Gymnastics injuries: A quantitative profile of athletes in the greater Durban area.

By

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I, Ingrid Adamson, do hereby declare that this dissertation represents my own work in both concept and execution.

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Ingrid Adamson Date

APPROVED FOR FINAL SUBMISSION

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Dr. E. Lakhani Date

DEDICATION

I WOULD LIKE TO DEDICATE THIS TO MY FAMILY, FOR THEIR SUPPORT, UNFAILING PATIENCE, UNDERSTANDING AND LOVE; AND TO THE TEAM AT THE KWAZULU-NATAL GYMNASTICS UNION FOR ALL THEIR ASSISTANCE AND FOR ALLOWING ME TO CARRY OUT THIS PROJECT. I WOULD ALSO LIKE TO DEDICATE THIS TO MY DEAR FRIEND MARK PULLIN, WHO WILL ALWAYS BE REMEMBERED IN THE HEARTS OF EVERYONE IN THE GYMNASTICS COMMUNITY OF KWAZULU-NATAL.

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Chapter 1

Introduction to the study

This chapter deals with an explanation of the rationale behind this study, and includes the aims, objectives, hypotheses and limitations of the study.

1.1 Introduction

1.1.1 Definition

Gymnastics can be defined as the practice of performing exercises that increase strength, suppleness, or agility, especially those performed with special apparatus in a gymnasium, (Readers' Digest Universal Dictionary, 1987).

1.1.2 Background of the sport

Gymnastics has risen greatly in popularity over the past twenty years. This increased participation in gymnastics is encouraging because physical activity clearly provides many health-related benefits to those who participate (Caine and Nassar, 2005).

However, the range and number of risk elements incorporated into gymnastics routines has increased substantially since 1970 as coaches and athletes increased the complexity of manoeuvres (Daly et al., 2001). Associated with an increase in participation, due to the rise in popularity, is an earlier age of entry and specialization in the sport. Elite male and female gymnasts may begin training for their sport as early as ages nine and six years, respectively, with peak performance being ten or more years away. During this period, the degree of difficulty of manoeuvres practised and performed, and the volume and intensity of training increase drastically, in many cases without a concomitant increase in the preparation of the gymnast's body. This could be because of the fact that the

degree of body conditioning and strength training required in order to perform the difficult movements is often underestimated. (Mitchell, 2006).

Therefore, this increased involvement and difficulty of skills practised at an early age and continued through the years of growth, with the volume and intensity of training required to be competitive; gives rise to concern about the risk and severity and long-term effects of injury to the young gymnast. These injuries are often carried through into later life when the participants have retired from the sport. A decrease in the fitness level and protective mechanisms, which may have tended to mask the effects of the original injury, result in progression of the injury to one of a more chronic nature (Mitchell, 2006).

In addition, the amount of impact applied to the body is relatively high when compared with other childhood sport and recreational activities (Daly et al., 2001). This is because of the frequent high impact loading that occurs during both gymnastics training and competition. Gymnastics activities are characterized by this frequent high-impact loading on the body, resulting in extreme levels of mechanical stress on the musculoskeletal system. As skeletally immature athletes, gymnasts present a unique physiological predisposition to injuries because of growing spines, limbs, wrists and ankles (Winkler, 2001).

Furthermore, unlike most other sporting activities, gymnastics requires the use of both the upper and lower extremities as weight-bearing limbs (Panzer et al., 1988). Gymnastics therefore, holds more potential for chronic upper limb injuries than sports such as football, rugby and soccer, amongst others, in part because of the fact that it is the only sport that uses the upper extremities as weight-bearing limbs as well as the lower extremities (Winkler, 2001).

In view of these factors mentioned above, and according to Mitchell (2006), most gymnasts do not make it through their years of training and competition without incurring injury. It appears that most of the available literature on gymnastics

injuries, as utilised in this study, focuses on female gymnasts only, with the result that some of the discussion and conclusions drawn may not have been accurate as the possibility of gender bias, to a certain extent, does exist.

Studies have been performed in other countries to investigate injury rates in gymnastics, and although some have produced conflicting results, overall gymnastics appeared to be associated with a high injury incidence when compared with most other sporting activities (Kolt and Kirkby, 1996).

In accordance with the rise in popularity of gymnastics, most first world countries have incorporated gymnastics into the school syllabus as part of the physical education classes, especially at primary school level and most schools have the necessary equipment and qualified staff members for this activity. The benefit/advantage of this is that it makes talent identification and recruitment for the sport relatively simple. However, in South Africa this has not been possible in the past due to the fact that, amongst other things, there was insufficient funding available. For this reason, gymnastics is both less popular and less advanced in South Africa in comparison with other countries (Cameron-Smith, 2005).

Another reason for the delay in development in South African gymnastics is that during the years of apartheid, South African gymnasts were not permitted to take part in international tournaments or competitions. At the same time however, the sport was growing and changing rapidly everywhere else in the world leaving South Africa behind (Cameron-Smith, 2005), until 1991 when South Africa was once again allowed to participate in the World Championships (Cameron-Smith, 2005).

As a result of the lack of funding, and gymnasts not having been allowed to participate in international competitions for many years before 1991, the standard of South African gymnastics is lower than that of other countries. There is however, an intensive development program currently in place designed for the

purpose of improving the standard of the sport in South Africa to match that of international standards; and in addition, talent identification is presently being introduced at various schools and clubs throughout the country (Cameron-Smith, 2005).

Furthermore, there are also growing numbers of gymnasts in South Africa. Since 1991, participation has increased greatly. In 2001, there were 11250 registered competitive gymnasts in South Africa. However, in 2004, the estimated number of registered, competitive gymnasts in South Africa rose to 13500, four hundred of which were from KwaZulu-Natal (Chadwick, 2004). In 2005 the number has grown to almost 18000, which is sixty percent more than the 11250 that were registered in the year 2001 (Cameron-Smith, 2005). In 2005, the number of gymnasts in KwaZulu-Natal who participated in gymnastics competitions has risen to 456 (Chadwick, 2004).

In view of the intensive development program, and the growing numbers of gymnasts; and considering the associations made in studies overseas between gymnastics and potential injuries (as mentioned earlier), it is thought that studies investigating the injury profile in South African gymnastics would be as beneficial as those performed in other countries. However, no such studies have been conducted in South Africa thus far (Chadwick, 2004).

Research into gymnastics injuries in South Africa would help to identify any problems that may exist, quantify the extent of these problems and identify to some extent the potential risk factors for injury (Chadwick, 2004). This would be beneficial to South African gymnasts if recommendations for prevention of potential injuries were made, should any common injuries, or possible risk factors or associations be discovered/identified (Chadwick, 2004).

Therefore, this study aims to provide a quantitative profile of gymnastics injuries in the greater Durban area of KwaZulu-Natal, South Africa.

1.1.3 Aim of the study

The aim or purpose of this study is to determine the injury profile of gymnasts in the greater Durban area of KwaZulu-Natal, South Africa; and to compare it with the international data that are available.

Factors that should be considered regarding differences in the injury profile of South African gymnasts as compared with international gymnasts include:

1. Difference in standard of gymnastics (Cameron-Smith, 2005)
2. Sudden increase in the standard of South African gymnastics in an attempt to match that of other countries, which may lead to an increase in training hours, and attempts at more risky new manoeuvres. This, in turn, may increase the risk of injury (Cameron-Smith, 2005).

For the purpose of this study, the following information was gathered in terms of:

- Demographics of South African gymnasts
- The participants' gymnastics history
- The presence of any past or current injuries, and
- If present, factors relating to these injuries were investigated.

This information mentioned above was gathered with the aim of helping to identify any problems that may exist, quantifying the extent of these problems and identifying to some extent the potential risk factors. This would be beneficial to South African gymnasts if recommendations for prevention of potential injuries were made, should any common injuries, or possible risk factors or associations be discovered/identified (Chadwick, 2004).

1.2 Objectives

1.2.1 The first objective is the development of a contextualised questionnaire that is relevant to competitive gymnasts in the greater Durban area of KwaZulu-Natal, South Africa, with which to obtain the necessary information.

1.2.2 The second objective is to ascertain the injury profile of gymnasts in the greater Durban area of KwaZulu-Natal, South Africa, and compare this profile with other international studies. This will be achieved by means of data collection and documentation with respect to:

- Patient demographics including age, gender, race, and type of gymnastics participated in.
- Gymnastics history including years of experience in gymnastics, number of training hours per week and number of gymnastics classes attended per week.
- Factors directly related to injuries:
  - Location of current and past injuries.
  - Length of time for which current and past injuries were present.
  - Effect of current and past injuries on gymnastics training and competition.
  - Length of time for which gymnastics was prevented as a result of these injuries.
  - Mechanism of current injuries as well as any known technical weaknesses.
  - Severity of current injuries.
  - Treatment received for current and past injuries.
- Other factors indirectly related to injuries such as:
  - Eating habits and supplementation
  - Any additional recreational and / or competitive activities

- Utilization of regular maintenance treatment to improve performance.

1.2.3 The third objective is the interpretation of the data using cross tabulations, and the Pearson chi-squared test to assess the strength of the relationship of the various factors documented in objective two. This is to determine any associations between these factors, and to assess whether the trends in this study are comparable to those in other studies.

1.3 Hypotheses (based on the objectives)

1.3.1 The first hypothesis is that the questionnaire utilized in this study is contextualised to a form that is relevant to competitive gymnasts in the greater Durban area of KwaZulu-Natal, South Africa, and enables the researcher to gather the necessary information.

1.3.2 The second hypothesis is that the mapped profile for gymnastics injuries in South Africa is different from that of other countries, owing to the lower standard of gymnastics being produced in South Africa.

1.3.3 The third hypothesis is that it is thought that the risk factors associated with gymnastics injuries in South Africa will differ significantly from the risk factors found in other studies, because of the difference in standard of gymnastics produced in these countries.

1.4 Rationale behind this study

Gymnastics has risen greatly in popularity over the past twenty years, (Daly et al., 2001) internationally as well as locally. There are growing numbers of gymnasts in South Africa as well as an intensive development program designed

for the purpose of improving the standard of the sport to one that will match international standards (Cameron-Smith, 2005).

In addition to the above factors the amount of impact applied to the body is also relatively high during gymnastics training and competition when compared to other childhood sport and recreational activities (Daly et al., 2001). According to international studies, many children risk serious, long-term injury every day as a result of strenuous gymnastics training, associated with one or more types of gymnastics (Winkler, 2001); and gymnastics holds more potential for chronic upper limb injuries than sports such as football, rugby and soccer, amongst others, in part because it is the only sport that uses the upper extremities as weight-bearing limbs (Winkler, 2001). Because of the above-mentioned factors, studies performed on gymnasts overseas seem to show a high association of injuries compared with other sports.

Although some research has been carried out on this topic in other countries, no such research has been done in countries such as South Africa, (Chadwick, 2004). Therefore, the aim of this study was to determine the injury profile of gymnasts in the greater Durban area of KwaZulu-Natal, determine whether any relationships existed between risk factors (identified in other studies) and gymnastics injuries sustained, which might aid in the prevention of some injuries, and may lead to better training, treatment and management of gymnasts in South Africa.

1.5 Limitations of the study

A study such as this assumes that the respondents answer the questionnaires truthfully, based on the fact that the response is anonymous. It is also assumed that the respondents, under the supervision of the researcher and their parents (if under the age of 18), understand the questionnaire and the information that is required from them.

1.6 Conclusion

As yet, there have been no studies regarding the profile of gymnastics injuries in South Africa (Chadwick, 2004), and as a result there is very little literature on this subject in this country.

At present, South African gymnastics is far behind the standard of other countries. However, a great effort is being made to improve this situation (Cameron-Smith, 2005). Extensive development programs for these purposes are in place. Talent identification at rural schools is being carried out and the selected gymnasts are trained at those local gymnastics clubs that have offered this pro bono service. As a result and side effect of these extensive development programs however, more injuries are likely to occur as the standard required of the gymnasts and the numbers of gymnasts increases (Cameron-Smith, 2005).

Therefore, the aim of this study was to determine the injury profile of gymnasts in the greater Durban area of KwaZulu-Natal, determine whether any relationships existed between risk factors identified in other studies and gymnastics injuries sustained in this study, and to compare the results with those of other international studies.

In this chapter an introduction to gymnastics and the background of the sport both locally and internationally were provided. In Chapter Two, a definition of gymnastics is provided, as well as explanations of the different types of gymnastics that exist. Relevant information and results from related studies will be discussed with reference to gymnastics injuries and related risk factors. In Chapter Three, the materials and methods used in this study are explained, including the process of statistical analysis. Chapter Four deals with the results obtained from this study, as well as a discussion of each result and how it compares with the results of other studies. In Chapter Five, conclusions are drawn from this study, and recommendations are provided for future studies.

Chapter 2

A review of the related literature

This chapter provides the reader with a definition for gymnastics, and explanations of the various disciplines within the sport as well as the equipment utilized. Relevant information and results of related studies on gymnastics injuries, as well as current trends in the related literature are also discussed.

2.1 Introduction

In the following section, a definition of gymnastics will be provided, as well as information on each different type of gymnastics.

In South Africa, seven types of competitive gymnastics exist:

- Women's Artistic Gymnastics
- Men's Artistic Gymnastics
- Rhythmic Sportive Gymnastics
- Sport Aerobics
- Acrosport
- Tumbling
- Trampolining

2.1.1 Artistic gymnastics

Artistic gymnastics is usually divided into Men's (MAG) and Women's (WAG) Artistic Gymnastics, with each group performing different events. Men compete on Vault, Floor, Parallel bars, Pommel horse, Rings and the High bar, while women compete on Vault, Floor, Uneven bars, and the Balance Beam. Though routines performed on each event are short, they are physically exhausting and push the gymnast's strength, flexibility, endurance and awareness to the limit

(Encyclopedia: Gymnastics, 2005). Gymnastics routines usually consist of a mount (getting up onto the apparatus), a sequence of movements, and a dismount (getting off the apparatus or completing a floor exercise, typically landing on both feet) (Wikipedia, Artistic Gymnastics, 2005).

Vault

Photo by: Martin Kemsley

Floor

Photo by: Keith Cameron

Uneven Bars

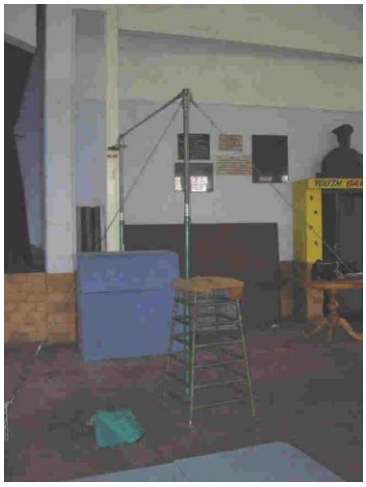
Photo by: Claire Schreuder

Beam

Photo by: Claire Schreuder

In **Women's Artistic Gymnastics**, the apparatus can be described as follows (White, 1989):

- Vault – The gymnast sprints down a 25 meter long runway, leaps onto a springboard, jumps onto the vaulting table (landing on her hands), and then pushes off the table and lands on her feet on the other side. In advanced vaults, somersaults and twists are added before the landing
- Floor – The floor is a carpeted area, twelve meters by twelve meters, which consists of mats placed on top of sprung wooden boards. The gymnast performs a series of tumbling and dance movements to music in a routine that is one minute to one and a half minutes in length
- Uneven bars – The gymnast performs various swinging movements whilst holding the bar with her hands, and performs release elements between the two bars and on the higher rail (this is where the gymnast releases the bar, performs an acrobatic element such as a somersault, and catches the bar once again), and the
- Beam – The gymnast performs a series of leaps, jumps, turns and acrobatic tumbling elements combined into an elegant, flowing sequence with dance movements. The beam is ten centimeters wide, 1.25 meters high, and five meters long, and looks something like a plank on stilts.



High Bar

Photo by: Ingrid Adamson

Parallel bars

Photo by: Claire Schreuder

Pommel horse

Photo: Keith Cameron

Rings

Photo: Keith Cameron

In **Men's Artistic Gymnastics**, the apparatus can be described as follows (White, 1989)

- Vault – This apparatus is the same in Men's and Women's Artistic Gymnastics
- Floor – The apparatus used is identical to that of the floor in Women's Artistic Gymnastics, however no music is used for the men's routines

- High Bar – A 2.5 centimeter diameter steel bar rail on 2.4 meter high upright supports is used. The gymnast must hold onto the bar with his hands whilst performing swinging skills and release elements
- Parallel bars – The gymnast holds himself on two bars about shoulder's width apart and about two meters high, whilst performing a series of swings and balances
- Pommel horse – The gymnast must perform circular movements around the horse with his legs whilst allowing only his hands to actually touch it. The apparatus is shaped like a horse, being an oblong box supported by four legs. There are two handles on top of this horse, on which the gymnast places his hands, and the
- Rings – This apparatus consists of two wooden rings suspended about two meters from the ceiling by cables. The gymnast must swing on the rings without letting the rings, themselves, swing.

2.1.2 Rhythmic Sportive Gymnastics

The discipline of Rhythmic gymnastics is competed only by women, and involves the performance of five separate routines with the use of five apparatus (ball, ribbon, hoop, clubs and rope) on a floor area, with a greater emphasis on the aesthetic rather than the acrobatic. (Encyclopedia: Gymnastics, 2005).

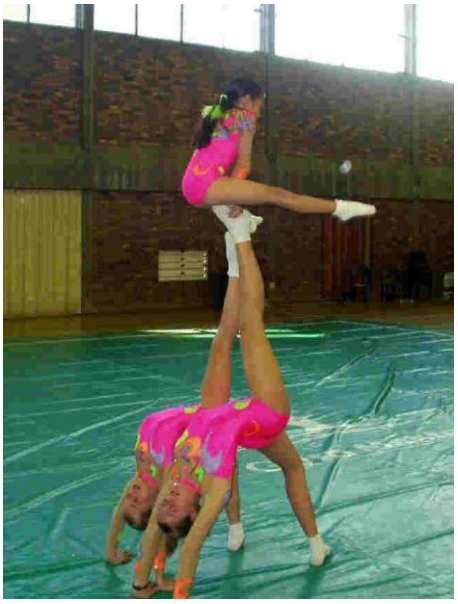
Photo courtesy of: SAGF

2.1.3 Sport Aerobics

Sport aerobics involves the performance of routines by individuals, pairs, or trios emphasizing strength, flexibility, and aerobic fitness rather than acrobatic or balance skills. Routines are performed on a small floor area (Encyclopedia: Gymnastics, 2005).

Photo courtesy of: SAGF

2.1.4 Acrosport



In this discipline, gymnasts perform group routines focusing on balance and tempo. Pairs or groups perform balances and throws in synchronized sequences (White, 1989).

Photo courtesy of: SAGF

2.1.5 Tumbling

Tumbling is performed on a long straight mat. Individual competitors perform routines that consist of a series of exercises in rapid succession, using somersaults, twisting elements and combinations of the two (White, 1989).

Photo courtesy of: SAGF

2.1.6 Trampolining

Trampolining routines involve a build-up phase during which the gymnast jumps repetitively to achieve height, followed by a sequence of ten leaps without pauses during which the gymnast performs a sequence of aerial tumbling skills. (Encyclopedia: Gymnastics, 2005).

Photo courtesy of: SAGF

2.2 Biomechanics involved in the sport

In gymnastics technique, there are four important biomechanical factors to consider (Schembri, 1983):

2.2.1 Body alignment

A gymnast may be regarded as a “segmented body”. This segmented body will exhibit maximum stability when each individual segment lies on a vertical line, which passes through the center of the base of support. This applies for all movements that require a straight body, for example, a handstand.

2.2.2 Tight body postures

Tight body posture is a pre-requisite for efficient movement and has injury prevention implications; for example, in take-off and landing the lower back must remain stable.

2.2.3 Explosive power (spring)

Gymnasts must be extremely strong in the feet, legs, arms and shoulders in order to demonstrate good height when performing jumps, leaps, tumbling elements on the floor and vaulting activities. The jump action is classified into two categories: a) pushing off from the feet and b) pushing off from the hands.

2.2.4 Range of movement (flexibility)

When performing gymnastics, amplitude (range of movement) is important. The range of movement is an indication of the gymnast’s strength and flexibility. Good flexibility is required in order to execute the split position (the legs must be 180^0 apart), and to maintain an open shoulder angle (no angle present between the arms and the body, so that the arms are in a straight line that is continuous with the line of the body).

Unlike most other sports, in gymnastics, the upper extremities are used as weight bearing limbs causing high impact loads to be distributed through the elbow and wrist. Considering the upper extremity's ill-adapted design for weight bearing, it is not surprising that it is the second most frequently injured body region after the lower limb (Caine and Nassar, 2005).

The following section of the chapter highlights some of the relevant results from other studies performed in the field of gymnastics injuries, providing information on the possible reasons as to why gymnasts may be predisposed to injury. Included in the discussion of these studies, are individual discussions of certain factors (the anatomical locations of these injuries; the differences in the anatomical locations of the injuries with respect to gender differences; the types and mechanisms of gymnastics injuries; equipment involved in these injuries; and the risk factors for injury), so that the reader can gain a greater understanding of the factors implicated in studies performed internationally, which would allow the results and discussions in later chapters to be brought into perspective.

2.3 Injuries associated with gymnastics

According to international studies, many children risk serious, long-term injury every day as a result of strenuous gymnastics training, associated with one or more of the above types of gymnastics (Winkler, 2001). Gymnastics holds more potential for chronic upper limb injuries than sports such as football, rugby and soccer, amongst others, in part because it is the only sport that uses the upper extremities as weight-bearing limbs as well as the lower extremities (Winkler, 2001).

As with other sports, injuries in gymnastics occur all over the body – the neck, spine, elbows, wrists, fingers, knees and ankles– but close attention needs to be

paid particularly to the cumulative, repetitive micro-trauma to the wrists, ankles and knees, especially when dealing with skeletally immature individuals (Winkler, 2001). As skeletally immature athletes, gymnasts present a unique physiological predisposition to injuries because of growing spines, limbs, wrists and ankles (Winkler, 2001).

2.4 Anatomical location of these injuries:

2.4.1 The upper extremity

It has been found that upper extremity forces have magnitudes of 1.5 times the body weight for vault, 3.1 times the body weight for uneven bars, 3.9 times the body weight for high bar, 9.2 times the body weight for rings and 2 times the body weight for pommel horse (Caine et al., 1996). It has also been established that the wrist is exposed to repetitive forces of up to twice the body weight during certain activities such as the men's pommel horse event (Daly et al., 1999).

In view of the above factors, several case and cross-sectional studies have indicated a large number of gradual onset injuries that involve the distal radius, and distal humerus, and include distal radial growth plate disorders, and, primarily in females, osteochondritis dessicans of the humeral capitellum (loose bodies in the elbow) (Caine et al., 1996). The wrist is the most frequently injured site in the upper extremity of female gymnasts, followed by the elbow (Caine et al., 2003).

In terms of upper extremity injuries in males, shoulder injuries are particularly common in comparison with female gymnasts, and are most frequently muscle strains (acute) and shoulder joint impingements (chronic) (Meeusen and Borms, 1992).

Growth plate injury to the upper limb

The growth plate, also known as the epiphyseal plate or physis, is the area of growing tissue near the end of the long bones in children and adolescents (National Institute of Arthritis and Musculoskeletal and Skin diseases, 2005).

The cartilaginous growth plate in children is two to five times weaker than the adjacent joint capsule and ligamentous structures; therefore, a force that would produce a ligamentous sprain or dislocation in an adult is more likely to cause a growth plate injury in a paediatric patient (Rogers, 1970). While many growth plate injuries are caused by an acute event such as a fall or a blow to the limb, chronic injuries to the growth plates can also result from overuse, for example a gymnast who practises for long periods on the uneven bars, which may result in an overuse injury to the radial growth plate (National Institute of Arthritis and Musculoskeletal and Skin diseases, 2005).

Wrist pain in young gymnasts is often the first sign of growth plate changes at the wrist (Mandelbaum et al., 1989), and it is a commonly voiced concern in literature that gymnastics training may inhibit radial growth in female gymnasts (Caine et al., 1997).

McDaniel and Christeson-Shigemoto (2000) cite five potential factors for wrist injuries in gymnasts, these are:

- Growth spurts, in which the cartilage of the growth plate may be more susceptible to repetitive stress during the period of growth
- Delayed skeletal maturity, especially in young female gymnasts, which can cause a longer period of risk for growth plate injury
- Training beyond tolerance limits
- The use of incorrect techniques that can cause an increased risk of injury
- A previous injury that may predispose the gymnast to subsequent injury at the same site

Research has also shown that the use of dowel grips, which help to reinforce the hook grip strength of gymnasts during swinging skills, can cause a traction injury to the radial growth plate (Svihlik, 1996).

2.4.2 The lower extremity

In gymnastics, the lower extremity is involved in absorbing large repetitive forces over a long period of time, and it is a site of tremendous physical loading. This involves the repetitive jarring impact of vault takeoffs, and dismounts from a variety of heights and during tumbling activities (Mitchell, 2006). The magnitude of these forces is approximately four times the body weight for take-off, and twelve times the body weight for landing (Panzer et al., 1988).

Data gathered from prospective studies indicates that lower extremity injuries in female gymnasts typically occur suddenly from a “missed move” (Lindner and Caine, 1990), and are most often ankle sprains, lower leg strains (Caine et al., 1989) and knee dislocations (Lindner and Caine, 1990).

In contrast to the above, lower extremity injuries with a gradual onset typically include ankle impingements (from chronic pointing of the foot as a required technique), lower leg stress fractures, compartment syndromes (from the repetitive stress associated with landings), and patellofemoral knee problems (from biomechanically dysfunctional tracking of the patella) (Meeusen and Borms, 1992).

2.4.3 The Back and spine

Although not as common as lower extremity injuries, the severity of lower back injuries in gymnastics is of considerable concern. Common sites of lower back injury include vertebral bodies and intervertebral discs (Caine et al., 1996). The

movements most likely to result in lower back injury in female gymnasts are chronic repetitive flexion, extension and rotation demanded of the spine and its associated structures during gymnastics (Hall, 1986). In addition, the extreme loading forces that result from dismounts and tumbling landings place the spine under enormous stress (Mitchell, 2006). This stress has been implicated in pars interarticularis spondylolysis and spondylolisthesis, and in the genesis of vertebral growth plate disorders, which may disrupt growth and/or lead to chronic degenerative changes in the spine (Brukner and Khan, 1993). It has therefore been recommended that gymnasts should increase the amount of time spent on spinal preparation and stabilization in order to counteract these forces (Mitchell, 2006).

In the past, women's gymnastics focused on extreme reclination of the lumbar spine (e.g. frequent walkovers with extremely extended lumbar spine), which is believed to relate to the relatively high prevalence of spondylosis in this sport (Bruggemann, 1999). Recently however, women's gymnastics has concentrated on a fixed, well-controlled spinal movement with forward flexed spine during landing, which may result in a decreased risk of spondylosis (Bruggemann, 1999). This repeated trunk flexion when landing from various heights, however, may create biomechanical compression forces sufficient to damage the anterior aspects of the spine, resulting in anterior vertebral fractures and other anterior spine problems (Bruggemann, 1999).

Case studies indicate gymnastics lower back injuries tend to have a gradual onset (which could reduce the reported incidence of back problems), affecting primarily advanced level gymnasts. This implicates experience and competitive level as risk factors for injury (Caine et al., 1996).

2.4.4 Anatomical locations of injuries with reference to gender difference

A comparison study of injury location data from prospective studies (conducted abroad) of competitive female gymnasts indicates that the lower extremity was injured most often (54.1% to 70.1%), followed by the upper extremity (15.1% to 25%), and the spine/trunk region (7.5% to 16.7%). Of the lower extremity injuries, ankle injuries were the most common, followed by injuries of the knee, and then of the foot/toes. In the upper extremity, the wrist, elbow and the hand/fingers were most often injured as a percentage of total injuries, and for the spine/trunk region, injuries to the lower back were most frequent. (Caine et al., 1989)

For male gymnasts, there is evidence to suggest that along with a higher proportion of lower extremity injuries (36.4% to 43.1%), there is a higher proportion of upper extremity injuries (36.4% to 53.8%) when compared with women (Bak et al., 1994). In terms of specific body parts for men, there was a large proportion of lower back, ankle, knee, wrist, and in particular, shoulder injuries. The shoulders are particularly susceptible to injury during the rings event, due to the mechanical disadvantage associated with strength movements while the arms are held in full abduction (Szot et al., 1985).

2.5 Types of injuries

With regard to types of injuries, a comparison of prospective studies of women's competitive gymnastics indicates that sprains (ranging from 19% to 47%) and strains (ranging from 6.4% to 35%) are consistently the most common type of injury in female gymnasts (Lindner and Caine, 1990). A study of male gymnasts has also reported that sprains and strains are the most common injuries (NCAA,

1994). The high proportion of these injuries is not surprising given the highly repetitive nature of the impacts associated with landings from dismounts, and during floor routines (Caine et al., 1996).

The onset of an injury is generally classified as either acute or chronic. However, the definition of these two terms varies considerably within literature. One study interpreted an acute injury as one of sudden onset, whereas a chronic injury was related to overuse (Kolt and Kirkby, 1995). In another study, acute injuries were defined as those resulting from a specific event, which were short-lived and occasionally severe in nature (Dixon and Fricker, 1993). On the other hand, chronic injuries were defined as those endured for a longer period, originating either from an initial acute incident, or from repetitive, sub-threshold stresses (Dixon and Fricker, 1993).

In view of the above, the results from prospective (Lindner and Caine, 1990) and retrospective (Steele and White, 1983) studies indicate that the majority of injuries to female gymnasts at club and collegiate levels in the United States are sudden onset injuries (acute). In an attempt to yield additional information about the distribution of injuries in a sample population, a number of studies have cross-tabulated injury onset with the anatomical location of the injury. A review by Caine et al. (1996) indicated that ankle sprains or injuries, for example, were generally of sudden onset, whereas injuries affecting the low back and wrist, for example, developed more gradually (chronic).

2.6 Mechanisms of injury

A frequent mechanism of injury in gymnastics involves dismount landings from the apparatus, including the uneven and parallel bars, balance beam and rings (Grana and Weiker, 1994). In a prospective study involving 2558 club-level gymnasts, it was found that 16 injuries, including six fractures, were due to a poor dismount (Pettrone and Riciardelli, 1987). Priest and Weise (1981) reported

that 12% of elbow injuries in female gymnasts occurred whilst dismounting. Falling on an outstretched hand was hypothesized as the probable mechanism of injury (Priest, 1985). Twisting dismounts tend to be more highly correlated with subsequent gymnastics injury. For example, Hunter and Torgan (1983) found that injuries to the knee were often related to twisting dismounts, particularly those associated with the balance beam and uneven bars. The authors speculated that such dismounts, which occur at the end of a difficult and strenuous routine, could be related to fatigue and impaired strength and/or impaired /coordination.

Catastrophic injuries include fatalities, as well as severe injuries such as quadriplegia. In gymnastics, there are very few reported case studies of catastrophic injuries, and they occurred on the trampoline, mini-tramp, and to a lesser extent, the springboard (used for propulsion of the gymnast onto the vaulting horse). The case studies also reported that catastrophic injuries were most often sustained by highly experienced gymnasts (and/or trampolinists), which may indicate that these gymnasts have a greater risk of catastrophic injuries, due to the complexity of the manoeuvres that they perform (Caine et al., 1996).

2.7 Injuries related to gymnastics equipment

In terms of equipment, improved gymnastics safety equipment, in the form of sprung floors, sprung beams, thicker landing mats and fiberglass bar rails has offset the expected decrease in injury incidence, by enabling the performance of increasingly complicated and risky performance routines (Mitchell, 2006).

Research into which men's and women's gymnastics event is most commonly associated with injury, indicates that the largest percentage of injuries occur on the floor (Bak et al., 1994).

It is interesting to note that the balance beam in women's gymnastics is associated with the second highest injury rates (Caine et al., 1989), although considerable variability exists within the literature. Roy et al. (1985) indicated that routines involving dorsiflexion of the wrist could initiate or aggravate wrist pain in female gymnasts. Several tumbling manoeuvres on the balance beam require fixation of the hands with concomitant torsion of the forearms (Meeusen and Borms, 1992). The repetitive rotational forces induced during such actions can damage the most vulnerable part of the bone, i.e. the distal growth plate (Roy et al., 1985).

In addition, investigations into female gymnastics often report an incidence of injury sustained on the uneven bars, which approximates that of the balance beam (McAuley et al., 1987). The percentage of total gymnastics injuries incurred on the uneven bars has ranged from as low as 6% (Mackie and Taunton, 1994) to as high as 38% (Clark and Buckley, 1980). Priest and Weise (1981) found that of the 32 elbow injuries sustained by female gymnasts, approximately one third (31.3%) occurred on the uneven bars. With regard to male competitors, Lowry and Leveau (1982) identified the parallel bars to be the apparatus associated with the greatest number of injuries.

Vaulting is a high-speed activity. The potential for injury lies in the speed with which the vault is performed and the relative difficulty of the manoeuvre. The vault is associated with a relatively low proportion of injuries, which may be due to the short time a gymnast spends on this apparatus (Lindner and Caine, 1990). However, the twisting vault has been implicated in the aetiology of wrist pain in gymnasts (Roy et al., 1985). This may be because this vault induces both hyperextension of the wrist and associated movement of the ulna, particularly in the spurious 'leading' hand (Read, 1981). For male gymnasts, injuries sustained on the vault were found to account for only 8% of the total 345 gymnastics injuries incurred over 18 months by club level gymnasts (Lueken et al., 1993)

Information pertaining to injuries incurred on the pommel horse in male gymnasts is sparse. However, as was mentioned earlier, some studies indicate that wrist pain is commonly associated with training on this apparatus (Mandelbaum et al., 1989). This may be due to the relatively high peak forces imparted to the upper extremities of gymnasts during pommel work (Markolf et al., 1990).

Both the high bar and the rings exercise in male gymnasts, involve high velocity swinging movements, placing a large amount of stress on the shoulder joint (Meeusen and Borms, 1992).

2.8 Risk factors for injuries

Risk factors for gymnastics injuries are numerous and several of these have been researched and documented over the past few years (Caine et al., 1989). The following is a summary of some of the most commonly documented proposed risk factors associated with gymnastics injuries.

2.8.1 Increased age

According to Mitchell (2006), older gymnasts may be more likely to sustain injuries because they are performing more complex and difficult skills, and they have had greater accumulated exposure to training. Another factor creating vulnerability to injury could be when the gymnast undergoes a transition at puberty, resulting in an alteration in the power to weight ratio (Mitchell, 2006).

2.8.2 Level of gymnastics and years of experience

In a recent study by Caine et al. (2003) the relative risk for injury amongst high level female gymnasts was 1.47 times greater than in lower level gymnasts. Also, research supports an increase in injury rates as competition level increases (Caine et al., 1989).

2.8.3 Exposure to activity

According to a study by Caine et al., (1989), in terms of exposure to activity in female gymnasts, it was found that as the gymnasts became more skilled, the amount of time spent training increased, and consequently the number of injuries also increased.

2.8.4 Training conditions

With respect to training conditions, epidemiological research (NCAA, 1994) has indicated that a higher rate of injuries occur when gymnasts are not assisted by spotters (coaches who support the gymnast whilst they are performing complex movements). When investigating injury patterns in female gymnasts during gymnastics training sessions, Lindner and Caine (1990) reported an increased risk of injury with length of time spent on a particular apparatus. Furthermore, their data indicated that more injuries occurred when these gymnasts were performing well learned, basic or moderately difficult maneuvers. This indicates that, although there is evidence of an increased risk of injury with increased movement complexity (Caine et al., 1989), many injuries can occur when performing less complex movements simply as a consequence of inattention on the part of the gymnasts.

Lindner and Caine (1990) found that sudden onset injuries in female gymnasts occur more frequently relatively early in training sessions, possibly due to one of the following reasons: a) insufficient warm-up; b) poor progressions into training routines and c) more complex skills are practiced early in a training session when gymnasts are most fresh.

2.8.5 Nutrition

Nutrition plays an important role in sports training and performance, as well as the normal processes of growth and development. Success in gymnastics appears to be associated with small stature and a high level of lean body mass or reduced body fat. Studies in female gymnasts have shown that they have a lower percentage of body fat when compared with controls (Lindholm et al., 1995).

In addition, dietary assessments of gymnasts indicate that many are not consuming the recommended number of calories for their respective ages (Kirchner et al., 1995). Inadequate caloric intake and/or poor dietary practices in conjunction with intense physical training can lead to a number of health problems in gymnasts.

2.8.6 Participation in other forms of exercise

In this study, it was thought that participation and competition in other sports besides gymnastics would place these gymnasts at a higher risk of injury from gymnastics. It has been established that overuse of the body during sports training without sufficient recovery time can lead to chronic, or overuse injuries (Merck Manual, Home Edition, 1995). Thus, in addition to questions relevant to gymnastics and gymnastics injuries, questions pertaining to participation in sports other than gymnastics were also included in the questionnaire. These were included in order to ascertain whether a relationship existed between participation in other sports in addition to gymnastics and a higher risk of injury.

2.8.7 Regular maintenance treatment

It has been proven that regular treatments such as sports massage for example, can improve athletic performance by loosening the muscles, warming them up, and preparing them for extensive use. This not only helps to prevent injury, but also increases endurance (Schreyer, 2004). Post activity massage can assist in

pain relief, prevention of stiffness, and prevention of pooling of the blood in the extremities, which all aid the athlete in recovery (Schreyer, 2004).

In this study, because of the above information, it was thought that regular maintenance treatments might have reduced the risk of injury in these individuals.

The majority of documented risk factors in the above-mentioned studies referred mainly to female gymnasts, and due to the paucity of information on male gymnasts, conclusions regarding risk factors in male gymnasts are yet to be drawn.

2.9 Conclusion

At present, South African gymnastics is far behind the standard of other countries. However, a great effort is being made to improve this situation (Cameron-Smith, 2005). Extensive development programs are being carried out, and as a result, more injuries are likely to occur, as the standard required of the gymnasts increases (Cameron-Smith, 2005).

Studies have been performed in other countries to investigate injury rates in gymnastics, and although some have produced conflicting results, overall gymnastics appeared to be associated with a high injury incidence when compared with most other sporting activities (Kolt and Kirkby, 1996). This study, however, only focused on female gymnasts, and there was no similar report on male gymnasts. As yet, there have been no studies regarding the profile of gymnastics injuries in South Africa (Chadwick, 2004), and as a result there is very little literature on this subject in this country.

Therefore, the objective of this study was to determine the injury profile of gymnasts in the greater Durban area of KwaZulu-Natal. In this province, the two

most popular types of gymnastics are Artistic gymnastics and Rhythmic gymnastics, with very few participants in other disciplines. Therefore, it was decided that gymnasts participating in Artistic and Rhythmic gymnastics only would be included in the study (Chadwick, 2004).

For the purpose of this study, the following information was gathered in terms of:

- Demographics of South African gymnasts
- The participants' gymnastics history
- The presence of any past or current injuries, and
- If present, factors relating to these injuries were investigated.

This information mentioned above was gathered with the aim of helping to identify any problems that may exist, quantifying the extent of these problems and identifying to some extent the potential risk factors. This would be beneficial to South African gymnasts if recommendations for prevention of potential injuries were made, should any common injuries, or possible risk factors or associations be discovered/identified (Chadwick, 2004).

Research in this area might aid in the prevention of some injuries, and may lead to better training, treatment and management of gymnasts in South Africa.

In the following chapter, the materials and methods used in this study are discussed.

Chapter 3

Materials and methods

This chapter deals with the collection of data and the research methodology utilised. The process of statistical analysis is also discussed.

3.1 Study design

This study was a prospective, cohort, questionnaire-based study, investigating gymnastics injuries in the greater Durban area of KwaZulu-Natal, South Africa.

The data were collected by means of questionnaires (Appendix A), which were completed by the subjects, under supervision of the researcher.

3.2 Development of the questionnaire

A similar questionnaire (Appendix J) was designed and utilized by Balding (2003) for ballet dancers. For the purposes of this study, this questionnaire was converted into one that was relevant to gymnastics. The Gymnastics Injury Questionnaire was then validated. Validity refers to establishing the accuracy and trustworthiness of an instrument, data and findings in research thereby ensuring that future research utilizing that particular tool is accurate (Bernard, 2000).

The components of validity are face validity, content validity, construct validity, criterion validity and external validity. For the purposes of this study only face validity was required due to the type of information the questionnaire was to extract.

Face validity, which is the simplest type of validity, is determined by agreement between researchers and those with a vested interest in the questionnaire, that 'on the face of it' the tool seems valid (Bernard, 2000).

This was achieved prior to the study by the use of a focus group. A focus group is a qualitative research technique that collects data and insights through group interaction based on topics supplied by the researcher, who takes on the role of moderator (Greenbaum, 2000:3; Morgan, 1997:2,6).

Literature suggests that a focus group should consist of six to ten participants (Greenbaum, 2000:4; Morgan, 1997:43). The participants for this focus group were enlisted via word of mouth, with nine respondents coming forward and expressing interest in participating in the focus group. The group consisted of health care professionals, gymnastics coaches and judges, gymnastics club leaders and the researcher.

Before commencing, each participant was required to read an information letter (Appendix B), and sign an informed consent form (Appendix C) as well as a Statement of Confidentiality (Appendix D) and a Code of Conduct (Appendix E). In the focus group each participant was given a copy of the Gymnastics Injury Questionnaire (Appendix A). Comment was requested from the participants on how the questionnaire could be modified in order for it to be used to assess gymnastics injuries accurately.

The questions were discussed in sequential order. If inconsistencies were found or changes proposed, a unanimous vote was required to institute change. At the end of the discussion chance was given for any comment on the questionnaire. A video of the proceedings was made and is available as evidence of the individuals involved and the content of the discussion. The Gymnastics Injury Questionnaire was discussed to determine that it accurately reflected concepts

relating to gymnastics injuries. Suggestions for change were analyzed, and these changes were made to the questionnaire, yielding the version used in this study.

The content of the discussions from the focus group will be kept confidential. The transcripts, documents and video of the proceedings that were made will be kept in a secure area in the Durban Institute of Technology Chiropractic Day Clinic and shredded or destroyed after five years.

3.3 Allocation of participants

3.3.1 Sampling

Purposive separation was utilized (Galloway, 1997), where the researcher identified the relevant gymnastics clubs, approached all the gymnasts in those particular clubs, and informed them of the study. The study was limited to gymnasts residing in the province of KwaZulu-Natal, specifically those residing in the greater Durban area. There are seven gymnastics clubs within the greater Durban area, namely in the Bluff, Amanzimtoti, Pinetown, Durban North, and three clubs located in central Durban. All of these clubs were involved in the study with no preference being given to any particular club.

Self-selection of participants then occurred, where prospective participants chose to participate in the study, and approached the researcher (Galloway, 1997).

The researcher then utilized convenience sampling and accepted participants that volunteered, subject to their meeting such inclusion criteria as the correct age group, hours of training per week, competitive level of gymnastics and gymnastics being their main competitive sport (Galloway, 1997).

Based on the responses of the participants, the completed questionnaires were then purposively sampled (Galloway, 1997), based on the inclusion and exclusion criteria of the study; such as correctly filling in the questionnaire and

signing all the necessary consent/assent forms obtaining parental consent/assent where applicable (Mouton, 1996).

3.3.2 Sample size

Sixty participants were needed for the study; they comprised 15% or more of the population size in 2004. According to Chadwick (2004), the population size was approximately four hundred (400). However, due to the increase in the number of competitive gymnasts in KwaZulu Natal in 2005 from 400 to 456 (Chadwick, 2004), it was decided to increase the number of participants in the study to 75, which comprised 16% of the 456 competitive gymnasts in the current year.

3.4 Criteria for participation in the study

Leaders of gymnastics clubs in the greater Durban area, were contacted by the researcher (in person) and permission was obtained to carry out research at their respective clubs.

3.4.1 Inclusion criteria

Once permission was received from the gymnastics clubs, the researcher approached all the gymnasts at the relevant gymnastics clubs, and informed them of the study. Once self-selection and convenience sampling had occurred, the researcher then distributed letters of information (Appendix H) and informed consent/assent forms (Appendix F and G) to these prospective participants to complete.

The inclusion criteria for the subjects were as follows:

- Participants were required to be gymnasts who took part in gymnastics competitions.

- Participants were required to fill in the informed consent/assent forms, thereby providing an informed decision to participate in the study. Parental consent/assent was obtained for participants under the age of 18.

- According to Chadwick, (2004), the majority of gymnasts in South Africa were between the ages of eight and 12. However, it was ascertained that there were a number of gymnasts participating in higher levels of gymnastics who did not fit into the above-mentioned age category, therefore for the purposes of this study, gymnasts between the ages of eight and 35 were utilized in order to provide a more accurate representation of the gymnastics population as a whole.

- Participants were required to practise for at least four hours per week. According to Chadwick, 2004, in order to be able to be a competitive gymnast in South Africa, one must train at least four hours per week. This would not have coincided with international studies, as the level of competition in South Africa was much lower than elsewhere in the world.

- Participants included in the study were allowed to take part in more than one discipline of gymnastics.

- Gymnastics was required to be the main sporting activity in which the participant was involved at a competitive level.

3.4.2 Exclusion criteria

The exclusion criteria for participants were as follows:

- Participants who did not correctly fill in and sign the consent/assent forms were excluded from the study. If parental consent/assent was not obtained for participants under the age of 18 they were also excluded.

- Participants under the age of eight or over the age of 35 were excluded from the study.

- Participants who did not practise for at least four hours per week were excluded.

3.5 Ethical considerations

Access to research questionnaires was limited to the researcher and the researcher's supervisor. The questionnaires were numbered after completion and data were coded, thus ensuring anonymity and participant confidentiality.

3.6 Data collection and analysis

Subjects meeting the requirements for the study received personal assistance in filling in the questionnaire from the researcher, the subject's trainer and a translator (if one was required).

Participants filled out the face- validated questionnaire with respect to:

- Patient demographics including age, gender, race, and type of gymnastics participated in.
- Information on the participants' gymnastics history, including years of experience in gymnastics, number of training hours per week and number of gymnastics classes attended per week.
- Factors directly related to injuries:

- Location of current and past injuries.
- Length of time for which current and past injuries were present.
- Effect of current and past injuries on gymnastics training and competition.
- Length of time for which gymnastics was prevented as a result of these injuries.
- Mechanism of current injuries as well as any known technical weaknesses.
- Severity of current injuries.
- Treatment received for current and past injuries.

- Other factors indirectly related to injuries such as:
  - Eating habits and supplementation
  - Any additional recreational and / or competitive activities
  - Utilization of regular maintenance treatment to improve performance.

The data collected from each questionnaire were then used for data capturing purposes, and analysis was performed in order to determine the injury profile of the gymnasts in the greater Durban area of KwaZulu-Natal, South Africa. An attempt was made to determine whether any potential risk factors as identified in previous studies, existed in participants of this study; and if so, whether any significant relationships existed between these risk factors and gymnastics injuries sustained in this study. These results were then compared with those of other international studies.

3.7 Statistical Analysis

SPSS version 11.5 was used for analysis of data (SPSS Inc, Chicago, Ill, USA). Calculating frequencies and percentages for categorical variables, and reporting means and standard deviations for quantitative variables achieved descriptive

analysis. Bivariate associations for categorical variables were done using a Pearson's chi-square test or Fisher's exact tests where appropriate.

Body parts were ranked in order, from the most commonly injured to the least commonly injured body part for past injuries. The categories of very often, often and seldom were assigned scores of 3 to 1. The scores were summed across all body parts and the higher the score the more frequently that body part was reported injured in the sample. Risk factors for injuries were assessed for significance using logistic regression. Factors were entered individually into the model to evaluate their crude odds ratios and Wald chi-square values. Multivariate analysis was not done due to the small sample size. A p value of <0.05 was considered as statistically significant.

3.7.1 Wald chi-square test

The Wald test is used to test the significance of each co-efficient (ß) in the model. A Wald test calculates a Z statistic, which is:

$$Z = \frac{B}{SE}$$

This Z value is then squared, yielding a Wald statistic with a chi-squared distribution.

This test is used for logistical regression analysis, which is used in the analysis of relationships between risk factors and gymnastics injuries in Chapter Four of this study. The value of the co-efficient used in this type of analysis can be interpreted in the same way as Pearson's chi-square test, discussed below.

3.7.2 Pearson's chi-squared test

This test is used to test for an association between variables, for example, whether there is an association between level of gymnastics and gymnastics injuries.

H_o: There is no association between both variables.

H_1: There is an association between both variables.

The test statistic is calculated:

$\chi^2 = \sum((O - E)^2)/E$ where the observed frequencies are equal to (row total $\times$ column total)/ grand total.

The tabulated value is obtained from Tables = χ^2.

The following information pertains to all the methods of statistical analyses used in this study:

$\alpha = 0.05$

Note: α = probability of rejecting H_o (Type 1: error)

Note: The p-value = the probability of H_o being true.

If the p-value is $< \alpha = 0.05$ then H_o is rejected.

If the p-value is $> \alpha = 0.05$ then H_o is accepted.

Note that ideally in the chi-square Test all cells should be greater than or equal to five, however, if this is not so categories can be grouped. When this is not possible, then Yates' Continuity Correction is used if it is a two by two table and Fisher's Exact Test is used if the table is greater than a two by two table.

In the following chapter the results from this study and a discussion of these results are provided, as well as the limitations of this study.

Chapter 4

Results and discussion

This chapter reveals the results obtained from the statistical analysis of the data collected, and contains a discussion of each result.

Definitions of terms and key for symbols utilized in this chapter:

n = sample size

SD = Standard Deviation

Mode = The most frequent value of a random variable

Mean = The average of n numbers computed by adding some function of the numbers and dividing by some function of n.

OR = Odds ratio

CI = Confidence interval

4.1 Demographics of the study participants

4.1.1 Sample Size

The sample consisted of 75 gymnasts residing in the greater Durban area, which comprised 16% of the 456 gymnasts in KwaZulu-Natal who participated in competitions in 2005.

4.1.2 Gender distribution

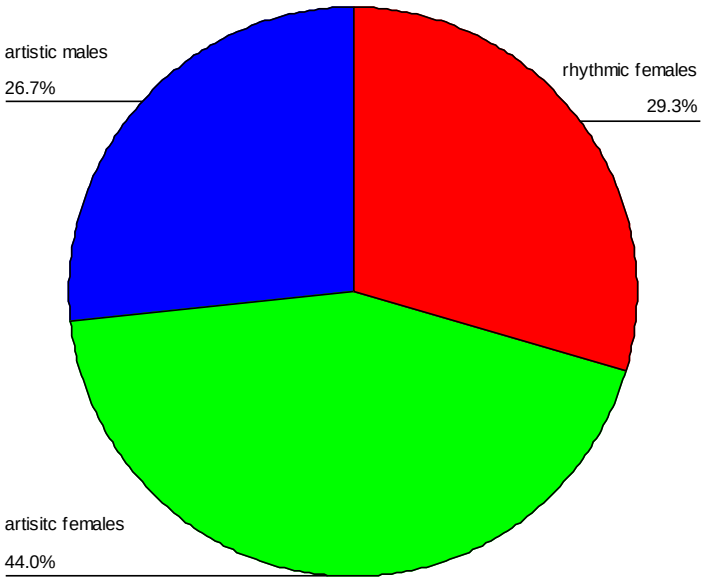


Figure 1: gender distribution by type of gymnastics of study participants (n=75)

Of the 75 participants in the study, 55 (73.3%) were female and 20 (26.7%) were male. The gender distribution by type of gymnastics is shown in Figure 1.

The proportion of male and female artistic gymnasts in this study reflects that of other studies performed on artistic gymnasts (Dixon and Fricker, 1993; NCAA, 1994). However, most of the studies on gymnastics injuries focus specifically on only one of the genders. In particular, a number of studies have been performed on female gymnasts (Garrick and Requa, 1980; Weiker, 1985; Caine et al., 1989; Lindner and Caine, 1990), whereas comparatively few studies have been carried out on male gymnasts (Kerr, 1991; Lueken et al., 1993).

Rhythmic gymnastics is strictly a women's only sport (White, 1989), thus the sample population of rhythmic gymnasts in this study is 100% female.

4.1.3 Ethnic distribution

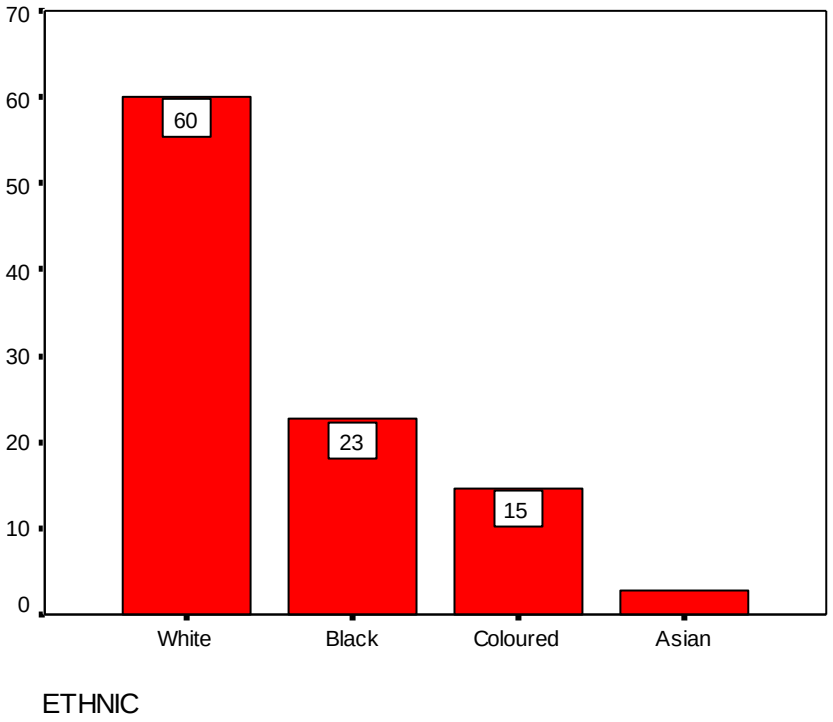


Figure 2: Ethnic distribution of study participants (n=75)

The ethnic distribution is shown in Figure 2. The majority of the gymnasts in this study were White (60%, n=45), followed by Black (23%, n=17), Coloured (15%, n=11) and very few Asian (3%, n=2). At present, the number of black gymnasts in South Africa is on the increase due to an intensive development program that is currently being implemented (Cameron-Smith, 2005). This has resulted in a sudden increase in the level of gymnastics being produced, the time spent training, and the complexity of the movements being performed. In this study, it was questioned whether the above factors would have exposed these gymnasts in South Africa who were targeted by the intensive development program, to a higher risk of injury. Thus it was considered necessary to take racial grouping into account.

Also, as this was the first study of its kind in South Africa, an attempt was made to gain an understanding to some extent, of the demographics of the population of gymnasts in the greater Durban area of KwaZulu-Natal, South Africa. This information ascertained in this study could be utilized for comparative purposes in future studies in order to assess whether the development program (making gymnastics equally accessible to all race groups in the country) had performed its function.

It is interesting to note, however, that despite an accelerated rate of skill development in black South African gymnasts, there does not seem to be an apparent significant increase in the risk of injury amongst this population who have been targeted intensively by the development program, as compared with the white population who were not targeted by this program because of unrestricted access to the sport in the past. This is apparent when considering that 73% of the 45 white gymnasts reported ever having had an injury, while 59% of the 17 black gymnasts had ever been injured.

Due to the relative accessibility of gymnastics to all race groups in first world countries in which related studies were performed, there did not seem to be the necessity for this intensive development program as was implemented in South Africa. Therefore, it is possible that racial grouping was not taken into account in these studies performed overseas, because of the fact that it may not have been viewed as a significant risk factor for injury in these instances.

4.1.4 Age distribution

The inclusion criterion for this study, in terms of age, was for participants between eight and 35 years of age. However, the participants who took part in this study ranged from nine to 25 years, with the mean age being 13.4 (SD 3.1). The mean age for females was 12.6, and for males was 15.6. In this study, there were no participants above the age of 25 years even though the maximum age

criterion was 35 years of age. This could have resulted from the fact that the older gymnasts in KwaZulu-Natal chose not to participate in the study, or did not train at gymnastics clubs within the greater Durban area. The age distribution of participants in this study is consistent with some other studies performed on female gymnasts only (Theintz et al., 1993; Lindholm et al., 1994).

The highest numbers of participants in KwaZulu-Natal were between eight and 12 years of age (Chadwick, 2004) and the mean age of gymnasts in this study was 13.4 years. This was in contrast to a study by Daly et al. (2001) who reported that the highest numbers of participants in gymnastics as a sport were found to be between five and seven years of age, decreasing substantially by the age of 13 to 14 years.

4.2 Information gathered on participants' gymnastics history

4.2.1 Age of onset of gymnastics

In this study, the mean age of starting gymnastics was 7.7 years (SD 3.2, ranging between three and 16 years), the mean age of starting competitive gymnastics was 8.6 years (SD 2.7, ranging between five and 16 years) and the mean years of experience were 5.7 (SD 3.2, ranging between one and 15 years).

In support of the results obtained from this study, according to a study by Daly et al. (2001), due to the fact that there are many different levels and disciplines in the sport, it is possible to begin gymnastics at almost any age.

4.2.2 Type of gymnastics practised by study participants

Table 1: Type of gymnastics practised by study participants (n=75)

	Frequency	Percent
Artistic	53	70.7
Rhythmic	22	29.3
Total	75	100.0

In terms of the type of gymnastics, majority of the gymnasts participated in artistic gymnastics (70.7%), while a smaller percentage participated in rhythmic gymnastics (29.3%). This can be seen in Table 1.

Most studies in this field dealt with gymnasts from only one discipline of gymnastics. For example, Caine et al. (1989) and Sands et al. (1993) both dealt with female artistic gymnasts only, whereas Georgopoulos et al. (1999) dealt solely with rhythmic gymnasts (this study however, did not focus on injury epidemiology, but rather on developmental aspects of the participants). Hume (1999) included both disciplines of gymnastics, although the numbers in the study (19 gymnasts in total) are significantly fewer than those in this study.

4.2.3 Level of gymnastics practised by study participants

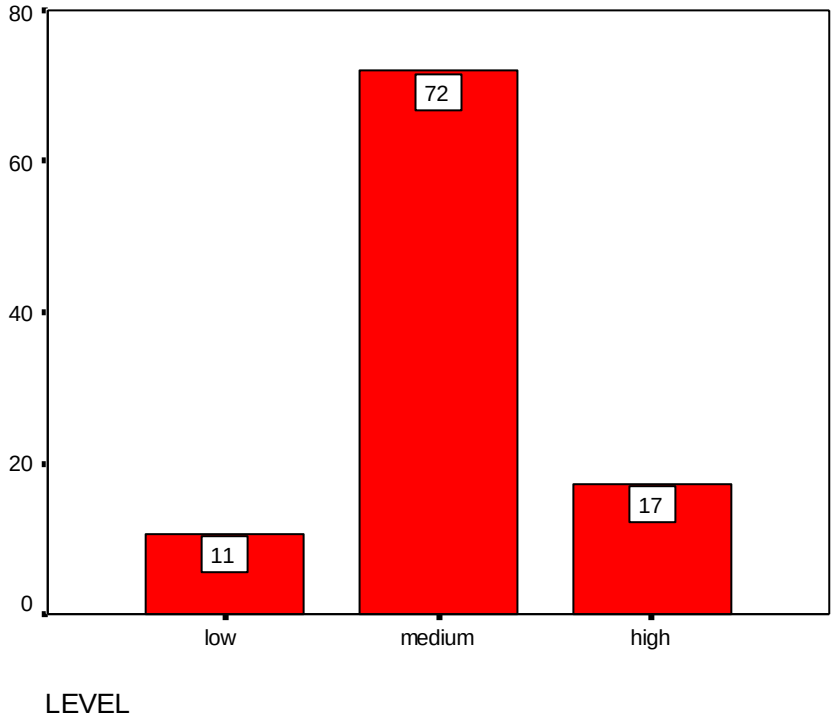


Figure 3: Level of gymnastics practised by participants (n=75)

Figure 3 shows that the majority of the gymnasts in this study were at medium level (72%) followed by high level (17%) and then low level (11%).

As can be seen above, there are generally three levels of gymnastics, including recreational (or low level), competitive (medium level) and elite (high level) gymnastics (Daly et al., 2001). In South Africa, because the standard of gymnastics is so much lower than that in the rest of the world, it is possible to be competitive in the sport even at a recreational (low) level (Chadwick, 2004).

Previous studies have focused mainly on one particular level of gymnasts. For example, Caine et al. (1989) used competitive (medium level) gymnasts only for

their study. However, Dixon and Fricker (1993) focused on elite (high level) gymnasts. Some studies however, do incorporate gymnasts of all levels, for example Sands et al. (1993).

4.2.4 Hours of training per week

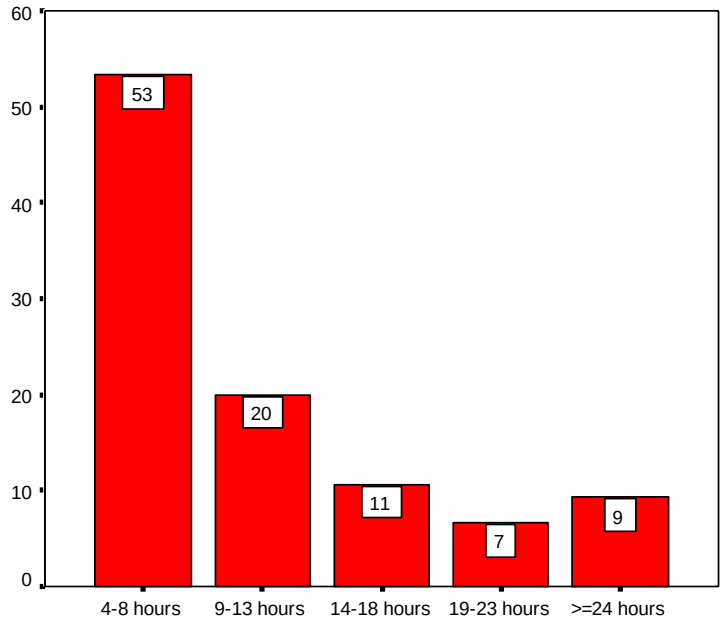


Figure 4: Hours per week spent training in gymnasium

Out of 75 participants in this study, 53% trained for between four and eight hours per week, 38% trained for between nine and 23 hours per week and 9% trained for 24 hours per week or more (Figure 4).

According to Daly et al. (2001), competitive gymnasts may train for between six and 30 hours per week, and elite gymnasts for between 21 and 37 hours (or more) per week. However, according to Chadwick (2004), gymnasts in South Africa may train for as little as four hours per week in order to compete. The small percentage of South African gymnasts who train for 24 hours per week or more, are generally regarded as being elite level gymnasts (Chadwick, 2004).

4.2.5 Number of training sessions per week

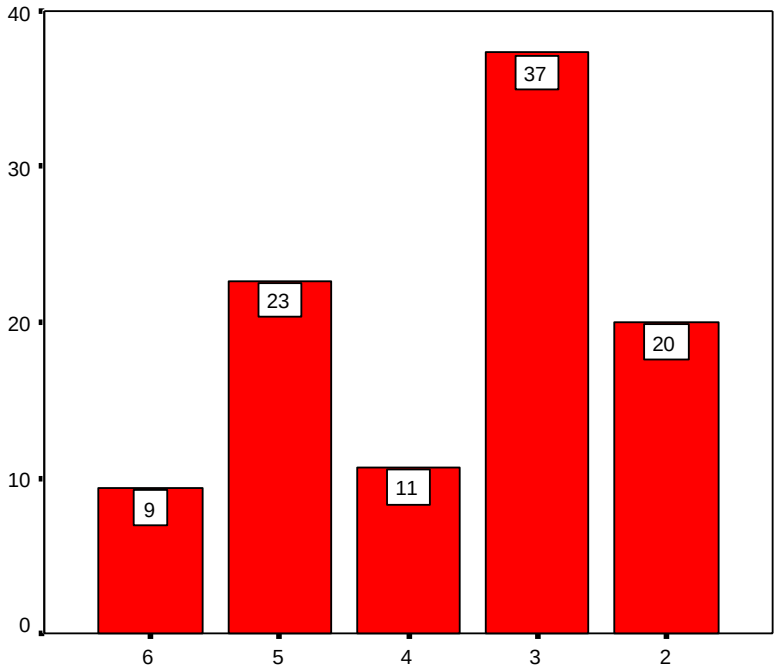


Figure 5: Classes per week spent training in gymnasium

Figure 5 demonstrates that most participants in this study attended three gymnastics classes per week. Current literature suggests that gymnasts at competitive (medium) and elite (high) levels may train anywhere between two and six classes per week, or more (Daly et al., 2001).

In South Africa the length of training sessions and the number of classes per week vary greatly between various gymnastics clubs and even between individual gymnasts (Heathman, 2005). In some cases, training is frequent but for short periods of time, whilst in others, the sessions are longer and less frequent, depending on the availability of facilities and coaches, as well as the schedules of other extramural activities (Heathman, 2005).

4.2.6 Other forms of regular exercise practised by participants

4.2.6.1 Other forms of regular recreational exercise practised by participants

Table 2: Other forms of regular recreational exercise practised by participants (n=25)

	Frequency	Percent
netball	5	20.0
athletics	4	16.0
dance	4	16.0
swimming	3	12.0
karate	2	8.0
aerobics	1	4.0
canoe	1	4.0
capoeira	1	4.0
hockey	1	4.0
soccer	1	4.0
softball	1	4.0
tennis	1	4.0
Total	25	100.0

Twenty-five participants (33.3%) participated in another form of exercise besides gymnastics on a regular basis. These exercises are listed in Table 2. The most frequent form of exercise was netball (20%, n=5) followed by athletics and dance (16%, n=4) in equal distribution.

Nine participants also participated in a third regular form of exercise (not displayed in Table 2), of which swimming was the most common.

4.2.6.2 Forms of competitive sports other than gymnastics practised by participants

Table 3: Forms of competitive sports other than gymnastics practised by participants (n=17)

	Frequency	Valid Percent
athletics	4	23.5
netball	4	23.5
karate	2	11.8
swimming	2	11.8
canoe	1	5.9
dance	1	5.9
hockey	1	5.9
soccer	1	5.9
tennis	1	5.9
Total	17	100.0

Seventeen subjects (22.7%) in this study participated in competitive sports other than gymnastics. The most common competitive sports other than gymnastics were athletics and netball (23.5%, n=4), followed by karate and swimming (11.8%, n=2). These sports are listed in Table 3. Five subjects (6.7%) also reported a third competitive sport (not displayed in Table 3).

4.2.6.3 Injuries sustained from participation in other sports

The first injury, as recorded by study participants, refers to the first or only injury that the participants ever sustained from another sport besides gymnastics. If there was a second injury from another sport, it was recorded by the participants as the second injury.

Table 4: First injury, as recorded by participants, sustained from participating in sports other than gymnastics (n=10)

	Frequency	Percent
Finger	3	30.0
Arm	2	20.0
Hamstring	2	20.0
Calf	1	10.0
Ankle	1	10.0
Heel	1	10.0
Total	10	100.0

Table 4 shows the first injury, as recorded by participants, sustained from participation in sports other than gymnastics. There were only 10 (13.3%) participants who had sustained injuries from other sports. The most common first injury was to the fingers (30%). Of these participants, two sustained a second injury (not shown in Table 4), and these were to the shoulder and ankle.

From 4.2.3, 4.2.4 and 4.2.5, it can be seen that some South African gymnasts do not only participate in gymnastics as an extramural activity. There were relatively few injuries sustained from these other sports mentioned above. It is interesting to note that there is a distinct paucity of information on this topic in the available literature. For this reason, it might be a possibility that data on gymnastics injuries from other studies may be skewed; as participation in other sports does not seem to have been considered as a possible risk factor for injury in these studies. However, it must be considered, that other studies only included gymnasts who did not participate in any other sporting activities, as gymnasts from other countries tend to specialize in gymnastics as their only chosen sport. In South Africa however, the nature of the education system is such that extramural activities (besides gymnastics) are compulsory at most schools (Heathman, 2005). Therefore the subjects were not excluded from the study if they also participated in other sports.

4.3 Injuries

Out of the 75 study participants, 28 had never been injured, one reported only a current injury, 28 reported only past injuries, and 18 reported having both past and current injuries.

In this study, it was explained to the participants that a past injury was defined as an injury from which they had already recovered at the time that they were responding to the questionnaire. A current injury was defined as an injury from which the participant was suffering at the time that the questionnaire was being filled in, even if this injury was chronic and had been present since earlier in the participant's gymnastics career.

4.3.1 Past injuries

Forty-six (61.3%) participants in this study had sustained an injury from gymnastics in the past, from which they had recovered by the time the questionnaire was filled in. In contrast to the above, past injury rates recorded in other studies have been shown to range from 0.1 to 13.76% (Meeusen and Borms, 1992; Sands et al., 1993).

4.3.1.1 Association between gender and past injuries

Table 5: Association between gender and past injuries

			Injury ever		Total
			Yes	No	
GENDER	**Female artistic**	Artistic Count	23	10	33
		% within GENDER	41.8%	18.2%	60%
	Rhythmic females	Rhythmic count	6	16	22
		% within GENDER	10.9%	29.1%	40%
	Female overall	Overall count	29	26	55
		% within GENDER	52.7%	47.3%	100%
	Male (artistic) overall	Count	17	3	20
		% within GENDER	85.0%	15.0%	100.0%
Total		Count	46	29	75
		Total %	61.3%	38.7%	100.0%

Fisher's exact p=0.015

Of the 75 participants in this study, 55 were female and 20 were male and it was found that there was a significant association between past injuries and gender (p=0.015). Eighty-five percent of the 20 males reported past injuries while only 53% of the 55 females that participated in this study reported past injuries. Of the injuries in females, the majority (41.8%) were sustained from artistic gymnastics, whilst only 10.9% resulted from rhythmic gymnastics. This is shown in Table 5.

Literature suggests, with the exception of one study (Lowry and Leveau, 1982), that the incidence of injury has generally been reported to be greater in female than in male gymnasts (Daly et al., 2001).

4.3.1.2 Association between type of gymnastics and past injuries

Table 6: Association between type of gymnastics and past injuries

			Injury ever		Total
			yes	no	
TYPE GYM	**artistic males**	Count	17	3	20
		% within TYPE GYM	85%	15%	100.0%
	artistic females	Count	23	10	33
		% within TYPE GYM	69.7%	30.3%	100.0%
	rhythmic females	Count	6	16	22
		% within TYPE GYM	27.3%	72.7%	100.0%
Total		Count	46	29	75
		Total %	61.3%	38.7%	100.0%

Fisher's exact $p<0.001$

There was a highly significant association, in this study, between type of gymnastics and past injuries ($p<0.001$). Artistic gymnastics carried a higher risk of injury than rhythmic gymnastics as can be seen in Table 6. In this study, 75.5% of artistic gymnasts, overall, had reported past injuries whilst only 27.3% of rhythmic gymnasts had sustained an injury. Of the 20 artistic male gymnasts, 85% had sustained a previous injury from gymnastics, and out of 33 female artistic gymnasts, 69.7% had sustained a previous injury from gymnastics.

4.3.1.3 Association between level of gymnastics and past injuries

Table 7: Association between level of gymnastics and past injuries

			Injury ever		Total
			yes	no	
LEVEL GYM	**low**	Count	6	2	8
		% within LEVEL GYM	75.0%	25.0%	100.0%
	medium	Count	27	27	54
		% within LEVEL GYM	50.0%	50.0%	100.0%
	high	Count	13	0	13
		% within LEVEL GYM	100.0%	.0%	100.0%
Total		Count	46	29	75
		Total %	61.3%	38.7%	100.0%

Pearson's chi square 11.75, p=0.003

Level of gymnastics was also a significant risk factor for past injury (p=0.003), with 100% of the 13 high level gymnasts reporting past injuries, and only 50% of the 27 medium level and 75% of the six low level gymnasts respectively reporting past injuries. This fact might have been compounded by the years of experience (higher level gymnasts would have had more years of experience, longer exposure time and longer training sessions in which to injure themselves).

A number of epidemiological studies have suggested that the risk of gymnastic injury is proportional to the level of skill of the athlete (McAuley et al., 1987). In the United States, high level gymnasts tend to sustain a higher number of injuries than recreational gymnasts (Garrick and Requa, 1978). The injury rate for gymnasts who participate primarily in recreational gymnastics seems to be relatively low, ranging between 0.1 to 0.7% when compared with competitive gymnasts ranging from 5.3 to as high as 76% (Meeusen and Borms, 1992).

4.3.1.4 Sum of past injury score for all body parts

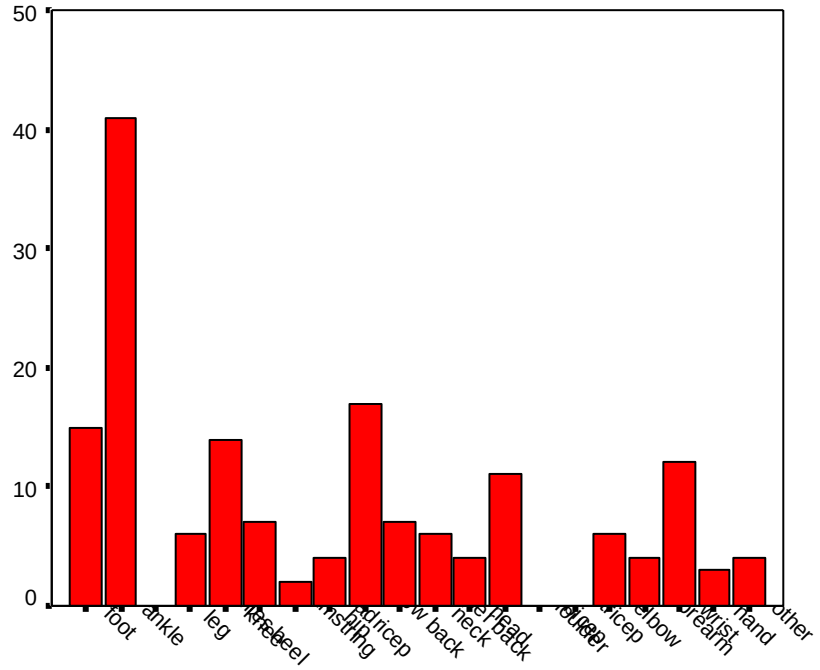


Figure 6: Sum of past injury score for all body parts

The total sum of past injury scores is shown in Figure 6. In terms of past injuries, the most commonly injured body part in this study was the ankle, followed by the lower back, foot and knee in sequential order. If, however, for the purposes of comparison, certain categories are added together (for example foot and ankle) then the most commonly injured body parts in this study were the foot and ankle, followed by the lower back, the knee and then the wrist and hand in sequential order. These results strongly support those of other studies for example Dixon and Fricker (1993) who reported that the ankle and foot were the most commonly injured body parts, followed by the lower back, then the knee, and then the elbow in sequential order.

Case studies indicate gymnastics lower back injuries tend to have a gradual onset (which could reduce the reported incidence of back problems), affecting primarily advanced level gymnasts (Caine et al., 1996). In support of this fact, the

lower back injuries in this study were reported mainly by high level participants. However in contrast to the results in the other studies, it can be seen in Figure 6 that the lower back was the second most commonly injured body part in this study.

4.3.1.5 Score (ranking) for each body part for past injury

Table 8: Score (ranking) for each body part for past injury by total, gender, type and level

		Gender		Type		Level		
Body part for past injury	**Total**	**female**	**male**	**artistic**	**rhythmic**	**low**	**medium**	**high**
Ankle	41(1)	29(1)	12(1)	37(1)	4(1)	4(1)	20(1)	17(1)
Low back	17(2)	9(4)	8(4)	15(2)	2(3)	1(3)	8(2)	8(3)
Foot	15(3)	11(2)	4(6)	15(2)	0	0	4(6)	11(2)
Knee	14(4)	10(3)	4(6)	14(3)	0	1(3)	6(4)	7(4)
Wrist	12(5)	3(9)	9(3)	11(4)	1(4)	0	7(3)	5(5)
Shoulder	11(6)	1(11)	10(2)	11(4)	0	1(3)	6(4)	4(6)
Hamstring	7(7)	6(5)	1(9)	4(8)	3(2)	1(3)	5(5)	1(9)
Upper back	7(7)	2(10)	5(5)	7(5)	0	2(2)	5(5)	0
Leg	6(8)	5(6)	1(8)	5(7)	1(4)	0	3(7)	3(7)
Neck	6(8)	2(10)	4(6)	6(6)	0	0	5(5)	1(9)
Elbow	6(8)	4(7)	2(8)	6(6)	0	0	3(7)	3(7)
Hip	4(9)	3(8)	1(9)	3(9)	1(4)	0	2(8)	2(8)
Head	4(9)	3(8)	1(9)	4(8)	0	0	2(8)	2(8)
Forearm	4(9)	2(10)	2(8)	4(8)	0	0	4(6)	0
Other	4(9)	1(10)	3(7)	3(9)	1(4)	1(3)	2(8)	1(9)
Hand	3(10)	1(10)	2(8)	3(9)	0	0	1(9)	2(8)
Quadriceps	2(11)	2(9)		2(10)	0	0	2(8)	0

The ranking of each body part according to total past injury score, by gender, type and level is shown in Table 8. The numbers listed in the brackets indicate the ranking for each body part from most common (one) to least common (11).

By gender:

It is evident that in female gymnasts in this study, the ankle was the most commonly injured body part, followed by the foot, knee and lower back. This correlates with the literature on other epidemiological studies. In these studies, it appears that the lower limb was the most frequently injured body region, and that the ankle was typically the most commonly injured body part in the lower extremity, followed by the knee (Garrick and Requa, 1980; Bak et al., 1994; Kolt and Kirkby 1995).

In terms of the upper limb in female gymnasts, the most commonly injured area in this study was the elbow, followed by the wrist, and then the forearm, with the shoulder and hand being the least common. However, in other studies, injuries to the hand, wrist and forearm were commonly placed into one general category as wrist injuries. If these injuries are added together in this study, then injuries to the wrist (combined) are the most common out of all the upper limb injuries, followed by the elbow. This supports the findings of other studies, which state that the wrist is the most frequently injured site in the upper extremity of female gymnasts, followed by the elbow (Caine et al., 2003). In other studies it has been determined that many wrist injuries result from growth plate injuries (Mandelbaum et al., 1989), and from the use of dowel grips (Svihlik, 1996), however in this study, the causes of these injuries were not specified in the same amount of detail.

A comparison study of injury location data from prospective studies (conducted abroad) of competitive female gymnasts indicates that the lower extremity was injured most often (54.1% to 70.1%), followed by the upper extremity (15.1% to 25%), and the spine/trunk region (7.5% to 16.7%). The results of this study strongly support these findings, with injuries to the female gymnasts being most commonly to the lower limb, followed by the upper limb, and then the lower back.

In male gymnasts in this study, the ankle was also the most commonly injured body part, followed by the shoulder, wrist and lower back. There were more (32) upper limb injuries than lower limb (23), and only 17 injuries to the spine and trunk in the male gymnasts in this study. This supports the findings in the most extensive and well-documented study on male gymnasts, where it was reported that the proportion of upper extremity injuries was greater than the proportion of lower extremity injuries, which in turn was greater than the proportion of spinal injuries (Dixon and Fricker, 1993).

By type of gymnastics:

In the rhythmic gymnasts in this study, the most commonly injured body part was the ankle, followed by the lower back, foot and knee. In the study by Hume (1999), the most commonly injured body part in rhythmic gymnasts was the hip, followed by the lower back. However, only four rhythmic gymnasts participated in the study, and out of those four, only two had ever reported injuries. Owing to the small sample size, confidence intervals were wide. Other than this study by Hume (1999), there appears to be a lack of available information on injuries to rhythmic gymnasts specifically; therefore comparison of data is difficult.

The artistic gymnasts in this study also reported the ankle as being the most commonly injured body part, followed by the lower back, foot and knee, which corresponds with previous studies (Garrick and Requa, 1980; Bak et al., 1994; Kolt and Kirkby 1995).

By level of gymnastics:

In high, medium and low level gymnasts in this study, the ankle was the most commonly injured body part, followed by the foot and lower back in high level gymnasts; the lower back and wrist in medium level gymnasts; and the upper back, lower back, shoulder and hamstring in low level gymnasts.

It therefore seems to be apparent in this study that gymnasts are susceptible to ankle injuries irrespective of gender, type of gymnastics, or level of competition.

4.3.1.6 Length of time for which past injuries prevented gymnastics with respect to the affected area

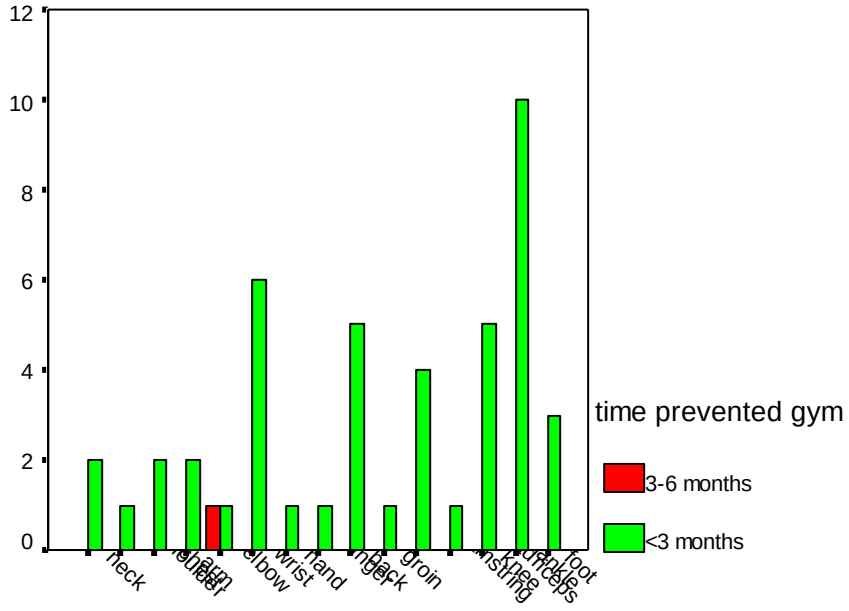


Figure 7: Length of time for which past injuries prevented gymnastics with respect to the affected area (n=46)

Figure 7 shows that, in this study, out of the 46 past injuries, only one participant (female artistic gymnast) was prevented from training because of an elbow injury

for a period between three and six months. In this instance, there were multiple fractures of the humerus, radius and ulna, as well as a dislocation of the elbow, which was caused by a fall on the outstretched hand whilst performing a dismount off the uneven bars, and required surgery, immobilization, and intensive rehabilitation. This supports the findings of a study performed by Priest and Weise (1981), which reported that 12% of elbow injuries in female gymnasts occurred whilst dismounting, and falling on an outstretched hand was hypothesized as the probable mechanism of injury (Priest, 1985).

The majority of participants who experienced past injuries were prevented from training for fewer than three months.

Time loss due to injury is difficult to measure in gymnastics because injured gymnasts, depending on the severity of the injury, tend to continue to train on selected apparatus with some skill or movement modifications. In addition, there are many possible subjective and objective factors that may influence performance time lost due to injury such as personal motivation, peer influence, coaching staff reluctance or encouragement, approaching competition (Caine and Nassar, 2005).

Data from two studies (Caine et al., 1989; Caine et al., 2003) indicate that advanced level female participants experienced a greater proportion of severe (greater than 21 days time loss) injuries than beginning level female gymnasts. Similarly, other studies reported that mean time loss per injury was greater for advanced level than beginning level female gymnasts (Kolt and Kirkby, 1995; Kolt and Kirkby, 1999). Interestingly and in support of these findings, the elbow injury that was responsible for the most time lost from training in this study was in a high level, female, artistic gymnast.

4.3.1.7 Analysis of past ankle injuries

Table 9: Severity of past ankle injuries (n=25)

	Frequency	Percent
mild	6	24.0
moderate	11	44.0
severe	8	32.0
Total	25	100.0

Table 10: Effect of past ankle injuries (n=25)

	Frequency	Percent
prevented gym	2	8.0
limited gym	15	60.0
no effect	8	32.0
Total	25	100.0

In this study there were 25 participants (33.3%) who had injured their ankle in the past due to gymnastics, and because this was by far the most commonly injured body part in this study, it was decided to do a separate analysis on ankle injuries alone. Of these ankle injuries, six (24%) were reported by the participants as being mild injuries, 11 (44%) as moderate and eight (32%) as severe injuries, as can be seen in Table 9. The effect that the ankle injuries had was mainly to limit participation in gymnastics (60%), but the period of time for which participation was limited was not established. This was because the participants were only required to provide details (such as time loss from training) on their most severe injury. Therefore, as their ankle injury was not necessarily their worst injury, they may not have recorded this information in the questionnaire. Limited participation indicated that training could continue, but elements placing large stresses on the joint were avoided. The ankle injuries prevented gymnastics only for a limited period of time in 8% of the cases, which is evident in Table 10. None of these 25 participants had ever injured their ankle in any other sport.

Because of the fact that there is a lack of available literature that analyzes the most commonly injured body part in other studies, a comparison cannot be made. However, it is interesting to note that the anatomical locations of the

injuries sustained from other sports in this study did not appear to correlate with the anatomical locations of injuries sustained from gymnastics in the same participants. In other words, the participant who had suffered an ankle injury from another sport for example did not report any ankle injuries from gymnastics, and those participants who reported ankle injuries from gymnastics did not report any ankle injuries from other sports.

4.3.2 Current injuries

Nineteen (25.3%) participants in this study reported having current injuries.

4.3.2.1 Association between gender and current injury

Table 11: Association between gender and current injury

			Current injury		Total
			yes	no	
GENDER	**female**	Count	7	48	55
		% within GENDER	12.7%	87.3%	100.0%
	male	Count	12	8	20
		% within GENDER	60.0%	40.0%	100.0%
Total		Count	19	56	75
		Total %	25.3%	74.7%	100.0%

Fisher's exact p <0.001

There was a highly significant difference in proportions of males and females with current injuries ($p<0.001$) in this study. Of the 55 female participants 13% were currently injured, while of the 20 males 60% were currently injured. This is shown in Table 11.

4.3.2.2 Association between type of gymnastics and current injury

Table 12: Association between type of gymnastics and current injury

			Current injury		Total
			yes	no	
TYPE GYM	**Artistic males**	Count	12	8	20
		% within TYPE GYM	60.0%	40.0%	100.0%
	Artistic females	Count	6	27	33
		% within TYPE GYM	18.2%	81.8%	100%
	Artistic overall	Count	18	35	53
		% within TYPE GYM	34%	66%	100%
	Rhythmic overall (females only)	Count	1	21	22
		% within TYPE GYM	4.5%	95.5%	100.0%
Total		Count	19	56	75
		Total %	25.3%	74.7%	100.0%

Fisher's exact p=0.008

Artistic gymnastics had a significantly higher prevalence of current injuries than rhythmic gymnastics (p=0.008) as is shown in Table 12, although this was mainly due to the high percentage of injuries amongst the male artistic gymnasts. Of the 20 artistic males, 60% were currently injured, and of the 33 artistic females, 18.2% were currently injured.

Owing to the minimal information on studies involving both types of gymnastics, it is difficult to draw conclusions about the correlation between type of injury and type of gymnastics. Hume (1999) found that 66.7% of artistic males, 55.6% of artistic females, and 50% of rhythmic gymnasts in the study had reported injuries, and that 60% of artistic gymnasts overall had been injured. However, as

mentioned earlier, due to the small sample population in Hume's study (n=19), these figures may be slightly exaggerated.

4.3.2.3 Association between level of gymnastics and current injury

Table 13: Association between level of gymnastics and current injury

			Current injury		Total
			yes	no	
LEVEL GYM	**Low**	Count	1	7	8
		% within LEVEL GYM	12.5%	87.5%	100.0%
	Medium	Count	11	43	54
		% within LEVEL GYM	20.4%	79.6%	100.0%
	High	Count	7	6	13
		% within LEVEL GYM	53.8%	46.2%	100.0%
Total		Count	19	56	75
		Total %	25.3%	74.7%	100.0%

Pearson's chi square 6.99, p = 0.030

Fifty-four percent of the high level gymnasts were currently injured in this study, whereas 20.4% of medium level gymnasts and only 12.5% of low level gymnasts reported current injuries. It was apparent that, in this study, the higher the level of gymnastics, the more prevalent the injuries (p = 0.030) as can be seen in Table 13, which coincides with the results from previous studies (Meeusen and Borms, 1992).

4.3.2.4 Frequency (Ranking) of body parts for current injuries in total, by gender, type and level

Table 14: Frequency (Ranking) of body parts for current injuries in total, by gender, type and level (n=19)

		Gender		Type		Level		
Body part	Total	female	male	artistic	rhythmic	low	medium	high
Shoulder	4(1)	0	4(1)	4(1)	0	0	3(1)	1(1)
Ankle	3(2)	1(2)	2(2)	2(2)	1(1)	0	2(2)	1(1)
Foot	2(3)	1(2)	1(3)	2(2)	0	0	1(3)	1(1)
Knee	2(3)	2(1)	0	2(2)	0	0	1(3)	1(1)
Low back	2(3)	2(1)	0	2(2)	0	0	2(2)	0
Upper back	2(3)	0	2(2)	2(2)	0	0	1(4)	1(1)
Wrist	2(3)	0	2(2)	2(2)	0	0	1(4)	1(1)
Hamstring	1(4)	1(2)	0	1(3)	0	1(1)	0	0
Hand	1(4)	0	1(3)	1(3)	0	0	0	1(1)
Total	19	7	12	18	1	1	11	7

In terms of current injuries, the most commonly injured body part, in this study, was the shoulder, followed by the ankle, foot and knee, and, as was found in other studies (Caine and Nassar, 2005), the lower limb was the most commonly injured extremity in this study. The order of frequency and rank of current injuries is shown in Table 14 in total and by gender, type and level of gymnastics. The numbers shown in brackets give the ranking of the body parts, from most commonly injured (one), to least commonly injured (four).

By type of gymnastics, and gender:

As can be seen in the table above, all of the current shoulder injuries in this study were in males. This strongly supports the findings from other epidemiological studies (Dixon and Fricker, 1993; Lueken et al., 1993), which state that the most commonly injured body part in male gymnasts is the shoulder, due to the large

stresses placed on this joint by events such as the rings and high bar. After shoulder injuries, the next most commonly reported injury in male gymnasts, in this study, was the ankle, followed by the upper back, the wrist, the foot, the knee and the lower back (all ranked third).

The most commonly injured body parts, in this study, in female artistic gymnasts were the knee and lower back, followed by the ankle, foot and hamstring which correlate with the literature on other epidemiological studies. In these studies, it appears that the lower limb was the most frequently injured body region (Garrick and Requa, 1980; Bak et al., 1994; Kolt and Kirkby 1995). The only current injury in rhythmic gymnasts in this study was to the ankle.

By level of gymnastics:

In medium level gymnasts in this study, the most commonly injured body part was the shoulder, followed by the ankle and lower back, and then the foot, knee, upper back and wrist (all ranked third). Injuries to the high level gymnasts in this study were evenly distributed about the body, with exception of the lower back and hamstring (to which there were no reported current injuries), and the only current injury reported in low level gymnasts was to the hamstring.

4.3.2.5 Activity or equipment implicated in current injury by gender

Table 15: Activity or equipment implicated in current injury by gender (n=19): count (ranking)

		GENDER		Total
		female	male	
ACTIVITY	**Floor**	1(3)	5(1)	6(1)
	Unsure	3(1)	0	3(2)
	Pommel horse	0	2(2)	2(3)
	Vault	2(2)	0	2(3)
	Rings	0	2(2)	2(3)
	Warm up	0	1(3)	1(4)
	Parallel bars	0	1(3)	1(4)
	High/ Uneven bars	0	1(3)	1(4)
	Beam	1(3)	0	1(4)
Total		7	12	19

The numbers (one to four) in the brackets indicates the ranking of the activities in terms of resulting injuries. The activity that caused the most current injuries in this study was the floor work (32%), followed by the category entitled ”unsure” (16%) in which case the participants were not certain as to the cause of the injury. The pommel horse, rings and vault were each responsible for 10.5% of current injuries, and the parallel bars, beam, warm up and high bars each caused 5.3% of current injuries.

By gender, females were mostly unsure of the cause of their current injury. The vault was second, followed by beam and floor as the third most likely causes of injury in females. In contrast the males were most likely to get injured on the floor, followed by the pommel horse and rings (both ranked second), and the parallel bars, high bars and warm up (all ranked third), in sequential order. This is shown in Table 15.

The majority of gymnastics studies report that the floor exercise is associated with the greatest number of acute injuries (Garrick and Requa, 1980; Lowry and Leveau, 1982; Steel and White, 1983; Pettrone and Riciardelli, 1987), and this is reflected by the data obtained from this study. This is not unexpected, since a greater number of hours are generally devoted to training on the floor (Daly et al., 2001). Other studies report that the balance beam is associated with the second highest injury rates in female gymnastics (Garrick and Requa, 1980; Pettrone and Riciardelli, 1987), although considerable variability exists (Daly et al., 2001). In this study, the balance beam was the third highest ranked apparatus associated with injury, which supports the above findings to some extent.

Considerable variability exists amongst the information from other studies on the other apparatus. For example, some studies reported an injury rate on the girls' uneven bars as low as 6% (Garrick and Requa, 1980; Mackie and Taunton, 1994) and others reported as high as 38% (Clark and Buckley, 1980). In this study, there were no current injuries reported on the uneven bars, therefore there is no correlation with findings from the above studies.

The vault is typically associated with a relatively low proportion of injuries, which may be due to the short time a gymnast spends on this apparatus (Garrick and Requa, 1980; Vergouwen, 1986). Despite this, the vault was ranked second as an apparatus associated with injury in this study. However it shares the ranking with several other apparatus.

Information pertaining to injuries on the pommel horse in male gymnasts is sparse (Daly et al., 2001). However one study by the NCAA (1994) lists the pommel horse as the event associated with the third highest injury rate, following the floor and high bar. In this study the pommel horse was ranked the second most common apparatus associated with injury, following the floor, but before the high bar.

The causes of previous gymnastics injuries were not investigated in this study since it was thought that the gymnasts might have forgotten this information especially since many of the injuries had occurred a long time ago.

4.3.2.6 Activity or equipment implicated in current injury by type of gymnastics

Table 16: Activity or equipment implicated in current injury by type of gymnastics (n=19): count (ranking)

		TYPE of GYM		Total
		artistic	rhythmic	
ACTIVITY	**Floor**	5(1)	1(1)	6
	Unsure	3(2)	0	3
	Vault	2(3)	0	2
	Pommel horse	2(3)	0	2
	Rings	2(3)	0	2
	Warm up	1(4)	0	1
	Horizontal bars	1(4)	0	1
	Parallel bars	1(4)	0	1
	Beam	1(4)	0	1
Total		18	1	19

The only current injury in rhythmic gymnastics in this study was caused by floor work. The causes of current injuries for artistic gymnasts were very similar to those for the total, as is shown in Table 15. Table 16 shows the apparatus ranked from most common to least cause of injury as indicated by the numbers in brackets (one to four).

4.3.2.7 Cause implicated in current injury by gender

Table 17: Cause for current injury as implicated by participants by gender (n=19): count (ranking)

		GENDER		Total
		female	male	
CAUSE	**repetitive movements**	2(1)	2(2)	4(1)
	other	2(1)	1(3)	3(2)
	twisting	0	3(1)	3(2)
	insufficient rest	0	3(1)	3(2)
	falls	1(2)	1(3)	2(3)
	incorrect posture	0	2(2)	2(3)
	incorrect landings	1(2)	0	1(4)
	overstretching	1(2)	0	1(4)
Total		7	12	19

Causes and rankings (see the numbers one to four in brackets) of current injuries in this study are shown in Table 17. Overall the first ranking cause reported by participants was repetitive movements (21%), followed by twisting, insufficient rest and other causes which together ranked second. By gender the most common cause for males was twisting and insufficient rest, and for females the causes were repetitive movements and other causes (for the latter, the gymnasts were uncertain as to the definitive cause of the injuries).

The findings in this study support those in a study by Sands et al. (1993), where it was found that over a five year period of recording injuries in gymnasts, the highest percentage of injuries resulted from repetitive stress and unknown causes, which were placed in a category together by the author of the above study.

4.3.2.8 Severity of current injury

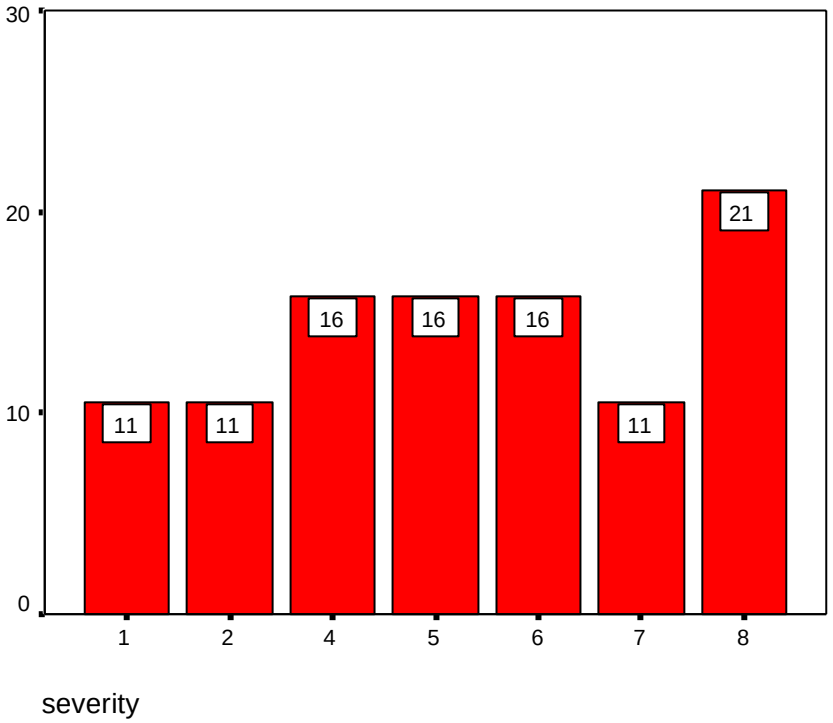


Figure 8: Severity of current injury on a scale of 1 to 10 as per the Numerical Rating Scale (Tesler et al., 1991)

The severity of current injuries in this study, as reported by the study participants, ranged between one and eight on a scale of one to ten, with a mode of eight (21%). The percentage of participants, as shown by ranking of severity for current injuries, is shown in Figure 8. None of the participants in this study reported the severity of their injuries to be worse than a score of eight out of ten.

This particular method of recording the severity of the injuries was not used in the section for past injuries. This was owing to the fact that it was thought that the participants might have forgotten the details of these injuries, as they may have occurred many years previously. However, a simpler method of recording the severity of the past injuries was used, where the participants were required to report their injuries as being “mild”, ”moderate” or “severe”.

4.3.2.9 Effect of current injury on gymnastics

Table 18: Effect of current injury on gymnasts (n=19)

	Frequency	Valid Percent
some pain	6	31.6
severe limitation and pain	5	26.3
some limitation	4	21.1
no effect	3	15.8
prevents gym	1	5.3
Total	19	100.0

The most commonly reported effect of the current injuries on gymnastics training and competition was some pain (32%) followed by severe limitation and pain (26.3%) and then some limitation (21.1%). No effect was present in 16%, and gymnastics was prevented in 5.3% as shown in Table 18.

The gymnasts who reported no effect of their injuries on their training (in other words no pain or limitation) were all white, medium level artistic females between nine and 13 years of age, with an average of five years gymnastics experience. It was apparent that the gymnasts who reported no effect of their injuries on training or competition were generally younger, at a lower level of gymnastics and had fewer years of experience than those who reported pain and limitation. In support of the above it is apparent from the results of other studies that factors such as greater height, weight and age tend to characterize older gymnasts with more years training and involvement in higher levels of training and competition. Older gymnasts may also be more likely to sustain injury because of more complex and difficult skills and greater accumulated exposure to training (Caine and Nassar, 2005). There was no apparent correlation between the affected body parts amongst these gymnasts who reported no effect.

4.3.2.10 Time period for which participants had had their current injuries

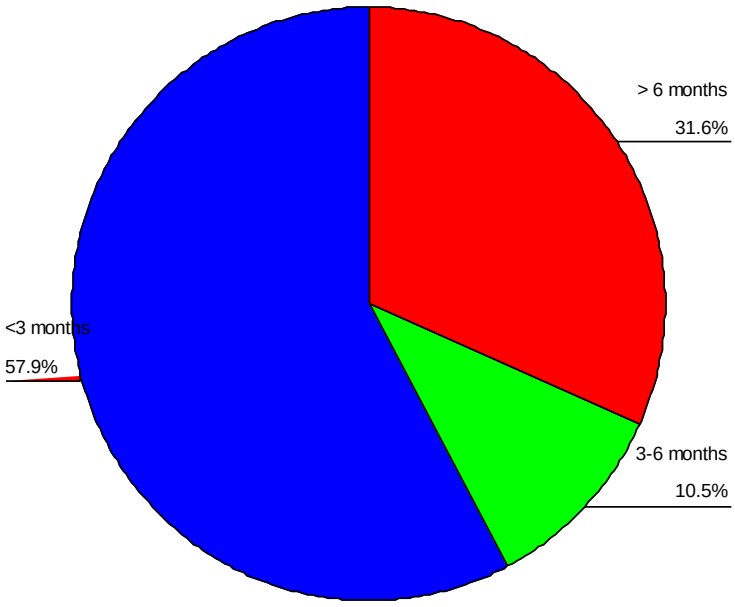


Figure 9: Time period for which participants had had their current injuries (n=19)

The majority of participants in this study had had their current injury for fewer than three months (58%) as shown in Figure 9, which is probably the reason for the results in Table 16 above. Of the six participants who had had their injury for more than six months, in only two cases had the injury prevented gymnastics for greater than six months. These two injuries are discussed in detail in 4.3.2.11. The other four participants in this category were possibly able to continue with their training with only some limitation or pain, despite their long term injuries.

It was difficult to predict whether the injuries in the three to six month category would have persisted for longer or not, because of the fact that the injuries were recorded in this study, at a stage when these injuries were still between the three and six month range, and the participants' injuries may have persisted after the questionnaires were completed. Therefore the greater than six month category may, in fact, have been larger than was reflected.

4.3.2.11 Length of time for which current injuries prevented gymnastics, by area of current injury

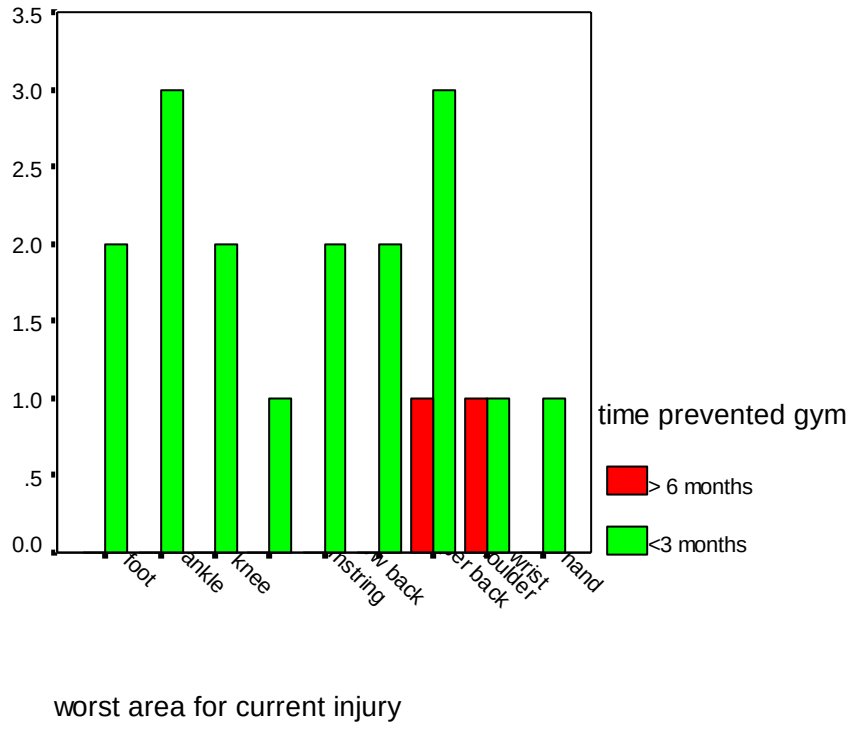


Figure 10: Length of time for which current injuries prevented gymnastics, by area of current injury (n=19)

Figure 10 shows the number of participants in this study who had current injuries that prevented gymnastics for fewer than three months, between three and six months and for greater than six months, by the current injury area. Only one shoulder and one wrist injury prevented gymnastics for greater than six months (two cases).

Owing to the fact that categories: fewer than three months; three to six months and greater than six months were provided, into which the participants were required to categorize their information, the greater than six months category

does not specify the exact amount of time for which these participants have had their injuries.

The majority of current injuries in this study prevented gymnastics for fewer than three months (89.5%). Only two injuries have prevented gymnastics for more than six months. These two injuries (one to the wrist, and one to the shoulder) are both of a chronic (long term) nature, and both gymnasts are high level artistic gymnasts. In both cases the gymnasts were instructed by medical personnel to rest completely from gymnastics for at least six months in order to spare the growth plates and tendons from permanent damage.

It has been established in previous studies that high level gymnasts experienced greater time loss from training than their lower level counterparts did (Caine et al., 1989; 2003), which could have been due to the fact that high level gymnasts were characterized by a significantly greater proportion of chronic injuries than lower level gymnasts (Kolt and Kirkby, 1995; 1999). These findings are supported by the results in this study, where it was found that the two injuries that prevented gymnastics for more than six months both affected high level gymnasts.

4.4 Treatment

4.4.1 Treatment for past injuries

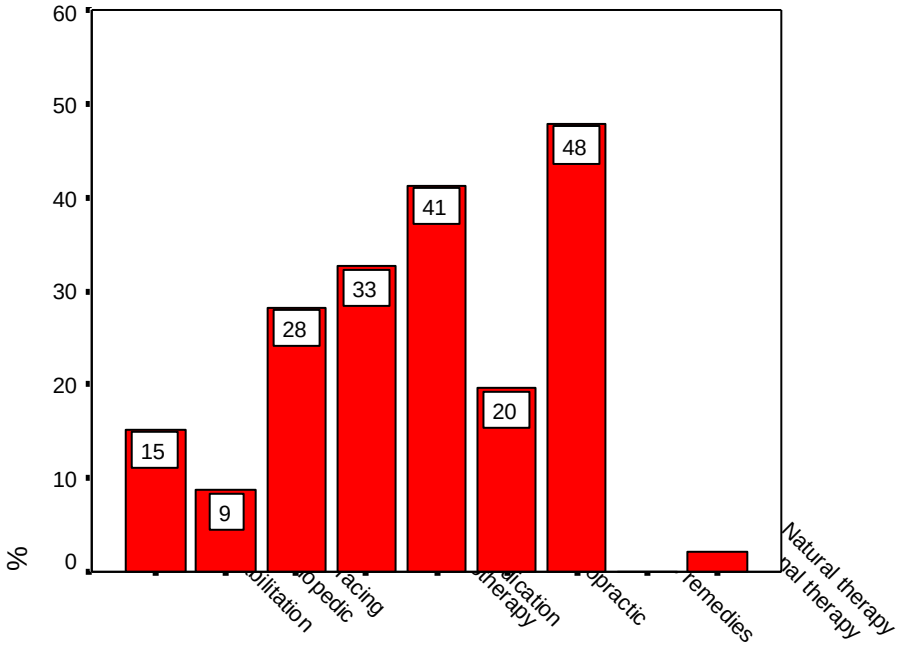


Figure 11: Type of treatment received for past injury (n=41)

Out of 46 athletes, in this study who had reported past injury, 41 (89.1%) had received treatment. The most common form of treatment for past injuries was home remedies (48%) followed by medication (41%). Natural therapy (n=1) and nutritional therapy (n=0) were least commonly used. Physiotherapy was used in 33% of cases, whilst chiropractic was used in 20% of cases. This is shown in Figure 11.

Not much literature exists on the topic of treatment sought for gymnastics injuries in other such studies, however, Daly et al. (2001) state that, because many gymnastics injuries are from overuse, or are musculoskeletal in nature, it is likely that the majority of these cases would seek treatment at a sports medicine clinic, physiotherapy practice or general practice clinic for treatment of their injury.

4.4.2 Treatment for current injuries

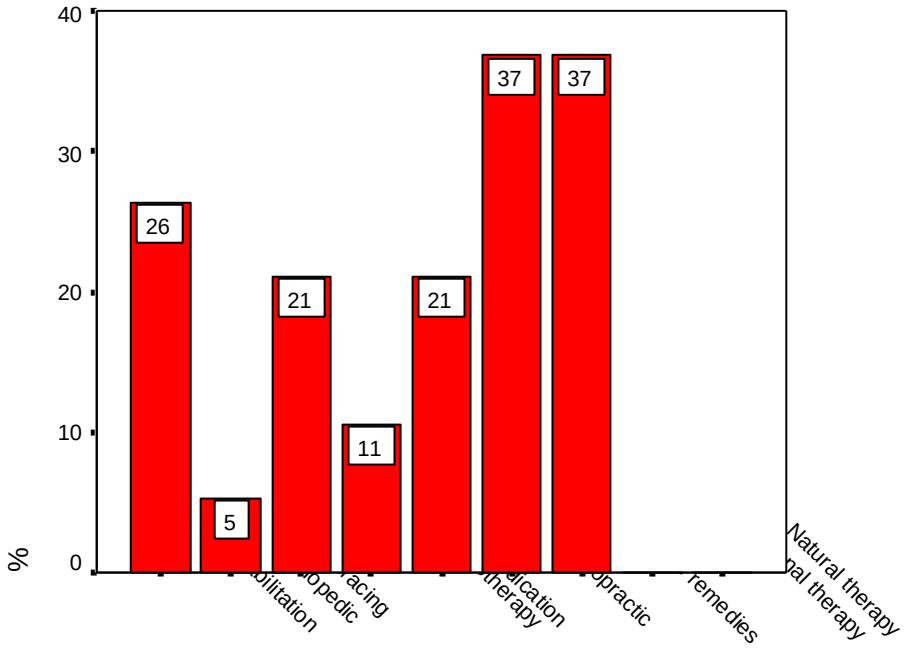


Figure 12: Type of treatment received for current injury (n=15)

Fifteen of the nineteen currently injured gymnasts in this study had received treatment (79%). The most common forms of treatment for current injuries were chiropractic (37%) and home remedies (37%) in equal distribution. This is shown in Figure 12.

It is interesting to note here the high percentage of gymnasts in this study who sought chiropractic treatment for their injuries. This could be explained by the fact that a number of study participants had received treatment and advice over a period of six years from the researcher, who was a gymnastics coach as well as a chiropractic student during this period. At the time that the research was being performed, the researcher was a chiropractic intern, thus many of the gymnasts belonging to the researcher's gymnastics club, who had volunteered to participate in the study, had received chiropractic treatment for their injuries.

Another factor to consider is that the sample size of participants receiving treatment for their current injuries was a lot smaller than the number receiving treatment for past injuries, thus it is possible that the percentage of participants receiving chiropractic treatment may have been exaggerated.

From the results in this study there appears to be a recent trend towards alternative treatment methods rather than the conventional methods previously sought. For example, the number of participants receiving medication and bracing for their injuries has decreased, whilst the number seeking rehabilitation has increased.

It also appears that the number of participants seeking physiotherapy for their injuries has dropped, whilst there has been a relative increase in the number of participants receiving chiropractic treatment. This could be explained by a general increase in public awareness of the fact that new generation chiropractors are able to manage spinal problems as well as extremity complaints, sports injuries and rehabilitation.

4.5 Risk factors for ever having had an injury

Table 19: Factors associated with injury in gymnasts (n=75) (Crude OR and 95% CI)

Factor		p value	OR	95% CI
Age		0.021	1.25	1.03-5.11
Type of gym (artistic vs. rhythmic)		<0.001	9.11	2.92-28.42
Level of gymnastics	medium vs. high vs. low	0.451	0.526	0.099-2.80
Experience		0.009	1.282	1.06- 1.55
Gender	male vs. female	0.008	8.07	1.71 – 38.17
Ethnic group	baseline Coloured and Asian	0.028		
	Black	0.133	3.21	0.701-14.74
	White	0.008	6.19	1.60-23.88

Out of the 75 study participants, 28 had never been injured, one reported only a current injury, 28 reported only past injuries, and 18 reported having both past and current injuries. Table 20 shows the factors that were associated with injuries, the crude odds ratios (OR) and 95% confidence intervals (CI).

In this study, a one year increase in age increased the risk of injury by 1.25 times (p=0.021). This correlated significantly with the findings of other such studies, although these studies only focused on female gymnasts, and not on male gymnasts as well, as was the case in this study. Analytical cohort studies indicated that in comparison with uninjured or low injury risk gymnasts, the injured or high injury risk gymnasts were characterized by: greater age, body size (height and weight) and body fat (Steele and White, 1986; Lindner and Caine,

1990). It is possible that factors such as greater height, weight and age tend to characterize older gymnasts with more years training and involvement in higher levels of training and competition. Older gymnasts may also be more likely to sustain injury because of more complex and difficult skills and greater accumulated exposure to training (Caine and Nassar, 2005).

If the type of gymnastics was artistic compared with rhythmic, the risk of injury in this study increased nine fold ($p<0.001$).

As mentioned earlier, the higher the level of participation in this study, the more prevalent the injuries, as 53.8% of the high level gymnasts were currently injured, whilst 20.4% of the medium level gymnasts were currently injured, and only 12.5% of low level gymnasts were currently injured ($p=0.451$). This is supported by the results from a recent study by Caine et al. (2003), where it was found that the relative risk for injury amongst advanced female gymnasts was 1.47 times greater than in beginner gymnasts. Furthermore, when proportional time loss and injury rate were used as criterion variables (Caine et al., 1989), the analysis resulted in a significant effect, and competitive level surfaced as best discriminator between high and low injury risk female gymnasts.

In contrast to the above, only two studies seemed to report significantly lower injury rates in high level as compared with lower level female gymnasts (Kolt and Kirkby, 1995; Kolt and Kirkby, 1999). Therefore, it can be seen that the results of analytical studies on risk factors thus far, seem to be inconclusive as to whether injury rates are greatest at advancing levels of competition (Kolt and Kirkby, 1995; Kolt and Kirkby, 1999; Caine et al., 2003).

In this study, it was found that as years of experience increased by one year, the risk of injury simultaneously increased 1.3 times ($p=0.009$), which is in keeping with the findings of previous studies (Steele and White, 1986; Lindner and Caine, 1993).

None of the other factors such as diet, supplementation, participation in other forms of exercise, or regular treatment to keep the body in good condition, were significantly associated with injury in this study (data not shown).

4.6 Limitations of the study

- Although many factors seem to be implicated as significant risk factors to injury in this study, it is requested that the reader take caution when associating some of these factors (especially those related to demographics of the participant), owing to the fact that the interpretation of the results of this study in terms of the strength of association between certain risk factors and gymnastics injuries may have been skewed by the small sample size. The study was underpowered for a multivariate analysis of risk factors for injury. Wide 95% confidence intervals in univariate logistic regression lead to this conclusion. There was therefore a possibility of type II errors in the statistical analysis; as a result trends shown by the data should be taken into consideration as well as statistical findings. A larger study would be recommended to confirm the risk factors identified here and possibly to identify further causes and risks.

  Therefore, it is the opinion of the author that the associations in this study be viewed as subtle trends noticed in the participants of this study; and that further research is required using a larger sample size, before any of these causes/ risk factors identified in this study are definitively implicated.

- It appears that most of the available literature on gymnastics injuries, as utilised in this study, focuses on female gymnasts only, with the result that some of the discussion and conclusions drawn may not have been accurate as the possibility of gender bias, to a certain extent, does exist.

- Because this study was the first of its kind in South Africa, it was necessary, first and foremost to establish an injury profile of the gymnastics population in South Africa, and to obtain a reflection to some extent, of the demographics of this population. In addition to this, an attempt was also made in this study, to identify certain potential risk factors to injury. Therefore the questionnaire in this study was designed to touch on a broad number of issues while concentrating primarily on gymnastics injuries. More attention was paid on acquiring detailed information on the injuries themselves, while only basic questions were included pertaining to certain factors. It was not possible to investigate each one of these risk factors in detail, as this would have made the questionnaire more time-consuming, possibly resulting in decreased compliance of participants. However, in order to investigate all the factors that were mentioned, in a more thorough manner, more questions regarding each factor and more objectively defined options, could have produced more definitive conclusions. These factors will be discussed in greater detail in the recommendations at the end of Chapter Five.

The following chapter provides the reader with a conclusion to the study, as well as recommendations for future studies.

Chapter 5

Conclusions and recommendations

This chapter incorporates a summary of the results of the study. Conclusions about the results are drawn, and recommendations are provided for future studies based on the results as well as the limitations of the study.

5.1 Conclusions

The vast majority of gymnasts in this study (73.3%) were female, whilst only 26.7% were male. The sample population was predominantly young (less than 20 years of age), with a mean age of 13.4 years. The mean age for females was 12.6, and for males was 15.6. In terms of racial grouping and the types of gymnastics practised, there were more white than non-white participants, and more artistic than rhythmic gymnasts in the sample group respectively.

The mean age of starting gymnastics was 7.7 years, and the mean age of starting competitive gymnastics was 8.6 years. The mean years of experience was 5.7 years. Fifty-three of the gymnasts in the study (70.7%) practised artistic gymnastics, while only 22 (29.3%) practised rhythmic gymnastics. A large proportion (72%) of the gymnasts in the sample population were medium level gymnasts, whilst 17% were high level and only 11% were low level gymnasts.

The majority of participants in this study trained for between four and eight hours per week, but there were 9% (mainly elite gymnasts) who trained for 24 hours per week or more.

Twenty-five participants (33.3%) in this study participated in a second form of recreational exercise besides gymnastics on a regular basis, with the most frequent exercise being netball (n=5). Nine of those participants participated simultaneously in a third regular form of exercise, of which swimming was the

most common. Seventeen subjects also participated in competitive sports other than gymnastics, with five of those subjects reporting participation in a third competitive sport. Only 10 (13.3%) participants had sustained injuries from other sports. The most common first injury (as reported by participants) resulting from other sports was to the fingers (30%). This is significant, as the reported finger injuries were mainly caused by netball, which was the most common of the other forms of exercise. Of these participants, two sustained a second injury due to other sporting activities, and these were to the shoulder and ankle.

It was interesting to note that the anatomical locations of the injuries sustained from other sports did not appear to correlate with the anatomical locations of injuries sustained from gymnastics in the same participants. In other words, the participant who had suffered an ankle injury from another sport for example did not report any ankle injuries from gymnastics, and those participants who reported ankle injuries from gymnastics did not report ankle injuries from other sporting activities.

The percentage of past injuries reported in this study was 61.3%, and the percentage of current injuries was 25.3%. Although the proportion of current injuries appeared to be comparatively low, it must be considered that the past injuries that have been reported in this study, took place over a number of years, whereas the current injuries were recorded over a period of a few months. There was a highly significant difference in numbers of males and females with current injuries ($p<0.001$) in this study. Of the 27 female participants 13% were currently injured, while 60% of the 20 male participants were currently injured.

In this study, there appeared to be some trends in associations between risk factors and injuries. It seemed to appear that male gender was significantly associated with higher risk of injury and trends were also apparent with respect to type of gymnastics and racial grouping being associated with higher risk of injury. In these instances it seemed that white gymnasts were at a higher risk of

injury than non-white gymnasts, and that artistic gymnasts were at a higher risk of injury than rhythmic gymnasts. These risk factors may be different should a larger sample size be used in future studies.

Increased age and years of experience were also found to be significant risk factors for injury, and it was found that the higher the level of gymnastics, the more prevalent the injuries, as 53.8% of the high level gymnasts were currently injured, whilst 20.4% of the medium level gymnasts were currently injured, and only 12.5% of low level gymnasts were currently injured ($p=0.451$). In terms of past injuries, 100% of the 13 high level gymnasts had been injured, whilst only 50% of the 27 medium level gymnasts and 75% of the six low level gymnasts respectively, reported past injuries. Therefore it could be concluded that greater exposure to training and competition, experience in gymnastics, and age appeared to be directly related to an increased risk of injury, as the high level gymnasts in this study tended to train for longer hours, more frequently than the low and medium level gymnasts, and were generally older and more experienced than lower level participants.

In terms of past injuries, the most commonly injured body part in this study was the ankle, followed in sequential order by the lower back, foot and knee. In terms of current injuries, the most commonly injured body part in this study was the shoulder, followed by the ankle, foot and knee. All four of the current shoulder injuries were in male gymnasts, which could be due to the fact that more strain is placed on the upper limb in male gymnasts than in female gymnasts, because both apparatus used exclusively by male gymnasts, namely the high bar and the rings exercise, involve high velocity swinging movements, placing a large amount of stress on the shoulder joint (Meeusen and Borms, 1992).

In terms of current injuries, the activity or equipment that caused the most injuries (32%) in this study was the floor work, and the first ranking cause of injury in this study as implicated by the participants was repetitive movements (21%). There is

an apparent correlation between these two factors, which could be explained by the fact that much of the floor work involves the repetition of sequences of tumbling elements, which places stresses on the upper and lower extremities, as well as the spine (Sands et al., 1993).

In terms of past injuries in this study, out of the 46 past injuries, only one participant with an elbow injury was prevented from training for a period between three and six months. The remaining participants who experienced past injuries were prevented from training for fewer than three months.

The majority of participants in this study had had their current injury for fewer than three months (58%). Of the six participants who had had their current injury for more than six months, in only two cases had the injury prevented gymnastics for greater than six months. The remaining four participants in this category were possibly able to continue with their training with only some limitation or pain, despite their long term injuries.

In terms of current injuries, the main reported effect on gymnastics training and competition was some pain (32%), and most of the current injuries in this study prevented gymnastics for fewer than three months (89.5%).

Out of 46 athletes who reported past injuries in this study, 41 (89.1%) had ever received treatment for their injuries, with the most common forms of treatment being home remedies (48%) and medication (41%). Fifteen of the nineteen currently injured gymnasts had received treatment (79%). The most common forms of treatment for current injuries were chiropractic (37%) and home remedies (37%) in equal distribution. The high percentage of gymnasts seeking chiropractic treatment for their current injuries could be explained by the fact that a number of study participants had received treatment and advice over a period of six years from the researcher, who was a gymnastics coach and chiropractic student simultaneously. At the time that the research was being performed, the

researcher was a chiropractic intern, thus many of the gymnasts belonging to the researcher's gymnastics club, who had volunteered to participate in the study, were receiving, or had previously received chiropractic treatment for their injuries.

From the results in this study there appears to be a recent trend towards alternative treatment methods rather than the conventional methods previously sought. For example, the number of participants receiving medication and bracing for their injuries has decreased, whilst the number seeking rehabilitation has increased.

It also appears that the number of participants seeking physiotherapy for their injuries has dropped, whilst there has been a relative increase in the number of participants receiving chiropractic treatment. This could be explained by a general increase in public awareness of the fact that new generation chiropractors are able to manage spinal problems as well as extremity complaints, sports injuries and rehabilitation.

Based on the findings of this study, recommendations (Appendix L) were made to gymnastics coaches and club leaders of gymnastics clubs in the greater Durban area of KwaZulu-Natal, South Africa in an attempt to improve the safety of the gymnasts and reduce the chances of injury.

The ***hypotheses*** made in chapter one, are discussed here in light of the findings and discussion in this chapter as well as the previous chapter.

1. The first hypothesis is that the questionnaire utilized in this study is contextualised to a form that is relevant to competitive gymnasts in the greater Durban area of KwaZulu-Natal, South Africa, and enables the researcher to gather the necessary information.

In this study, it seems to be apparent that the questionnaire that was utilized was, in fact, a contextualised questionnaire that was relevant to gymnastics, with which the necessary information could be obtained.

Therefore, the first hypothesis can be accepted.

2. The second hypothesis is that the mapped profile for gymnastics injuries in South Africa is different from that of other countries, owing to the lower standard of gymnastics being produced in South Africa.

The injury profile of gymnasts in the greater Durban area of KwaZulu-Natal, South Africa that was obtained appeared to be similar to that of other international studies.

Therefore, the second hypothesis was rejected.

3. The third hypothesis is that it is thought that the risk factors associated with gymnastics injuries in South Africa will differ significantly from the risk factors found in other studies, because of the difference in standard of gymnastics produced in these countries.

From the results of this study, it seems to be apparent that the risk factors associated with gymnastics injuries in South Africa did not appear to differ significantly from a number of the risk factors found in other studies, despite the difference in standard of gymnastics produced in these countries. These results appear to indicate that, irrespective of the lower standard of gymnastics having been produced in the country thus far, the injury rates and related effects of these injuries correlate closely with those of previous studies on gymnasts from other countries where the standard may be higher.

Therefore, hypothesis three was also rejected.

Although discussed earlier, it is important to mention here that even though many factors seem to be implicated as significant risk factors to injury in this study, it is requested that the reader take caution when associating some of these factors (especially those related to demographics of the participant), owing to the fact that the interpretation of the results of this study in terms of the strength of association between certain risk factors and gymnastics injuries may have been slightly inaccurate due to the small sample size.

It is the opinion of the author therefore, that the associations in this study be viewed as subtle trends noticed in the participants of this study; and that further research is required using a much larger sample size, before any of these causes or risk factors identified in this study are definitively implicated.

5.2 Recommendations

- A larger sample population is required in future studies in order to accurately assess the risk factors for injury without the possibility of incurring type two errors in statistical analysis.
- A more in depth study with regards to timing of injury occurrence is needed. For example, whether the injuries occurred in training or competition, and during which part of the training session they occurred.
- Furthermore, it is recommended that gender specific questions regarding the proposed cause and exact mechanisms of the injury be asked with respect to each individual body part. As an example, Hunter and Torgan (1983) found that injuries to the knee were often related to twisting dismounts, particularly those associated with the balance beam and uneven bars, therefore it would be necessary to include questions pertaining to knee injuries caused by twisting dismounts in female gymnasts. Similarly, more detailed questions can be asked taking into account all the information provided by previous studies to get a more detailed and accurate account of the injury.
- If factors such as dietary habits, regular maintenance treatment and specific causes and effects of injuries are to be investigated, it is recommended that more specific and/or objective evaluation criteria be applied. For example, in terms of nutritional intake, instead of asking the participant whether or not they follow a healthy diet, it is suggested that questions include caloric intake, intake of specific food groups and nutrients. Also, measurement of weight and body fat percentage is recommended because of the associations (Steele and White, 1986; Lindner and Caine, 1993) between greater percentage of body fat and increased risk of injury. Another factor that should be investigated in more detail is whether there is any correlation between the age at which gymnasts reach their peak performance levels, and the age at which there is the highest incidence of injury. This study was designed simply to assess whether or not a relationship between risk factors in general, and

gymnastics injuries existed. Thus, in future studies it is recommended that risk factors such as nutrition be assessed in greater detail.

- There appear to be relatively few studies performed on male gymnasts specifically, as well as comparison studies between male and female gymnasts. Therefore, it is recommended that future studies compare factors such as injury rates and risk factors between males and females in more detail, and include an equal distribution of males and females into their studies to prevent gender bias and to allow more conclusions to be accurately drawn in terms of these above-mentioned factors.

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List of references for photographs used in the study

All artistic gymnastics photographs provided by the KwaZulu-Natal Gymnastics Union, with kind permission of:

- Claire Schreuder
- Martin Kemsley
- Keith Cameron

Rhythmic gymnastics, Sports aerobics, Acrosport, Tumbling and Trampolining photographs and permission for use provided by the South African Gymnastics Federation.

APPENDIX A (Finalized Questionnaire)

Durban Institute of Technology: Department of Chiropractic

Gymnastics injuries in the greater Durban area: A quantitative profile of competitive athletes.

The Gymnastics Injury Questionnaire.

Gymnast	Coach/Judge	Administrator

Please place a cross in the appropriate box. Please answer all the questions.

Section 1: Personal information

1. What is your sex?

Female	Male
01	02

2. Which ethnic group do you belong to?

Black	White	Coloured	Asian
01	02	03	04

3. What is your age (in years)?

years

4. What other exercise do you perform on a regular basis (ie at least twice a week)?

5.Do you take part in any other competitive sporting activities? If yes, please specify your two primary activities other than gymnastics.

_____

6. Please state your worst two injuries from the sports mentioned in question 6.

_____

_____

7. Do you eat a balanced, healthy diet?

Yes	No
01	02

8. Do you take any supplements?

Yes	No
01	02

Section 2: Gymnastics History

9. At what age did you start gymnastics? _____ years

10. At what age did you start competing in gymnastics? _____ years.

11. How many years experience do you have in gymnastics? _____ years.

12. At present, how many hours do you train in the gymnasium per week?

4-8 hours	9-13 hours	14-18 hours	19-23 hours	24 hours or more
01	02	03	04	05

13. At present, how many gymnastics classes do you attend per week?

7 0r more	6	5	4	3	2	1
01	02	03	04	05	06	07

Section 3: Previous gymnastics injuries

14. Have you **ever** sustained an injury from gymnastics?

Yes	No
01	02

15. Have you ever received regular treatment from any of the below, to keep your body in good condition, even if you have never sustained an injury?

Rehabilitation	01	Medication/injections	05
Orthopaedic	02	Chiropractic	06
Bracing/strapping	03	Home remedies eg. ice	07
Physiotherapy	04	Nutritional therapy	08
		Natural therapy eg. homoeopathy	09

If your answer to question 14 (above) is "No", please move on to Section 4.

16. How often have the following areas of your body been injured during gymnastics? (This includes any injuries from gymnastics sustained at any time during your gymnastics career).

Seldom: once or twice

Often: 3 to 5 times

Very often: More than 5 times

	01	02	03
A. Foot/toes	Very often	Often	Seldom
B. Ankle	Very often	Often	Seldom
C. Achilles tendon	Very often	Often	Seldom
D. Leg (calf/shin)	Very often	Often	Seldom
E. Knee	Very often	Often	Seldom
F. Hamstrings (back of thigh)	Very often	Often	Seldom
G. Quadriceps (front of thigh)	Very often	Often	Seldom
H. Hip/groin	Very often	Often	Seldom
I. Low back	Very often	Often	Seldom
J. Upper back	Very often	Often	Seldom
K. Neck	Very often	Often	Seldom
L. Head	Very often	Often	Seldom
M. Shoulder	Very often	Often	Seldom
N. Biceps (front of upper arm)	Very often	Often	Seldom
O Triceps (back of upper arm)	Very often	Often	Seldom
P. Elbow	Very often	Often	Seldom
Q. Forearm	Very often	Often	Seldom
R. Wrist	Very often	Often	Seldom
S. Hand	Very often	Often	Seldom
T. Other	Very often	Often	Seldom

If “other”, please specify: _____

17. Consider the worst injury (noted in the above table) that you have sustained during gymnastics. How would you describe the severity of this injury?

Mild	Moderate	Severe
01	02	03

From the list above (Q. 16 A-T), please state the area that was worst injured:_____

18. How have injuries to any of the areas listed below affected your gymnastics?

	01	02	03
A. Foot/toes	Prevented gymnastics	Limited gymnastics	No effect
B. Ankle	Prevented gymnastics	Limited gymnastics	No effect
C. Achilles tendon	Prevented gymnastics	Limited gymnastics	No effect
D. Leg (calf/shin)	Prevented gymnastics	Limited gymnastics	No effect
E. Knee	Prevented gymnastics	Limited gymnastics	No effect
F. Hamstrings (back of thigh)	Prevented gymnastics	Limited gymnastics	No effect
G. Quadriceps (front of thigh)	Prevented gymnastics	Limited gymnastics	No effect
H. Hip/groin	Prevented gymnastics	Limited gymnastics	No effect
I. Low back	Prevented gymnastics	Limited gymnastics	No effect
J. Upper back	Prevented gymnastics	Limited gymnastics	No effect
K. Neck	Prevented gymnastics	Limited gymnastics	No effect
L. Head	Prevented gymnastics	Limited gymnastics	No effect
M. Shoulder	Prevented gymnastics	Limited gymnastics	No effect
N. Biceps (front of upper arm)	Prevented gymnastics	Limited gymnastics	No effect
O. Triceps (back of upper arm)	Prevented gymnastics	Limited gymnastics	No effect

P. Elbow	Prevented gymnastics	Limited gymnastics	No effect
Q. Forearm	Prevented gymnastics	Limited gymnastics	No effect
R. Wrist	Prevented gymnastics	Limited gymnastics	No effect
S. Hand	Prevented gymnastics	Limited gymnastics	No effect
T. Other	Prevented gymnastics	Limited gymnastics	No effect

If “other”, please specify: _____

_____

19. What is the longest period for which you were not able to do gymnastics due to the injury mentioned above?

Greater than 6 months	3-6 months	Less than 3 months
03	02	01

Section 4: Present gymnastics injuries

20. Are you **presently** suffering from an injury due to gymnastics? **(If the answer to this question is “No”, please move on to section 5).**

Yes	No
01	02

21. If you currently have more than one injury, please specify how many: _____

24. Which part of your body is **most** injured at the moment?

A. Foot/toes	01	L. Head	12
B. Ankle	02	M. Shoulder	13
C. Achilles tendon	03	N. Biceps (front of upper arm)	14
D. Leg (calf/shin)	04	O. Triceps (back of upper arm)	15
E. Knee	05	P. Elbow	16
F. Hamstrings (back of thigh)	06	Q. Forearm	17
G. Quadriceps (front of thigh)	07	R. Wrist	18
H. Hip/groin	08	S. Hand	19
I. Low back	09	T. Other	20
J. Upper back	10		
K. Neck	11		

If “other”, please specify: _____

25. How would you describe the severity of this injury on a scale of 1 to 10? (0 represents no pain, and 10 represents severe pain).

1	2	3	4	5	6	7	8	9	10

26. At the moment, how does your present injury affect your gymnastics?

Prevents gymnastics	Severe limitation and pain	Some limitation	Some pain	No effect
01	02	03	04	05

27. What is the longest period for which you were not able to do gymnastics due to your present injury?

Greater than 6 months	3-6 months	Less than 3 months
03	02	01

28. How long have you had your present injury?

Greater than 6 months	3-6 months	Less than 3 months
03	02	01

29. Which of the following factors do you feel is the most likely cause of your present injury?

Insufficient warm-up/cold	01	Equipment failure	08
Stretching	02	Difficult movements	09
Overstretching	03	Repetitive movements/landings	10
Jumping	04	Team/group work	11
Incorrect landings	05	Falls	12
Insufficient rest/overwork	06	Collisions	13
Incorrect posture/placement	07	Twisting	14
		Other	15

If “Other”, please specify: _____

30. During which activity was your present injury sustained?

Warm-up/stretching	01	Beam	05	Using hand apparatus	09
Vault	02	Parallel bars	06	Conditioning	10
Horizontal/asymmetric bars	03	Rings	07	Strength training	11
Floor/dance work	04	Pommel horse	08	Unsure	12

31. Has anyone ever pointed out a weakness in your gymnastic technique?

Yes	No
01	02

If so, please describe **briefly** (for example, you always work with an

arched back, or you bend your legs in everything you do):

_____

_____

Section 5: Treatment

32. Have you **ever** received treatment for a gymnastics injury?
If your answer to this question is "No", please leave out the rest of the questionnaire.

Yes	No
01	02

33. What type/s of treatment have you received for your past injury?

Rehabilitation	01	Medication/injections	05
Orthopaedic	02	Chiropractic	06
Bracing/strapping	03	Home remedies eg. ice	07
Physiotherapy	04	Nutritional therapy	08
		Natural therapy eg. homoeopathy	09

34. Have you received treatment for your **present** injury?

Yes	No
01	02

35. What kind of treatment have you received for your present injury?

Rehabilitation	01	Medication/injections	05
Orthopaedic	02	Chiropractic	06
Bracing/strapping	03	Home remedies eg. ice	07
Physiotherapy	04	Nutritional therapy	08
		Natural therapy eg. homoeopathy	09

APPENDIX B

LETTER OF INFORMATION

(Focus Group)

Dear Participant,

Welcome to the focus group of my study. Thank you for your interest.

The title of my research project is: **Gymnastics injuries in the greater Durban area: A quantitative profile of competitive athletes.**

Name of supervisor: Dr. E. Lakhani (031-2042533)

Name of Research Student: Ingrid Adamson (031-2042205)
Name of Institution: Durban Institute of Technology

The purpose of this focus group is to validate the use of the Gymnastics Injury Questionnaire in terms of gathering information from gymnasts. The discussions will focus on the changes that are necessary in order to alter the Gymnastics Injury Questionnaire in order to convert the Questionnaire into a more accurate tool.

Your participation is much appreciated and it is assured that your comments and contributions will remain confidential. You are at any point permitted to disagree, however if this is the case, please give your reasons for this as it will assist in the research process. The results of this focus group will only be used for research purposes.

Thank you for your participation,

Yours sincerely,

Ingrid Adamson
(Chiropractic Intern)

Dr. E. Lakhani
(Supervisor)

APPENDIX C

Informed Consent/Assent Form
(To be completed by members of the focus group)

Date:

Title of research project: Gymnastics injuries in the greater Durban area: A quantitative profile of competitive athletes.

Name of supervisor: Dr. E. Lakhani (031-2042533)

Name of Research Student: Ingrid Adamson (031-2042205)

Name of Institution: Durban Institute of Technology

Please circle the appropriate answer

1. Have you read the patient information sheet? YES/NO
2. Have you had opportunity to ask questions regarding this study? YES/NO
3. Have you received satisfactory answers to your questions? YES/NO
4. Have you had an opportunity to discuss this study? YES/NO
5. Have you received enough information about this study? YES/NO
6. Who have you spoken to regarding this study? _____
7. Do you understand the implications of your involvement in this study? YES/NO
8. Do you understand that you are free to withdraw from this study? YES/NO
   a) at any time?
   b) without having to give a reason for withdrawing?
   c) without affecting your future health care?
9. Do you agree to voluntarily participate in this study? YES/NO

IF YOU HAVE ANSWERED NO TO ANY OF THE ABOVE, PLEASE OBTAIN THE NECESSARY INFORMATION FROM THE RESEARCHER AND / OR SUPERVISOR BEFORE SIGNING. THANK YOU.

PLEASE PRINT IN BLOCK LETTERS

FOCUS GROUP MEMBER _____ SIGNATURE_____

WITNESS' NAME _____SIGNATURE_____

RESEARCHERS' NAME _____ SIGNATURE_____

SUPERVISORS' NAME _____ SIGNATURE_____

APPENDIX D

Confidentiality statement declaration (for members of the focus group)

IMPORTANT NOTICE: THIS FORM IS TO BE READ AND FILLED IN BY EVERY MEMBER PARTICIPATING IN THE FOCUS GROUP, BEFORE THE FOCUS GROUP MEETING CONVENES.

CONFIDENTIALITY STATEMENT – FOCUS GROUP

DECLARATION

1. All information contained in the research documents and any information discussed during the focus group meeting will be kept private confidential. This is especially binding to any information that may identify any of the participants in the research process.
2. The patient files will be coded and kept anonymous in the research process.
3. None of the information shall be communicated to any other individual or organisation outside of this specific focus group as to the decisions of this focus group.
4. The information from this focus group will be made public in terms of a journal publication, which will in no way identify any participants of this research.

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

Please Print in block letters:

Focus group member: _____ Signature: _____

Witness name: _____ Signature: _____

Researcher's name: _____ Signature: _____

Supervisor/

Co-supervisor's name: _____ Signature: _____

APPENDIX E

Code of conduct: For members of the focus group

CODE OF CONDUCT

This form needs to be completed by every member of the Focus Group prior to the commencement of the focus group meeting.

As a member of this committee I agree to abide by the following conditions:

1. All information contained in the research documents and any information discussed during the focus group meeting will be kept private and confidential. This is especially binding to any information that may identify any of the research process.
2. None of the information shall be communicated to any other individual or organisation outside of this specific focus group as to the decisions of this focus group.
3.The information of this focus group will be made public in terms of a journal publication, which will in no way identify any participants of this research.

Member Represents	Member's name	Signature	Contact details

APPENDIX F

ASSENT FORM

Date:

Title of research project: Gymnastics Injuries: A quantitative profile of athletes in the greater Durban area.

Name of supervisor: Dr. E. Lakhani (031-2042533)

Name of Research Student: Ingrid Adamson (031-2042205)

Name of Institution: Durban Institute of Technology

Please circle the appropriate answer

1. Have you read the patient information sheet? YES/NO
2. Have you had opportunity to ask questions regarding this study? YES/NO
3. Have you received satisfactory answers to your questions? YES/NO
4. Have you had an opportunity to discuss this study? YES/NO
5. Have you received enough information about this study? YES/NO
6. Who have you spoken to regarding this study? _____
7. Do you understand the implications of your involvement in this study? YES/NO
8. Do you understand that you are free to withdraw from this study? YES/NO

a) at any time?
b) Without having to give a reason for withdrawing?
c) Without affecting your future health care?

9. Do you agree to voluntarily participate in this study? YES/NO

IF YOU HAVE ANSWERED NO TO ANY OF THE ABOVE, PLEASE OBTAIN THE NECESSARY INFORMATION FROM THE RESEARCHER AND / OR SUPERVISOR BEFORE SIGNING. THANK YOU.

PLEASE PRINT IN BLOCK LETTERS

SUBJECTS NAME _____ SIGNATURE_____

WITNESS' NAME _____ SIGNATURE_____

RESEARCHERS' NAME _____ SIGNATURE_____

GUARDIAN'S /
PARENT'S NAME_____ SIGNATURE_____

APPENDIX G

Letter of assent

Dear Participant,

I am conducting research on injuries among gymnasts in the greater Durban area. The purpose of this study is to investigate the frequency and nature of injuries among gymnasts and to help identify potential risk factors.

This study will include 60 gymnasts, from gymnastics clubs in the Durban area. If you agree to participate, you will be required to complete a questionnaire. All the information supplied by you will be treated confidentially and used for research purposes only.

Participation is voluntary and failure to participate will not result in any adverse consequences.

Please feel free to contact Ingrid Adamson (researcher), or my supervisor,
Dr. Ekta Lakhani if you have any questions.

Thank you very much

Yours sincerely,

Ingrid Adamson
(Chiropractic Intern)
204 2205 (w) 2612613 (h)

Dr. E. Lakhani
(Supervisor)
204 2533 (w)

I _____ hereby agree to Participate in the above-mentioned study.

Signature: _____ Date: _____

Parent's Name _____

Signature: _____ Date: _____

APPENDIX H

LETTER OF INFORMATION

Dear Participant,

Welcome to my study. Thank you for your interest.

The title of my research project is:
Gymnastics injuries in the greater Durban area: A quantitative profile of competitive athletes.

Name of supervisor: Dr. E. Lakhani (031-2042533)
Name of Research Student: Ingrid Adamson (031-2042205)
Name of Institution: Durban Institute of Technology

The purpose of the study:
This study will involve research on 60 gymnasts to determine the factors influencing the occurrence of gymnastics injuries in KwaZulu-Natal.

Procedures:
You will be required to complete a questionnaire about gymnastics injuries, where and how they occur. The average time for gymnasts to complete the questionnaire will be 15 – 30 minutes.

Benefits: Should you be suffering from any injuries during the course of your participation in this research, you are offered 2 optional free Chiropractic treatments at the Chiropractic Day Clinic at the Durban Institute of Technology. Also the results of this research will be forwarded to the club leaders of the gymnastics clubs for distribution to your coach, to allow for improved recommendations with regard to your training. This will assist in the general improvement of the state of gymnastics in this province.

Risks/ Discomforts and Cost:
There are no risk / discomfort or cost involved from your participation in the study.

Confidentiality:
All patient information is confidential and the results will be used for research purposes only. You have the right to be informed of any new findings that are made and you may ask questions of an independent source if you so wish. If you are not satisfied with any area of the study please feel free to contact the Durban Institute of Technology Research Ethics Committee.

Thank you for your participation,

Yours sincerely,

Ingrid Adamson **Dr. E. Lakhani**

APPENDIX I

Letter of consent/assent.

Dear Club Leader,

This letter serves as a request to perform research at your gymnastics club.
The title of my research project is:
Gymnastics injuries in the greater Durban area: A quantitative profile of competitive athletes.

Name of supervisor:	Dr. E. Lakhani	(031-2042533)
Name of Research Student:	Ingrid Adamson	(031-2042205)
Name of Institution:	Durban Institute of Technology	

The purpose of the study:
This study will involve research on 60 gymnasts to determine the epidemiology of gymnastics injuries in KwaZulu-Natal.

Procedures:
The gymnasts will be required to complete a questionnaire about gymnastics injuries, where and how they occur. The average time for the gymnasts to complete the questionnaire will be 15 – 30 minutes.

Benefits: Should they be suffering from any injuries during the course of their participation in this research, they are offered 2 optional free treatments at the Chiropractic Day Clinic at the Durban Institute of Technology. Also the results of this research will be forwarded to you as the Club leader of your gymnastics club to allow for improved recommendations with regard to training.

Risks/ Discomforts and Cost:
There are no risk / discomfort or cost involved from participation in the study.

Confidentiality:
All patient information is confidential and the results will be used for research purposes only. You have the right to be informed of any new findings that are made and you may ask questions of an independent source if you so wish. If you are not satisfied with any area of the study please feel free to contact the Durban Institute of Technology Research Ethics Committee.
If there are any questions please do not hesitate to contact myself, Ingrid Adamson or my supervisor, Dr Lakhani at the above mentioned numbers.

Yours sincerely,

Ingrid Adamson	**Dr. E. Lakhani**
(Chiropractic Intern)	(Supervisor)

I (name) _____ hereby give Ingrid Adamson consent to conduct the above mentioned research at this gymnastics club.
Signature:_____ Date:_____

APPENDIX J

APPENDIX 6 Questionnaire number: _____

Durban Institute of Technology: Department of Chiropractic

An epidemiological investigation of dance injuries in ballet in KwaZulu-Natal

Name: _____ Tel. (home): _____

Tel. (work): _____

Ballet company/studio: _____

Ballet grade/level: _____

Student	Teacher	Professional

Please place a cross in the appropriate box. Please answer all the questions.

Section 1: Personal information

1. What is your sex?

Female	Male
01	02

2. Which ethnic group do you belong to?

Black	White	Coloured	Asian
01	02	03	04

3. What is your age (in years)? _____ years

4. What is your height (in centimeters)?: _____ cm

5. What is your weight (in kilograms)?: _____ kg

6. What other sport/exercise do you perform on a regular basis? _____

7. How would you describe your dietary habits?

Poor	Adequate	Good	Excellent
01	02	03	04

8. How would you describe your emotional stress levels?

Very high	High	Average	Low	Very low
01	02	03	04	05

Section 2: Ballet history

9. At what age did you start ballet? _____ years old

10. Since you started ballet, how consistently have you danced (attended class and/or performed)?

Very consistently	Consistently	Irregularly	Very irregularly
01	02	03	04

11. How many years experience do you have in ballet? _____ years

12. At present, how many hours do you dance per week?

More than 10 hrs	8-10hrs	5-7hrs	2-4hrs	Less than 2 hrs
01	02	03	04	05

13. At present, how many ballet classes/sessions do you dance per week?

7 or more	6	5	4	3	2	1
01	02	03	04	05	06	07

Section 3: Previous ballet injuries

14. Have you **ever** sustained an injury from ballet dancing?

Yes	No
01	02

15. How often have you sustained injuries from ballet?

1 injury / month	1 injury / 3 months	1injury / 6 months	1 injury / 12 months	No injuries
01	02	03	04	05

16-25. How often have the following areas of your body been injured during ballet?
(This includes any injuries from ballet, sustained at any time during your ballet career)

	01	02	03	04
16. Foot/toes	Very often	Often	Seldom	Never
17. Ankle	Very often	Often	Seldom	Never
18. Achilles	Very often	Often	Seldom	Never
19. Leg (calf/shin)	Very often	Often	Seldom	Never
20. Knee	Very often	Often	Seldom	Never
21. Hamstrings (back of thigh)	Very often	Often	Seldom	Never
22. Quadriceps (front of thigh)	Very often	Often	Seldom	Never
23. Hip/groin	Very often	Often	Seldom	Never
24. Low back	Very often	Often	Seldom	Never
25. Other	Very often	Often	Seldom	Never

If "other", please specify: _____

26. Consider the worst inury you have sustained during ballet. How would you describe the severity of this injury? (Please mark "N/A/"not applicable" if you answered "No" to Quest. 14)

N/A	Mild	Moderate	Severe
01	02	03	04

From the list above (Q.16-25), please state the area that was injured: _____

27-36. How have injuries to any of the areas listed bel low effected your dancing?
(Please mark "N/A" if you answered "No" to Quest. 14)

	01	02	03	04
27. Foot/toes	Prevented dancing	Limited dancing	No effect	N/A
28. Ankle	Prevented dancing	Limited dancing	No effect	N/A
29. Achilles	Prevented dancing	Limited dancing	No effect	N/A
30. Leg (calf/shin)	Prevented dancing	Limited dancing	No effect	N/A
31. Knee	Prevented dancing	Limited dancing	No effect	N/A
32. Hamstrings	Prevented dancing	Limited dancing	No effect	N/A
33. Quadriceps	Prevented dancing	Limited dancing	No effect	N/A
34. Hip/groin	Prevented dancing	Limited dancing	No effect	N/A
35. Low back	Prevented dancing	Limited dancing	No effect	N/A
36. Other	Prevented dancing	Limited dancing	No effect	N/A

If "other" area, please specify: _____

Section 4: Present ballet injuries

37. Are you **presently** suffering from an injury due to ballet?

Yes	No
01	02

38. Which part of your body is most injured at the moment?
(Please mark "N/A", here and below, if you answered "No" to Quest. 37)

Foot/toes	01	Hamstrings	06	N/A	11
Ankle	02	Quadriceps	07		
Achilles	03	Hip/groin	08		
Leg	04	Low back	09		
Knee	05	Other	10		

If "other", please specify _____

39. How would you describe the severity of this injury?

Severe	Moderate	Mild	N/A
01	02	03	04

40. At the moment, how does your present injury affect your dancing?

Prevents dancing	Severe limitation/pain	Some limitation/pain	No effect	N/A
05	04	03	02	01

41. What is the longest period for which you were not able to dance due to your present injury?

Greater than 6 months	3-6 months	Less than 3 months	N/A
04	03	02	01

42. How long have you had your present injury?

Greater than 6 months	3-6 months	Less than 3 months	N/A
04	03	02	01

43. Which of the following factors do you feel is the most likely cause of your present injury?

Insufficient warm-up / cold	01	Unsuitable floors	08
Stretching	02	Difficult choreography	09
Twisting	03	Repetitive movements	10
Jumping	04	Partnerships	11
Pointe work	05	Falling	12
Insufficient rest / overwork	06	Other	13
Incorrect posture/placement	07	N/A	14

44. During which part of your class was your present injury sustained?

Warm-up	01	Pirouettes	04	Pointe work	07
Barre	02	Adage	05	Unsure	08
Centre	03	Allegro	06	N/A	09

45. Has anyone ever pointed out a weakness in your dancing posture?

Yes	No

01	02

If so, please describe briefly: _____

Section 5: Treatment

46. Have you **ever** received treatment for a ballet injury?

Yes	No	N/A
01	02	03

47. What type/s of treatment have you received?

Rehabilitation	01	Medication/injections	05
Orthopaedic	02	Chiropractic	06
Bracing/strapping	03	Other	07
Physiotherapy	04	N/A	08

48. Have you received treatment for your **present** injury?

Yes	No	N/A
01	02	03

49. What kind of treatment have you received for your present injury?

Rehabilitation	01	Medication/injections	05

APPENDIX K
Focus group

Hi everyone, and thank you for coming today. Starting at the top of the form we have the name, telephone number, gymnastics club, grade or level, and gymnast, coach/judge or administrator. That's fairly straightforward I think. Is there anybody you think has been left out?
No.
Okay, the first questions about personal information are fairly straightforward: What is your sex? Male/Female. Which ethnic group do you belong to? These are just for statistical purposes, alright? What is your age in years? What is your height in centimeters, your weight in kilograms? I am going to work out there body mass index with that, and see if there is any correlation between a large BMI and an increased proportion of injuries, or something like that, alright?
Just a question, make sure you have a scale and some sort of a tape measure with you.
If you're using BMI as a measurement there, are you going to use the straight BMI as you did in nutrition, because you're going to get over-readings. Your weight ratio is going to be higher because of the muscle. Because I'm deemed as being overweight!
Well, look I mean it's a bit difficult to measure their body fat percentage, or other ways of determining whether they're overweight. I think the main thing I'm trying to find out is whether they're grossly obese or not.
With BMI you're not going to be accurate.
Ja, especially with kids. Are there any other suggestions about that? Do you think I should leave it out?
If you're going to do that rather use a caliper, for body or skin fat. Calipers are easy to use as well.
Ja.
It just makes the questionnaire take half an hour instead of 15 minutes.
But you could process people, because they could fill it in and you could just call them one at a time and measure it quickly.
That's not a bad idea!
Okay, and "what other sport do you perform on a regular basis?" I, personally, think we should state a competitive level", because if they do social swimming once a week, I don't think it's really going to contribute that much to their injuries as opposed to if they're playing rugby or something like that. I don't know what you think?
Personally, I would just like to know what you mean by "regular"?
Okay, do you want me to define it in terms of hours per week or what?
You need to give them a baseline. If you say anything below "X" hours per week is regular, then you may need a separate question, as anything over that being competitive.
Ja, okay.
So, I had two questions….
Rather have them as subdivisions.
Okay.
Alright, dietary habits. In the original questionnaire for the ballet dancers, I know that this question wasn't really well enough defined. I mean, what is a kid going to write about dietary habits? What do they even know about dietary habits?
Ja.
So, I'm not going to launch into a full-on nutritional thing with them, but do you think I should maybe say three meals per day, or lots of fruit and vegetables? I'm open to suggestions.
Well, if their mom and dad are there, at least you could get a feel as to whether it's a balanced diet. Or something more along those lines.
Okay, either a lot of junk food, or….
Junk food, balanced diet, something like that.
Okay.
So, "do you consider yourself to eat a healthy, balanced diet?", or something like that?
Do you want to ask anything like what Barry's just mentioned about supplements? You know, like sports supplements?
Okay, separate question.
"Are you on supplements? If so, which ones?"

Okay. “How would you describe your emotional stress levels?” I was tossing up as to whether to put this one in, or not, but I think it is actually important to consider it, because if you are under a lot of emotional stress, it can take a toll on your physical performance. Maybe you are not going to concentrate so well, or something like that? I don’t know what the eight-year-olds are going to make of that?
Just put a happy, smiley face, or do it like that.
I was actually going to say rather use smiley faces for that one, so a happy face, a not-so-happy face, or something so that they can understand that you are talking emotions if they don’t understand the word or its associations or anything.
Okay, for gymnastics history, “at what age did you start gymnastics?”. Fairly straightforward I think.
“Since you started gymnastics, how consistently have you trained or competed?”
Um, what do you mean by consistently?
It’s a bit of a dodgy question I’m afraid.
Maybe you need to put it in as hours per week.
Okay, they have got “how many hours do you train per week?”.
At present, but this is since you started gym, so some of them could have been training for ten years, and they wouldn’t necessarily have been training at that level for ten years.
Maybe you want to ask for an average per month or week. But that’s at present, not in the past.
Maybe I should say “when you first started gym, approximately how many hours per week did you train?” or something like that, and now, “at present, how many hours do you train per week?”.
I think you should just leave it out perhaps? If you say “at what age did you start gymnastics?” and maybe “at what age did you start competing gymnastics” that will give you an indication. Once you’re competitive, obviously hours are a little bit more. Otherwise it’s very hard to define.
Ja.
So, rather say “at what age did you start competing?” because then you can see, if they started at age 6, and competed at age 8…. Ja.
Okay, what does everyone else think about that? Do you think I should just leave out question 10?
Yes.
I think it gets a bit confusing myself.
Just add a question on the competitive age.
Ja, it will be just underneath the top one.
Okay, “how many years experience do you have?” That will just help to clarify. “At present, how many hours do you train per week?” I’ve said, in my write up about the study, that I would like them to train at least four hours per week, because in order to be competitive, even at South African Gymnastics level (which is really low), you still need to train about four hours per week, minimum.
When you’re talking about “training”, are you talking about straight floor work (or what ever), or are you talking about gym? What are you talking about? Swimming, Cycling, Cross training?
Training as in being at the gym.
Okay.
Then, just a question, “more than ten hours”, a kid that trains 12 hours is very different from a kid that trains 25 to 26 hours!
I can add in another category if you like?
Because, if any of my gymnasts fill this in, they train for more than 20 hours a week, so it brings in another perspective, because 20 hours per week is quite a lot more than 10.
I could possibly say “10-20 hours” and then “greater than 20 hours”.
Ja.
Try and keep your categories even, though. Don’t have smaller categories and bigger categories because then you can’t compare categories.
10-12.
0-4. Oh, you wanted a minimum of 4!
So, 4-8, 9-13, 14-18, 19-23 and more. Because if they’re training more than 23 hours per week then that’s basically the best we’ve got in the country anyway!
Okay, “at present, how many gymnastics classes do you attend per week?” That is just to see basically what there attendance is.
Can they do all 23 in one go, or over a period of blotches?
Or, if they’re not attending, if they’re only coming to gym once a month!
The weekend warriors!
Ja, I mean, if you’ve got children who do a class in the morning before school, and then in the afternoons, do you count that as two?
Ja, those are two separate classes.
Ok, so they’re 7 or more.
Ja.

Basically those kids are going to be your high-level, you know?
Your number 12, the hours that you train per week, does that include your classes?
That is your classes. That is the amount of time that you're in the gym.
You might want to say "in the gymnasium", so that they don't say cycling!
How many hours do you spend, or do you train in the gymnasium.
You see, that's a bit….
….do you do gymnastics training.
…. Do you train in the gymnasium.
Ja.
"How many hours of gymnastics training do you do per week?"
Okay, then with regards to previous gymnastics injuries, because you're going to get those who stopped doing gymnastics competitively like 12 years ago, but they had a cruciate ligament injury or something like that in the past. And then, you get those who are injured at the moment. So we decided to take both of those.
"Have you ever sustained an injury from gymnastics?". Should I say "in the past" or something else?
It does say "previous" at the top.
I was going to say, that question should be put in categories, so if they say "no", then they automatically jump to the next category.
Ja.
And if they sat "yes" then they go onto the "previous" section.
So, the heading must come below these?
Ja.
Okay, "how often have the following areas of your body been injured during gymnastics?" This includes any injuries from gymnastics sustained at any time during your gymnastics career.
Okay, I read through this earlier, and I've got a problem with it because it doesn't have anything above the waist!
There's no neck, shoulder, elbow, nothing that gymnasts have because it was designed for ballerinas, who don't use their arms!
You've got a lot of pieces of body to add in there!
Ja, I'll include head, neck, shoulder, elbow, wrist….
Also upper back.
Whatever detail you have here for the lower extremity you're going to need it for the upper extremity too.
Ja, I'll do that.
Also, your numbering goes a little bit AWOL after number 15.
Oh, yes!
I don't know if you guys are happy with very often, often and seldom, because my often might actually be very seldom, whereas….
Ja.
I don't know if you should maybe put in numbers or something?
Ja, once, 0-2, 2-4, 6-8 or greater than 6?
Okay, so I say "never", that's fine?
Ja.
Either that, or above the table, say "seldom" is so many, "very often" is so many and so on.
Okay, so "seldom" would be about once?
Once or twice.
Okay, "often" would be….
Three to five times.
"Very often" is greater than five times.
Give up gym!!
Okay, so then I'll just put that as a key above the table.
Just a question, do we count when they stub their toes? Because that would happen, so I don't know if you maybe want to say "mild" or "serious"?
Ja, but then how are they going to classify that?
Ja.
I think an injury would be classified as something where the child goes to the coach.
Should I say "excluding skin injuries"? But then what if they chop their head open or something?
But if it's stopped them from gymming then it's serious.
What if it prevented you from training?
That would be "an injury that prevented you from training" or something like that maybe?
…"that affected your training"
Ja.

Actually, they most commonly come to you with complaints like stubbed toes!
And glass in their feet!
Ingrid, just for the others, you may need to make space for others, or rate the table and then put "other", and then add a few more lines.
Ja.
So that they can fill in and then go across.
I don't want to encourage them to write an essay, so I'll just put about five lines.
If you put a block, they only have one word that they can fill in, so….
Okay, will do. "Consider the worst injury you have sustained during gymnastics, how would you describe the severity of this injury?" and obviously if you've never injured yourself then you just mark "N/A". That's simple.
Technically you don't need to have an "N/A", you could just tell them to skip the section.
Ja.
Okay, so you just put….
So, if you answer "no", then you skip the whole section.
Also, it makes it quicker for them to fill in, which will make their moms very happy!
I broke my arm, does that count?!
Okay, and then obviously they've got to take the area in which they had an injury from that table, and then fill in that number in the space.
Then maybe say "consider the worst injury you noted in question 15"
Ja.
Because otherwise they may not have recorded it properly.
Ja, okay, so it's just reminding them.
"Worst injury above"
Your question 16-25 is going to change.
Ja.
Rather make those "A" to something, or what ever.
Okay, right, the numbering for this one will obviously change.
Ja.
"How have injuries to any of the areas below affected your gymnastics?"
You're going to need to be more specific.
Add categories.
Okay, so, ja, and then I'm going to have to specify, "no effect" means obviously they carried on with their sport. "Limited", I'm going to have to have a time frame on that one, maybe how long they were off training for?
One to two days maybe?
No, "limited" means that they can carry on training but they have to limit themselves to certain things, so, like, if you get a sore foot, then you can go and do bar, if it's mild, like just a rolled ankle, then they can carry on training but it would be limited. That's how I understand it, and then "prevented" means they can't gym at all.
Does it mean they can't gym ever again? Or….
No, for the time of the injury, I assume.
You could almost have another category, "ended career in gymnastics".
You have to take out the non-applicables anyway, because some people aren't going to fill in this section.
They wouldn't be filling it in anyway!
Well, the N/A's aren't in this section.
Maybe say "prevented gymnastics", "prevented participation", "limited participation", and "no effect".
Ja.
Well, maybe "ended gymnastics" instead of "prevented gymnastics"? You need it to sound terminal.
Ja, but then, as Dr Grossberg said, if it ended their gymnastics, are they going to be there to fill in the questionnaire?
They could be, because they could be an administrator, or a coach or something like that.
Okay, so "ended gymnastics", "prevented gymnastics"….
Like Claire, as an example, with her cruciate ligament.
Ja, okay, so it's "ended gymnastics", prevented gymnastics", limited gymnastics", "no effect". And the N/A's go.
Again, make two or three others available for the bottom.
Okay.
Alright then, "present gymnastics injuries". "Are you presently suffering from an injury due to gymnastics?"

I just have a question, like my gymnasts that have pain in their SI region, that's probably not caused by the gymnastics, but it's exacerbated by the gym, so now, does that qualify as a present injury? Because they could….
That's not an injury, that's a condition.
They might consider it an injury.
Are we talking about an outside source, or an injury you had in the gym?
Well, how would you tell?
It's a bit of a chicken-or-egg thing really, did they have the problem and then it got worse with gym, or did gym cause the problem?
That's why I asked, I just wanted to know.
That's a separate topic.
So, then, it must be something that's not related to that, because….
Something that they consider painful maybe?
All of mine are going to say that they have sore bums!
They're so used to Ingrid treating them for their SI's, they come into the clinic.
Okay, so….
I'm just asking because otherwise, I know they're going to be guided when they answer the questions, but they might consider that an injury.
Well, then perhaps we should consider it an injury?
Then you should specify whether it's from an outside source, or whether the gymnastics is exacerbating the problem.
Maybe we should say "are you presently suffering from an injury due to gymnastics?", or made worse by….
Will an eight-year-old know that?
"… Made worse by gymnastics"?
"Injuries that are caused by gymnastics", because you only want stuff that's caused by gymnastics.
You see, children won't consider an SI problem to be an injury.
Okay.
Injuries to them are broken, or needing a bandage or a plaster, that's an injury!
I'll just tell them that they're not allowed to include it. You get pain in your hip? Tough!
Did you fall? No? Okay!
Also, another way to consider it is if they weren't gymnasts, would they still have the SI problem from an external or an internal source?
I think it's probably best to just leave it out.
You're opening up a can of worms otherwise!
But it's still necessary in my mind, if you're looking at the profile of injuries that a gymnast presents with, based on the normal population.
You could just put "What injury are you suffering from?"
Because gymnasts are more lax and stretch themselves more than the average person.
Maybe, because they're using their bodies in a greater rang of motion than is normal, maybe that would cause…
Okay, I tell you what, why don't we include it, because later on it asks what you think caused your injury and I could add a category to that effect.
Gymnastics aggravated the problem, or…
Use of the body in unusual ranges of motion, ja!
They're not going to understand that.
No.
Well, instead of just "stretching" you could make it sound more hectic, like "overstretching".
Ja, that might be an idea.
And then we include anything that's painful, so if their SI is painful, then when they get to this category they must just say…
Or insufficient rest, or overwork, maybe that's caused something?
No, I just wanted to clarify, because I'm probably going to be helping supervise some of these kids that don't have parents in the gym.
Okay, I realize that the next one doesn't have an upper body! Don't worry, I will add that in and make blocks for the others.
Okay, "how would you describe the severity of this injury?"
Is this the present injury?
Ja.
Now, what if they've got more than one?
I think you may need to put a question in earlier, "if you're suffering from an injury, and there's more than one, please specify the worst"

Because it is possible!
Or state how many.
Ja, so “if more than one, please state how many”
Okay, and then 39 would have to change appropriately.
Severity of the worst of your injuries.
Ja. Half of these kids walk around with two or three things that are a little bit sore at the same time, so…
Okay.
You see it in the gyms, where you see a child with a knee brace, an ankle brace, a wrist guard, and you wonder how many injuries they are actually carrying.
Okay, so “describe the severity of the worst of these injuries”
I think most of the questions from now will have to be on the worst injury.
So maybe, earlier on, I’ll say “please pick the worst one, and answer the following questions on that one”
So you can ask about any injuries, and let them specify, and then they can carry on from there with the worst one.
Ok.
Maybe you could specify for “mild”, “moderate”, and “severe”?
Maybe an NRS?
On a scale of 0-10, if 0 is no pain, and 10 is the worst pain, how severe is it?
Or just use NRS along here, and say worst and best, and they just circle the number that’s appropriate. You can categorise them for your data capturing purposes into categories.
Okay.
“At the moment, how does your present injury (obviously the worst one) affect your gymnastics?”
Okay, that one I’ll do the same as I did for the other one.
I have a question, if it’s preventing their gymnastics, you’re not going to get them to fill the form in.
Oh, we will!
We’ll make sure they do, even if we have to go to their homes!
Track them down!
Okay, “what is the longest period for which you were not able to do gymnastics due to your present injury?” I’m not actually sure whether we…
Do we really need that question?
How do they know if they’ve just injured themselves, they’re not going to know if it’s going to be longer than six weeks until it gets better.
I think we should leave that one out.
That should rather be a question before, when you were talking about injuries in general, in other words any injury you’ve had in the past that you’ve recovered from.
Okay, so stick that in the past injuries section.
Ja, and leave it out of this one.
Okay, “how long have you had your present injury?” That is a relevant point.
And again, with the “N/A’s” I’ll just do the same as I did earlier.
“If you do not have an injury at present, please move to section 5”
Alright, “which of the following factors do you feel is the most likely cause of your present injury?”
What I did here is, for the question that this was based on, for the ballet dancers, they had a whole lot of technical terms like “point work” etc, which I then sort of converted into gym.
Um, what is “partnership work”?
I actually put that in for the sports aerobics people, because I know that they do work in partners, and if your partner drops you on your head, that would cause an injury.
Is there another lay term for that, other than “partnerships”?
Perhaps “pair work’, or “partner work” or “team work”? Because it’s trio’s, and quad’s and all sorts.
“Partnerships” could also mean other things, and then you could have a problem!
I’ll say “team work”, or maybe I’ll just put it in brackets and explain it briefly.
“Group work” – someone throws a club at your head…
“Group training”
Okay.
I think “insufficient warm up” and “cold” should be in the same category.
Okay. “Stretching”, I should probably add in “overstretching as a separate category.
Yes.
“Twisting”, ”jumping”, “landing”? “Insufficient rest or over work”, do you think I should simplify these terms? Or, I could just explain it on the day?
I think most people will know what that means.
Okay.

“Incorrect posture or placement”?
‘Landings”
You can land, and you can land incorrectly, if you land properly you can still sustain an injury.
Should we say “repetitive landings”, and “incorrect landings”?
Because it takes one incorrect landing to mess you up.
I’ll make those two into separate one’s.
“Unsuitable apparatus”. I thought if there was a hole in the floor, or a hole in the mat, or the bar collapses, or the beam collapses…
Maybe put “equipment failure” rather.
Okay.
Will a littley understand that?
Ja.
They know all about equipment that fails!
Number 6, “insufficient rest” or “over work”, shouldn’t those be in two separate categories?
Probably.
You’re probably over working something because you’re not resting it enough.
Generally, those two categories result in the same kind of thing, like chronic overuse injuries.
I think they’re fine together, myself. I’ll look at it. Okay, now I’ve got “repetitive movements” separately, because that’s quite a distinct category. Anything else you can think of to add in there?
For “other” you’re obviously going to have to get them to specify.
The coach beat me up!
No, the coach got beaten up by the gymnast!
That would be “team work”!
Okay, so what I’ll do is say “if other, please specify”, and give them a few options.
They don’t ever collide with anything, if they’re not on line? With objects, instruments, tables, chairs, anything that you could collide with.
Yes!
Well, you might want to include that!
“Collision with things that are not instruments”
“Collision with apparatus”
They collide with apparatus and with other things.
So, you might want to add that in as a category.
But won’t that be a partnership, but a partnership that’s not supposed to be there?!
“Accidental partnership”!
Between who?
Like those beams that jump to the side when you stand up on them!
Okay, “during which part of your class was your present injury sustained?” I think, personally, that I should change that to “which activity in your class” or something like that.
Are you not repeating some of 43 in 44, like warm up and stretching?
Possibly, but there are separate times in your class that you do certain things. At the beginning of your class you do your warm up, at the end of your class you generally do conditioning, so maybe it would help me to establish which…
Maybe you could put “warm up” and “stretching” as one category, because most of the time your stretching is done…
Put ‘conditioning’ and “strength” in one category as well.
Ja.
Okay. Then, I’ve put in all the artistic apparatus, I don’t know if you want me to specify all the rhythmic apparatus as well, but that would add in like…
No. Use hand apparatus.
But what about the sports aerobics people, because there’s nothing that’s really applicable?
They do floor.
Maybe you should say “floor work” or something like that?
“Floor/dance”, because then that would apply to rhythmic as well.
Ja, so “floor/dance work”?
Ja. Okay, the next question I really have my doubts about, because I think they might interpret it as, “well, gee, every time I do a handstand my coach says I have bent legs”! I’m going to have a list this long! What I actually wanted to establish is do they have one fault, for example in their posture, that is carried out throughout their gymnastics? For example, do they always have an arched back? This could contribute to injury.
Okay, so, “…pointed out a postural weakness?” Or, “…a weakness in your body posture?” Or, “…in your body preparation?”
But are these kids actually going to understand that? I doubt it.

Ask them what their coach mostly complains about.
Maybe I should say “what does your coach mostly complain about?” Bent legs, bad posture, incorrect posture etc.
Or you could put “arched back”, “bent legs”
Give some of the most common ones, because from that you could basically deduce that if they’re always in trouble for having an arched back that they are likely to have bad posture.
And I will say “if other, please specify”
Okay.
The coach will most definitely be the one to point it out the most often, so…
Ja, I just didn’t want to end up with “when I do forward rolls…”
Okay, section 5, the treatment. “Have you ever received treatment for a gymnastics injury?” Or, should I say “…an injury sustained from gymnastics?”
Maybe you should specify some treatments? Like, treatments at home, with a doctor etc.
Okay, that’s the next question, except I haven’t got a category for home treatments.
“Home remedies e.g. ice”?
And pain tablets, but that would be medication.
You forgot Band-aids!
That would be bracing or strapping!
Are you going to want them to specify “other”?
Ja.
Surely if they say “N/A” for treatment they can skip?
So, all the “N/A’s” will be out.
Okay, “have you received treatment for your present injury?” “What kind or treatment?” “Rehab”, “medication”, “injections” is basically to see whether they’re going for the physical rehab for the injury, or if they’ve just taken painkillers or injections or something like that.
Is there stuff missing down the bottom there?
No, that was just two broad categories.
Then it should be 01 and 02.
Oh, sorry.
Are you sure you don’t want to put the other categories in again?
I think the top line of the last block was just copied and pasted.
We’ll just do that whole table again.
And that’s it! Does anyone have anything to add? Any questions that you think are relevant that I haven’t addressed?
Do you want to know if they’ve ever had dietary advice? Or anything like that, a treatment plan?
That would be treatment received for past injuries.
Okay.
Do you want to know anything about dietary intervention?
Maybe I should put that as “other”?
Or as “nutritional advice/intervention”?
Not advice, but something they can change in their lifestyle, not just having gone to…
What should I call that? “Supplementation”?
Not necessarily.
But if they need to strengthen up, they might go on a protein shake or something?
“Nutritional therapy/supplementation” or something like that?
Ja.
Is diet a main focus?
In gymnastics it generally is, even from a young age.
As far as treatment goes, are you putting in “natural remedies” or “homeopathy” or “Rescue remedy”?
Should I say “natural, e.g. homeopathy”?
And then if they’re going to say they went for Ayurvedic therapy they can put that under “other”. I’m not really interested in specifying all that other stuff.
But if you put it under “other”, you’re also classifying that as a treatment?
Ja, as natural treatment. Anything else?
Is there anything else that would be interesting to extract from people in the gymnastics environment? Something about coaching, or advice to people?
Direct planning, or something that’s not on there that would be valuable.
I think that every gymnast should be made aware of the usage of their body both physically and mentally, and that they should have regular treatment just to keep their body in working order. For example, you have to service your car regularly to avoid problems, and the same goes for the body, or else injuries occur. Perhaps you should have an educational program saying that if you’re going to take up gymnastics, from as early as age eight, once or twice a month (depending on how intense the

training is) that they must have a regular “service”. A spinal problem is probably a cause of dysfunction in the long run. It is the body and it’s movements that rely on the split second timing in gymnastics. That message from the brain to the arms and legs has to be perfect, otherwise they are going to injure themselves, and the parents don’t know about it . The parents should be educated on that, so that their child can participate in a program like here at the Technikon, like Ingrid does, where once a month they all file in here to the clinic.
What about if I added a statement or a question, under “treatment”, “do you receive regular medical check-ups?” or…
Remember, we’re dealing with mechanical problems here, medical is just on the side of aspirations etc. We’re talking the mechanical aspect of…
So, maybe put it under “chiropractic”? Some of them would answer that they had chiropractic treatment for one of their injuries, you could maybe ask if they now have continued the chiro treatment to…
Or, have you considered…
Because, if they said they had it, maybe it was just a once off, and then they haven’t been back? They must get away from “Crisis therapy” to maintenance.
So maybe we should say “do you receive maintenance treatment in the form of Chiropractic?”
Or even so, for your two tables, 47 and 49, where you say “what type of treatments…?”, and then after the table, what ever they said there, and then do they receive regular care from who ever they’ve indicated in that table?
Yes.
Regular or once off.
Maybe their Homeopath that they go to tells them to go once a month, as opposed to their Chiropractor.
So, “do you receive regular care from your choice of the above?”
“…from the person that you mentioned in 47, or 49?”
And then, maybe, how often?
You don’t want to link it to an injury, though, because you’re also interested in gymnasts who might not have had an injury, whether they’re involved in regular check-ups?
Yes, because if they’ve had regular check-ups there might be less chance of injury.
Ja, maybe you need to mention some statistics on children that haven’t necessarily had injuries, have they received any maintenance treatment, so that maybe they’re not getting injured? Because that’s an angle you could go on, that maybe a child hasn’t had any major injuries, and they go once a month a get a check-up at their local what ever?
I, personally, think that the gymnasts at our club would be the only ones that fir under that.
So, start the ball rolling at other clubs.
What I can do is, when I’ve got the results, is go around to the clubs and impart my knowledge about that.
And also teach them about the correct stretching, or how to minimize muscle pain in certain areas.
Ja, I’m willing to do that.
Like “bum stretching”, my kids know how it reduces pain and all that.
Ja, but it’s not necessary…
Ja, but when she’s going around educating people, the coaches need to be educated on ways to stretch their kids more effectively. As part of the education, maybe, put in helping the coaches with stretching the correct muscle groups, that would help maintain…
Ja, I’ll do that all afterwards as a follow-up from the questionnaire.
Maybe you want to, for section 3, where you say “have you ever sustained an injury from gymnastics?” is somewhere, either before or after that question, ask them whether they have ever been on a rehabilitation plan, or have had other forms of strength or co-ordination training, so you can make a direct link either to injury or lack thereof in a particular sub-group of gymnasts. This may be apparent even if it’s only your handful of people that you are treating, but then at least you can say that they are having treatment and others aren’t. Therefore there is a direct correlation or lack of correlation to injury.
Perhaps we should say “have you ever received regular treatment from any of the following:” and have manipulation or Chiropractic …
Or you could essentially take the table we had at the back and bring it to the front.
Ja.
It’s just that anyone who says “no” to “have you ever sustained an injury from gymnastics?” won’t carry on with the questionnaire, so you have to put it right in the front.
Okay, so I’ll take the table and pop it in here, and say “have you ever had regular treatment from blah blah despite never having had an injury?”
Okay, that can be part of my motivation for doing the study.

Anything else?
Going back to the cross training, do you want to know how much they cross-train?
Or what kind of cross training they do?
I was debating about whether to ask that!
I don't know how much that impacts on…
The high-level kids don't cross train, because gymnastics in itself is about five or six different sports!
Ja, but the low-level kids do. Think about how we had kids that were relatively low-level and they would come to gym with a different netball, hockey or what ever injury just about every week.
And athletics is the worst one. Long jump, high jump…
Maybe I should say "what other sports do you play competitively?"
In the history, just to find out, where you look at diet etc, just to see which other factors could be involved, or that you…
Maybe I should say…
You decided to divide it into two parts, regularly and competitively…
Because a lot of kids sustain injuries at school sports level, which they don't do regularly, and that if they say "right, you're doing high jump", and everyone does high jump and they end up injuring themselves. So then you could say that the injury happened because they're not training it regularly.
And also, don't give them a list, give them maybe two that they can write down. Otherwise you are going to get another list of "I do this, this, this and this in the holidays, and…"
I'll say maximum two.
And then maybe "have you ever sustained an injury in any other sport?"
That's not really relevant.
No, but it might be. If a child twists its ankle playing hockey, the ankle is then weakened in the future, and then landing on it incorrectly in the gym will make a bigger injury than it would have without the hockey injury.
Ja.
Perhaps you should consider it?
Okay, "state your worst injury that you have received from any of the above sport"
Well, because, thinking back to Celestie, when she trained with us she had knee problems due to netball training on the hard surface, and then that impacted on the gymnastics training, because she then couldn't do anything involving the knees, so…
Okay, well if they choose the worst injury, so if they injured their shoulder playing rugby, and now they've got a shoulder problem from gymnastics, we can maybe do a cross-correlation kind of thing. Because, also, you need to be able to eliminate the shoulder they report later from the shoulder from another cause.
Ja, they might injure it in rugby, and then it gets better, and then two months later they injure it in gym and they think it's gym that's done it but it could be an old weakness from the rugby injury.
I think what we'll do is find out the worst injury, and then just do a correlation between those two questions. The worst injury from other sports, and injuries in gym, and see if there's a correlation.
Everyone happy?
Yes.
Thank you all very much for coming, and spending your evening with me, I appreciate it a lot!

APPENDIX L

Recommendations to club leaders and coaches to improve safety of the gymnasts (extracted from Caine and Nassar, 2005)

1) Coaching

1.1) Education of coaches

Coaches should meet a minimum level of qualification (Weiker, 1985) and should protect the gymnast from premature attempts to execute advanced manoeuvres (Clark, 1977).

1.2) Physical preparation of gymnasts

- Coaches must provide specific stretching and strengthening exercises – particularly for the Achilles tendon, hamstring and quadriceps muscles (Mackie and Taunton, 1994)
- Maximum conditioning of those muscles used for spinal and abdominal strengthening to avoid chronic back conditions must be implemented (Garrick and Requa, 1980; Soler and Calderson, 2000)
- Conditioning programs to prevent muscle strains associated with the short bursts of running in floor exercise and vaulting must be used (Garrick and Requa, 1980)
- Gymnastics-specific flexibility should not be emphasized before extent flexibility at various joints is adequately developed (Lindner and Caine 1990)
- Coaches must encourage wrist strengthening and flexibility exercises to help protect the wrist against chronic injury (Caine et al., 1992)
- Correct landing techniques should be taught and practiced to prevent fractures and dislocations of the upper extremity (Mackie and Taunton, 1994)
- Coaches should ensure an adequate warm up (Caine et al., 1989; Kolt and Kirkby, 1999)

- The potential for growth plate injuries, and the importance of referring the gymnast for medical evaluation as soon as symptoms occur, must be recognized (Caine et al., 1992; Kolt and Kirkby, 1995 and 1999)
- Conditioning specifically designed to “smooth the transition” from skill training to routine training must be used (Caine et al., 1992)
- Coaches must ensure the correct technical performance of movements to avoid unnecessary overloading of the spine (Soler and Calderson, 2000)

1.3) Training of gymnasts

1. Alternate loading types during workouts; for example, alternate swinging and support movements so as to reduce stress on the wrist (Caine et al., 1992)
2. Gymnasts must be trained in a cyclically progressive manner so that the gymnast is not increasing the dose of load bearing in a progressive stepwise fashion, but rather in a cyclical manner; every escalation must be followed by a decrease in overall load for one week, followed by another increase, thereby allowing reparative time for connective tissue structures (Caine et al., 1992; Pettrone and Riciardelli, 1987)
3. Coaches must reduce the duration of rotations and increase their number per workout, to avoid lack of concentration and inattentiveness; avoid training when concentration is poor (Lindner and Caine, 1990; Mackie and Taunton, 1994)
4. Training loads must be reduced during periods of rapid growth (Caine et al., 1992; DeFiori et al., 2002; Caine et al., 1989; Lindner and Caine, 1990)
5. “Spotting” should be used more extensively during practice, and obligatory during high risk events (Lindner and Caine, 1990)
6. Well-trained “spotters” should be available (Bak et al., 1994; Weiker, 1985)

2) Equipment

- Encourage use of personal protective equipment such as dowel grips and hand guards (Caine et al., 1992)

- Increase the thickness of the landing mats during practice and competition (Goldstein et al., 1991)

It has also been suggested that a physical screening program (to monitor the gymnasts' health) be implemented (Solder and Calderson, 2000; Kolt and Kirkby, 1995 and 1999; Caine et al., 1989; Steele and White, 1986) another suggestion is that gymnastics clubs include within their cost structure sufficient funds to hire an athletic trainer or physical therapist, at least on a part-time basis (Caine et al., 1992; Jackson et al., 1976; Kolt and Kirkby, 1999; Garrick and Requa, 1980).

Both of the above factors are very good suggestions, however, in South Africa, because of the intensive development plan, many previously disadvantaged gymnasts are training at gymnastics clubs free of charge. Thus, funding for these recommendations is not possible.

Lastly, a few studies (Bak et al., 1994; Caine et al., 2003) have suggested that the scoring system and the competition rules and performance environment be re-evaluated, given the high incidence of injury with competition.