Listing of insignificant results

4.6.1 Breed

Due to multiple categories with small sample sizes, chi square testing of the risk of lifetime prevalence of MS injury in the different sample population breeds yielded an invalid test result. The trends in the different breeds will be discussed in this section as per results obtained under objective one.

Nine breeds participated in this study, of which the Border Collie was the most well represented. Out of a total of 34 Border Collies, there was an even split (50%) of dogs not affected by MS conditions and dogs that had been affected by at least one injury during their lifetime. This finding is in keeping with results established by Levy *et al,* (2009).

Also with an even 50% split of affected and unaffected breeds were: the Belgian Groenendael and the Schipperke.

Comparatively, the second most well represented breed was the Australian Shepherd, although cross tabulation indicated only 22.2% of the population had had a MS injury during their lifetime.

The German Shepherd showed a 75% lifetime prevalence of MS injury with three out of the four dogs having had at least one injury. This is in keeping with results established by Asher *et al.,*

(2009) in which the German Shepherd was found to be the breed with the highest predisposition for MS conditions, but also the most highly predisposed breed to a wide range of MS conditions.

The Belgian Malinois followed on from the German Shepherd with a 66.7% prevalence of developing a MS injury with two out of three dogs having had an injury in its lifetime.

The Pembroke Welsh Corgi had only one representative and a 100% lifetime prevalence rate of a MS injury due to the dog having previously incurred injuries.

The Australian Kelpie, Belgian Tervuren and the White Swiss Shepherd had a zero percentile predisposition for MS injury in this study.

4.6.2 Sex of the dog

There was no evidence of an association between sex and the prevalence of MS conditions in agility dogs in this study (p=0.257). The differences observed are more likely due to chance and are not a true reflection of the population differences. There was also no association between age of sterilization and the age of development of a MS condition for this study (p=0.969). However, associations do exist as discussed in Chapter 2, where, for example: Reichler (2009) found that intact animals were at half the risk of developing MS injuries.

4.6.3 Height

There was no evidence of an association between height and the prevalence of MS conditions in this study (p=0.739). However, associations do exist as previously discussed in Chapter 2, in which Birch and Lesniak (2013) highlighted that dogs on the borderline of each height category are more predisposed to developing MS injuries due to the greater size of the jump in relation to their body height.

4.6.4 Weight

There was no association between weight and the risk of development of MS conditions for this study (p=0.560), however associations have been reported. Fascetti, (2006) stated that obesity has been proven to increase the production of inflammatory cytokines, providing a connection between over nutrition and/or obesity and the development of osteoarthritis and other orthopaedic conditions, with obese large dogs particularly at higher risk of developing MS conditions.

4.6.5 Discipline

Table 4.21 *p*-values for the different disciplines

Discipline	*P*-Value
Breed shows	*p*=0.715
Carting	*p*=1.000
Obedience	*p*=0.558
Other	*p*=0.169

The risk of MS injury for the above listed disciplines were statistically insignificant for this study. See the significant associations between flyball and dog jumping and the risk of developing MS injury as discussed in Chapter 5.

4.6.6 Food

Table 4.22 *p*-values for the different types of food diets

Food	*P*-Value
Acana	*p*=1.000
Acana specific	*p*=0.090
Bob Martin	*p*=0.458
Eukanuba specific	*p*=0.495
Mixed	*p*=0.416
Montego	*p*=0.588
Montego specific	*p*=1.000
Raw diet	*p*=0.437
Royal Canin	*p*=0.362
Royal Canin specific	*p*=1.000
Vets Choice	*p*=1.000
No Answer	*p*=1.000

The majority of diets fed to the dogs' in this study yielded insignificant results. Marginally significant results for diet have been discussed in Chapter 5. It was found that those dogs fed any of the products from the Hills diet range where more at risk of developing MS injury. However, the associations may have been due to reverse causality rather than true causality.

4.6.7 Joint Supplementation

Table 4.23 *p*-values for joint supplementation

Supplement	*P*-Value
Green Lipped Muscle extract	*p*=0.240
Other	*p*=0.593
Not Applicable	*p*=0.290

Although no association between joint supplementation with Green Lipped Muscle extract and MS injury was found in this study, the supplement is reported to be highly effective in the symptomatic treatment of osteoarthritis and for healthy joint maintenance (Henrotin and Lambert, 2013). See significant results and the relevant discussion for joint supplementation in Chapter 5.

4.6.8 Additional Supplementation

Table 4.24 *p*-values for additional supplementation

Supplement type	*P*-Value
Coat enhancement	*p*=1.000
General Vitamins	*p*=0.205
Other	*p*=0.319
Not Applicable	*p*=0.604

There were no associations between general vitamin or coat enhancement supplementation and the development of MS injury in agility dogs found in this study or in the current literature.

4.6.9 Show specific results

Table 4.25 *p*-values for show specific activity results

Show characteristics	*P*-Value
Show quantity	p=0.105
Warm up	p=0.497
Warm up Length	Invalid test result
Warm down	p=0.070
Warm down length	p=0.061
Time elapsed (Between warm up and Competition)	p=0.452
Training sessions (Per week)	p=0.060
Length (Of training session)	p=0.503

No association between warm-up, cool-down and the development of MS injury was found in this study. However, associations do exist. Baltzer (2012a) stated that an adequate warm up of 10 minutes before an athletic event such as agility has been shown to reduce the incidence of injury. However, it was stated that this is only effective if the competition happens within minutes after the warm-up activity.

4.6.10 Specific warm up activities

Table 4.26 *p*-values for specific warm up activities

Activity	*P*-Value
Lead walking	p=0.606
Lead running	p=0.200
Massage	p=1.000
Off lead walking	p=0.266
Off lead running	p=0.302
Practice jumps	p=1.000
Stretches	p=0.147
Toy throwing	p=0.788
Toy tugging	p=0.796
Not applicable	p=1.000

There were no associations between warm up activity and the risk of MS injury in this study. However, Baltzer (2012a) stated that including activities such as walking, trotting, and a few practice jumps before an athletic event such as agility has been shown to reduce the incidence of injury.

See chapter 5 for the discussion on warm up technique training. Handlers who have had training in warm up techniques were found to significantly lower their dogs risk of MS injury (p=0.047).

4.7 Summary

Results from this study indicate that participation in certain canine sporting disciplines posed a greater risk of the dog developing a MS condition than participation in other disciplines.

Dogs that participated in dog jumping were shown to be at a marginally reduced risk of developing MS conditions throughout their career, while those dogs participating in flyball were exposed to an increased risk of developing MS conditions.

Associations between dogs fed certain food brands and increased risk of MS conditions were noted to most likely be as a result of reverse casualty rather than true casualty and the same result was indicated for additional supplementation and medicating with anti-inflammatories. The results indicated that supplements or anti-inflammatories were given as an aid in the prevention of injury or due to an existing injury and were not linked to an increased risk of injury.

Handler training in warm up techniques indicated a marginally significant result in terms of prevention against MS injury, highlighting the importance of allowing a warm up period.

Specific demographic association with the risk of MS injury was largely insignificant for this study in terms of lifetime prevalence of MS injury.

From the data received, a demographic and injury risk profile of herding dogs in KZN was established.

The associations between the demographic profile, and risk of musculoskeletal injury over the lifetime of herding dogs in KZN was determined (Section 4.5.3). There were several factors associated with lifetime prevalence of MS injuries. However, due to the cross sectional nature of this study and the fact that the risk factor information was collected after the injury had occurred (instead of before), the associations might have been due to reverse causality rather than true causality.

Thus, in this context, Chapter Five will discuss the results for this study and the similarities or lack thereof in the current available literature.

CHAPTER FIVE

Discussion

5.1 Introduction

A discussion of the statistical analysis of the data collected during the study is presented in this chapter. Included in the discussion are comparisons of results from previous relevant studies.

5.2 Objective One: Demographics

Border Collies made up the majority of the sample population (58%), and as expected, would yield higher rates of MS injuries (63%). This finding is in line with a study done by Levy *et al., (*2009) in which Border Collies were the breed most affected by MS injuries purely due to their popularity.

The German Shepherd was the second breed most affected by MS injuries (11%) despite the small population size (7%). German Shepherd dogs are not often seen participating in agility in KZN, possibly due to their anatomical structure. The exaggerated downward slope of the back preferred in the breed show ring and the resultant weakened hocks hinder their speed and ability to execute fast turns that come naturally to other herding breeds.

Neutered males represented the vast majority of the dogs with the highest number of MS conditions (52%), yet only 30% of spayed females had been reported as having MS injuries. This finding was supported by Reichler (2009), who discovered that intact animals were at half the risk of developing MS injuries. The relationship between sterilization and an increased predisposition to MS injury has been clearly proven, however, sterilized dogs made up the majority of the study sample population (Sterilized n=48, Intact n=11) and this may contribute to the results reflecting a higher incidence of MS conditions in sterilized dogs for this particular study. This, however, does not take into account breed predisposition and correct conformation.

The majority of the study population fell into the 2-4 year old category (25%), followed by the 4-6 year old category (22%). The age group most affected by MS conditions however, was the 8-10 year old category (26%) followed by the 2-4 year old category (22%). The higher incidence of MS injury in the older age category may be as a result of the cumulative repetitive strain that agility dogs face during the years of training and competition.

The high incidence of MS injury in the 2-4 year old category is supported by findings in a study performed by Cullen *et al.,* (2013), in which agility dogs with less than four years experience are associated with increased odds of injury, while dogs with more than four years experience are associated with decreased risk of injury. However, these results do not consider the amount of training put into teaching an inexperienced dog how to correctly and efficiently negotiate an agility obstacle or whether the dogs in this category belong to a first time agility competitor or a seasoned competitor. A seasoned competitor would have the skills and knowledge to be able to better prepare their young dog to correctly and safely complete a course of agility obstacles and therefore lessen the repetitive forces acting on the musculoskeletal system of the dog.

The large breed category made up the majority of the study population (86%), and out of the small, medium and large height categories, 85% of dogs affected were large breed dogs while the population of small breed dogs equalled 5% of the total sample population and had a prevalence rate of 7% for those affected by MS conditions. These findings are supported by examination of the results depicting the weight categories most affected by MS conditions. In this study, the 15-20Kg category held the highest percentile of MS conditions (41%), followed by the 20-25Kg category (26%).

5.3 Objective Two: Period and lifetime prevalence

5.3.1 Characteristics of the cases

5.3.1.1 The age of injury

The 0-1 year old category had the highest frequency of MS injury occurring with 11% of the sample population affected. Accumulatively, 15% of dogs affected occurred in the 1-2 year, 2-4 year and 4-6 year category with 5% a piece. Many injuries can occur due to poor technique and inadequate conditioning of a young dog as well as vigorous training and conditioning of a young dog (Cullen *et al.,* 2013). This reiterates the fact that it is unknown whether the owners are first time agility handlers, unskilled in the methods of training their dogs to safely complete an agility obstacle. Agility dogs are eligible to compete at 18 months of age, this may also account for a higher number of injuries in the 0-1 and 1-2 year old age category as some handlers may enter competitions before their young dog is ready and can safely judge how to negotiate the obstacles at high speed.

5.3.1.2 Activity when injury occurred

Injury one was shown to be predominantly as a result of play activities, such as: vigorous play or extended sessions of fetching a ball resulting in numerous ‘stop-start’ bursts. Previous studies have shown that high intensity exercise before the age of between 9-12 months results in extensive wear and tear on the growth plates (Baltzer, 2012a) and as agility handlers often aid agility training with play after the dog completes a task correctly and also to maintain a young dogs focus, this may explain why play activities have been indicated as a predominant causative factor for MS injury.

Injury two was shown to have occurred predominantly during agility competitions. Running and jumping at high speed together with rapid directional changes are vital to success in agility competition (Pfau *et al.,* 2011) however, years of repetitive strain on the MS system or exposure to extensive obstacle training in young dogs can predispose the dogs to many different MS conditions, for example: osteoarthritis, ligament sprains and stress fractures.

Injury three was also predominantly as a result of play but closely followed by injury due to activities involved in competitions. The category was small however, and answers to this question indicated that only five dogs were reported as having sustained a third or additional injury during their agility career. These dogs were in the older age categories, which supports the possibility that repetitive strain and continued high intensity activity may increase their predisposition to injury and the development of MS injuries over time. This specifically may be the case of over-training and with dogs who are not adequately conditioned as stated by Baltzer, 2012a.

5.3.1.3 Discipline in which the injury occurred

This question was only answered if the dog has had a MS injury in its lifetime, and then only if the injury was sustained during competition or training.

Agility was the most common discipline resulting in a MS injury. Fourteen dogs (24% of the total study population) sustained an injury while participating in the agility discipline. Levy’s *et al.,* (2009) study showed that 33% of dogs participating in agility events developed injuries which is similar to Cullen’s *et al.,* (2013) findings in which it was reported that 32% of dogs participating in agility had at least one injury during their career. The sport of agility is naturally a high impact sport, obstacles such as the A-frame place a large amount of the dog’s weight on the forehand, combine this weight displacement with speed and the forelimb of the dog is placed under a large amount of stress.

The percentage of agility injuries in a South African context is slightly reduced due to South Africa not only offering the discipline of Agility, but also Dog Jumping. This discipline is based on horse show jumping and is uniquely South African. Dog jumping incurred an injury frequency of seven dogs (11.8% of the total sample population). There has been no research done on the prevalence of injury in Dog Jumping but since it follows a similar description to agility in terms of jumping, executing tight turns, and completing obstacles, a similar predisposition to the development of MS conditions as seen in agility is assumed to be likely.

Flyball contributed toward a small percentage of MS injuries as two owners reported that flyball caused their dogs' injury (3.3% of the sample population). Dogs that are not taught the correct technique of ball retrieval from the flyball box are highly predisposed to chronic overuse injury, especially to the forelimbs due to hitting the box at full speed, twisting and then pushing off with the fore limbs instead of the hind limbs as taught in the "Swimmer's Turn" (Baltzer, 2012a). In modern times, flyball has introduced a spring loaded box in order to absorb the impact of the dogs hitting the box at high speed, however correct training on how to properly execute a turn has shown to be vital for the dogs MS wellbeing.

Flyball is usually held on the same day as agility events and so the dogs competing in both disciplines endure extensive wear and tear on their musculoskeletal system throughout the events held on that day. Over the dogs' competitive career, such wear and tear may accumulate causing MS injuries and so proper conditioning and technique training is vital in order to decrease the amount of injuries seen in these sporting disciplines.

5.3.1.4 Body regions injured

Forelimb injury made up the majority of the general body region injured in this study (n=20). This is in keeping with Levy *et al.,* (2009) and Birch *et al.,* (2015) in which injury to the forelimb, the shoulder in particular, was found to be the most prevalent site of injury in agility dogs. The same result was found in this study in which the shoulder was the most frequent specific body region injured (n=10).

Shoulder problems in agility dogs are as a result of repetitive stress due to hard landings and high speed directional changes involved in the sport of agility (Birch *et al.,* 2015). This is also true for the rest of the musculoskeletal system as shown in this studies results with incidence of injury to the knee (n=6), wrist (n=5) and in the “Other” regions (n=9).

The hip was the second most common region of injury in this study (n=9). It is assumed that some owners would not make the distinction between injury to the hip or to the sacroiliac region and record it as the same region instead of “Other”, which presumed to include the spine, tail and other areas not mentioned as listed categories.

Birch and Lesniak, (2013) found a significant increase in extension of the sacroiliac region in agility dogs when jumping increased height ranges, leading to injury of the region over prolonged periods. This was not only true for the hip region; increased hurdle height also showed significant changes in the joint angles of the entire forelimb and the vertebral column. This may account for the high incidence of injury in the shoulder, back and hip regions of agility dogs, as supported by this study.

Specific diagnosis and description of the injuries will be discussed in the following section.

5.3.1.5 Injury description

There were a total of 30 different injuries recorded in the study. Arthritis and degenerative joint disease were the most prevalent conditions as a whole, followed by osteochondritis dessicans. This finding is in keeping with studies by Canapp (2007) and Jerram *et al.,* (2009), that highlights involvement in agility places repetitive stress on the musculoskeletal system which tend to result in an increase in the incidence of arthritis and degenerative joint disease, especially in the shoulders and wrists of agility dogs.

In terms of the most prevalent injuries, this study found that accumulatively, muscle strains and muscle stiffness accounted for the vast majority of injuries with 18 cases recorded. Affected areas included the shoulder, spinal and hip musculature (in general), iliopsoas and hamstrings specifically, as well as general muscle stiffness. The high prevalence of these particular affected areas in this study is supported by the findings of the majority of the limited studies available.

Cruciate ligament tears were among the more prevalent injuries with nearly even distribution between full and partial tears. This finding is in keeping with Baltzer’s (2012b) study in which cruciate ligament tears were identified to be amongst the most prevalent of hind limb injuries in agility dogs.

There were only two cases of toe and nail injury. The majority of agility competitions abroad are held indoors on artificial surfaces, whilst in South Africa, there are no indoor competition arenas and majority of competitions as well agility training is held on grass surfaces. This may be a contributing factor when considering the low prevalence of toe and nail injuries in this study. However, there have been no studies as to how the floor surface may be linked to the prevalence of toe and toe nail injury.

The agility season is year long with some months having shows every weekend (Appendix P). Handlers usually run three rounds per show, sometimes including a fourth jump off round in order to determine the fastest time with a clear round after the first qualifying round. At bumper show weekends, there are usually two shows on the same day over three or four days. If there is just one show on each of the four days, that is 12 rounds that the dog is required to run. Additionally, during each week the dogs will usually attend two or more training sessions whether at a club or at the handler’s home, running multiple sequences of obstacles or training on one obstacle specifically but with multiple executions. The accumulative effect of all the wear and tear on the dog’s MS system over an entire agility career is remarkably high. This again highlights the importance of proper training and conditioning, as with any athlete, human or animal.

5.3.1.6 Veterinary diagnosis, rest periods and retirement

The majority of injuries were officially diagnosed by a veterinarian; the owners not obtaining a veterinarian diagnosis are assumed to have relied on past experience with previous dogs and the injuries that those previous dogs might have obtained.

Rest periods ranged from 4 days to 48 weeks, depending on the severity of the injury and whether surgery was required. It is assumed that the rest period is based on veterinary guidance and owner observation of their dog as to when the dog appears fit for return to sport after the appropriate rest and rehabilitation.

Repetitive strain injuries can be highly debilitating, often resulting in degenerative osteoarthritis, ongoing pain and lameness (Worth and Bruce, 2008) this would ultimately lead to retirement from a competitive agility career. In this study, four dogs were retired from agility after sustaining injuries or due to repeated occurrence of these injuries resulting in the dogs being chronically lame.

Although there is a need for further research in injured working dogs and their performance in agility competition after recovery (Baltzer, 2012b), all participants in this study apart from the four dogs that were retired, are still competing regularly on a provincial level.

5.3.1.7 Injuries related to agility equipment

Only two injuries (3.4% of the total study population) in this study were related to agility equipment. This contradicts findings by Levy *et al.,* (2009), who reported that the A-Frame, hurdles and dog walk were responsible for two-thirds of reported injuries. However, the equipment that resulted in an injury in this study supported those findings as the A-Frame and hurdle were sited.

The equipment used for agility in South Africa complies with the international standards set by the FCI. This factor rules out differences in equipment being the result of increased injury in studies done outside of South Africa. Agility is relatively small scale in South Africa as compared to agility in countries outside of South Africa. Therefore, the sheer scale of dogs competing overseas as compared to the number of dogs competing in South Africa results in a higher prevalence of injury related to agility equipment.

Competition equipment follows international standards but training equipment is not regulated. Typical contact equipment surfaces include sand painted, rubberized, felt or wood. Hurdle crossbars are typically PVC piping and wings have a stainless steel frame. The tyre jump is usually a rubber motorbike style tyre secured with chains in a stainless steel frame which the dogs are required to jump through without having any sort of contact with the tyre (FCI, 2016). Competition tyres are now required to be magnetised in the middle so that in the event that the dog collides with the tyre, it gives way easily and the dog is not 'hung' by the neck, causing severe whiplash type injuries. Tyre jumps used in training are not regulated and solid tyres are still used, often due to limited funds available to replace outdated equipment.

Modern agility contact equipment favours a rubberized surface over the older sand painted style surface as even in wet conditions, it offers greater traction for the dogs. A slippery surface coating on contact equipment may contribute unnecessarily to trauma inflicted on the musculoskeletal system of agility dogs (Canapp, 2007). The FCI states that all contact surfaces should be non-slip but the type of surface is not specified. It is possible that because all agility equipment used in competition in South Africa is now in keeping with updated international standards and that the new all weather rubberized surfaces are now replacing sand painted surfaces in training equipment as well, that the prevalence of injuries related to agility equipment has been decreased as depicted by the low number of cases in this study.

5.3.1.8 Weather conditions and floor surface at the time of injury

The study showed that majority of injuries occurred during clear conditions on dry short grass, followed by sand surfaces. As all agility competitions in KZN occur outside on sports club fields, this finding is to be expected. Unknown weather conditions at the time of the injury are presumed to be due to the fact that the injury could have occurred some years ago and the participant cannot recall the weather on that particular day.

In the event of severe rain or thunder storm conditions, the agility judge will usually make the decision to cancel the show due to the potential risk of both dogs and handlers slipping and causing unnecessary injury to themselves. This may account for only one injury having been recorded in wet conditions in this study.

5.4 Objective Three: Risk factors

5.4.1 Disciplines and the related risk of MS injury

The herding breeds who participated in dog jumping were shown to have a decreased risk of developing MS problems throughout their career. This result could be due to the fact that dog jumping courses do not include any of the contact equipment used in agility and therefore, the prevalence and risk of injury could be decreased due to less risk of injury as a result of contact equipment.

However, this study documented that those herding breeds participating in flyball were shown to have an increased predisposition for MS injury over the course of their careers, although the result is not a significant representation for the entire population. Baltzer (2012a) and Baltzer (2012b) stated that during preliminary stages of training, the dogs hit the box directly with their forelimbs, which highlights the need for trainers to teach their dogs' to hit the platform in a manner that will not predispose them to MS injuries. Flyball competitions are held infrequently in South Africa and so it is possible that handlers do not train and condition their dogs regularly for the discipline throughout the year and rather only sporadically as events come up. This may account for this study highlighting an increased predisposition for MS injury in those dogs participating in the flyball discipline.

5.4.2 Diet, supplementation and the risk of MS injury

Nutrition plays an important role regarding injury prevention in working dogs, not only in supplying adequate nutrients to maintain a healthy locomotive system but conversely, adding to a possible increased risk of injury (Fascetti, 2006). Dogs fed from the Hills specific diet (Hills specific diet included Joint, Senior, Allergen, Healthy Mobility, Metabolic, Reduced Calorie and Ideal Balance) were found to be more at risk of MS injury (p=0.008), although, due to the cross-sectional nature of the study and the fact that information regarding potential risk factors was collected after the injury had occurred (instead of before), the associations may have been due to reverse causality rather than true causality and the owners may be feeding specific joint foods as a result of previous injuries and not only as a preventative measure.

The same is true when considering the results concerning supplementation. It may be said that dogs are given the chondroitin and glucosamine as a supplement after injury in order to aid in protection and maintenance of joints from further injury and therefore, association with injury in this study is not likely as a result of the supplements being a causative factor but as an association as a result of the dog being treated for a current injury, or purely as a preventative measure in the case where no previous injury has occurred.

5.4.3 Warm-up technique training and activities

This study determined that handlers with specific training in terms of warm-up techniques are protecting their dogs from the risk of MS injury. This finding is supported by Baltzer (2012a) in which it is stated that an adequate warm-up before an athletic event such as agility has been shown to reduce the incidence of injury.

In this study, 25 (46.3%) dogs were allowed a warm-up period, 14 of which warmed up for between 1-5 minutes, 2 between 5-10 minutes, 5 between 10-15 minutes and 1 had a warm-up of over 15 minutes prior to competition, with the remainder having not completed the question regarding duration of the warm-up period. Warm up activities included both on-lead and off lead walking, toy throwing or toy tugging, massage and the use of a practice jump.

The duration of warm-up results produced an invalid chi-square test (p=0.609) and so for this study, the result is assumed to be insignificant.

5.4.4 Insignificant results

Under objective three, risk factors related to the development of a musculoskeletal injury or condition throughout the lifetime of the different herding breeds produced several insignificant test results. Majority of these insignificant results were related to the demographic profile of the dog. In this study, the breed, sex, height and weight do not yield any specific preferences as to those at a higher risk of developing a MS condition in terms of the general population, however there were clear representations within the sample population of this study as discussed in section 5.2 of this chapter.

The prevalence of MS injuries in agility dogs in KZN is low when compared to studies done outside of South Africa. A larger population is needed in order to further analyse the risk of injury in sporting dogs in a South African context.

CHAPTER SIX

Conclusion, Limitations, Recommendations

6.1 Introduction

In this chapter, conclusions based on the outcome of the results and discussions are drawn and recommendations for further studies related to this topic are discussed. Limitations to this study will also be highlighted.

6.2 Conclusion

The prevalence of musculoskeletal (MS) injuries in agility dogs in KZN is low when compared to studies done outside of South Africa. Injuries were found to occur most often during play, followed by injury during agility competition, a very small percentage of the injuries incurred were due to direct contact with agility equipment.

Shoulders and hips were the body structures most commonly affected, with arthritis and DJD being the most prevalent type of conditions and muscular strains being the most prevalent type of injury. The majority of injuries documented were formerly diagnosed by a veterinarian.

The breed with the highest prevalence of injury was the Border Collie, this is in keeping with the findings of Levy *et al.,* (*2009*) and Cullen *et al.,* (2013), however, this particular breed represented the majority of all breeds included in this study which may account for the Border Collie having the highest prevalence of MS injury. Due to multiple categories with small sample sizes, chi square testing of the risk of lifetime prevalence of MS injury in the different sample population breeds was not valid for this study.

Neutered males had the highest prevalence of injury, followed by spayed females. This finding is supported by previous studies in which it was reported that intact animals are at half the risk of developing MS injuries and/or conditions (Reichler, 2009). However, there was no evidence of a significant association between sex of the dog and the prevalence of MS conditions in agility dogs in KZN. The differences observed are therefore seen as to be due to chance and are not a true reflection of the population differences. There was also no association between age of sterilization and the age of development of a MS condition for this study however, associations do exist as discussed in Chapter 2.

The higher prevalence of MS injury in the older age category may be as a result of the cumulative repetitive strain that agility dogs face during the years of competition (Birch *et al.,* 2015) while the high incidence of MS injury in the 2-4 year old category is supported by findings in a study performed by Cullen *et al.,* (2013), in which agility dogs with less than 4 years experience are associated with increased odds of injury.

Large breed dogs constituted the majority of the study population, this may account for the 15-20kg weight category showing the highest prevalence of MS injury for this study. There was no evidence of an association between height and weight and the risk of development of MS conditions for this study. However, associations have been reported in previous studies.

When considering risk factors for the development of MS injuries in herding breeds, results showed that dogs participating in dog jumping had a reduced risk of developing MS injuries. This is possibly due to the fact that dog jumping courses do not include any of the contact equipment used in agility and therefore, the prevalence and risk of injury may be less due to less risk of injury as a result of contact with equipment. Dogs participating in flyball were found to have an increased risk of MS injury, possibly due to chronic overuse injury related to poor technique training and repetitive hyperextension and compressive forces acting on the dogs' wrist joints. Handler training in warm-up techniques showed significant results for the decreased risk of MS conditions in this study. This highlights the importance of allowing time for a warm-up period before participation in these sporting events.

The dogs which were fed the Hills specific diet range, showed a significant increased risk of MS injury. However, due to the cross-sectional nature of the study and the fact that information regarding potential risk factors was collected after the injury had occurred (instead of before), the associations may have been due to reverse causality rather than true causality. Thus, the owners may be feeding specific joint foods as a result of previous injuries and not only as a preventative measure. The same may be true for the dogs who received additional supplementation with chondroitin and glucosamine. However, the results were borderline insignificant.

Dogs currently receiving anti-inflammatories were shown to be at significant risk of developing MS injury. However, the association between the intake of anti-inflammatories and the increased risk of injury in this study is not likely as the anti-inflammatories are likely being given as treatment for a current injury. Therefore, anti-inflammatories are not a causative factor for MS injury but only present as an association.

By increasing the knowledge of the profile of sporting canines at risk of injury, it could potentially assist in supplementing the limited literature available to allied health professionals working with canines, such as Chiropractors.

Ultimately, by increasing the body of knowledge with regard to animal chiropractic, it is envisioned that a greater acceptance in the veterinary field and by the general public will be achieved (Roecker, 2011).

6.3 Limitations

- The agility community in KZN is relatively small when compared to other provinces such as Gauteng.
- Using breeds only listed in the KUSA herding breed category further narrowed down the already limited population.

6.4 Recommendations

Recommendations arising from the results of this study include:

- Extend the study to include all provinces in South Africa and not only KZN. This would increase the sample size and allow for a distinct association between agility and the risk of musculoskeletal injury to be detected.
- Include breeds listed under the KUSA working breed category to further increase the potential sample size.

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APPENDIX A

DURBAN UNIVERSITY OF TECHNOLOGY

EXPERT GROUP

CONFIDENTIALITY STATEMENT AND CODE OF CONDUCT

IMPORTANT NOTICE: This form is to be read and filled in by every member participating in the expert group, before the expert group meeting convenes.

DECLARATION

1. All information contained in the research documents and any information discussed during the expert group meeting must be kept private and confidential. This is especially binding to any information that may identify any of the participants in the research process.
2. The information from this expert group will be made public in terms of a dissertation/thesis and/or journal publication, which will in no way identify any of the participants involved in this expert group.
3. None of the information shall be communicated to any other individual or organization outside of this specific expert group as to the decisions of this expert group.
4. The returned questionnaires will be coded and kept anonymous in the research process.
5. The expert group may be video or voice recorded, as a transcript of the proceedings will need to be made. The data will be secured under password protection.
6. All data generated from this expert group (including any video recordings) will be kept for 5 years in a secure location at the Durban University of Technology and thereafter will be destroyed.

Once this form has been read and agreed to, please fill in the appropriate information below and sign to acknowledge agreement.

Expert Group Member:________________________ Signature: _________________________

Witness Name:______________________________ Signature: _________________________

Researcher's Name:__________________________ Signature: _________________________

Supervisor's Name: ______________________________ Signature: ______________________________

Co-supervisor's Name: ___________________________ Signature: ______________________________

APPENDIX B

EXPERT GROUP

INFORMED CONSENT

Thank you for your interest in this research study.

TITLE OF RESEARCH PROJECT:

The prevalence and risk factors of musculoskeletal injuries affecting working canines in Kwa-Zulu Natal.

RESEARCHER: Storm Radtke 072 583 0897

SUPERVISOR: Dr.G.Matkovich 0312018204

CO-SUPERVISOR: Dr.S.Singh 0312607671

I…………………………………….., ID number……………………………………….., have read this Document in its entirety and understand its contents. Where I have had any questions or queries, these have been explained to me by…………………………………………… to my satisfaction. Furthermore, I fully understand that I may withdraw from this study at any stage without any adverse consequences and my future health care will not be compromised. I, therefore voluntarily agree to participate in this study.

Please write in block letters:

Focus group member:______________________ Signature: ___________________________

Witness: ______________________ Signature: ______________________

Researcher's Name: ______________________ Signature: ______________________

Supervisor's Name: ______________________ Signature: ______________________

APPENDIX C

EXPERT GROUP

LETTER OF INFORMATION

Dear Participant,

I would like to thank you for taking part in my expert group.

Title of the study:

The prevalence and selected risk factors of musculoskeletal injuries affecting working canines in Kwa-Zulu Natal.

Researcher:

Storm Radtke 0725830897

Supervisor:

Dr.G Matkovich 0312018204

Co-supervisor:

Dr.S Singh 0312607671

Purpose of the study:

In South Africa, there are few chiropractic studies which have been conducted on animals due to ethical and legal issues, as well as a lack of educational infrastructure related to animal chiropractic in South Africa (Taverner, 2011).

An increase in public interest has been seen with regard to complementary and alternative veterinary therapies (Taylor and Romano, 1999; Maurer 2000), and animal chiropractic has been gaining traction, with set courses available in select universities (Maurer, 2000). There is a need for additional information regarding the profile of canines at risk for injury and the common type of injury that working agility canines face (Baltzer, 2012) and this will be the first step in building on the available literature.

Risk factors such as age, sex and breed of the canine have been shown to have a high impact on the prevalence and type of injury that certain working canines are at risk for, most commonly, hip dysplasia and cruciate tears. These abnormalities can lead to a reduced lifespan (Witsberger *et al.,* 2008). Other risk factors have been identified; however, there is limited literature available regarding these.

Agility is a sport designed to test a handler's skills and a canine's willingness to negotiate a course of obstacles against the clock (Apps.akc.org, 2014). The course involves hurdles, weaving poles, ramps, see-saws and tunnels; therefore, resulting in twisting, hard landings, abrupt high speed turns and stops (Usdaa.com, 2014) which puts the dog at risk for certain injuries. The herding breed category listed under KUSA are breeds most commonly seen partaking in agility competition. The title "herding" refers to the task the breed was originally bred for in centuries past (Kusa, 2014).

As agility dogs undertake added stressor to their musculoskeletal system, this study aims to determine the prevalence of and most common types of injuries facing these athletes, as well as the predisposing risk factors involved.

By increasing the knowledge of the profile of working canines at risk for injury and the most common injuries seen, it could potentially assist in supplementing the limited literature available to allied health professionals working with canines, such as Chiropractors.

Ultimately, by increasing the body of knowledge with regard to veterinary chiropractic, it is envisioned that a greater acceptance in the veterinary field and by the general public will be achieved (Roecker, 2011).

<u>The aim of this study is to:</u>

1. To determine the demographic profile of herding breeds affected by musculoskeletal conditions in KZN.
2. To determine the prevalence of musculoskeletal injuries in herding breeds in KZN
3. To determine the selected risk factors associated with the development of musculoskeletal injuries in herding breeds in KZN.

<u>Outline of the procedures:</u>

- Please read and sign the informed consent letter and the confidentiality statement prior to commencement of the expert group meeting.
- All expert group participants will be handed a copy of the questionnaire and are invited to review the questionnaire. Each question will be discussed in sequential order.
- As a member of the expert group, please feel free to make your opinions or suggestions known to the researcher as all comments can contribute to the questionnaire validity.
- This expert group is voluntary; the participant may at any time withdraw from the study.
- The questionnaire will take approximately 20 minutes to complete.
- The researcher will review the data and make the necessary changes to the questionnaire.

Risks or Discomfort to the subject:

None.

Benefits:

Your participation in this study will assist in adding to the expansion of the body of knowledge regarding potential risk factors facing working canines in a South African context. This will be beneficial to veterinary chiropractic in South Africa as there is a paucity of available literature currently available.

Remuneration:

None.

Costs of the study:

None.

Confidentiality:

All forms of consent and questionnaires will be collected in separate boxes to ensure confidentiality of the participant. Information obtained will be available I the form of a dissertation at the Durban University of Technology.

Persons to Contact in the event of any Queries:

Researcher:	Storm Radtke	0725830897
Supervisor:	Dr.G Matkovich	0312018204

The Research Office: 031 3732055

APPENDIX D

EXPERT GROUP

QUESTIONAIRRE

Thank you for your participation in this study. Please review the questionnaire and return it to the researcher at the end of the expert group meeting.

SECTION A - Demographics. Please fill in the relevant information below.

Breed:				
KUSA Registration Number:				
D.O.B:				
Sex: (Mark correct answer with **X.** If the canine has been sterilized, please state the age at the time of the sterilization in the space provided.)	Female(Intact)	Female(Spayed) Canine's age at time of spay?	Male(Intact)	Male(Neutered) Canine's age at time of Neuter?
Height of the canine in Cm's: (According to the KUSA Agility regulations)	Small (<35cm)	Medium (36-43cm)	Large (44cm<)	
Approximate weight of the canine? (In KG's)				
Is your canine involved in any other working discilines? (Please specify.)				
What food is the canine on? (Please specify)				
Is the canine given any vitamins or supplements?				

(Please specify)	

SECTION B - Prevalence.

Has your canine ever sustained an injury during training or competition? (If yes, Please complete the table below)

	Injury 1 (I1)			**Injury 2 (I2)**			**Additional Injuries (AI)**		
What was the age of the dog at the time of injury?									
When was the injury sustained?	Training	Competition	Play	Training	Competition	Play	Training	Competition	Play
If injured during competition/ training, please state for which discipline? **What body region was injured?**									
Please describe the injury?									

Was an official diagnosis made by a vet?(If yes, please state the diagnosis)	Yes Diagnosis:	No	Yes Diagnosis:	No	Yes Diagnosis:	No
How long was the dog rested for after the injury?						
Was your dogs injury related to contact equipment? (Please circle Yes/ No and then the corresponding piece of equipment if Yes)	Yes	No	Yes	No	Yes	No
	A-Frame		A-Frame		A-Frame	
	Cloth Tunnel		Cloth Tunnel		Cloth Tunnel	
	Dog Walk		Dog Walk		Dog Walk	
	Hurdles		Hurdles		Hurdles	
	Rigid Tunnel		Rigid Tunnel		Rigid Tunnel	
	See-Saw		See-Saw		See-Saw	
	Tyre Jump		Tyre Jump		Tyre Jump	
	Weave Poles		Weave Poles		Weave Poles	
	Other		Other		Other	
If the injury was caused by contact equipment, please select the surface type and	Sand Painted	Rubberized	Plastic	Wood	Other	**Not Applicable**
	Injury 1	Injury 1	Injury 1	Injury 1	Injury 1	

corresponding injury.	Injury 2	Injury 2	Injury 2	Injury 2	Injury 2
	AI	AI	AI	AI	AI
What were the weather conditions at the time of injury?	Clear	Rainy	Windy	Rain+wind	**Unknown**
	Injury 1	Injury 1	Injury 1	Injury 1	
	Injury 2	Injury 2	Injury 2	Injury 2	
	AI	AI	AI	AI	

	Injury 1 (I1)	**Injury 2 (I2)**	**Additional Injuries (AI)**
What was the floor surface AND condition at the time of injury?	Grass-dry/wet/muddy/long/short	Grass-dry/wet/muddy/long/short	Grass-dry/wet/muddy/long/short
	Sand-dry/muddy/soft/hard	Sand-dry/muddy/soft/hard	Sand-dry/muddy/soft/hard
	Indoor-fibre/astroturf	Indoor-fibre/astroturf	Indoor-fibre/astroturf
	Other-	**Other-**	**Other-**

SECTION C – Risks

On average, how many shows per month do you compete in with your canine?		
Do you allow time for a warm up period for your canine prior to jumping	Yes	No- If no, ignore the following questions marked with an asterix.(*)

<table>
<tr><td>your class at a show?</td><td colspan="4"></td><td colspan="5"></td></tr>
<tr><td>*Have you had formal training with regard to warm up techniques? Please elaborate.</td><td colspan="4">Yes</td><td colspan="5">No</td></tr>
<tr><td>*How long is your canines warm up period?</td><td colspan="9"></td></tr>
<tr><td>*What does the warm up involve?</td><td>Lead walking</td><td>Lead running</td><td>Off lead walking</td><td>Off lead running</td><td>Massage</td><td>Practice jumps</td><td>Stretches</td><td>Toy throwing</td><td>Toy tugging</td></tr>
<tr><td>*How much time passes between warm up and the class round?</td><td colspan="9"></td></tr>
<tr><td>*Do you do a warm down period?</td><td colspan="4">Yes</td><td colspan="5">No- if not, ignore the last question marked with an asterix (*).</td></tr>
<tr><td>*How long is your warm down period?</td><td colspan="9"></td></tr>
<tr><td></td><td colspan="9"></td></tr>
<tr><td>At what age did you begin agility</td><td colspan="9"></td></tr>
</table>

foundation training with your canine?				
At what age did you begin obstacle specific training with your canine?	Contact Equipment:	Jumping a cross bar:	Weave poles:	Other:
How many times per week do you attend training with your canine?				
How long is a typical training session?				
At what age did your canine begin competing in agility?				

APPENDIX E

CORRECTIONS SUBMITTED TO IREC

POST EXPERT GROUP QUESTIONAIRRE

Storm Radtke 20800587

IREC Number: REC 97/15

Post Expert group questionnaire correction/adaptation sheet

- General cell shading for distinction and visibility throughout.
- Research title added to top of questionnaire.
- Instructions added at beginning of questionnaire- “Please mark an X where applicable…”

Section A

- Age changed from exact date of birth to categorical options in years: 1-2, 2-4, 4-6, 6-8, 8-10, 10+years
- Format of layout changed under question regarding '“Canine’s sex”, “Height”.
- Weight of canine changed from open to categorical options in kilograms: 1-5, -10, 10-15, 15-20, 20-25, 25+Kg’s.
- Question regarding whether the canine is involved in any other discipline was changed from open ended into categorical options of disciplines: Breed shows, Carting, Dog Jumping, Flyball, Obedience, Other, Not Applicable.
- Question regarding food supplementation was changed from open ended and expanded into two questions. Previous question: Is the canine given any vitamins or supplements?

  Final question: Do you add joint supplements into your canine’s diet? Yes/No. If Yes, options: Chondroitin, Glucosamine, Green Lipped Muscle Extract, Other were offered. The second question: Is any additional supplementation given? Yes/No. If yes options: Anti-Inflammatories, Coat Enhancement, General Vitamins and Other were offered.

Section B

- Question: When was the injury sustained? Additional option of “warm up” added.

- Question: If injured during competition/Training, which discipline? This was changed from open ended into categories with the options of: Agility, Breed Show, Carting, Dog Jumping, Flyball, Obedience and Other.
- Question regarding which body region was injured wad changed from open ended into Foreleg: Elbow, Nail, Shoulder, Toe, Wrist and Hindleg: Knee, Hip, Hock, Nail, Toe and Other.
- Question: 'Was an official diagnosis made by a vet?' was changed to only a Yes/No option.

Section C

- Question regarding how many shows are attended per month was changed from open ended into categories of 1-3, 3-6, 6-9, 9-12 and 12+ shows.
- Question regarding how long was the warm up period allowed was changed from open ended to time categories of 1-5, 5-10, 10-15, 15+Minutes.
- Question regarding how many training sessions are attended per week was changed from open ended into categories of 1-2, 2-3, 3-4, and 4+ session per week.
- Question regarding length of training sessions was changed from open ended to categories of minutes: 5-10, 10-15, 15-20 and 20+ Minutes.

Added onto the bottom of the questionnaire: "Thank you for your time and effort in completing this questionnaire."

APPENDIX F

POST EXPERT GROUP QUESTIONNAIRE

Title: The prevalence and selected risk factors of musculoskeletal injuries affecting working canines in Kwa-Zulu Natal.								
• **Please complete one questionnaire per canine that qualifies for inclusion in this study.**								
• **Please mark an X indicating your choice where applicable. Some questions are open-ended and will entail a more detailed answer.**								
• **Please kindly hand the completed questionnaire back to the researcher.**								
	SECTION A-DEMOGRAPHICS							
Breed:								
KUSA Registration Number:								
Age of the canine:	1-2 Years	2-4 Years	4-6 Years	6-8 Years	8-10 Years	10+ Years		
Sex:	Female(Intact)		Female(Spayed)		Male(Intact)		Male(Neutered)	
Canine's age at time of Spay /Neuter? (If Applicable)		**Height of canine(KUSA Regulations)**	Small (<35cm)	Medium (36-43cm)	Large (44cm<)			
Approximate weight of the canine?	1-5 KG	5-10 KG	10-15 KG	15-20 KG	20-25 KG	25 KG +		
Is your canine involved in any other working disciplines besides agility?	Breed shows	Carting	Dog Jumping	Flyball	Obedience	Other	NA	
What food is the								

canine on?(Please specify)								
Do you add joint supplements into your canine's diet?	Yes		No		**Is any additional supplementation given?**	Yes		No	
	Chondroitin				Anti-Inflammatories				
	Glucosamine				Coat Enhancement				
	Green Lipped Muscle Extract				General Vitamins				
	Other				Other				

SECTION B-PREVELANCE					
Has your canine ever sustained a musculoskeletal (bone/muscle/joint) **injury over its lifetime?** **Yes / No** (If yes, Please complete the table below)					
	Injury 1 (I1)Most Severe		**Injury 2 (I2)Second most severe**		**Additional Injury (AI)**
What was the age of the dog at the time of injury?					
	I1		**I2**		**AI**
When was the injury sustained?	Competition		Competition		Competitio n	
	Play		Play		Play	
	Training		Training		Training	
	Warm-up		Warm-up		Warm-up	

	Other		Other		Other	
	I1		**I2**		**AI**	
If injured during competition/ training, which discipline?	Agility		Agility		Agility	
	Breed Show		Breed Show		Breed Show	
	Carting		Carting		Carting	
	Dog Jumping		Dog Jumping		Dog Jumping	
	Flyball		Flyball		Flyball	
	Obedience		Obedience		Obedience	
	Other		Other		Other	

	I1						**I2**						**AI**					
What body region was injured?	**Foreleg**		**Hindleg**		**Other**		**Foreleg**		**Hindleg**		**Other**		**Foreleg**		**Hindleg**		**Other**	
	Elbow		Knee				Elbow		Knee				Elbow		Knee			
	Nail		Hip		-		Nail		Hip		-		Nail		Hip		-	
	Shoulder		Hock		-		Shoulder		Hock		-		Shoulder		Hock		-	
	Toe		Nail		-		Toe		Nail		-		Toe		Nail		-	
	Wrist		Toe		-		Wrist		Toe		-		Wrist		Toe		-	

Please describe the injury?												
Was an official diagnosis made by a vet?	Yes		No		Yes		No		Yes		No	

How long was the dog rested for after the injury?			
	I1	**I2**	**AI**

	I1				I2				AI			
Was your dogs injury related to contact equipment? (If yes, Please mark the relate equipment option with an X)	**Yes**		**No**		**Yes**		**No**		**Yes**		**No**	
	A-Frame				A-Frame				A-Frame			
	Cloth Tunnel				Cloth Tunnel				Cloth Tunnel			
	Dog Walk				Dog Walk				Dog Walk			
	Hurdles				Hurdles				Hurdles			
	Rigid Tunnel				Rigid Tunnel				Rigid Tunnel			
	See-Saw				See-Saw				See-Saw			
	Tyre Jump				Tyre Jump				Tyre Jump			
	Weave Poles				Weave Poles				Weave Poles			
	Other				Other				Other			

If the injury was caused by contact equipment, please select the surface type <u>AND</u> corresponding injury.	**Sand Painted**		**Rubberized**		**Plastic**		**Wood**		**Other**		**Not Applicable**	
	Injury 1		Injury 1		Injury 1		Injury 1		Injury 1			
	Injury 2		Injury 2		Injury 2		Injury 2		Injury 2			
	AI		AI		AI		AI		AI			

What were the weather conditions at the time of injury?	**Clear**		**Raining**		**Windy**		**Rain+ wind**		**Unknown**	
	Injury 1		Injury 1		Injury 1		Injury 1			
	Injury 2		Injury 2		Injury 2		Injury 2			

	AI		AI		AI		AI			

I1 **I2** **AI**

What was the floor surface <u>AND</u> condition at the time of injury? (please mark the surface type with an 'X' and <u>circle</u> the relevant options)	**Grass**		**Grass**		**Grass**			
	(Dry/ Muddy/ Wet) **and** (Long/ Short)		(Dry/ Muddy/ Wet) **and** (Long/ Short)		(Dry/ Muddy/ Wet) **and** (Long/ Short)			
	Sand		**Sand**		**Sand**			
	(Dry /Muddy) **and** (Soft /Hard)		(Dry /Muddy) **and** (Soft /Hard)		(Dry /Muddy) **and** (Soft /Hard)			
	Indoor	(fibre/Astroturf)	**Indoor**	(fibre/Astroturf)	**Indoor**	(fibre/Astroturf)		
	Other		**Other**		**Other**			

<u>SECTION C-RISK</u>				
On average, how many shows per month do you compete in with your canine?	1-3 Shows	3-6 Shows	6-9 Shows	9+ Shows

Do you allow time for a warm up period for your canine prior to jumping your class at a show?	Yes		No		***Have you had formal training with regard to warm up techniques?**		
	If <u>no,</u> ignore the following questions marked with an asterix (*).				Yes		No

***How long is your canines warm up period?**	1-5 Minutes	5-10 Minutes	10-15 Minutes	15+ Minutes

***What does the warm up involve?**	Lead walking	Lead running	Massage	Off lead walking	Off lead running	Practice jumps	Stretches	Toy throwing	Toy tugging

***How much time passes between warm up and the class round?**	1-5 Minutes	5-10 Minutes	10-15 Minutes	15+ Minutes

***Do you do a warm down period?**	Yes		No		***How long is your warm down period?**	1-5 Minutes	
						5-10 Minutes	
	If <u>no</u>, ignore the next question marked					10-15 Minutes	

	with an asterix (*).			15+Minutes	
What age was your canine when you began agility foundation training?			**At What age did obstacle specific training begin?**	Contact equipment	
				Jumping	
				Weave Poles	
				Other	
At what age did your canine begin competing in agility?					
How many times per week do you attend training with your canine?	1-2 times		**How long is a typical training session?**	5-10 minutes	
	2-3 times			10-15 minutes	
	3-4 times			15-20 minutes	
	4+ times			20+ minutes	
THANK YOU FOR YOUR TIME AND EFFORT IN COMPLETING THIS QUESTIONNAIRE.					

APPENDIX G

LETTER OF INFORMATION-PILOT STUDY

Thank you for your interest in this research study.

Title of the study:

The prevalence and selected risk factors of musculoskeletal injuries affecting working canines in Kwa-Zulu Natal.

Researcher:

Storm Radtke 0725830897

Supervisor:

Dr.G Matkovich 0312018204

Co-supervisor:

Dr.S Singh 0312607671

Research Office: 031 3732055

Purpose of the study:

In South Africa, there are few chiropractic studies which have been conducted on animals due to ethical and legal issues, as well as a lack of educational infrastructure related to animal chiropractic in South Africa (Taverner, 2011).

An increase in public interest has been seen with regard to complementary and alternative veterinary therapies (Taylor and Romano, 1999; Maurer 2000), and animal chiropractic has been gaining traction, with set courses available in select universities (Maurer, 2000). There is a need for additional information regarding the profile of canines at risk for injury and the common type of injury that working agility canines face (Baltzer, 2012) and this will be the first step in building on the available literature.

Risk factors such as age, sex and breed of the canine have been shown to have a high impact on the prevalence and type of injury that certain working canines are at risk for, most commonly, hip dysplasia and cruciate tears. These abnormalities can lead to a reduced lifespan (Witsberger *et al.,* 2008). Other risk factors have been identified; however, there is limited literature available regarding these.

Agility is a sport designed to test a handler's skills and a canine's willingness to negotiate a course of obstacles against the clock (Apps.akc.org, 2014). The course involves hurdles, weaving poles, ramps, see-saws and tunnels; therefore, resulting in twisting, hard landings, abrupt high speed turns and stops (Usdaa.com, 2014) which puts the dog at risk for certain injuries. The herding breed category listed under KUSA are breeds most commonly seen partaking in agility competition. The title "herding" refers to the task the breed was originally bred for in centuries past (Kusa, 2014).

As agility dogs undertake added stressor to their musculoskeletal system, this study aims to determine the prevalence of and most common types of injuries facing these athletes, as well as the predisposing risk factors involved.

By increasing the knowledge of the profile of working canines at risk for injury and the most common injuries seen, it could potentially assist in supplementing the limited literature available to allied health professionals working with canines, such as Chiropractors.

Ultimately, by increasing the body of knowledge with regard to veterinary chiropractic, it is envisioned that a greater acceptance in the veterinary field and by the general public will be achieved (Roecker, 2011).

<u>Outline of the procedures:</u>

Please complete the questionnaire according to the instructions given.

All answers are confidential thus you are requested to be honest and answer all questions. Mark the appropriate box with an X and specify answers where it is required.

Hand delivery/return

Once you have completed the questionnaire in full, place the questionnaire into the envelope provided and seal the envelope. The researcher will collect the letter of information and consent as well as the questionnaire from you and place it into two separate sealed boxes.

- All of the data will be analysed by a qualified statistician and the results will be represented in aggregate, thus no personal details will appear in the results and no single participant's results will be displayed in the results. Once the research has been completed the results will be available at the Durban University of Technology library.

Risks or Discomfort to the subject:

None.

Benefits:

Your participation in this study will assist in adding to the expansion of the body of knowledge regarding potential risk factors facing working canines in a South African context. This will be beneficial to veterinary chiropractic in South Africa as there is a paucity of available literature currently available.

Remuneration:

None.

Costs of the study:

None.

Confidentiality:

All forms of consent and questionnaires will be collected in separate boxes to ensure confidentiality of the participant. Information obtained will be available I the form of a dissertation at the Durban University of Technology.

Reason/s why the Subject May Withdraw from the Study:

At any time during the research process you may withdraw from the study, however once your questionnaire is posted into the sealed container it may not be removed to protect the confidentiality of the other respondents.

Persons to Contact in the event of any Queries:

Researcher:	Storm Radtke	0725830897
Supervisor:	Dr.G Matkovich	0312018204
Research Office:		031 3732055

APPENDIX H

DURBAN UNIVERSITY OF TECHNOLOGY

INFORMED CONSENT-PILOT STUDY

Statement of Agreement to Participate in the Research Study.

Thank you for your interest in this research study.

TITLE OF RESEARCH PROJECT:

The prevalence and risk factors of musculoskeletal injuries affecting working canines in Kwa-Zulu Natal.

RESEARCHER: Storm Radtke 072 583 0897

SUPERVISOR: Dr.G.Matkovich 0312018204

CO-SUPERVISOR: Dr.S.Singh 0312607671

- I hereby confirm that I have been informed by the researcher, Storm Radtke, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: ___________.
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

Please print in block letters:

Participant:____________________________ Signature:____________________________

Witness:______________________________ Signature:____________________________

Researcher's Name:________________________ Signature:____________________________

APPENDIX I

PILOT STUDY EVALUATION FORM

Q1: What is your opinion of the subject matter raised in this questionnaire? (Please only select one option)

Very interesting	
Average interest	
Lacks interest	
No interest at all	

Q2: Do you think the topic raised in this questionnaire was adequately covered?

Yes	
No	

O3: Did you understand all the instructions before each question?

Yes	
No	

Q4: Do you think the questionnaire is too long?

Yes	
No	

If you had any trouble answering or any problems with a specific question, please indicate which question and state how the question can be revised.

Thank you for your time in assisting me with my research study.

Please be reminded that all information regarding the topic discussed is confidential.

APPENDIX J

PILOT STUDY CORRECTIONS SUBMITTED TO IREC

Storm Radtke 2800587

IREC reference number: REC 97/15

Post Pilot Study amendments/Corrections

- No corrections or amendments were given by the participants of the pilot study. The questions and layout were stated to be clear and understandable by all participants.

- The researcher has numbered each question for ease of statistical analysis. This was the only adaptation made to the research tool.

APPENDIX K

FULL APPROVAL BY IREC

DUT DURBAN UNIVERSITY OF TECHNOLOGY

Institutional Research Ethics Committee
Faculty of Health Sciences
Room MS 49, Mansfield School Site
Gate 8, Ritson Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2900
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Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

19 October 2015

IREC Reference Number: **REC 97/15**

Ms S Radtke
9 Rose Crescent
New Germany
3610

Dear Ms Radtke

The prevalence and selected risk factors of musculoskeletal injuries affecting working canines in Kwa-Zulu Natal

The Institutional Research Ethics Committee acknowledges receipt of your notification regarding the piloting of your data collection tool.

Please note that Full Approval is granted to your research proposal. You may proceed with data collection.

Kindly ensure that participants used for the pilot study are not part of the main study.

Yours Sincerely,

[redacted]

Professor J K Adam
Chairperson: IREC

DUT DURBAN UNIVERSITY OF TECHNOLOGY

2015 -10- 19

INSITUTUTIONAL RESEARCH ETHICS COMMITTEE
P O BOX 1334 DURBAN 4000 SOUTH AFRICA

APPENDIX L

FINAL QUESTIONNAIRE-MAIN STUDY

<u>Title:</u> **The prevalence and selected risk factors of musculoskeletal injuries affecting working canines in Kwa-Zulu Natal.**
• **Please complete one questionnaire per canine that qualifies for inclusion in this study.**
• **Please mark an X indicating your choice where applicable. Some questions are open-ended and will entail a more detailed answer.**
• **Please kindly hand the completed questionnaire back to the researcher.**

	<u>SECTION A-DEMOGRAPHICS</u>
Breed:	
KUSA Registration Number:	

1.Age of the canine:	1-2 Years	2-4 Years	4-6 Years	6-8 Years	8-10 Years	10+ Years

2.Sex:	Female(Intact)		Female(Spayed)		Male(Intact)		Male(Neutered)	

3.Canine's age at time of Spay /Neuter? (If Applicable)		**4.Height of canine(KUSA Regulations)**	Small (<35cm)	Medium (36-43cm)	Large (44cm<)

5.Approximate weight of the canine?	1-5 KG	5-10 KG	10-15 KG	15-20 KG	20-25 KG	25 KG +

6.Is your canine involved in any other working disciplines besides agility?	Breed shows	Carting	Dog Jumping	Flyball	Obedience	Other	NA

7.What food is	

the canine on?(Please specify)									
8.Do you add joint supplements into your canine's diet?	Yes		No		**9.Is any additional supplementation given?**	Yes		No	
	Chondroitin				Anti-Inflammatories				
	Glucosamine				Coat Enhancement				
	Green Lipped Muscle Extract				General Vitamins				
	Other				Other				

SECTION B-PREVELANCE			
1.Has your canine ever sustained a musculoskeletal (bone/muscle/joint) **injury over its lifetime?** **Yes / No** (If yes, Please complete the table below)			
	Injury 1 (I1)Most Severe	**Injury 2 (I2)Second most severe**	**Additional Injury (AI)**
2.What was the age of the dog at the time of injury?			
	I1	**I2**	**AI**
3.When was the injury	Competition	Competition	Competitio n

sustained?	Play			Play			Play		
	Training			Training			Training		
	Warm-up			Warm-up			Warm-up		
	Other			Other			Other		
	I1			**I2**			**AI**		
4.If injured during competition/ training, which discipline?	Agility			Agility			Agility		
	Breed Show			Breed Show			Breed Show		
	Carting			Carting			Carting		
	Dog Jumping			Dog Jumping			Dog Jumping		
	Flyball			Flyball			Flyball		
	Obedience			Obedience			Obedience		
	Other			Other			Other		
	I1			**I2**			**AI**		
5.What body region was injured?	**Foreleg**	**Hindleg**	**Other**	**Foreleg**	**Hindleg**	**Other**	**Foreleg**	**Hindleg**	**Other**
	Elbow	Knee		Elbow	Knee		Elbow	Knee	
	Nail	Hip	-	Nail	Hip	-	Nail	Hip	-
	Shoulder	Hock	-	Shoulder	Hock	-	Shoulder	Hock	-
	Toe	Nail	-	Toe	Nail	-	Toe	Nail	-
	Wrist	Toe	-	Wrist	Toe	-	Wrist	Toe	-
6.Please describe the injury?									

7.Was an official diagnosis made by a vet?	Yes		No		Yes		No		Yes		No	
8.How long was the dog rested for after the injury?												

	I1				**I2**				**AI**			
9.Was your dogs injury related to contact equipment? (If yes, Please mark the relate equipment option with an X)	**Yes**		**No**		**Yes**		**No**		**Yes**		**No**	
	A-Frame				A-Frame				A-Frame			
	Cloth Tunnel				Cloth Tunnel				Cloth Tunnel			
	Dog Walk				Dog Walk				Dog Walk			
	Hurdles				Hurdles				Hurdles			
	Rigid Tunnel				Rigid Tunnel				Rigid Tunnel			
	See-Saw				See-Saw				See-Saw			
	Tyre Jump				Tyre Jump				Tyre Jump			
	Weave Poles				Weave Poles				Weave Poles			
	Other				Other				Other			

10.If the injury was caused by contact equipment, please select the surface type <u>AND</u> corresponding injury.	**Sand Painted**		**Rubberized**		**Plastic**		**Wood**		**Other**		**Not Applicable**	
	Injury 1		Injury 1		Injury 1		Injury 1		Injury 1			
	Injury 2		Injury 2		Injury 2		Injury 2		Injury 2			
	AI		AI		AI		AI		AI			
11.What were the weather conditions at	**Clear**		**Raining**		**Windy**		**Rain+ wind**		**Unknown**			

the time of injury?	Injury 1		Injury 1		Injury 1		Injury 1			
	Injury 2		Injury 2		Injury 2		Injury 2			
	AI		AI		AI		AI			

I1 **I2** **AI**

12.What was the floor surface <u>AND</u> condition at the time of injury? (please mark the surface type with an 'X' and <u>circle</u> the relevant options)	**Grass**		**Grass**		**Grass**	
	(Dry/ Muddy/ Wet) **and** (Long/ Short)		(Dry/ Muddy/ Wet) **and** (Long/ Short)		(Dry/ Muddy/ Wet) **and** (Long/ Short)	
	Sand		**Sand**		**Sand**	
	(Dry /Muddy) **and** (Soft /Hard)		(Dry /Muddy) **and** (Soft /Hard)		(Dry /Muddy) **and** (Soft /Hard)	
	Indoor	(fibre/Astroturf)	**Indoor**	(fibre/Astroturf)	**Indoor**	(fibre/Astroturf)
	Other		**Other**		**Other**	

<u>SECTION C-RISK</u>									
1.On average, how many shows per month do you compete in with your canine?	1-3 Shows		3-6 Shows		6-9 Shows		9+ Shows		
2.Do you allow time for a warm up period for your canine prior to jumping your class at a show?	Yes		No		**3.*Have you had formal training with regard to warm up techniques?**				
	If <u>no,</u> ignore the following questions marked with an asterix (*).				Yes		No		
4.*How long is your canines warm up period?	1-5 Minutes		5-10 Minutes		10-15 Minutes		15+ Minutes		
5.*What does the warm	Lead walking	Lead running	Massage	Off lead walking	Off lead running	Practice jumps	Stretches	Toy throwing	Toy tugging

<table>
<tr><td>up involve?</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">6.*How much time passes between warm up and the class round?</td><td colspan="2">1-5 Minutes</td><td colspan="2">5-10 Minutes</td><td colspan="2">10-15 Minutes</td><td colspan="3">15+ Minutes</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td rowspan="4">7.*Do you do a warm down period?</td><td rowspan="2">Yes</td><td rowspan="2"></td><td rowspan="2">No</td><td rowspan="2"></td><td rowspan="4">8.*How long is your warm
down period?</td><td>1-5 Minutes</td><td></td></tr>
<tr><td>5-10 Minutes</td><td></td></tr>
<tr><td colspan="4" rowspan="2">If <u>no</u>, ignore the next question marked with an asterix (*).</td><td>10-15 Minutes</td><td></td></tr>
<tr><td>15+Minutes</td><td></td></tr>
<tr><td rowspan="4">9.What age was your canine when you began agility
foundation training?</td><td rowspan="4"></td><td rowspan="4">10.At What age did obstacle
specific training begin?</td><td>Contact equipment</td><td></td></tr>
<tr><td>Jumping</td><td></td></tr>
<tr><td>Weave Poles</td><td></td></tr>
<tr><td>Other</td><td></td></tr>
<tr><td>11.At what age did your canine begin competing in agility?</td><td colspan="9"></td></tr>
<tr><td rowspan="4">12.How many times per week do you attend training with your canine?</td><td>1-2 times</td><td></td><td rowspan="4">13.How long is a typical training session?</td><td>5-10 minutes</td><td></td></tr>
<tr><td>2-3 times</td><td></td><td>10-15 minutes</td><td></td></tr>
<tr><td>3-4 times</td><td></td><td>15-20 minutes</td><td></td></tr>
<tr><td>4+ times</td><td></td><td>20+ minutes</td><td></td></tr>
<tr><td colspan="10">THANK YOU FOR YOUR TIME AND EFFORT IN COMPLETING THIS QUESTIONNAIRE.</td></tr>
</table>

APPENDIX M

DURBAN UNIVERSITY OF TECHNOLOGY

LETTER OF INFORMATION AND CONSENT-MAIN STUDY

Thank you for your interest in this research study.

Title of the study:

The prevalence and selected risk factors of musculoskeletal injuries affecting working canines in Kwa-Zulu Natal.

Researcher:

Storm Radtke 0725830897

Supervisor:

Dr.G Matkovich 0312018204

Co-supervisor:

Dr.S Singh 0312607671

Research Office: 031 3732055

Purpose of the study:

In South Africa, there are few chiropractic studies which have been conducted on animals due to ethical and legal issues, as well as a lack of educational infrastructure related to animal chiropractic in South Africa (Taverner, 2011).

An increase in public interest has been seen with regard to complementary and alternative veterinary therapies (Taylor and Romano, 1999; Maurer 2000), and animal chiropractic has been gaining traction, with set courses available in select universities (Maurer, 2000). There is a need for additional information regarding the profile of canines at risk for injury and the common type of injury that working agility canines face (Baltzer, 2012) and this will be the first step in building on the available literature.

Risk factors such as age, sex and breed of the canine have been shown to have a high impact on the prevalence and type of injury that certain working canines are at risk for, most commonly, hip dysplasia and cruciate tears. These abnormalities can lead to a reduced lifespan (Witsberger *et al.,* 2008). Other risk factors have been identified; however, there is limited literature available regarding these.

Agility is a sport designed to test a handlers skills and a canine's willingness to negotiate a course of obstacles against the clock (Apps.akc.org, 2014). The course involves hurdles, weaving poles, ramps, see-saws and tunnels; therefore resulting in twisting, hard landings, abrupt high speed turns and stops (Usdaa.com, 2014) which puts the dog at risk for certain injuries. The herding breed category listed under KUSA are breeds most commonly seen partaking in agility competition. The title "herding" refers to the task the breed was originally bred for in centuries past (Kusa, 2014).

As agility dogs undertake added stressor to their musculoskeletal system, this study aims to determine the prevalence of and most common types of injuries facing these athletes, as well as the predisposing risk factors involved.

By increasing the knowledge of the profile of working canines at risk for injury and the most common injuries seen, it could potentially assist in supplementing the limited literature available to allied health professionals working with canines, such as Chiropractors.

Ultimately, by increasing the body of knowledge with regard to veterinary chiropractic, it is envisioned that a greater acceptance in the veterinary field and by the general public will be achieved (Roecker, 2011).

<u>Outline of the procedures:</u>

Please complete the questionnaire according to the instructions given.

All answers are confidential thus you are requested to be honest and answer all questions. Mark the appropriate box with an X and specify answers where it is required.

Hand delivery/return

Once you have completed the questionnaire in full, place the questionnaire into the envelope provided and seal the envelope. The researcher will collect the letter of information and consent as well as the questionnaire from you and place it into two separate sealed boxes.

- All of the data will be analysed by a qualified statistician and the results will be represented in aggregate, thus no personal details will appear in the results and no single participant's results will be displayed in the results. Once the research has been completed the results will be available at the Durban University of Technology library.

<u>Risks or Discomfort to the subject:</u>

None.

<u>Benefits:</u>

Your participation in this study will assist in adding to the expansion of the body of knowledge regarding potential risk factors facing working canines in a South African context. This will be beneficial to veterinary chiropractic in South Africa as there is a paucity of available literature currently available.

<u>Remuneration:</u>

None.

<u>Costs of the study:</u>

None.

<u>Confidentiality:</u>

All forms of consent and questionnaires will be collected in separate boxes to ensure confidentiality of the participant. Information obtained will be available I the form of a dissertation at the Durban University of Technology.

<u>Reason/s why the Subject May Withdraw from the Study:</u>

At any time during the research process you may withdraw from the study, however once your questionnaire is posted into the sealed container it may not be removed to protect the confidentiality of the other respondents.

<u>Persons to Contact in the event of any Queries:</u>

Researcher:	Storm Radtke	0725830897
Supervisor:	Dr.G Matkovich	0312018204
Research Office:		031 3732055

APPENDIX N

DUT DURBAN UNIVERSITY OF TECHNOLOGY

INFORMED CONSENT-MAIN STUDY

Statement of Agreement to Participate in the Research Study.

Thank you for your interest in this research study.

TITLE OF RESEARCH PROJECT:

The prevalence and risk factors of musculoskeletal injuries affecting working canines in Kwa-Zulu Natal.

RESEARCHER: Storm Radtke 072 583 0897

SUPERVISOR: Dr.G.Matkovich 0312018204

CO-SUPERVISOR: Dr.S.Singh 0312607671

- I hereby confirm that I have been informed by the researcher, Storm Radtke, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: ___________.
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.

- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

Please print in block letters:

Participant:______________________________ Signature:______________________________

Witness:______________________________ Signature:______________________________

Researcher’s Name:______________________________ Signature:______________________________

APPENDIX O

KENNEL UNION OF SOUTHERN AFRICA HERDING GROUP

Title	Published Date
Anatolian Shepherd Dog	04 September 2012
Australian Cattle Dog	04 September 2012
Australian Kelpie	04 September 2012
Australian Shepherd	04 September 2012
Bearded Collie	04 September 2012
Beauceron	04 September 2012
Belgian Shepherd Dog	04 September 2012
Bergamasco Shepherd (Cane da pastore Bergamasco)	24 April 2013
Berger Picard	04 September 2012
Border Collie	04 September 2012
Bouvier des Flandres	04 September 2012
Briard	04 September 2012
Collie (Rough)	27 August 2013
Collie (Smooth)	04 September 2012
Corgi (Cardigan Welsh)	04 September 2012

Title	Published Date
Corgi (Pembroke Welsh)	04 September 2012
Dutch Shepherd Dog (Hollandse Herdershond)	04 September 2012
Finnish Lapphund (Suomenlapinkoira)	11 December 2012
Hungarian Kuvasz	04 September 2012
Hungarian Puli	04 September 2012
Kangal Dog	04 September 2012
Komondor	04 September 2012
Lancashire Heeler	04 September 2012
Maremma Sheepdog	04 September 2012
Old English Sheepdog	04 September 2012
Polish Lowland Sheepdog	04 September 2012
Pyrenean Sheepdog	29 January 2014
Samoyed	04 September 2012
Shetland Sheepdog	04 September 2012
White Swiss Shepherd Dog	

APPENDIX P

ANNUAL SHOW CALANDER 2015

DATE	NAME OF CLUB	PROBABLE VENUE	DOG JUMPING	AGILITY	TYPE
11-Jan	BOXER CLUB	SCOTTBURGH CC			OPEN
18-Jan	SAAC/AWC	SCOTTBURGH CC			NAT TRIALS
25-Jan	SAAC/AWC	SCOTTBURGH CC			NAT TRIALS
01-Feb	TOP ACHIEVER				
08-Feb	NATAL COAST	ASHLEY			OPEN
15-Feb	HKC	PORT SHEPSTONE			OPEN
22-Feb	SAAC/AWC	SCOTTBURGH CC			NAT TRIALS
01-Mar	SAAC/AWC	SCOTTBURGH CC			NAT TRIALS
08-Mar	NATAL GUNDOG CLUB	SCOTTBURGH CC			OPEN
22-Mar	SAAC/AWC	RESERVE DATE			
05-Apr	NATAL BOXER CLUB	SCOTTBURGH CC			OPEN
12-Apr	HKC	BOROUGH SPORTS GROUND			OPEN
26-Apr	KZNDAA	SCOTTBURGH			CHAMP
10-May	BLUFF	ASHLEY			OPEN
15-17 May	SAC & AWC QUALIFIER	TO BE ANNOUNCED			CHAMP
22-May	NATAL GOLDEN RETRIEVER CLUB	ASHLEY			CHAMP
23-May	KZN STAFFIE	ASHLEY			CHAMP
23-May	UMFOLOZE BULL TERRIER	ASHLEY			CHAMP
24-May	BORDER COLLIE CLUB	ASHLEY			CHAMP
28-30 May	SAAC/AWC FINALS	ROYAL SHOW			NAT TRAILS
14-Jun	KZNDAA	WOODLANDS			OPEN
21-Jun	MARGATE KENNEL CLUB	PORT SHEPSTONE			OPEN

03-Jul	NATAL GUNDOG CLUB	SHOW TO BE CHANGED			CHAMP
19-Jul	UMBOGINTWINI DTC	HUTCHINSON PARK			OPEN
25-Jul	ZULULAND	SCOTTBURGH			CHAMP
26-Jul	NORTHERN NATAL	SCOTTBURGH			CHAMP
6 - 9 Aug	BLOEMFONTEIN	BLOEMFONTEIN			CHAMP
16-Aug	HKC	PORT SHEPSTONE			OPEN
22-Aug	BOXER CLUB	WOODLANDS			CHAMP
23-Aug	NATAL GSD CLUB	WOODLANDS			CHAMP
13-Sep	BORDER COLLIE CLUB	HUTCHINSON PARK			OPEN
20-Sep	NATAL WORKING & HERDING	ASHLEY			OPEN
25-Sep	NATAL AFGHAN CLUB	PORT SHEPSTONE			CHAMP
26-Sep	HIBISCUS KENNEL CLUB	PORT SHEPSTONE			CHAMP
26-Sep	DOBERMAN CLUB	PORT SHEPSTONE			CHAMP
27-Sep	MARGATE KENNEL CLUB	PORT SHEPSTONE			CHAMP
04-Oct	KZNDAA	SCOTTBURGH			OPEN
23-Oct	PIETERMARITZBURG KC	ASHLEY			CHAMP
24-Oct	NATAL WORKING & HERDING	ASHLEY			CHAMP
25-Oct	BLUFF DTC	ASHLEY			CHAMP
01-Nov	GUNDOG	SCOTTBURGH			OPEN
15-Nov	NATAL COAST	ASHLEY			OPEN
22-Nov	NATAL GSD CLUB	WOODLANDS			OPEN
06-Dec	HIBISCUS KENNEL CLUB	PORT SHEPSTONE			OPEN
	KZNDAA FUN EVENT	TBC			

APPENDIX Q

LETTER OF PERMISSION FROM THE KWA-ZULU NATAL DOG ATHLETICS ASSOCIATION

KZNDAA
KZN DOG ATHLETICS ASSOCIATION

KwaZulu Natal Dog Athletics Association

20TH May 2015

TO WHOM IT MAY CONCERN

As a Club we are delighted to have one of members, Storm Radtke, take such an interest in our competing dogs welfare, and can only wish her well in her studies.

The purpose of this letter is to grant Miss Radtke permission to ask our members to complete animal chiropractic questionnaires relating to these studies.

[redacted]

Kay Sargent

CHAIRMAN

APPENDIX R

INSIGNIFICANT STATISTICAL RESULTS

Breed-lifetime prevalence

Crosstab

			lifetimeprevalence		
			no	yes	Total
breed	0	Count	2	0	2
		% within breed	100.0%	0.0%	100.0%
	1	Count	7	2	9
		% within breed	77.8%	22.2%	100.0%
	2	Count	1	2	3
		% within breed	33.3%	66.7%	100.0%
	3	Count	1	0	1
		% within breed	100.0%	0.0%	100.0%
	4	Count	1	1	2
		% within breed	50.0%	50.0%	100.0%
	5	Count	17	17	34
		% within breed	50.0%	50.0%	100.0%
	6	Count	1	3	4
		% within breed	25.0%	75.0%	100.0%
	7	Count	0	1	1
		% within breed	0.0%	100.0%	100.0%
	8	Count	1	1	2
		% within breed	50.0%	50.0%	100.0%
	9	Count	1	0	1
		% within breed	100.0%	0.0%	100.0%
Total		Count	32	27	59
		% within breed	54.2%	45.8%	100.0%

Chi square test is not valid due to many categories with small sample sizes.

Sex – lifetime prevalence

Crosstab

			lifetimeprevalence		
			no	yes	Total
sex	0	Count	1	1	2
		% within sex	50.0%	50.0%	100.0%
	1	Count	17	8	25
		% within sex	68.0%	32.0%	100.0%
	2	Count	5	4	9
		% within sex	55.6%	44.4%	100.0%
	3	Count	9	14	23
		% within sex	39.1%	60.9%	100.0%
Total		Count	32	27	59
		% within sex	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.043[a]	3	.257
Likelihood Ratio	4.097	3	.251
Linear-by-Linear Association	3.254	1	.071
N of Valid Cases	59		

a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is .92.

No association with sex

Height- lifetime prevalence

Crosstab

			lifetimeprevalence		
			no	yes	Total
height	0	Count	1	2	3
		% within height	33.3%	66.7%	100.0%
	1	Count	3	2	5
		% within height	60.0%	40.0%	100.0%
	2	Count	28	23	51
		% within height	54.9%	45.1%	100.0%
Total		Count	32	27	59
		% within height	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.604[a]	2	.739
Likelihood Ratio	.608	2	.738
Linear-by-Linear Association	.247	1	.619
N of Valid Cases	59		

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is 1.37.

Weight-lifetime prevalence

Crosstab

			lifetimeprevalence		
			no	yes	Total
weight	1	Count	1	2	3
		% within weight	33.3%	66.7%	100.0%
	2	Count	2	2	4
		% within weight	50.0%	50.0%	100.0%
	3	Count	20	11	31
		% within weight	64.5%	35.5%	100.0%
	4	Count	5	7	12
		% within weight	41.7%	58.3%	100.0%
	5	Count	4	5	9
		% within weight	44.4%	55.6%	100.0%
Total		Count	32	27	59
		% within weight	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.988[a]	4	.560
Likelihood Ratio	3.013	4	.556
Linear-by-Linear Association	.236	1	.627
N of Valid Cases	59		

a. 6 cells (60.0%) have expected count less than 5. The minimum expected count is 1.37.

Age of sterilization

		lifetimeprevalence	
		no	yes
asteri	Median	6,0	6,0
	Percentile 25	1.5	2.0
	Percentile 75	9.0	11.0

No association with age of sterilization

Breed shows-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
Breed shows	no	Count	27	24	51
		% within Breed shows	52.9%	47.1%	100.0%
	yes	Count	5	3	8
		% within Breed shows	62.5%	37.5%	100.0%
Total		Count	32	27	59
		% within Breed shows	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.255[a]	1	.614		
Continuity Correction[b]	.015	1	.902		
Likelihood Ratio	.258	1	.612		
Fisher's Exact Test				.715	.455
Linear-by-Linear Association	.250	1	.617		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 3.66.
b. Computed only for a 2x2 table

Carting- lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
Carting	no	Count	31	26	57
		% within Carting	54.4%	45.6%	100.0%
	yes	Count	1	1	2
		% within Carting	50.0%	50.0%	100.0%
Total		Count	32	27	59
		% within Carting	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.015[a]	1	.903		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.015	1	.903		
Fisher's Exact Test				1.000	.710
Linear-by-Linear Association	.015	1	.903		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .92.
b. Computed only for a 2x2 table

Obedience-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
Obedience	no	Count	25	19	44
		% within Obedience	56.8%	43.2%	100.0%
	yes	Count	7	8	15
		% within Obedience	46.7%	53.3%	100.0%
Total		Count	32	27	59
		% within Obedience	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.464[a]	1	.496		
Continuity Correction[b]	.145	1	.703		
Likelihood Ratio	.463	1	.496		
Fisher's Exact Test				.558	.351
Linear-by-Linear Association	.457	1	.499		
N of Valid Cases	59				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.86.
b. Computed only for a 2x2 table

Other- lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
Other	no	Count	31	23	54
		% within Other	57.4%	42.6%	100.0%
	yes	Count	1	4	5
		% within Other	20.0%	80.0%	100.0%
Total		Count	32	27	59
		% within Other	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.580[a]	1	.108		
Continuity Correction[b]	1.293	1	.256		
Likelihood Ratio	2.693	1	.101		
Fisher's Exact Test				.169	.128
Linear-by-Linear Association	2.536	1	.111		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.29.
b. Computed only for a 2x2 table

N/A- lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
N/A	no	Count	29	21	50
		% within N/A	58.0%	42.0%	100.0%
	yes	Count	3	6	9
		% within N/A	33.3%	66.7%	100.0%
Total		Count	32	27	59
		% within N/A	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.870[a]	1	.172		
Continuity Correction[b]	1.008	1	.315		
Likelihood Ratio	1.881	1	.170		
Fisher's Exact Test				.277	.158
Linear-by-Linear Association	1.838	1	.175		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 4.12.
b. Computed only for a 2x2 table

No answer-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
No answer	no	Count	32	26	58
		% within No answer	55.2%	44.8%	100.0%
	yes	Count	0	1	1
		% within No answer	0.0%	100.0%	100.0%
Total		Count	32	27	59
		% within No answer	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.206[a]	1	.272		
Continuity Correction[b]	.007	1	.932		
Likelihood Ratio	1.584	1	.208		
Fisher's Exact Test				.458	.458
Linear-by-Linear Association	1.185	1	.276		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .46.
b. Computed only for a 2x2 table

Food mixed-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
fdmixed	no	Count	26	24	50
		% within fdmixed	52.0%	48.0%	100.0%
	yes	Count	6	3	9
		% within fdmixed	66.7%	33.3%	100.0%
Total		Count	32	27	59
		% within fdmixed	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.661[a]	1	.416		
Continuity Correction[b]	.202	1	.653		
Likelihood Ratio	.675	1	.411		
Fisher's Exact Test				.488	.330
Linear-by-Linear Association	.650	1	.420		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 4.12.
b. Computed only for a 2x2 table

Food Hills-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
fdhills	no	Count	28	27	55
		% within fdhills	50.9%	49.1%	100.0%
	yes	Count	4	0	4
		% within fdhills	100.0%	0.0%	100.0%
Total		Count	32	27	59
		% within fdhills	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.620[a]	1	.057		
Continuity Correction[b]	1.913	1	.167		
Likelihood Ratio	5.139	1	.023		
Fisher's Exact Test				.118	.079
Linear-by-Linear Association	3.559	1	.059		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.83.
b. Computed only for a 2x2 table

Food Royal Canin-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
fdroyalcanin	no	Count	28	26	54
		% within fdroyalcanin	51.9%	48.1%	100.0%
	yes	Count	4	1	5
		% within fdroyalcanin	80.0%	20.0%	100.0%
Total		Count	32	27	59
		% within fdroyalcanin	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.461[a]	1	.227		
Continuity Correction[b]	.547	1	.460		
Likelihood Ratio	1.577	1	.209		
Fisher's Exact Test				.362	.234
Linear-by-Linear Association	1.436	1	.231		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.29.
b. Computed only for a 2x2 table

Food Royal Canine specific- lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
fdroyalcaninespecific	no	Count	31	27	58
		% within fdroyalcaninespecific	53.4%	46.6%	100.0%
	yes	Count	1	0	1
		% within fdroyalcaninespecific	100.0%	0.0%	100.0%
Total		Count	32	27	59
		% within fdroyalcaninespecific	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.858[a]	1	.354		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	1.238	1	.266		
Fisher's Exact Test				1.000	.542
Linear-by-Linear Association	.844	1	.358		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .46.
b. Computed only for a 2x2 table

Food Raw diet- lifetime prevalence

Crosstab

			lifetimeprevalence		
			no	yes	Total
fdrawdiet	no	Count	27	25	52
		% within fdrawdiet	51.9%	48.1%	100.0%
	yes	Count	5	2	7
		% within fdrawdiet	71.4%	28.6%	100.0%
Total		Count	32	27	59
		% within fdrawdiet	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.946[a]	1	.331		
Continuity Correction[b]	.323	1	.570		
Likelihood Ratio	.981	1	.322		
Fisher's Exact Test				.437	.289
Linear-by-Linear Association	.930	1	.335		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 3.20.
b. Computed only for a 2x2 table

Food Acana-lifetime prevalence

Crosstab

			lifetimeprevalence		
			no	yes	Total
fdacana	no	Count	31	26	57
		% within fdacana	54.4%	45.6%	100.0%
	yes	Count	1	1	2
		% within fdacana	50.0%	50.0%	100.0%
Total		Count	32	27	59
		% within fdacana	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.015[a]	1	.903		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.015	1	.903		
Fisher's Exact Test				1.000	.710
Linear-by-Linear Association	.015	1	.903		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .92.
b. Computed only for a 2x2 table

Food Acana specific- lifetime prevalence

Crosstab

			lifetimeprevalence		
			no	yes	Total
fdacanaspecific	no	Count	32	24	56
		% within fdacanaspecific	57.1%	42.9%	100.0%
	yes	Count	0	3	3
		% within fdacanaspecific	0.0%	100.0%	100.0%
Total		Count	32	27	59
		% within fdacanaspecific	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3.746[a]	1	.053		
Continuity Correction[b]	1.798	1	.180		
Likelihood Ratio	4.881	1	.027		
Fisher's Exact Test				.090	.090
Linear-by-Linear Association	3.683	1	.055		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.37.
b. Computed only for a 2x2 table

Food Montego- lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
fdmontego	no	Count	31	25	56
		% within fdmontego	55.4%	44.6%	100.0%
	yes	Count	1	2	3
		% within fdmontego	33.3%	66.7%	100.0%
Total		Count	32	27	59
		% within fdmontego	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.556[a]	1	.456		
Continuity Correction[b]	.023	1	.880		
Likelihood Ratio	.560	1	.454		
Fisher's Exact Test				.588	.435
Linear-by-Linear Association	.547	1	.460		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.37.
b. Computed only for a 2x2 table

Food Montego specific-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
fdmontegospecific	no	Count	30	26	56
		% within fdmontegospecific	53.6%	46.4%	100.0%
	yes	Count	2	1	3
		% within fdmontegospecific	66.7%	33.3%	100.0%
Total		Count	32	27	59
		% within fdmontegospecific	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.197[a]	1	.657		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.202	1	.653		
Fisher's Exact Test				1.000	.565
Linear-by-Linear Association	.193	1	.660		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.37.
b. Computed only for a 2x2 table

Food Vets Choice-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
fdvetschoice	no	Count	31	26	57
		% within fdvetschoice	54.4%	45.6%	100.0%
	yes	Count	1	1	2
		% within fdvetschoice	50.0%	50.0%	100.0%
Total		Count	32	27	59
		% within fdvetschoice	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.015[a]	1	.903		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.015	1	.903		
Fisher's Exact Test				1.000	.710
Linear-by-Linear Association	.015	1	.903		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .92.
b. Computed only for a 2x2 table

Food Eukanuba specific-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
fdeukanubaspecific	no	Count	30	27	57
		% within fdeukanubaspecific	52.6%	47.4%	100.0%
	yes	Count	2	0	2
		% within fdeukanubaspecific	100.0%	0.0%	100.0%
Total		Count	32	27	59
		% within fdeukanubaspecific	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.747[a]	1	.186		
Continuity Correction[b]	.360	1	.549		
Likelihood Ratio	2.506	1	.113		
Fisher's Exact Test				.495	.290
Linear-by-Linear Association	1.717	1	.190		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .92.
b. Computed only for a 2x2 table

Food Bobmartin-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
fdbobmartin	no	Count	32	26	58
		% within fdbobmartin	55.2%	44.8%	100.0%
	yes	Count	0	1	1
		% within fdbobmartin	0.0%	100.0%	100.0%
Total		Count	32	27	59
		% within fdbobmartin	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.206[a]	1	.272		
Continuity Correction[b]	.007	1	.932		
Likelihood Ratio	1.584	1	.208		
Fisher's Exact Test				.458	.458
Linear-by-Linear Association	1.185	1	.276		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .46.
b. Computed only for a 2x2 table

Food No answer-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
fdnoanswer	no	Count	31	27	58
		% within fdnoanswer	53.4%	46.6%	100.0%
	yes	Count	1	0	1
		% within fdnoanswer	100.0%	0.0%	100.0%
Total		Count	32	27	59
		% within fdnoanswer	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.858[a]	1	.354		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	1.238	1	.266		
Fisher's Exact Test				1.000	.542
Linear-by-Linear Association	.844	1	.358		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .46.
b. Computed only for a 2x2 table

Joint supplementation-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
jsupp	no	Count	16	18	34
		% within jsupp	47.1%	52.9%	100.0%
	yes	Count	16	9	25
		% within jsupp	64.0%	36.0%	100.0%
Total		Count	32	27	59
		% within jsupp	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.666[a]	1	.197		
Continuity Correction[b]	1.053	1	.305		
Likelihood Ratio	1.680	1	.195		
Fisher's Exact Test				.290	.152
Linear-by-Linear Association	1.638	1	.201		
N of Valid Cases	59				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 11.44.
b. Computed only for a 2x2 table

Joint Supplementation-Green lipped muscle- lifetime prevalence

Crosstab

			lifetimeprevalence		
			no	yes	Total
stgreenlippedmuscle	no	Count	26	18	44
		% within stgreenlippedmuscle	59.1%	40.9%	100.0%
	yes	Count	6	9	15
		% within stgreenlippedmuscle	40.0%	60.0%	100.0%
Total		Count	32	27	59
		% within stgreenlippedmuscle	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.643[a]	1	.200		
Continuity Correction[b]	.963	1	.326		
Likelihood Ratio	1.642	1	.200		
Fisher's Exact Test				.240	.163
Linear-by-Linear Association	1.615	1	.204		
N of Valid Cases	59				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.86.

b. Computed only for a 2x2 table

Other-lifetime prevalence

Crosstab

			lifetimeprevalence		
			no	yes	Total
stother	no	Count	21	15	36
		% within stother	58.3%	41.7%	100.0%
	yes	Count	11	12	23
		% within stother	47.8%	52.2%	100.0%
Total		Count	32	27	59
		% within stother	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.624[a]	1	.429		
Continuity Correction[b]	.273	1	.602		
Likelihood Ratio	.624	1	.430		
Fisher's Exact Test				.593	.301
Linear-by-Linear Association	.614	1	.433		
N of Valid Cases	59				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.53.

b. Computed only for a 2x2 table

Na-lifetimeprevalence

Crosstab

			lifetimeprevalence		
			no	yes	Total
stna	no	Count	16	18	34
		% within stna	47.1%	52.9%	100.0%
	yes	Count	16	9	25
		% within stna	64.0%	36.0%	100.0%
Total		Count	32	27	59
		% within stna	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.666[a]	1	.197		
Continuity Correction[b]	1.053	1	.305		
Likelihood Ratio	1.680	1	.195		
Fisher's Exact Test				.290	.152
Linear-by-Linear Association	1.638	1	.201		
N of Valid Cases	59				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 11.44.
b. Computed only for a 2x2 table

Additional Supplementation-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
addsupp	no	Count	13	14	27
		% within addsupp	48.1%	51.9%	100.0%
	yes	Count	11	10	21
		% within addsupp	52.4%	47.6%	100.0%
	2.0	Count	8	3	11
		% within addsupp	72.7%	27.3%	100.0%
Total		Count	32	27	59
		% within addsupp	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.948[a]	2	.378
Likelihood Ratio	2.019	2	.364
Linear-by-Linear Association	1.592	1	.207
N of Valid Cases	59		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.03.

Coat enhancement- lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
ascoatenhancement	no	Count	24	21	45
		% within ascoatenhancement	53.3%	46.7%	100.0%
	yes	Count	8	6	14
		% within ascoatenhancement	57.1%	42.9%	100.0%
Total		Count	32	27	59
		% within ascoatenhancement	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.062[a]	1	.803		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.063	1	.802		
Fisher's Exact Test				1.000	.525
Linear-by-Linear Association	.061	1	.804		
N of Valid Cases	59				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.41.
b. Computed only for a 2x2 table

Vitamins-lifetime prevalence

Crosstab

			lifetimeprevalence no	lifetimeprevalence yes	Total
asvitamins	no	Count	32	25	57
		% within asvitamins	56.1%	43.9%	100.0%
	yes	Count	0	2	2
		% within asvitamins	0.0%	100.0%	100.0%
Total		Count	32	27	59
		% within asvitamins	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.454[a]	1	.117		
Continuity Correction[b]	.713	1	.398		
Likelihood Ratio	3.210	1	.073		
Fisher's Exact Test				.205	.205
Linear-by-Linear Association	2.412	1	.120		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .92.

b. Computed only for a 2x2 table

Other-lifetime prevalence

Crosstab

			lifetimeprevalence no	lifetimeprevalence yes	Total
asother	no	Count	25	24	49
		% within asother	51.0%	49.0%	100.0%
	yes	Count	7	3	10
		% within asother	70.0%	30.0%	100.0%
Total		Count	32	27	59
		% within asother	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.205[a]	1	.272		
Continuity Correction[b]	.562	1	.453		
Likelihood Ratio	1.242	1	.265		
Fisher's Exact Test				.319	.229
Linear-by-Linear Association	1.185	1	.276		
N of Valid Cases	59				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.58.

b. Computed only for a 2x2 table

Na-lifetime prevalence

Crosstab

			lifetimeprevalence no	lifetimeprevalence yes	Total
asna	no	Count	15	15	30
		% within asna	50.0%	50.0%	100.0%
	yes	Count	17	12	29
		% within asna	58.6%	41.4%	100.0%
Total		Count	32	27	59
		% within asna	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.442[a]	1	.506		
Continuity Correction[b]	.162	1	.687		
Likelihood Ratio	.442	1	.506		
Fisher's Exact Test				.604	.344
Linear-by-Linear Association	.434	1	.510		
N of Valid Cases	59				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 13.27.
b. Computed only for a 2x2 table

Show quantity-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
Showquantity	.0	Count	27	18	45
		% within Showquantity	60.0%	40.0%	100.0%
	1.0	Count	5	6	11
		% within Showquantity	45.5%	54.5%	100.0%
	4.0	Count	0	3	3
		% within Showquantity	0.0%	100.0%	100.0%
Total		Count	32	27	59
		% within Showquantity	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.499[a]	2	.105
Likelihood Ratio	5.638	2	.060
Linear-by-Linear Association	4.423	1	.035
N of Valid Cases	59		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 1.37.

Warm-up-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
warmup	.0	Count	29	25	54
		% within warmup	53.7%	46.3%	100.0%
	1.0	Count	2	0	2
		% within warmup	100.0%	0.0%	100.0%
Total		Count	31	25	56
		% within warmup	55.4%	44.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.673[a]	1	.196		
Continuity Correction[b]	.324	1	.569		
Likelihood Ratio	2.425	1	.119		
Fisher's Exact Test				.497	.302
Linear-by-Linear Association	1.643	1	.200		
N of Valid Cases	56				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .89.
b. Computed only for a 2x2 table

Warm-up length-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
warmuplength	.0	Count	16	14	30
		% within warmuplength	53.3%	46.7%	100.0%
	1.0	Count	12	2	14
		% within warmuplength	85.7%	14.3%	100.0%
	2.0	Count	1	5	6
		% within warmuplength	16.7%	83.3%	100.0%
	3.0	Count	0	1	1
		% within warmuplength	0.0%	100.0%	100.0%
	4.0	Count	2	2	4
		% within warmuplength	50.0%	50.0%	100.0%
Total		Count	31	24	55
		% within warmuplength	56.4%	43.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.217[a]	4	.037
Likelihood Ratio	11.462	4	.022
Linear-by-Linear Association	.609	1	.435
N of Valid Cases	55		

a. 6 cells (60.0%) have expected count less than 5. The minimum expected count is .44.

Invalid test

Lead walking-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
leadwalking	no	Count	18	13	31
		% within leadwalking	58.1%	41.9%	100.0%
	yes	Count	14	14	28
		% within leadwalking	50.0%	50.0%	100.0%
Total		Count	32	27	59
		% within leadwalking	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.385[a]	1	.535		
Continuity Correction[b]	.129	1	.719		
Likelihood Ratio	.386	1	.535		
Fisher's Exact Test				.606	.360
Linear-by-Linear Association	.379	1	.538		
N of Valid Cases	59				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.81.

b. Computed only for a 2x2 table

Lead running-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
leadrunning	no	Count	24	24	48
		% within leadrunning	50.0%	50.0%	100.0%
	yes	Count	8	3	11
		% within leadrunning	72.7%	27.3%	100.0%
Total		Count	32	27	59
		% within leadrunning	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.862[a]	1	.172		
Continuity Correction[b]	1.059	1	.303		
Likelihood Ratio	1.934	1	.164		
Fisher's Exact Test				.200	.152
Linear-by-Linear Association	1.831	1	.176		
N of Valid Cases	59				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.03.
b. Computed only for a 2x2 table

Massage-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
massage	no	Count	30	26	56
		% within massage	53.6%	46.4%	100.0%
	yes	Count	2	1	3
		% within massage	66.7%	33.3%	100.0%
Total		Count	32	27	59
		% within massage	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.197[a]	1	.657		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.202	1	.653		
Fisher's Exact Test				1.000	.565
Linear-by-Linear Association	.193	1	.660		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.37.
b. Computed only for a 2x2 table

Offlead walking-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
offleadwalking	no	Count	24	16	40
		% within offleadwalking	60.0%	40.0%	100.0%
	yes	Count	8	11	19
		% within offleadwalking	42.1%	57.9%	100.0%
Total		Count	32	27	59
		% within offleadwalking	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.662[a]	1	.197		
Continuity Correction[b]	1.019	1	.313		
Likelihood Ratio	1.662	1	.197		
Fisher's Exact Test				.266	.156
Linear-by-Linear Association	1.634	1	.201		
N of Valid Cases	59				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.69.
b. Computed only for a 2x2 table

Offlead running-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
offleadrunning	no	Count	13	15	28
		% within offleadrunning	46.4%	53.6%	100.0%
	yes	Count	19	12	31
		% within offleadrunning	61.3%	38.7%	100.0%
Total		Count	32	27	59
		% within offleadrunning	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.309[a]	1	.253		
Continuity Correction[b]	.779	1	.377		
Likelihood Ratio	1.313	1	.252		
Fisher's Exact Test				.302	.189
Linear-by-Linear Association	1.287	1	.257		
N of Valid Cases	59				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.81.
b. Computed only for a 2x2 table

Practice jumps-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
practicejumps	no	Count	7	6	13
		% within practicejumps	53.8%	46.2%	100.0%
	yes	Count	25	21	46
		% within practicejumps	54.3%	45.7%	100.0%
Total		Count	32	27	59
		% within practicejumps	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.001[a]	1	.974		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.001	1	.974		
Fisher's Exact Test				1.000	.609
Linear-by-Linear Association	.001	1	.975		
N of Valid Cases	59				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.95.
b. Computed only for a 2x2 table

Stretches- lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
stretches	no	Count	26	17	43
		% within stretches	60.5%	39.5%	100.0%
	yes	Count	6	10	16
		% within stretches	37.5%	62.5%	100.0%
Total		Count	32	27	59
		% within stretches	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.478[a]	1	.115		
Continuity Correction[b]	1.639	1	.200		
Likelihood Ratio	2.484	1	.115		
Fisher's Exact Test				.147	.100
Linear-by-Linear Association	2.436	1	.119		
N of Valid Cases	59				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.32.
b. Computed only for a 2x2 table

Toy throwing-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
toythrowing	no	Count	21	16	37
		% within toythrowing	56.8%	43.2%	100.0%
	yes	Count	11	11	22
		% within toythrowing	50.0%	50.0%	100.0%
Total		Count	32	27	59
		% within toythrowing	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.254[a]	1	.614		
Continuity Correction[b]	.055	1	.815		
Likelihood Ratio	.254	1	.615		
Fisher's Exact Test				.788	.407
Linear-by-Linear Association	.249	1	.617		
N of Valid Cases	59				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.07.
b. Computed only for a 2x2 table

Toy tugging-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
toytugging	no	Count	15	14	29
		% within toytugging	51.7%	48.3%	100.0%
	yes	Count	17	13	30
		% within toytugging	56.7%	43.3%	100.0%
Total		Count	32	27	59
		% within toytugging	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.145[a]	1	.703		
Continuity Correction[b]	.014	1	.905		
Likelihood Ratio	.145	1	.703		
Fisher's Exact Test				.796	.452
Linear-by-Linear Association	.143	1	.706		
N of Valid Cases	59				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 13.27.
b. Computed only for a 2x2 table

Not applicable-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
notapplicable	no	Count	30	25	55
		% within notapplicable	54.5%	45.5%	100.0%
	yes	Count	2	2	4
		% within notapplicable	50.0%	50.0%	100.0%
Total		Count	32	27	59
		% within notapplicable	54.2%	45.8%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.031[a]	1	.860		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.031	1	.860		
Fisher's Exact Test				1.000	.627
Linear-by-Linear Association	.031	1	.861		
N of Valid Cases	59				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.83.
b. Computed only for a 2x2 table

Time lapse between warm up and competition-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
timelapse	.0	Count	17	11	28
		% within timelapse	60.7%	39.3%	100.0%
	1.0	Count	8	5	13
		% within timelapse	61.5%	38.5%	100.0%
	2.0	Count	1	4	5
		% within timelapse	20.0%	80.0%	100.0%
	3.0	Count	1	2	3
		% within timelapse	33.3%	66.7%	100.0%
	4.0	Count	2	2	4
		% within timelapse	50.0%	50.0%	100.0%
Total		Count	29	24	53
		% within timelapse	54.7%	45.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.672[a]	4	.452
Likelihood Ratio	3.789	4	.435
Linear-by-Linear Association	1.363	1	.243
N of Valid Cases	53		

a. 6 cells (60.0%) have expected count less than 5. The minimum expected count is 1.36.

Warm down- lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
warmdown	.0	Count	10	10	20
		% within warmdown	50.0%	50.0%	100.0%
	1.0	Count	21	11	32
		% within warmdown	65.6%	34.4%	100.0%
	2.0	Count	0	3	3
		% within warmdown	0.0%	100.0%	100.0%
Total		Count	31	24	55

	% within warmdown	56.4%	43.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.320[a]	2	.070
Likelihood Ratio	6.444	2	.040
Linear-by-Linear Association	.039	1	.843
N of Valid Cases	55		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 1.31.

Length warm down-lifetime prevalence

Crosstab

			lifetimeprevalence		
			no	yes	Total
lengthwarmdown	.0	Count	10	6	16
		% within lengthwarmdown	62.5%	37.5%	100.0%
	1.0	Count	0	4	4
		% within lengthwarmdown	0.0%	100.0%	100.0%
	4.0	Count	21	14	35
		% within lengthwarmdown	60.0%	40.0%	100.0%
Total		Count	31	24	55
		% within lengthwarmdown	56.4%	43.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.600[a]	2	.061
Likelihood Ratio	7.072	2	.029
Linear-by-Linear Association	.172	1	.679
N of Valid Cases	55		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 1.75.

Training sessions per week-lifetime prevalence

Crosstab

			lifetimeprevalence		
			no	yes	Total
trainingperweek	0	Count	14	5	19
		% within trainingperweek	73.7%	26.3%	100.0%
	1	Count	10	16	26
		% within trainingperweek	38.5%	61.5%	100.0%
	2	Count	3	1	4
		% within trainingperweek	75.0%	25.0%	100.0%
	3	Count	4	1	5
		% within trainingperweek	80.0%	20.0%	100.0%
Total		Count	31	23	54
		% within trainingperweek	57.4%	42.6%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.426[a]	3	.060
Likelihood Ratio	7.620	3	.055
Linear-by-Linear Association	.002	1	.968
N of Valid Cases	54		

a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is 1.70.

Length of session-lifetime prevalence

Crosstab

			lifetimeprevalence		Total
			no	yes	
lenghtof session	0	Count	12	7	19
		% within lenghtof session	63.2%	36.8%	100.0%
	1	Count	12	7	19
		% within lenghtof session	63.2%	36.8%	100.0%
	2	Count	4	6	10
		% within lenghtof session	40.0%	60.0%	100.0%
	3	Count	2	3	5
		% within lenghtof session	40.0%	60.0%	100.0%
Total		Count	30	23	53
		% within lenghtof session	56.6%	43.4%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.348[a]	3	.503
Likelihood Ratio	2.340	3	.505
Linear-by-Linear Association	1.700	1	.192
N of Valid Cases	53		

a. 3 cells (37.5%) have expected count less than 5. The minimum expected count is 2.17.