

**CUMULATIVE INCIDENCE OF MUSCULOSKELETAL INJURIES AMONG
STUDENT DANCERS AT TSHWANE UNIVERSITY OF TECHNOLOGY**

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**A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
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ABSTRACT

Dance movements requires explosive power, sustained effort and both local and general endurance. Musculoskeletal injuries (MSI) are the most frequent medical problems among dancers in ballet, which is partly owing to inadequate training and dancers not being properly prepared for the demands of the dance performance. The study involved a prospective, cohort design. A population of 49 student dancers at Tshwane University of Technology (TUT) were studied over 16 weeks academic year in 2007. The purpose of the present study was to determine the cumulative incidence of musculoskeletal injuries amongst student dancers at TUT. The student dancers filled on a questionnaire about previous injuries, their study schedules and factors they believed increased the risk of injuries. Of the 49 student dancers, 41 (83 %) consent to participate. There were 10 cumulative injuries incurred by 41 student dancers over 16 weeks period i.e. 7.1 %, 0.06 injuries incurred per student month at risk. The main limitations to this study were small sample size and misclassification, recall, and reporting biases. Further research should aim to standardize injury definitions and classifications.

KEYWORDS

Dance, Musculoskeletal injuries, Cumulative, Incidence, Prevalence, Risk factors, Prevention

DECLARATION

I declare that “*The cumulative incidence of musculoskeletal injuries among student dancers at Tshwane University of Technology*” is my own work, that it has not been submitted for any degree or examination in any other University, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Nontembiso Magida

Signature

November 2009

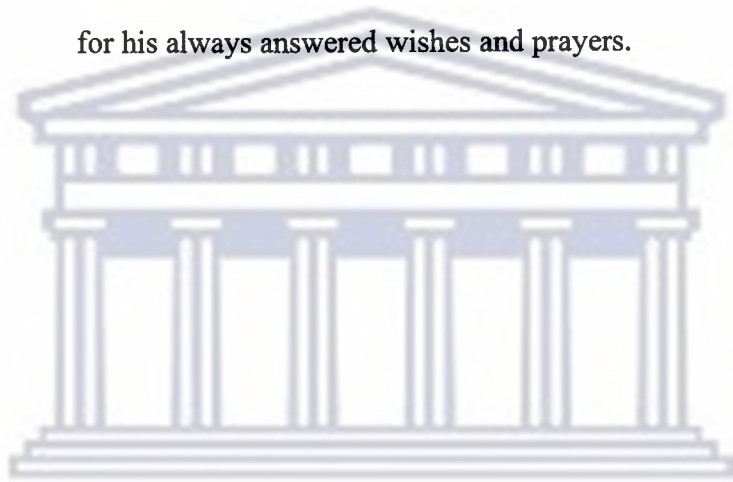


Prof Julie Phillips (Witness)

Signature

DEDICATIONS

I dedicate this work to my family, for all their patients, support and unconditional love; to Richard Seabi for his support, love and understanding in the whole process and to God for his always answered wishes and prayers.



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Lastly, but not least, my daughter Atlega, I have taken too much of her time trying to complete this thesis and she never complained. Thank you so much my baby girl, your mom loves you so much.

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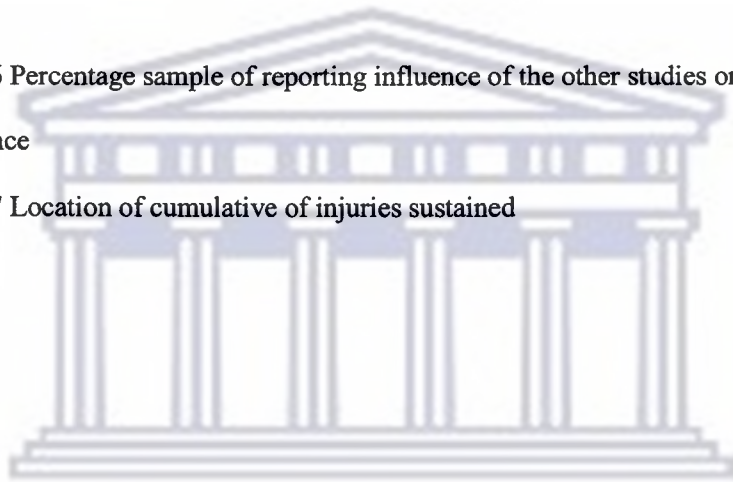
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CHAPTER 1

INTRODUCTION

1.1 Introduction to the chapter

Dance has been found to be more physically demanding than most sports, as it requires the mastering of very specific and precise technique that differs immensely from normal movement. Dancers have unphysiological training with extreme movements, such as excessive turnout of the hips, which is the part of the daily exercise and performance in the dance. Dancers often face the possibility of specific injuries, probably caused by their training program. Dancing through the pain or after injury can result in acute and chronic medical problems and will have negative effects on training intensity, cause a faulty technique and poor performance (Miletic , Miletic & Males, 2008). Dancers may avoid seeking medical care for various reasons, including lack of insurance coverage and financial resources, fear of losing positions or roles, and belief that health professionals do not have an adequate understanding of the demands of dance training (Weigert & Erickson, 2007)

The present study examined the cumulative incidence of musculoskeletal injuries (MSI) amongst dance students at Tshwane University of Technology (TUT) during a semester. In this chapter the background of the study is stated and aims and objectives are discussed. The significance of the study is highlighted as the identification of risk factors is important for preventative strategies. Information on student dancers regarding the risk

factors is important and therefore able to assist in preventative strategies. Aims and objectives are discussed. The chapter ends with the definition of terms and the abbreviations used in the study.

1.2 Background to the study

Dance is a special form of performing art, which uses body motions and an aesthetic form to express and communicate (Deighan, 2005; Bronner, Ojofeitimi, & Spriggs. 2003 a).

Dance is an art form in which the body is the instrument of expression. The physical demands on dancers from current choreography and performance schedules make their physiology and fitness just as important as skill development (Koutedakis & Jamurtas, 2004). Like athletes in competitive sports, dancers are an “athletic” population that performs in a highly demanding environment and that is at high risk for physical injury. Both athletes and dancers suffer from musculoskeletal injuries, and the types and sites of injury are very similar in dancers and traditional sport (Nilsson, Leanderson, Wykman & Strender, 2001). Dancers often push themselves to their physical limitations to achieve excellence.

Dancers are highly trained athletes who are at significant risk for injury due to intense and the repetitive nature of their movement pattern (Gamboa, Roberts, Maring & Fergus, 2008). Professional dance companies have reported that as many as 67 % to 95 % of their dancers are injured on an annual basis, while one dance school reported that as many as 77 % of their adolescent dancers were injured in one academic year. In ballet, the greatest proportion of injuries is reported to occur in adolescent dancers 12 -18 years of age. The

majority of ballet injuries are classified as overuse, and most injuries occur in the lower extremity followed by the spine.

Although differences exist between various dance forms, and between dance and other forms of athletic activity, it is the similarities between the disciplines of sport and dance that is important (Koutedakis & Jamurtas, 2004). As in sport, dance performance is not a single act. It is a rather complex phenomenon depending on a large number of elements with direct and indirect effects (Koutedakis & Jamurtas, 2004). At a professional level, dancers must be experts in the aesthetic and technical sides of the art psychologically prepared to handle the stress of critical situations and free from injury.

Young people who are committed to developing careers in dance typically maintain that they must practice their art everyday to meet its demands. Unfortunately, the daily practices of movements that are extreme and repetitive make dancers more susceptible to injury than the population at large. Unlike their fellow athletes in most other sports, dancers seldom experience career-threatening traumatic injuries but they do manifest a wide range of micro-traumatic syndromes (Koutedakis & Jamurtas, 2004). Although some dancers do not have some perfect bodies for ballet such as, for doing turn-out anatomically, they try to compensate by using external rotation of the hips in to seek greater turn-out. Studies have shown a significantly increased incidence of arthrosis in the foot, knee and hip joints of former dancers, which is similar to that found in former soccer players (Weigert, 2005).

Dancers, both female and male, are the physical means by which the choreographer sculpts a composition of expressive motion. The grace and art of ballet performance belie the great physical strain on the body as whole and the foot and the ankle in particular (Kennedy, Hodgkins, Colombier, Guyette & Hamilton, 2007). The researchers further stated that, from an early age the dancer must learn to be artist, gymnast and athlete. Most ballet dancers train for a minimum of 10 years before attaining the skill set necessary to join a corps de ballet. Throughout this time of training, the body is placed under great strain, and it is by process of natural selection that those dancers that are flexible and technically proficient survive the rigors of training to advance further.

Female dancers spend a considerable time 'en point' or on the points of the toes, whereas male dancers tend not to dance on their toes and spend much of their times in turning, lifting and holding ballet dancers. As such, male and female dancers tend to present with distinct dance injuries. The most disturbing data suggests that female dancers weigh less than 15% below the ideal weight for their height. This has metabolic consequences leading to stress fractures and slower union rate in injured female dancers. In contradiction, male dancers have fewer metabolic problems, but are prone to overuse injuries from repetitive motion, and to stress fractures, from the sudden deceleration of large leaps, vole, sauté or jete (Kennedy et al, 2007).

Among dancers, musculoskeletal injuries (MSIs) are the most frequently reported problems, with 60 – 80 % of dancers being affected (Shape, 2004). These injuries include strains and sprains of bones, muscles, tendons, ligaments and soft tissues injuries. Dance

movements requires explosive power, sustained effort and both local and general endurance. The physical and performance stresses of dance upon musculoskeletal structures of the dancer are similar to those of other sports activities and were recognized in the 1984 Olympic Scientific Congress Proceedings (Koutedakis & Jamurtas, 2004). Both dancers and athletes are seeking perfection, both needs to keep in shape and undertake repetitive practices before a performance. The musculoskeletal injuries the athletes and dancers are experiencing are almost the same. MSI are the most frequent medical problems among dancers in classical ballet and modern dance (Weigert, 2005; Askling, Lund, Saartok & Thorstensson, 2002). These researchers further stated that professional dancers have a high prevalence of self-reported work-related aches and pains of the musculoskeletal system. Several researchers and dancers have suggested that this is partly owing to inadequate training and dancers not being properly prepared for the demands of the dance performance (Askling et al., 2002).

Student dancers take several dance classes each day in addition to their daily performance or rehearsal schedules. In addition, they often perform extracurricular dance and other athletic activities. Dance training can generally be characterized as intermittent exercise with bouts of brief duration (Wyon & Redding, 2005; Koutedakis & Jamurtas, 2004). Both dance training and performance involves dynamic and static work of large and small muscle groups, and also emotional stress. It is thus clear that preparation for a career in dance is accompanied by a high potential risk for physical injuries. Most dance injuries are overuse problems related to dance technique and repetitive loading (Weigert, 2005; Askling et al., 2002; Byhring & Bo, 2002). Over half of the injuries involve the

lower extremities. Dancers' feet are the instruments on which their art depends. They require, in addition to an extraordinary flexibility and strength, particular anatomical profile. Over time a dancer's foot will evolve and only the strongest will survive.

Dancers' feet are typically intrinsic-plus; they have narrow metatarsal width with straight toes (Kennedy et al., 2007). Apart from muscle strength, dancers' feet require great flexibility. Different dance forms have their own special patterns of injuries.

For most people, performing dance is about technique, style and (in the case of ballet) tradition (Koutedakis & Jamurtas, 2004). However, the physical demands placed on dancers develop from current choreography make their physiology and fitness just as important as skill development.

While a lot of studies have been done abroad regarding the prevalence, incidence, and epidemiology of dance injuries, very little has been done in South Africa.

1.3 Problem statement

Although surveys of injuries to professional and student dancers have been done abroad, little information is available for student dancers in South Africa. Information on student dancers' injuries that occur frequently is important to know as it will assist in the preventive measures and therefore improving the performance of the students.

1.4 Aims of the study

The primary aim of this study was to assess the incidence of injuries in a semester sustained by student dancers at Tshwane University of Technology and to assess the risk factors associated with these injuries.

1.5 Objectives

The primary objective of the study was:

- To establish the cumulative incidence of musculoskeletal injuries (MSI) among student dancers at TUT.

The secondary objectives of the study were:

- To establish the prevalence of MSI among student dancers at TUT
- To establish the location and recurrence of MSI in student dancers at TUT.
- To identify possible risk factors associated with MSI in student dancers.
- To investigate possible preventative strategies

1.6 Significance of the study

In the light of the limited information available on the incidence and prevalence of MSI among student dancers in South Africa, the present study will provide baseline information regarding the prevalence of injuries among this population. Furthermore the identification of risk factors will assist dance instructors to correct techniques, prevent injuries, minimize the impact of injuries and improve the performance of student dancers.

1.7 Definition of terms

Dance: is defined as a conscious effort to create visual designs in space by continuously moving the body through a series of poses and pattern tracings. The movements must also be in sync to a particular rhythm (Hamilton, 2006).

Musculoskeletal injuries (MSI): An injury or disorder of the muscles, bones, joints, tendons, ligaments, or related soft tissues that may be caused or aggravated by activities related to performing, rehearsing, practicing or taking classes in dance (Hamilton, 2005).

Prevalence: the proportion of people who have a given disease or condition at a specific point in time (Dawson & Trapp, 2004).

Incidence: a rate giving the proportion of people who develop a given disease or condition within a specific period of time (Dawson & Trapp, 2004).

Classical ballet: characterized by the turnout of the hip, rising up on toes, elevation, beats, turns and toe dancing (Hamilton, 2006).

Modern dance: characterized by barefoot dancing, asymmetry and personal choreographic or dance styles (Hamilton, 2006).

Pointe` shoes: also referred to as toe shoes, are special types of shoe used by ballet dancers for pointe` work.

Demi pointe`: a ballet term meaning to raise high onto the balls of the feet, ankles fully stretched.

Ballet: a classical dance form characterized by grace and precision of movement and by elaborate formal gestures, steps and poses.

Plie`: a movement in which the knees are bent outward, with the back held straight.

Releve`: a rising up into full point or half point from the flat of the foot (Wiley Publishing, 2005)

Sprung floor: Is a floor that absorbs shock, giving it a softer feel (Machleder, 2000)

Genu valgum: knees rotated to the outside (The oxford pocket dictionary, 2009)

1.8 Abbreviations used in the study

TUT: Tshwane University of Technology

MSI: Musculoskeletal injuries

SEFIP: Self – Estimated Functional Inability because of Pain

1.9 Outline of the thesis

The first chapter has highlighted the need for cumulative incidence of musculoskeletal injuries in student dancers. The statement of the problem was stated. In addition, the study objectives and significance were explained.

Chapter two presents a review of relevant literature in the field of dance injuries. As dance is sport and art at the same time, both fields were looked at. Literature was reviewed regarding injuries sustained by both professional and amateur dancers. Furthermore, literature highlighting risk factors and preventive measures were reviewed.

In Chapter three, the research methods used in the study is described. The study design, the population and the study sample used are discussed. Furthermore, the research instruments and the statistical methods for analysis are discussed.

Chapter four presents the results of the data analysis. The results include information related to the demographic data, prevalence of previous injuries in dancers, sites and mechanisms of injuries, results on cumulative injuries obtained and the incident rate of the injuries.

In Chapter five, the results of the study are discussed and compared to previous studies.

Chapter six provides a summary of the study and draws conclusions based on the findings. The limitations of the study and the recommendations for future researched are

also presented. In addition, recommendations based on the main findings of the study are made.



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CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter sources competency texts and journal studies in an attempt to review current thinking and research finding in the arena of dance injuries in students. A literature review of injuries in dancers, including professional and amateur dancers was conducted. Relatively few articles have reviewed dance injury prevalence and mechanisms of injury in South Africa. The purpose of this review was to provide a thorough literature review of the cumulative injuries, mechanisms and prevalence of dance injuries

2.2 DANCE AS AN ATHLETIC ACTIVITY

Dance is a specific form of performing art, which uses body motions and an aesthetic form to express and communicate (Koutedakis & Jamurtas, 2004). Dancing is an activity with high physical and artistic demands. Dance is unique – being both art and sport. Its technical demands override what other athletes consider proper muscle recovery time (Buxton , 2008). Although dance is considered to be a performing art, the athleticism of the dancers is without question. Dancers are athletes who are artists and artists who are athletes (Simpson, 2006). Dancers believed they are “performing artists” not athletes and so have a different attitude to training. The skill of dance is often contrasting; they may need to jump and perform explosive movements but are also required to demonstrate

flow, lightness, balance and sequential turning whilst appearing aesthetically pleasing (Redding, 2007).

Like athletes in competitive sports, dancers are an “athletic” population that performs in a highly demanding environment and that is at high risk for physical injuries. Unlike many sports, dance has no seasonal breaks, meaning a constant high level of fitness is required. Because the physical and psychological skills required for success in this profession rival and in some cases exceed those of other athletic population, dancers have attracted recent empirical attention by sports medicine researchers (Koutedakis & Jamurtas, 2004). The dance community however, has been slow to react to the mounting evidence supporting the importance of health and fitness in relation to dance performance. Dance has been described as an art form in which the body is the instrument of expression Simpson, (2006). Furthermore in seeking the maximum style and technique, dancers often exceed their capacities, overstretching or abnormally compressing the body’s tissue. These forces result in injuries such as muscle strain, joint and ligament sprains, bruises, or even fractures and dislocations that may be temporary or permanent.

One might compare the lifestyles of dancers and athletes and the similarities may be surprising to some. Due to the physical demands that are placed on the body, diet and discipline are all crucial to both dance and athletics (Noa, 2006). The careers of both dancers and athletes are threatened by injuries and therefore the conditioning and care for the body is similar. A career in either profession is likely to begin at a young age and end by the time they are forty (40), due to the extreme physical nature. The thrust of dance as

fitness into mainstream media has made the dance popular as a means of keeping in shape. When an audience member who has experienced dance goes to see a professional company they may appreciate better the skill and physical fitness required to achieve such feats (Bhaba, 2007).

There is more to dance than physical skill and virtuosity (Darts, 2005). Often dancers are described as athletic as they have trained in many different genres giving them powerful muscular physiques and an element of attack in their movement. Whilst it is clear that the physical attribute of a dancer are similar to those of an athlete; dance is considered an art form and there is much more to the art than physical skill and virtuosity (Noah, 2006). Dancers may feel that if they are described as athletes their ability is being reduced to their physical skill alone whereas it is the joy of dance that will drive a dancer to continue their training at such a pace for so many years.

Student dancers take several hours dance classes each day in addition to their daily performance or rehearsal schedule. In addition they often perform extracurricular dance and other athletic activities. Dance training can generally be characterized as intermittent exercise with bouts of brief duration (Wyon & Redding, 2005). Dance training as well as performance, involves both dynamic and static work of large and small muscle groups and also emotional stress. According to (Noah, 2006), the largest portion of training and performance is spent focusing on technique, but the building block that all other technical training relies on is the physical technique of movement..

In dance hard work is essential from extra technique classes in ballet, modern and jazz to supplemental training at the gym. While its no surprise that exhaustion is related to burning out, tired dancers has less wiggle room than athletes when it comes to preventing overload (Hamilton, 2005). Unlike sports, the dance profession does not embrace the idea of periodization, where hard workouts alternate with easier routines that have rest built into them. Instead dancers are expected to work out 100 % everyday, potentially exacerbating symptoms of burnout like mental and physical fatigue, decrease levels of achievement and work related injuries. The scientific and medical communities are now beginning to acknowledge that many forms of dance are as strenuous and physically demanding as most sports activities (Liederbach, 2007).

Different dance styles require distinctly different skills, steps, and fundamental physical demands (Noh, 2005). Furthermore, ballet requires standard foot points, which are connected kinaesthetically with pointing along the centre line of the foot, and turn-out, which maintains the 180° external rotation of the lower extremities from the hip joints through the upper and lower legs and feet. Modern dance has no rules or techniques as an attitude toward dance, because it stresses individual creativity and personal choreographic styles (Botha, 2007). Furthermore modern dance involves free expression and movement based on the basic principles of “tension and relaxation”, “fall and recovery”, and “contraction and release”. Because modern dance involves the distorted use of lines, shapes, and forms to achieve a new aesthetic, any topic can be expressed freely with any movements.

Ballet and jazz require the most flexibility, ballet, jazz and modern require the most endurance, hip-hop requires a lot of endurance but the least flexibility (Buxton, 2008). Ballroom, traditionally, has not required any of the physical requirements of ballet. Ballet is traditionally the most particular art form for physique (Buxton, 2008; Clabaught & Morling, 2004). Highly arched feet are also preferred in ballet, even though lesser arches get stronger earlier in training (Morris, 2001). In the early days of modern dance, such as in the early Martha Graham days, those dancers did not need to look like ballet dancers, the priority was the presentation of her peculiar movements that evolved into a technique (Foulkes, 2002).

Dancers in a professional company usually rehearse 8 hours a day (Buxton, 2008). When performing they may do eight performances a week. The principal dancer roles will be less frequent and they are more demanding (Reiter, 2007) Except in the larger companies, many dancers rehearse eight hours a day, or perform, and maintain an outside work schedule as well.

2.3 Injuries

2.3.1 Definition of injury

Various definitions of the injuries are found in the literature reviewing injuries associated with dance. The discrepancy between the number of reported injuries and the amount of pain reported at any given time could be related to the definition of injury, or how dancers themselves perceive injury with respect to pain and activity limitation thresholds (Jacobs, 2007). Injuries can be defined in a variety of ways, such as in terms of the

medical problems, by assessment of their severity, from the time- loss they cause, in terms of their frequency, and by considering the activity modification they require. Luke et al. (2002) are of opinion that injuries cannot be defined as “missing practice or class” because the dancers often dance through injuries. In dance, some researchers, who have examined the relationship between psychosocial factors and injuries, have used injury report forms. Murphy, Connolly, and Beynnon, (2003) used history of injuries to measure the earliest injury participants could remember and measured the severity of each injury (i.e., major and minor injuries) by the ratings of an orthopedist. The weakness of this definition of injury is that it is difficult to measure severity of injury, because this usually depends on an individual’s response to the injury or it is based on classifying injuries only according to the number of days for which normal activities are disrupted or missed. In addition, it does not clearly distinguish what major or minor injuries are and whether the injury was caused by dance. Murphy et al. (2003) further suggested that duration of injury is a more objective measurement than severity of injury. The rate of injury for dancers is difficult to establish because there are no uniform standards for measuring or defining injuries, and no standard methodology from capturing workload exposure i.e. number of actual hours spent dancing (Gamboa et. al. 2008). Likewise, the number of injuries each year is not widely reported. Some authors reported injury rates per dancer, but study periods vary from 9 months to 5 years and methods from defining and reporting injuries are inconsistent.

2.3.2 Prevalence and rate of dance injuries

Studies of ballet dancers show that 90% of professional dancers and 63% of student dancers have had a dance-related injury at some point in their ballet career. As dancers use their bodies for expressive purposes, they frequently overuse various body parts when they learn and perform dance techniques. Most dancers invest a great deal of effort in their preparation and this is often associated with injuries both in practice and during performance. Until recently, most researchers who were interested in dance studied aspects of injuries, including their frequency, the physical causes, and the effects of dance styles, such as ballet, modern, and aerobic dance (Noh, 2005). Noah (2005) further reported that most injuries are musculoskeletal affecting the soft tissues of the back and legs. Sprains, strains, tendon problems, and stress fractures from overuse are the most common. Most of the injuries are minor and do not require time off. Many dancers suffer from more than one injury at a time. Injuries are not always reported and/or treated (Hincapie, 2008). Overuse injuries, also called cumulative trauma disorder, is a category of sports related injuries that result from repetitive use.

Constant training without sufficient downtime can cause burnout, leading to problems like mood changes, respiratory infections, a loss of technique and injuries. Dancers in all settings are known to have high injury rates. Identifying risk factors is critical in developing strategies for preventing injury (Weigert, 2005). Indeed, several scientific and dance studies report that dancers face a greater risk of suffering long-term disabilities than other elite athletes.

Luke et al. (2002) reported 2.6 injuries per 1000 athlete exposures for a group of elite adolescent dancers where athlete exposure were defined as a dance event e.g. a 1.5 hour ballet class, a 3 hour rehearsal or 20 minutes performance. Nilsson et al. (2001) reported an average rate of 0.6 injuries per 1000 hours of dance over a five year study period for a group of professional dancers with a mean age of 28.3 years. Dancers are aware of the high rate of injuries and also of procedures that might help to prevent injury -for example, dancing on floors that are sprung and in warmer studios; teachers' and choreographers' awareness of a dancer's limitations and the need for rest and adequate treatment when an injury occurs.

In the study conducted by Weigert (2005), the overall injury rate of dancers was 67 % for the first semester and 77 % for the second semester. No correlations were found between the presences or duration of prior ballet, modern dance, or jazz dance training and overall injury rates, number of days class missed or modified, or total pain score. No differences were found when subjects were stratified by the technique or academic level.

According to Smith (2002), injury rate for ballet dancers over an eight-month period was 61 % .This is comparable to the rates found other studies for athletes in collision sports such as football and wrestling. The author further stated that ballet dancers are as vulnerable as athletes because ballet is a very pressure-packed activity with tremendous amount of competition. Ballet is physical grueling and the fact that other dances are competing with them adds to the physical stress. Dancers often perform hurt and are

afraid someone will take their place. The level of precision required is comparable to that of an Olympic Gymnastics (Smith, 2000).

As in other populations engaged in athletic pursuits, epidemiological research has revealed a high prevalence of injuries among dancers. On any given day, the prevalence of injuries among professional ballet and modern dancers can be as high as 70 % (Liederbach, 2008; Peterson, 2005; Askling et al. 2002). A disproportionate incidence of injuries occurs among a relatively small proportion of dancers, indicating the presence of vulnerability factors, some of which may be psychosocial in nature (Byhring & Bo, 2002). Noh and Lee (2001) examined the frequency and severity of injuries among dancers and found that ballet dancers had experienced higher frequency and greater severity of dance injuries compared to Korean and modern dancers. Garrick and Requa (1993) as cited by Byhring and Bo (2002) reported on a total of 309 injuries among 104 professional dancers sustained over a three-year period. Moreover 23 % of these dancers accounted for 52 % of all injuries.

2.3.3 Types of injuries

Bronner et al (2005) examined the types of injuries among 30 professional ballet dancers in a Broadway show. As in previous study, they found that ankle-foot injuries were the most frequent reported injuries (50 %). Bronner et al (2005) suggested that choreography, environment (floor surface), and footwear likely contributors to the increased incidence of foot and ankle injuries. Byring and Bo (2002) also indicated that financial demands,

physiological factors, and psychological consideration might make dancers injuries worse, and various pressures could lead dancers to leave injuries untreated.

An overview of the literature in dance injuries has examined classical ballet dancers, because it has been argued that ballet dancers are likely to experience higher rates of injuries than dancers in other dance styles (Liederbach & Compagno, 2001). This happens because ballet dance requires high levels of physical demands, repetitive movements, accentuated movements and positions, like turn-outs, and dancing a lot on the toes, which includes wearing pointe' shoes.

Hamilton (2004) found that chronic injuries were significantly higher in professional (61 %) and ex-dancers (66 %) compared to older (46 %) or younger (47 %) dance students. Professional ballet dancers, who had injuries, reported that they were afraid of losing their places to other dancers. In order to maintain their position or status among their peers, dancers may disregard their injuries or regard them as manageable nuisances.

Hamilton (1994) also reported that dancers (89 %) generally handle their injuries alone.

2.3.4 Location of injuries

Lehman (2008) stated that different styles of dance lead to injuries different parts of the body. Various body regions are commonly injured by dancers. The majority of dance injuries are foot injuries (Brown & Micheli, 2004). Dance postures and the repetitive, acute stress on the foot account for the high incidence of injury (Macintyre & Joy, 2000). The ankle joint connects the lower leg to the foot and, in dance, allows the pointing toe (plantar flexion) and flexing the foot during plie' (dorsiflexion), respectively. The 26

bones in the foot work in concert with ligamentous support and muscular force to create three separate arches, critical for shock absorption during jumps. Structurally the ideal foot for ballet is considered to be a flexible 'square foot', which has equal length first and second toes. The dancers' first metatarsophalangeal joint needs to dorsiflex to 90 degrees for when they are on demi-point. The dancers need extreme plantar flexion at the ankle.

Factors that contribute to the high incidence of foot injuries in dancers include repetitive impact on the dance floor, narrow ballet slippers with poor posture, dancing on pointe' shoes, weak posterior tibial tendons, tight heel cords, forced turnout and the technique (Stretanski, Michael & Weber, 2002). For modern dancers, the knee, foot, toe, ankle and spine are the areas most affected by the injuries (Noa and Lee, 2001) Factors predisposing to the increased incidence of injuries in the dance population include the classical position in which ballet dancers' stand, which is on the tips of the toes in the *en pointe* position or on the balls of the feet in the *demi pointe* position (Hillier et.al, 2004). Furthermore, the repetitious nature of ballet and the long hours spent rehearsing cause overuse injuries.

In a study conducted by Bronner et al (2003), also it was reported that most injuries were microtraumatic or overuse injuries in nature, encompassing minor sprains and strains (grade 1 and 2). Included in this category were metatarsal stress fractures and osteochondritis dissecans of the ankle. Bronner et al (2003) further reported that lower extremity injuries accounted for an average 58 % of their study sample. Of the lower extremity injuries, foot and ankle injuries were the most common.

Lower back and pelvic injuries accounted for an average 17% of the injuries. Possible causes of back problems include fatigue, hypermobility, scoliosis, leg length inequalities, and emotional stress. The most severe cases involve spasms in which the muscles contract to protect the joint (Hamilton, 2005). Hip injuries also account to the prevalence of injuries in dancers. According to Hamilton (2005) some dancers are born with perfect turnout. This large degree of rotation may be due to shallow hip socket which attempts to stabilize with a very large acetabular labrum. Studies have shown a significantly increased incidence of arthrosis in the foot, knee and hip joints of former dancers (Nilsson et al, 2001).

In a study conducted by Nilsson et al. (2001) the majority of the injuries were found to occur in the lower limbs, especially due to overuse, in the foot and ankle region. Most of the injuries were minor and did not require absence from dancing during recovery. The injury frequency was somewhat lower than in sporting activities but a majority of dancers sought medical consultations because of injuries during rehearsals. The most common overuse injuries in male dancers were more affected by traumatic injuries such as distortions, contusions and sprains while overuse injuries, especially around the foot and ankle region were more common in women. Studies of female athletes have indicated that they have an increased risk of injuries, particularly those involving the knee. Various anatomical and physiological factors have been suggested as causing the increased risk; i.e. the level of conditioning, the lower extremity alignment and anatomy and generalized joint laxity.

2.3.5 Mechanism of injuries

Usually, dancers perform repetitive open- chain movements with their lower limbs (Fyfe, 2005). The researcher further stated that these open chain lower limb movements require a high level of dynamic control through the whole lumbopelvic hip complex, e.g. the dancer begins in the turnout and must hold the stance leg in turnout. The other leg is then flexed and abducted while keeping the knee straight. Turn out of the feet to 180 degrees. This requires 45-60 degrees of external rotation at the hip (Air, 2009). This is difficult to achieve and to compensate dancers often tilt their pelvis anteriorly leading to increased lumbar lordosis. They also roll over on the forefoot, the arch falls and they place increasing stress on the first metatarsal joint leading to hallux valgus. The tilted pelvis also leads to weakness in abdominal and core muscles.

Aerobic dance movement tends to be repetitive and pounding (Lester, 2005). Pounding of the feet is one of the most common causes of stress fractures, which are tiny surface cracks in the bones, of the foot and shinbone. Overuse injuries of the knees are caused by repetitive bending and straightening (Lester, 2005; Shape, 2002). Furthermore knee sprains and strains are also common in aerobic dance. The impact or twisting of the knee inward or outward causes ligaments to be stretched or torn. Hyperextending or hyperflexing the knee joint can cause injury as well.

The type of floor used in aerobic dance can increase the risk for injury. Flooring may be the most overlooked cause of dance injuries (Schoene, 2005). Since most injuries are from overuse, a hard, concrete floor or other solid surface would put the dancer at risk to

increased stresses through the lower leg (Clifford, 2000). Stress injuries are commonly caused by impact since the floor may not provide absorption for the dancer and impact vibrations and energy will be directly returned to the body (Leotards, 2006). Professional dance companies often travel with their own floor to use for rehearsals and performances because there are no standards for the perfect dance floor.

A muscle cramp is a painful muscle contraction usually felt in the back of the leg and in the front of the thigh (Bedinghaus, 2008). Muscle cramps are caused by fatigue or muscle tightness, or an imbalance of fluid, salt or potassium from heavy sweating. Almost every athlete sustains a muscle cramp at one time or another (Bradley & Brzycki, 2004).

Several factors predispose the dancer to a cramp. Muscles that are overtaxed, injured, or exposed to extreme temperatures may be particularly vulnerable. When the muscle begins to fatigue and is placed under a sudden stretch or contraction, the muscle may cramp involuntarily.

Stress fracture is the most common acute fracture seen in dancers. This fracture occurs along the 5th metatarsal, the long bone on the outside of the foot. The typical method of injury is landing from a jump on an inverted (turned-in) foot (Franklin, 2004). The dancer will usually experience immediate pain and swelling. Stress fracture causes pain and swelling, and usually occurs in the shins or balls of the feet. They are usually caused by repeated jumping and landing. Risk factors of stress fracture are pronated feet and genu valgum (knees rotated to the outside) (Berardi, 2007). Repetitive loading with demanding movements, predisposition to amenorrhea (absence of menstruation) and restricted

caloric intake may also contribute. Female ballet dancers seem to be at high risk for developing stress fractures in the lower legs and feet (Buxton, 2008). Bone stress injuries and stress fractures increase in the female triad. Metatarsals, tibia and even the spine are all vulnerable areas for injury.

Plantar fasciitis is an inflammation of the plantar fascia. The plantar fascia encapsulates muscles in the sole of the foot. It supports the arch of the foot by acting as a bowstring to connect the ball of the foot to the heel. When walking and at the moment the heel of the trailing leg begins to lift off the ground, the plantar fascia endures tension that is approximately two times body weight. This moment of maximum tension is increased and "sharpened" (it increases suddenly) if there is lack of flexibility in the calf muscles (Leotards, 2006). A percentage increase in body weight causes the same percentage increase in tension in the fascia. Leotards (2006) further stated that due to the repetitive nature of walking, plantar fasciitis may be a repetitive stress disorder. The tough, fibrous band of tissue connecting the heel bone to the base of the toes becomes inflamed and painful. Dancers will often experience an increase in pain after class or following lengthy weight bearing activities (Kennedy et al., 2007). Plantar fascia pain can also be influenced by tightness in the calf or Achilles tendon, or dancing on a hard surface or on a non-sprung floor. This condition causes chronic pain and inflammation to the foot, especially to the heel. Pain may also be felt in the arch. Plantar fasciitis is particularly common in ballet dancers who wear pointe shoes. The classic sign of plantar fasciitis is heel pain with the first few steps in the morning. The heel may hurt when it strikes the ground, but plantar fasciitis is not caused by the heel striking the ground (Zhao, 2008).

The pain is usually in the front and bottom of the heel, but the definition of "plantar fasciitis" indicates it can be over any portion of the bottom of the foot where the fascia is located.

Muscle strains and lumbar strains are the most common causes of low back pain in dance. A low back muscle strain occurs when the muscle fibers are abnormally stretched or torn. Causes can include an acute injury such as lifting a heavy object or a sudden movement or fall. Other causes include repetitive injuries such as improper technique or working on the same lift over and over. Dancers will typically experience pain exclusively in low back area. Lumbosacral strains or sprains involve excessive stretching and injury to the spinal extensor muscles. Ligaments of the spine involving very forceful concentric contraction, forceful eccentric contraction used to decelerate the torso, mis-timing of a particular movement, or a sudden unexpected exertion during carrying of a heavy object (in dancers – heavy dancing partner). During lifting of heavy weights, or another dancer, small spinal muscles with small moment arms must counterbalance very large external forces with large moment arms and injury can readily occur. In other cases, the onset of pain is insidious and results from repetitive stresses of dance training that exceed heavily capacity (Clippinger, 2007).

Because of inherent structural weakness and the great forces it is subjected to from the body weight, externally applied forces, and contraction of muscles, the lumbar spine is particularly susceptible to injury. Back injuries appear to have a particularly high incidence in athletics involving weight loading and high compression forces; forceful

twists and; activities involving spinal hyperextension, such as competitive swimming (60%), track and field (48 %) and weightlifting (40 %) (Clippinger, 2007). Since dance contains all of these elements, it is not surprising that back injury is prevalent.

Clippinger (2007) further reported that 60 % to 80 % of ballet and modern dancers had a history of back injuries, while two other surveys involving longer time frames reported incidence of 86 % or higher (Clippinger, 2007). It is also noteworthy that back injuries may require more time off from dancing than some other types of injuries, in some cases whole year (Clippinger, 2007) Furthermore, spinal injuries can often result in chronic or recurrent back pain.

2.3.6 Risk factors of musculoskeletal injuries in dancers

Risk factors of MSI in dancers include environmental aspects, physical demands of activities, and personal characteristics (Shape, 2002). Furthermore, dancers incurred severe injuries that meant they could not perform any more. Noh (2005) reported that these injuries also led to psychological distress, which was related to loss of position or status. In a study of ballet injuries, Maya (2004) reported that 104 dancers had 309 injuries during a 3-year period. In particular, they stated it was remarkable that 23% of these dancers incurred 52% of all injuries. The author further emphasised that identifying factors that cause injuries might permit interventions that would decrease the risk of injuries. Overuse injuries, often related to training errors, inappropriate footwear, poor floor surface and biomechanical factors, are far the most common injuries in aerobic dance enthusiasts. Traumatic injuries are much less common than overuse syndromes and are seldom severe.

Dancing involves powerful movements as well as flexibility exercises, both of which may be related to specific injuries to the musculo-tendinonosus tissue (Askling et al, 2002). Mc Meeken, Tully, Stilman, Natrass , Bygott,, & Story, 2001 suggested that the overall number of active hours is one of the risk factors for adolescent dancers' injuries. The dancers who exceeded 30 hours of physical activity each week were more likely to experience back pain. According to Murphy, Connolly, & Beynnon, 2003, dance injuries may occur because of human (intrinsic) factors, or be the source of hazards in the dance environment (extrinsic factor) or, as is usually the case, from a combination of the two. Human factors include age, sex, general and mental health, prior injury history, fitness level, the body mass index, body alignment, morphology, limb dominance, muscular flexibility, joint range of motion, joint laxity, muscular strength, muscular balance, and muscular reaction time. The environmental factors in the dance workplace to which dancers are exposed, which can potentially affect their health include: floor construction and incline, shoe type and shoe surface interface, room temperature, noise and light, live music tempo, costume and set design, level of the performance demand, and policies and behaviours regarding hydration, body weight regulations, conditioning practices, and work-to-rest ratios.

Risk factors have been categorized according to the environmental factors, physical demands and personal characteristics (Shape, 2002).

Table 2.1 Risk factors associated with dance injuries

Environmental factors	Physical demands	Personal characteristics
Temperature	Awkward postures	Age and gender
Confined space	Forceful exertion	Physical fitness
Layout of space	Repetition	strength, flexibility & endurance
Equipment	Long duration activities	Nutrition
Layout or configuration	Inadequate rest	Posture
of equipment	Contact stress	Addictive substances
Surfaces (floors)	Vibration	Psychological stress

The causes of dance injuries are many and varied. They may range from faulty technique to slippery floor (Shape 2002) and to inadequate warm-up prior to activity (Simpson, 2006). Simpson (2006) divided the risk factors into extrinsic factors – external and intrinsic factors – internal. The extrinsic factors include training errors, type of dance activity; environmental factors i.e. temperature, equipment such as too soft pointe` shoes, workload e.g. being cast in a number of pieces. Extrinsic risk factor tracking includes quantification of exposure to specific environment, equipment, and technique demands. Exposure may be delineated as activity (number of performance, class, and rehearsal events) or time (hours of participation in dance activities) based (Bronner et al, 2006). Information is necessary concerning uninjured participants as well. This emphasizes the importance of pre-participation screening of potential intrinsic risk factors for all

participants. Pre-season screening permits assessment of intrinsic risk factors or individual-specific physical characteristics such as structural (skeletal) asymmetries, joint laxity, muscle flexibility, physical fitness (strength, aerobic conditioning), age, gender-specific factors (e.g., factors related to the female athlete triad: disordered eating, dysmenorrhea and amenorrhea, osteopenia, and osteoporosis), psychological factors, professional experience, and previous history of injury, that may or may not be modifiable (Bronner et al, 2006).

Neuromuscular fatigue has been suggested as an extrinsic factor in the mechanism of non-contact anterior cruciate ligament in both genders (Orenduff, Rohr, Segal, Medley, Green & Kadel, 2008)). Neuromusculoskeletal fatigue caused men and women to land more hip flexion. The author further stated that men exhibited greater peak knee flexion angles post fatigue than women. Biomechanical performance differences between men and women during cutting and landing have emerged as the significant risk factors that can be reliably measured in a controlled laboratory environment (Kernozek, Torry & Iwasaki, 2008). The author further stated that evaluating shoes during sport related movements may provide a better assessment of plantar loads associated with repetitive injury and provide more specific data for comparing shoes cushioning characteristics.

Micheli et al, (2005) mentioned that poor spinal posture and technique can contribute to pelvic and lower extremity malalignment and injury. There are numerous and varied explanations for the high incidence of injuries in the ballet/dance world. It appears, however, that the majority of ballet injuries are related to training errors and

biomechanical imbalances caused by technique flaws. Bronner et al (2006) reported that forcing the feet to achieve turnout position beyond what the hips will allow is probably the most serious training error a dancer can make.

2.4 Injury prevention

According to Macintyre & Joy (2000), among the most common injuries in dancers are those caused by overuse. Repetition of movement for extended periods of time places undue stress on the feet, legs, hips and backs of dancers. Ballet dancers are frequently sidelined by peroneal tendonitis, an overuse injury, while modern dancers commonly suffer from patellar tendonitis. Macintyre & Joy (2000) suggested that, an effective way to prevent overuse injuries is to complement daily dance classes with exercises that strengthen and stretch muscles not developed by the dancing activity.

Warm up before class, rehearsal and performance is necessary even if the dancer has already taken a class that day. According to Grant (1999) any means of artistic locomotion, that emphasizes turnout (lateral rotation from the hips) while simultaneously requiring landing on the ball of one foot or the other in quick succession, is bound to produce some injuries. The author's approach to minimizing injuries is to think about the objectives of the movements the dancers use for warming up and conditioning. That means that the best method of warm-up (or training) would be activities that mimic the physical demands placed on the body during the activity. Grant (1999) further stated that to mimic dance movements, a warm-up should occur in several planes of movement and involve multiple joints. New dancers must build their strength and flexibility slowly and

safely. One of the most important ways to prevent dance injuries is to take the time to properly warm up the major muscles of the body. To prepare for the stresses of launching and landing dance steps, a warm-up should also have the element of weighting. Cool down after each class, rehearsal and performance is also important. This is an important part of dance that has not been practiced sufficiently.

Dancers are turning toward more athletic workouts, as body conditioning aspects of the art form gain more attention. For dancers to have an increased likelihood of improved performance and remain injury free, they need to take their workouts outside the studio (Shaner, 2008). Dancers should train outside of the studio for optimal fitness. Dancers should strength train as a form of cross-training. Strength and resistance training gives the dancers more control over their bodies and increases their effectiveness on stage. Dance is anaerobic, so dancers should not solely work out in the rehearsal capacity. Shaner (2008) stressed the importance of plyometrics, exercises that use bursts of movements in order to increase muscular power, and ultimately improve leaps and other traditional dance movements.

One concern is that young dancers may eat a poor diet in order to try and be slim. It is easier for a male dancer to lift a lighter dancer. In the study conducted by Hamilton et al (2006), fifty-five white and eleven black female dancers in nine regional and national ballet companies in America and Europe (mean age 24.9) were surveyed for eating disorders. The dancers, as a whole, weighed 12% below their ideal weight for height. Aesthetically, slenderness is also an advantage, as dance is a visual art form and is more

pleasing to see corps of swans with a uniform slim physique. In a study conducted by Dobson (2005) shows that 16 % of dancers had an eating problem in the previous 12 months and that 25% had a body mass index below that recommended for good health. One of the biggest fears of a dancer is gaining weight and having to face themselves in the mirror donning only their leotards and tights. Vordtriede (2002) stated that one of the reasons people become trapped in an eating disorder is because they are perfectionists with a need to control their environment. Dancers are often severe perfectionists, practicing for hours a day and pushing themselves to their physical and psychological limit to achieve professional success.

2.5 CONCLUSION

This chapter detailed dance as an athletic sport and a performing art. Literature regarding the prevalence of injuries in dance was reviewed. Various studies were considered to provide the framework for understanding the prevalence and incidence of dance injuries, the site and mechanism of injuries involved the severity of injuries and the preventative mechanisms of those injuries. Very little literature about the prevalence and incidence of musculoskeletal injuries in dancers was found in South Africa.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter describes the purpose of the study as stated in Chapter one as well as the research setting in which the study was based. The study design, study population, sampling method and instruments used to obtain data are also described. Lastly, the specific statistical analysis used and ethical considerations are outlined.

3.2 PURPOSE OF THE STUDY

The primary purpose of the study was to investigate the cumulative incidence and prevalence of musculoskeletal injuries of the student dancers at Tshwane University of Technology over one academic semester in 2007. The study sought to identify the risk factors and the need for medical intervention in preventative factors from the epidemiological data obtained.

3.3 RESEARCH QUESTIONS

What is the cumulative incidence of musculoskeletal injuries (MSI) among student dancers at TUT?

What is the prevalent of MSI among student dancers at TUT?

What are the anatomical locations of MSIs and what is the recurrence of MSI in student dancers at TUT?

What are the possible risk factors associated with MSI in student dancers?

What are the possible preventative strategies?

3.4 STUDY DESIGN

A non-experimental prospective cohort research study was used to identify the injuries that cumulated during the period of 16 weeks of data collection. A non – experimental study design seemed to be the most appropriate as no interventions were used in the study. A non- experimental study assesses the role of chance, bias and confounding as well as plausibility of findings. The chosen design evaluates the role of chance; statistical tests (t-tests etc) used to test likelihood of findings as extreme as that only by chance ($p>0.05$), P-value reflects magnitude of difference and the sample size; confidence intervals help.

3.5 RESEARCH SETTING

The research setting for the present study was Tshwane University of Technology (TUT). TUT have several faculties and departments offering various courses. The TUT Art Campus that offers dance as part of their curriculum is situated in Pretoria, Gauteng Province.

There are seven (7) dancing types that students can choose from. These dance types are:- Ballet, Contemporary, Jazz, Tap dance, African dance, Pas de deux and Body conditioning. The dance course has two (2) mainstreams namely, Contemporary and Ballet. Students are allowed to choose one stream. Both streams include most of the

dance types except African and Jazz are only offered to the contemporary stream. In addition to the dance types mentioned above both streams are doing Pilates class once a week. Furthermore, all students train daily from 8h30 -13h00.

Previous ballet training and being younger than 25 years are requirements for admission to the ballet stream. However males are being accepted to the programme with no previous dance history due to the demand for male dancers.

Students wear flat or pointe' dance shoes during dance. The training floor is wooden.

3.6 STUDY POPULATION AND STUDY SAMPLE

The dance program is part of a four year course. Forty nine (49) students were registered for the 2007 academic year. The study population consisted of all the registered students for 2007 regardless of age and gender. A sample size calculation was not possible as the resources were limited to 49. In the event of all students consenting to participate in the study, it is possible with 95 % confidence to estimate the expected prevalence of 50 % to an accuracy of 14 %. The study sample was thus the entire registered student for the 2007 academic year who agreed to participate in the study.

3.7 METHODS OF DATA COLLETION

A questionnaire developed by Byring and Bo (2002) was used to collect the data from the dancers at the beginning of the study (retrospective data). To assess the cumulative

incidence of injuries over the 16-weeks period, the Self - Estimated Functional Inability because of Pain (SEFIP) scale, developed by Ramel (1999) was used.

3.7.1 The research instrument

The research instrument used to collect retrospective data regarding dance injuries consisted of five parts. The first part requested for demographic information such as age, gender, weight and height. Information regarding previous dance injuries was requested in the second part. Students had to report on the type of previous injuries sustained during dancing, such as the type of injury, the location of injury, and if they had to discontinue with their dancing activities. In the section that followed, student dancers had to report on their training routines, such as number of days and hours spent on training, warm up and cool down activities. The fourth section requested information regarding psychological factors related to studying and social support. These questions included information regarding university and rehearsal conditions, social support from the teachers, friends and family. These were done on a Likert-type scale ranging from daily to never, and strongly agree to strongly disagree. The last part of the questionnaire requested for information regarding possible risk factors associated with dancing. Questions were used to evaluate how the dancers considered possible risk factors. These questions were classified into three categories according to the model of etiology as suggested by Meeuswisse, Tyremal, Hagel & Emery 2007: 1) factors related to daily training, 2) factors related to organization and planning, 3) and environmental factors.

Following the first questionnaire, the daily incidence of injury during the period of the study was registered using the Self-Estimated Functional Inability because of Pain (SEFIP) questionnaire (Ramel, 1999). The mechanism of injury and absence from training was registered as proposed by Byhring and Bo (2002). Furthermore an injury was classified as acute when there was a history of a single, sudden, violent trauma such as contusion, laceration or fracture. Overuse injuries was those with a history of repeated microtrauma with a cumulative effect on.

3.7.2 Validity and reliability of the instrument

Validity and reliability are two of the most important criteria by which a quantitative instruments' adequacy is evaluated (Polit, Beck & Hungler, 2001). Validity refers to the extent to which an instrument measures what is supposed to be measuring (Sarantakos, 1997). Unlike reliability, validity of an instrument is extremely difficult to establish. Like reliability, validity has a number of aspects and assessment approaches. To ensure validity of the instrument, the questionnaire of Byhring and Bo, (2002) was used in this study. Face validity refers to whether the instrument looks as though it is measuring the appropriate construct (Polit, Beck & Hungler, 2001). Although there are no complete objective methods of assuring the adequate content coverage of an instrument, certain steps were taken to assure content validity. The questionnaires were preliminary tested on dancers not included in the study, to obtain views about the design and to achieve face validity. Furthermore, a pilot study was done to the professional dancers at University of Johannesburg to determine the clarity and ambiguity of the questions used in the questionnaire and to determine the duration it takes to fill in the questionnaires.

3.7.3 Procedures

After ethical clearance from the Senate Research Grants and Study Leave Committee and the Senate Higher Degrees Committee at the University of the Western Cape, the researcher requested for permission from the Registrar and the Head of the Art Department at TUT to conduct the study. A detailed explanation regarding the aims and objectives of the study was given to the Head of Department. After permission was granted to the researcher, a meeting was scheduled with the lecturer in charge. The lecturer distributed the questionnaires during a class period and all completed questionnaires were returned to the researcher. The SEFIP questionnaires were given to the student dancers on the same day as the other questionnaire. A detailed explanation regarding registration of injuries was given to the lecturer in charge and the student dancers. Follow-up phone calls were done to check if injuries were registered regularly. At the end of sixteen (16) weeks all the questionnaires were collected.

3.8 DATA ANALYSIS

Data was captured on a spreadsheet using the Microsoft Excel programme. The Statistical Package for Social Science (SPSS) version 16.0 was used to analyze the data. Descriptive statistics was employed to summarize the demographic data of the study sample. The demographic data was expressed as frequencies, percentages, means and standard deviations. The data were summarized and presented using tables and graphs. Injury prevalence and cumulative incidence was calculated as a proportion rate along with a 95 % confidence interval. Chi-square test was used to test for significant association

between categorical data and injuries sustained. Risk factors were assessed using suitable models for categorical data. Alpha level was set at $p < 0.05$.

3.9 ETHICAL CONSIDERATIONS

Ethical clearance and approval from the Senate Research and Grants and Study Leave Committee and the Senate Higher Degrees Committee at the University of the Western Cape was obtained prior to the commencement of the study. Furthermore, permission to conduct the study at Tshwane University of Technology was requested from the Registrar and the Head of the Art Department. Written consent was also obtained from the student dancers to participate in the study. The dancers were informed of the objectives of the study and they were assured of the confidentiality of the data. They were further assured that all the information obtained will remain confidential and anonymous unless a written request is received from the dancer. The participants had the right to withdraw from the study at anytime and their withdrawal did not have any effect on their current programme. The researcher referred all dancers that sustained injuries during the study to the physiotherapist for management. The researcher intends to disseminate the research findings and recommendations to the various stakeholders on completion of the study

3.10 SUMMARY

The study was conducted at TUT over a period of sixteen (16) weeks. The cumulative incidence of injuries over this time period was assessed among student dancers at TUT. The analysis of the data will be presented in the following chapter.

CHAPTER 4

RESULTS

4.1 INTRODUCTION

The results of the statistical analysis are presented and described in this chapter. The chapter is divided into two main sections. In the first section the results related to the retrospective data are presented. The second section describes the results of the statistical analysis for the cumulative incidence of injuries over a sixteen (16) weeks period.

SECTION A: RETROSPECTIVE DATA

4.2 Demographic characteristics of the study sample

From a total of 49 student dancers, 41 (83.7 %) agreed to participate in the study. Of these, the majority were females (35), the mean age of the study sample were 20.31707 (SD= 1.0825) as illustrated in table 4.1. Eight (8) students were not willing to participate in the study. The reason for not participating was not disclosed.

Table 4.1 Demographic characteristics of the sample (N=41) Mean and SD

Variable	Females	Males	Total
Age (years)	20.17 (0.9)	21.00 (1.29)	20.31 (1.08)
Body height (cm)	1.65 (0.07)	1.75 (0.98)	1.66 (0.08)
Body weight (kg)	54.86 (5.79)	61.25 (7.41)	55.61 (6.23)
BMI	20.24 (1.89)	20.13 (0.49)	20.23 (1.80)
Days training/wk	5.79(0.59)	5.71(0.75)	5.78(0.61)

4.3 Prevalence of previous injuries

The majority of the participants (87.8 %, N=36) sustained an injury prior to the study as illustrated in figure 4.1. Females (94.1 %) were significantly more likely than males (57.1 %) to report previous injuries ($X^2=7.411$; $p = 0.006$). Of the participants reporting injuries, the majority (70.7 %) continued with training/dancing while 17.1% had to stop training. All those that continued with dancing, consulted with a health professional regarding their injuries. The majority (88.6%) of the participants were of the opinion that the injury could have been prevented. Suggestions regarding prevention included education, improving muscle strength and improved concentration.

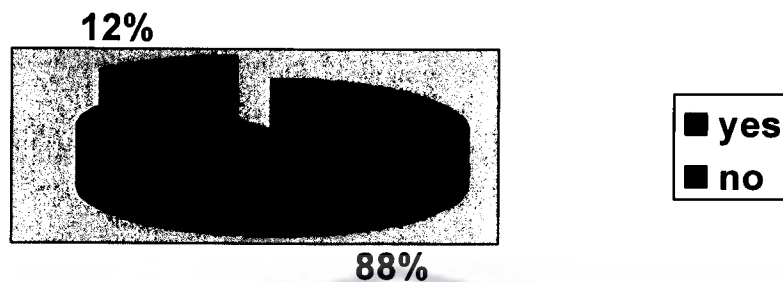


Figure 4.1 Percentage of participants with previous injuries (N=41)

4.4 Location of previous injuries

A total of 49 injuries were sustained by the participants in the study. The majority of the injuries were sustained to the ankle (28.6 %) and the lower back (24.5 %) as illustrated in Figure 4.2. The least amount of injuries (2.0%) was sustained to the neck.

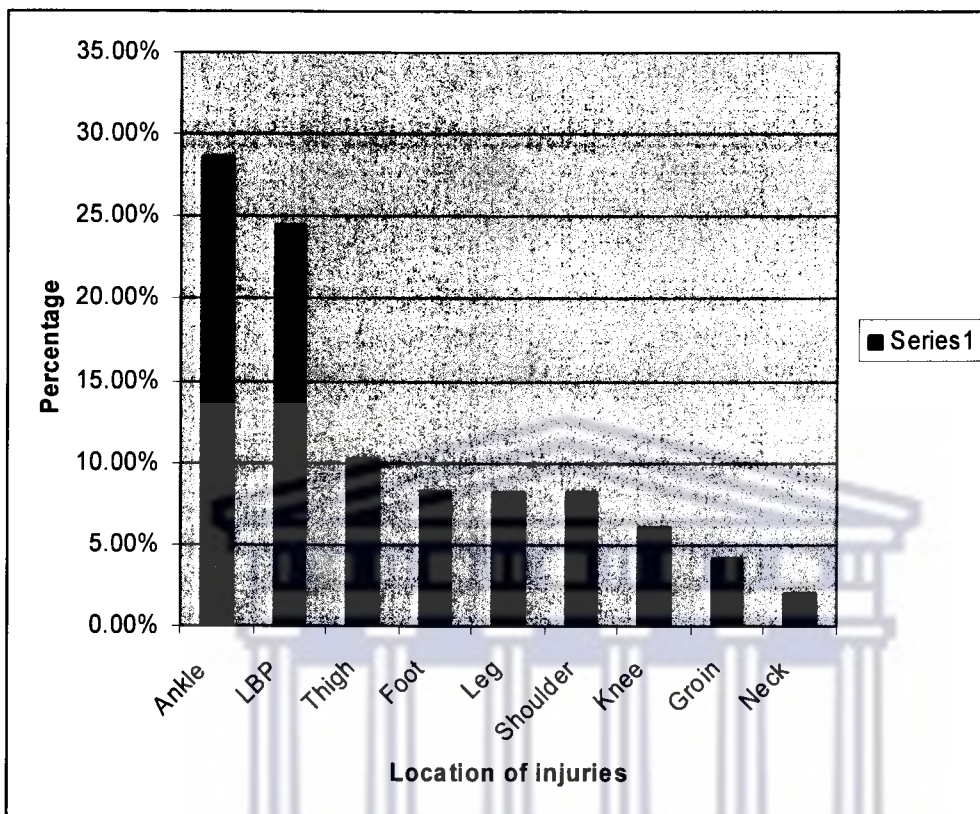


Figure 4.2 Location of previous injuries (N= 49)

4.5 Mechanism of Previous injuries

Participants recorded mechanism by which their injuries occurred. The majority of injuries were sustained due to either falls or jumps (41 %) as illustrated in Table 4.2.

Table 4.2 Mechanism of previous injuries (N=41)

Mechanism	Frequency (n)	Percentage (%)
Jumps /Poor landing	16	41 %
Twisting	4	10.2 %
Overstretched	2	5.1 %
Overuse	4	10.2 %
Improper warm-up	2	5.1 %
Poor technique	4	10.2 %
Lifting	2	5.1 %
Other	5	12.8 %
No answer	2	

4.6 Warm up/ cool down routine of study sample

All the participants (100%) reported warming up prior to dancing. More than half (58.5%) of the participants reported no cool down, whereas 12.2 % reported cooling down sometimes after dancing. A higher percentage of females (57.10 %) reported to cool down as opposed to males (23.5 %) as illustrated in Figure 4.3. This difference however was not statistically significant ($P>0.05$).

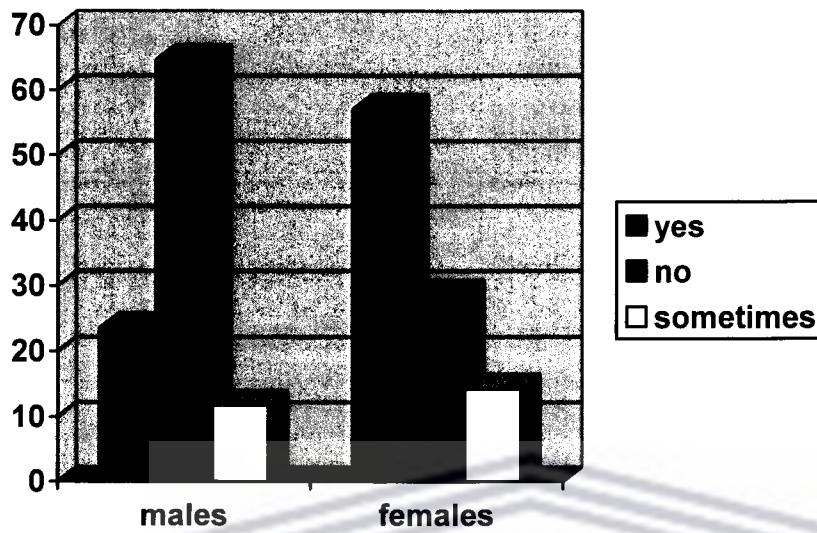


Figure 4.3 Percentage of participants reporting cool down by gender (N=41)

4.7 Severity of previous injuries

The majority of previous injuries reported by the participants were severe (58 %) and moderate (28 %) as illustrated in Figure 4.4

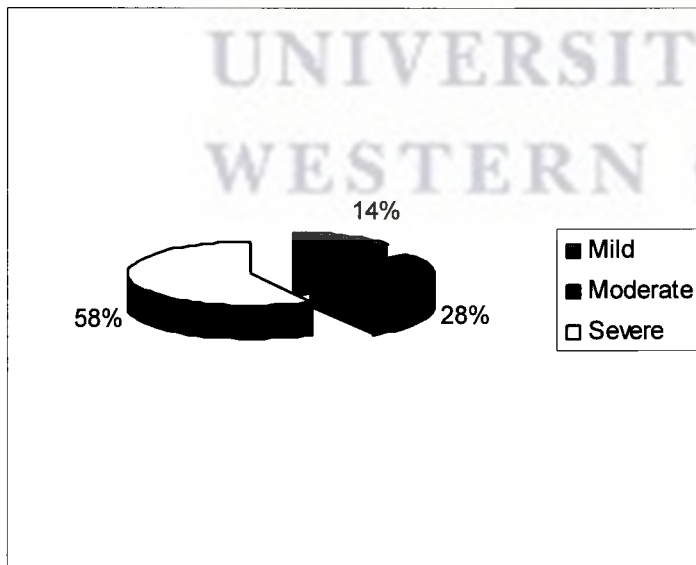


Figure 4.4 Severity of previous injuries

Severe injuries were reported by both males (50 %) and females (59.4 %). Dancers were further categorized as “dancers prone to injuries” defined as dancers having three or more injuries and injuries categorized as moderate to severe (Byhring & Bo, 2002). Less than one-tenth (7.3 %) of the dancers were categorized as dancers prone to injuries. All of these dancers were females with a mean age of 19.67 years (SD= 1.155)

4.8 Psychological factors related to studying

4.8.1 Social support

Participants were requested to report on the support received from family, friends and teachers while studying on a Likert scale ranging from strongly agree to strongly disagree. Responses were dichotomized into receiving support group or no support.

Table 4.3 Social Support (frequency)

Variable	Frequency (N)	Percentage (%)
Family	41	100
Friends	40	97.6
Teachers	38	92.7

The majority of the dancers reported that they received support from family (100 %), friends (98 %) and teachers 92.7 % as seen in Table 4.3.

4.8.2 Environmental factors

Participants reported on environmental factors related to injuries, considered important by them. Four environmental factors, as illustrated in Table 4.4, were reported as most important among the dancers as related to the injuries; the dancing shoes (85 %), slippery floors in the dance studio (83 %), small dancing room (83 %) and poor heating conditions (32 %).

Table 4.4 Environmental factors influencing participants

Variable	Frequency (N)	Percentage (%)
Slippery floors	34	82.9
Shoes	35	85.4
Small dancing room	34	82.9
Heating conditions	13	31.7

4.8.3 Theory workload

Participants were requested to report on the influence their theory workload and other studies at the university had on their rehearsal load. Responses regarding theory workload

were dichotomized from daily, often, sometimes, seldom, never to yes and no; where daily and often were equivalent to yes, and seldom and never to no.

Almost a quarter (24.4 %) of the participants reported that their theory workload interfered with their rehearsal load as illustrated in Figure 4.5. The majority (76 %) reported no effect on rehearsal/ dance performance.

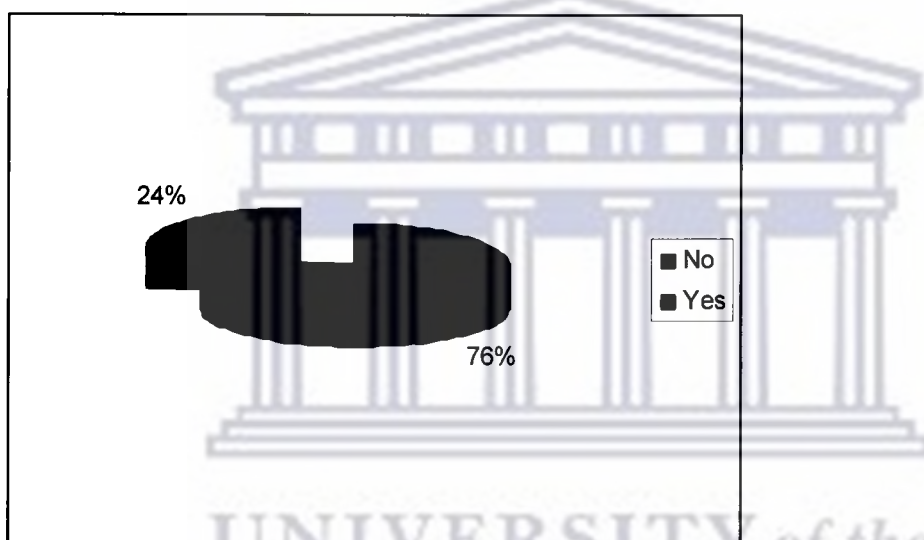


Figure 4.5 Percentage of sample of reporting interference of theory workload on rehearsal load.

The participants were requested to rate the influence of other studies on their rehearsal performance and practicing hours on a Likert scale ranging from strongly agree to strongly disagree. Responses were dichotomized into influencing or not influencing their

rehearsal/ dance performance. More than two-thirds (69.7%) of the participants reported that other studies had no influence on their rehearsal performance as shown in Figure 4.6

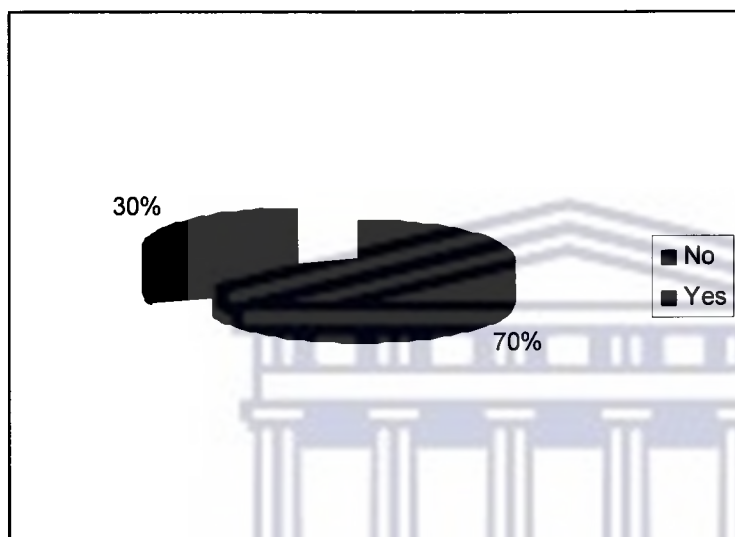


Figure 4.6 Percentage sample of reporting influence of other studies on rehearsal performance (N=41)

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SECTION B: CUMULATIVE INCIDENCE OF INJURY

4.9 Prevalence of MSIs

Seven of the participating dancers (17.1 %) experienced one injury or more during the 16 weeks of data collection. The prevalence of MSI at the end of the observational period was thus 17.1 %.

$$P_1 = \frac{7}{41} = 0.1707$$

These seven dancers sustained 10 injuries as illustrated in Figure 4.7. The injuries included Low back pain (3), Ankles (3), Calf (1) thigh (1) and feet (1).

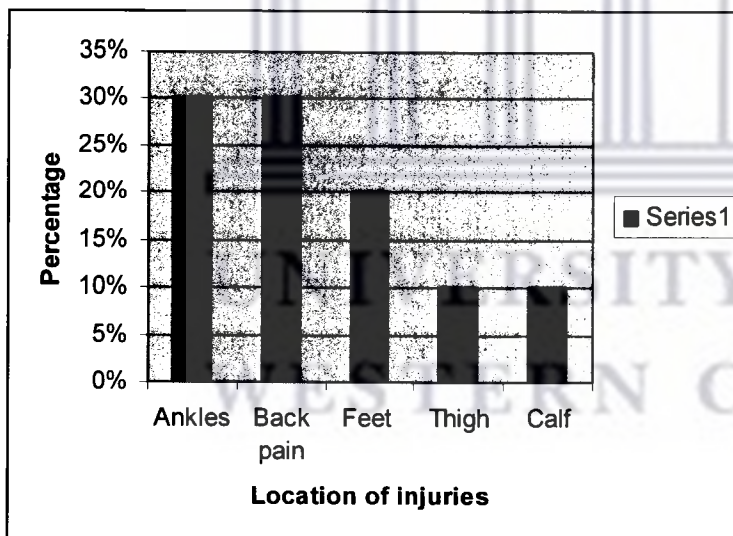


Figure 4.7 Location of cumulative of injuries sustained (N=10)

4.10 Incidence rate

Incidence rate is the basic measure of disease occurrence. During the 16 weeks period there were 10 injuries. The number of student dancers (individuals) at the beginning and end of the study was 41.

Risk Time = $41 \times 16 = 656$ person-months

Therefore the Incidence rate (I):

$$I = \frac{\text{No of cases of disease that occur in a population during a period of time}}{\text{Sum of each individual in the population of the length of time at risk of getting disease}}$$
$$= \frac{10}{164} = 0.06 \text{ per month.}$$

The incidence rate of injuries for the present study was thus 6% per month

During the 16 weeks period there were 10 injuries.

Risk Time = $41 \times 16 = 656$ person-weeks

$$I = \frac{10}{656} = 0.015 \text{ per week}$$

The incidence rate of injuries for the present study was thus 1.5 % per week.

4.11 Cumulative Incidence of MSIs

The Cumulative Incidence (CI) is the proportion of individuals in the disease-free state at the beginning of a specific period that moves to the disease state during that specific period.

$$CI = \frac{\text{Number of individual who get the disease during a certain period}}{\text{Number of individual in the population at the beginning of the period}}$$

$$= \frac{7}{41}$$

$$= 0.1707$$

The Cumulative-Incidence is 17.1% over a 4-month period. 17.1% of the student dancers got injuries during the 4 month period. 0.06 injuries occurred per student month at risk.

4.12 SUMMARY

The results of the study showed that 87.8 % of the participants sustained injuries prior to the commencement of the study. Females reported more injuries (94.1 %) than males (57.1 %). Forty-nine (49) injuries were sustained by the 41 participants. The location, mechanisms and severity of injuries were reported on. The cumulative incidence of injury within the period of sixteen weeks was 17%.

These results are discussed and compared to other studies found in literature.



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CHAPTER FIVE

DISCUSSION

5.1 INTRODUCTION

The primary aim of this study was to assess the cumulative incidence of musculoskeletal injuries sustained by student dancers at Tshwane University of Technology during one academic semester. Furthermore the study aimed to assess previous injuries, the mechanism of injuries and the risk factors associated with these injuries. Lastly the study also aimed to assist with the preventative measures to reduce the incidence of injuries in student ballet dancers. This chapter discusses the findings of the current study and compares the findings with similar published studies.

5.2 DEMOGRAPHIC CHARACTERISTICS OF STUDY SAMPLE

Various studies among dancers have been conducted in various parts of the world (Miletic et al., 2008; Gamboa et al., 2008; Negus et al., 2005; Byring & Bo, 2002). The sample of these studies included both students and professional working for large companies. Their age range from 11 – 50 years (Weiss et al., 2008; DuToit & Smith, 2001; MacIntyre & Joy, 2000). The current study sample's age ranged from 19 – 23 years with a mean age of 20.31. The mean age of this study is comparable to those of other studies (Rip et al., 2006; Askling et al., 2002; & Nilsson et al., 2001).

Most studies reported on higher number of female dancers than males. Weiss et al., 2008 has reported on 73.4 % females and 26.6 % males, Miletic et al., reported on 51.8% females and 48.1 % males whereas Rip et al., reported on 91.9 % females and 8.1 % males. These studies all clearly had a much higher prevalence of females compared to male dancers. In the present study this higher prevalence of female dancers (85.4 %), compared to male dancers (14.6 %) was also highlighted. These findings are clearly highlighting the fact that dance is more dominated by female dancers.

5.3 PREVALENCE OF PREVIOUS INJURIES

Although several authors have studied the prevalence and incidence of injuries in dancers, several inconsistencies exist with regard to study design and definition of injury, making it difficult to compare results between the studies. The study by Solomon et al. (2005) and Luke (2002) were both retrospective cohort studies and the subjects were pre-professional dancers with an average age of 15.8 years (14-18 years). In the study by Askling et al (2002), the occurrence of acute and overuse injuries to the rear thigh in dancers was investigated retrospectively by means of a questionnaire. In the recent study the investigation of the injuries was also done retrospectively by means of questionnaires.

Recent epidemiological research has revealed a high incidence of injuries among professional classical ballet dancers (Liederbach, 2008; Negus, 2005 & Nilsson et al., 2001) and modern dance (Weigert & Erickson, 2008; Shah & Weiss, 2006 & Bronner et al., 2003). Several researchers have reported on a history of injuries prior to the

commencement of their studies among dancers (Gamboa et al., 2008; Logan-Kronstad, 2006; Noh, 2005). The results of the present study showed that 87.8 % of the participants sustained injuries prior the study commencement. This shows a high prevalence of musculoskeletal injuries in the selected group. The findings of the present study are in agreement with that of Negus et al. (2005) that reported a history of injury among 93.2 % of their study sample. Gamboa et al. (2008) reported that professional dance companies have reported that as many as 67 % to 95 % of their dancers are injured on an annual basis, while one dance school reported that as many as 77 % of their adolescent dancers were injured in one academic school. Askling et al (2002) reported a prevalence of 51 % of reported injuries which are far less than the injuries sustained in the present study. Possible reason for these discrepancies could be possible is the fact that the researcher only examined hamstring injuries in dancers whereas in the present study the overall dance injuries were examined. Casidy & Jacobs (2007) reported that 95 % of professional dancers have ongoing pain.

Studies reported different prevalence rate of injuries between males and females. The differences in the prevalence of injuries are due to the area of injuries. Kadel (2006) reported that female dancers have a higher incidence of injuries in foot and ankle than males because the females are dancing with pointe shoes and the men are not. The findings of the present study are therefore coinciding with the other studies as the females reported more injuries (94.1 %) than males (57.1 %). Mayers, Judelson & Bronner (2003) who surveyed the prevalence of injury in tap dancers and female dancers were also reported more injuries (0.97/dancer) compared to males (0.64 injuries/dancer).

Gniady (2002) found that male dancers prefer a "softer, more compliant floor" for their big jumps, while female dancers want a "stiffer, more secure floor for pointe work." The hard flooring for the female dancers may be the reason for more prevalence of injuries compared to males who prefer soft flooring. The study of Weiss, Shah, & Burchette (2008) among professional modern dancers, shown different injury rates for females and males than the present study. In their study males reported more injuries than the females. Reasons for this discrepancy were the fact that females had started taking dance class earlier (age 6.5 ± 4.2 years) as compared to males (age 15.6 ± 6.2 years). Females were also more likely to have begun their training in ballet, while males more often began with modern classes. Solomon et al. (2005) assessed the injuries in the knee and males are more prone to injuries compared to female because they torn the menisci particularly, in folk dancers, for whom percussive squatting activities put the meniscus at risk during rapid flexion.

5.3.1 Location of previous injuries

A dancer's most important asset is his or her feet. Any form of dance relies heavily on a dancer's strength, especially in the legs and feet. Balancing on the balls of the feet, moving quickly into different positions, sliding, jumping, stomping and many other movements can cause injury to the feet over time (Finch, 2009). Most studies have reported the ankle and toes as the most common location of injuries in dancers.

Hillier et al (2004) are of the opinion that foot and ankle injuries are amongst the most common injuries among ballet dancers. The authors further explained that the factors

predisposing to the increase incidence of injuries in this population include the classical position in which ballet dancers' stand, which is on the tips of the toes in the *en pointe* position or on the balls of the feet in the *demi pointe* position. Furthermore, the repetitious nature of ballet and the long hours spent rehearsing cause over-use syndrome

This is evident from the present study that reported the ankle to be the site of the majority of injuries among student dancers. Other studies have also reported on ankle injuries being the most prevalent injuries among dancers (Solomon et al., 2005; Mayers et al., 2003 & Nilsson et al., 2001). However, Solomon et al., (2005) reported a much higher prevalence of ankle injuries (69 %) compared to the present study. The foot and ankle are prone to musculoskeletal injuries because there is lot of pressure during landing and the *pointe`* that the dancers are putting on when they are dancing. The foot and ankle are prone to musculoskeletal injuries because there is a lot of pressure during landing and the *pointe`* that the dancers are putting on when they are dancing. In his study Kadel (2006) also reported on 34 % to 62 % of foot and ankle injuries.

Lower back injuries are common in ballet dancers. In the present study back injuries accounted for 30 % of all previous injuries. This was slightly more than the 17 % reported by Nilsson et al. (2001). Researchers have indicated that there is a higher incidence in back injuries in males than in females due to their lifting requirements (Alderson, Hopper, Elliot & Ackland, 2009). The findings of the present study also revealed that back pain is more prevalent in males (50 %) than in females (20.5 %). In addition to males doing more lifting than females, other possible reasons for the high

percentage of prevalence in back pain in males could result from musculoskeletal factors such as postural lordosis, excessive tightness of the extensor musculature, and weakness of the abdominals. Poor technique and /or training increase the dancer's susceptibility to these risk factors. Male dancers frequently perform lifts with a lordotic back. In the study of Mayers et al., (2003) the back pain was prevalent in females (13%) than in males (2%).

This difference from the present study could be due to the fact that Mayers et al., (2003) reported on tap dancers only. Dance UK (2002) revealed that 80% of dancers had been injured in the previous 12 months. The low back was also reported as the most common site of injury. 38% of ballet dancers and 37% of contemporary dancers cited fatigue as their cause of injury, 37% and 31% respectively cited it was due to overwork.

5.3.2 Mechanism of previous injuries

Given the numerous repetitive movements in dance, there is a higher incidence of overuse injuries, which usually occur during class or rehearsals as opposed to happening during performance. Injuries of the lower extremity comprise the vast majority of all dance injuries. Most injuries increase seasonally as the rehearsal and performance schedules increase (Schoene, 2005). In this study the mechanism of injuries were reported to be mainly due to falls and jumps (41 %). Bull and Roberts (2004) stated that the most frequent mechanism of injuries among dancers was hyperextension upon landing from a jump.

Some risk factors to watch out for include excessive pronation (feet rolling in), excessive eversion (feet rolling out), muscular imbalance, forced turnout and structural anomalies (e.g., differences in leg length). Other factors include inadequate warm-up and training overload, as well as poor nutrition.

Ankle sprain risk factors are poor technique, fatigue, weak ankle and lower-leg muscles, history of ankle sprains. Stress fracture risk factors are a pronated foot and genu valgum (knees rotated to the outside). Repetitive loading with demanding movements, predisposition to amenorrhea (absence of menstruation) and restricted caloric intake may also contribute.

Low back disorders risk factors are lifting and jumping with poor alignment, muscle imbalance (which may involve a tight psoas, or hip flexor) and training overload.

Environmental factors, such as non-resilient floors, tight costumes or lifting a partner mismatched in height or weight, or with improper timing, may also contribute.

There are two possible risk factors for dance beginners: inappropriate training load and an intensive development process. Therefore, monitoring of the dancers pain status for beginners should be investigated in relation to their morphological status as well as in relation to their level of performance.

5.3.3 Severity of injuries

Researchers have reported that most injuries sustained by dancers to be varying from mild to severe (Byring & Bo; 2002). The majority of the past injuries sustained by dancers in the present study were reported to be severe (58 %), and moderate (28 %). The

major limitation in comparing severity of injuries reported by different studies is the definition of severity used by different studies. In the study conducted by Bronner et al. (2006) the definition of severity of injury was defined by time lost (e.g., the number of days elapsed from the date of injury until the date of dancer's return to full participation). The day on which the injury occurs is counted as day zero. If the dancer cannot participate for the rest of the dance day they were injured, but is able to return the next day, this is recorded as zero time-loss days.

Less than one-tenth (7.3 %) of the dancers in the present study were categorized as prone to injuries and all these dancers were females. Researchers have suggested that a reduced level of lower body muscular power is associated with increased severity of injuries in female contemporary dancers. More research using appropriate methodological designs, such as sample size calculations and randomization and the use of contemporary dance movements only is needed to investigate the effects of physical fitness levels on injury severity in contemporary dance (Angioi, Metsios, Koutekadis, Twitchett & Wyon, 2009).

5.4. FACTORS INFLUENCING STUDENT DANCERS

Solomon et al (2005) reviewed environmental factors and footwear relating to dance injuries. They concluded that ballet injuries have a multifactorial etiology that primarily involves the interplay of compensatory biomechanics in the spine and lower extremity, environmental factors, and footwear. Byring and Bo (2002) also stated that factors, dancers believed to be associated with risk of injuries, were related to training, organizational factors and environmental factors (Byring & Bo, 2002). The

environmental factors posing possible risk for injuries in the present study included dancing shoes (85 %), slippery floors (83 %), small dancing room (83 %) and poor heating conditions (32 %).

Berardi (2007) explained that some injuries occurred unexpectedly. An off-balance landing, a poorly timed lift or a slippery floor can cause a strain or sprain in a split second. This coincides with the results of the present study in which dancers reported that slippery floors were reported by 83 % do be a possible cause for injury. Most often, however, injuries develop slowly over a period of time and are caused by overuse or continual, low-level stress.

At the university level, lack of prior training overall or in a specific technique may be cited as a potential risk for injury. This could be related to increased demand of other theory load. The majority (69 %) of the dancers in the present study however reported that the University programme did not influence their dancing program whereas 23 % of the dancers reported that it influenced their dancing program. As part of a larger study examining injury patterns in university-level modern dancers, the association between prior training in ballet, modern dance, and jazz dance and rates of injury was examined (Weigert, 2005).

Researchers have suggested that ballet dancers are at increased risk for injury because of the tremendous physical and emotional demands placed upon them (Maya et al, 2004). Classical ballet distinguishes itself from purely athletic or artistic pursuits in that it combines the demands of both fields. For this reason, elite ballet dancers are exposed to a

tremendous amount of stress and anxiety in their professional life. Some of these sources of stress include high expectation of artistic excellence, pressure to maintain unrealistically low body weight, exhaustive training schedules, fierce competition, and lack of job security. The group of dancers most injured in their study included those dancers who had experienced a number of stressful life events and who had reported low levels of social support. The dancers in the present study reported a significant amount of support for their dancing programme (100 % from family; 98 % from friends; 92.7 % from teachers). This could be seen in a positive light as numerous researchers have highlighted the importance of exploring the role of a broader range of psychosocial factors in the development of dance-related injuries. Noah (2005) also identified freedom from worry and confidence as significant predictors for frequency of injury.

Warm-up is the process wherein you literally raise your body temperature (some say for about one to two degrees Celsius) to prepare your muscles from the normal to the exercise condition. Warm-ups are done at the beginning of a workout (Malliou, Rokka, Beneka, Mavridis and Godolias, 2007). Cool-down exercises allow your body to relax and to return to a resting state after you have completed it. Also, performing a cool-down is the best way to minimize muscle fatigue and soreness due to the high muscle exertion from your major activity/workout. Both warm-up and cool-down are aimed to enhance flexibility, minimize discomfort, and prevent injury. Also, they involve some stretching and relatively gentle movements.

In a study conducted by Malliou et al. (2007) a statistically significant relation between the rate of injuries and the duration of the warm up and cool down was found. When the

warm up and cool down during the program is about 15 minutes, the number of injured appeared significantly smaller. In the present study 100 % of the participants reported warming up before dancing but more than half (58.5 %) of the participants reported no cool down. More males (57.10 %) reported cool down as opposed to females (23.5 %). Researchers have stated that the increase of the flexibility of a muscle-tendon unit during warm up and cool down, promotes better performances and decreases the number of injuries (Witvrouw, Mahieu, Danneels and McNair, 2004).

In summary, injuries may occur because of many factors, but in dance, according to the results of the present study, the duration of warm up and cool down before, during and after a program, must be taken into serious consideration, as much as specialised knowledge and constant update, because these factors seem to contribute to injury rate.

5.5 CUMULATIVE INCIDENCE OF INJURY

In present study a cumulative incidence of 17.1% was found for injuries during the period of sixteen weeks. The present study contrast with the above author as there were 0.1707 injuries/1000 dance hours. Some injured more than once and in different body part. Ankles (30 %) and low back pain (30 %) were the most reported areas of injuries followed by calf pain and feet pain at 10 %. Solomon, Solomon and Minton (2007) surveyed 164 modern dancers with a history of injury in the previous 5 years about their injuries. The most common sites of injury were the knee (20.1%), ankle (19.6%), and lower back (15.3%), and 68% of injuries were overuse injuries. In the study conducted by Byring and Bo (2002), thirty-one dancers experienced injury or more. The six-month

retrospective survey found a total of six (6) dance related injuries. Weigert (2005) conducted a study on dance injuries and the overall injury. This shows a very low percentage compared to the other studies. In the study conducted by Byring and Bo (2002), 75 % of dancers experienced one injury or more during the 5 months period of the study. The injury rate in this study is very low compared to other studies but the some of the injured participant sustained more than one injury as in Byring and Bo (2002) study.

There was considerable disagreement about the most common site of injury, with some studies citing the lower leg as most affected, and other studies emphasizing the back. Solomon and Micheli (2005) suggest that there may be different injuries incurred depending on the style or type of modern dance being performed. In this study the incident rate is 6 % per month and 1.5 % per week. Bronner et al (2006) defined the injury incident rate as the number of new cases (dance injuries) that occur during a given time period, divided by total exposure (either activity-based event or time-based 1,000 hours depending on which exposure definition being used) of all the cases (dancers in the group) at risk. The rate of injury for dancers is difficult to establish because there are no uniform standards for measuring or defining injuries and no standard methodology for capturing workload exposure i.e. number of actual hours spent dancing (Gamboa et al 2008). Some authors have reported injury rates per dancer, but study periods vary from 9 months to 5 years and methods for defining and reporting injuries are inconsistency. In a prospective study of pre-professional dancers aged 14 -18 (35 females and 5 males), the incident rate of injuries per 100 hours of dancing was 0.47 for the self reported and 0.29

for the injuries reported to the medical professional (Luke et al, 2002). Nilsson et al (2001) reported a mean of 3.8 injuries/dancer during a five observational period with a calculated occurrence rate of 0.62 injuries/1000 hours of dance activity, 390 injuries incurred by 98 dancers over a five year period i.e. 0.6 injuries/1000 dance hours. The results of the present study contrast with the above author as there were 0.1707 injuries/1000 dance hours.

The limitations of the recent study were the small sample size and the duration of the study period which made it difficult to compare with the other studies. Solomon et al (2005) calculated the incident rate to be 4.7 injuries/ 1.000 hours of dance exposure. The incidence rate in this study is much lower than the previous author as the rate calculated per injury/ hour of dance. Obviously a standardized method of defining, classifying and rating the severity of injuries needs to be widely adopted so that results from different studies can be compared.

The incidence rate in this study is very low compared to other studies like Solomon et al (2005) where the self reported injuries were 43.7 recurrent injuries. At the injury occasion, 58 % of dancers immediately stopped the ongoing activity, while 42 % did not, according to their recollection. Fortunately in the recent study, there was no participant who decided to stop because of injury. The number of men and women in the group of dancers with acute injuries showed that women had a higher relative occurrence of reported injuries than men ($27/76= 36 \%$). Unfortunately, in the recent study the gender difference was not recorded as the questionnaire used (SEFIP) did not provide the

information on the gender. Analysis of various risk factors in these apparently “injury-prone” subjects (percent work time dancing, exercise hours/week, and daily time warming up and stretching) revealed significant differences in this study.



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CHAPTER 6

CONCLUSION

6.1 Conclusion

The main purpose of this study was to investigate the cumulative incidence and prevalence of musculoskeletal injuries of the student dancers at Tshwane University of Technology over once academic semester in 2007. Several researchers have highlighted the high prevalence of injuries among both student and professional dancers (Liederbach, 2008; Negus, 2005 & Nilsson et al., 2001). Various researchers have however also highlighted the inconsistencies around the different definitions used for studies regarding injuries among dancers. Some of these definitions include the definition of injury and severity of injuries (Solomon et al., 2005). Irrespective of these differences, the present study reported on a large number of injuries sustained by student dancers prior to the commencement of the study. The majority of the injuries reported involved the foot and ankle. Expand like this.

6.2 Limitations of the study

The results of the present study should be interpreted in the light of the following limitations:

1. The main limitations to this study were small population group which limited the researcher to select the sample size as a result the whole population had to be used as the sample regardless of the dancers who never concern to participate.

2. The recall and reporting bias of the injuries also were the limitations as some of the dance student were scared to report the injuries with fear that their response will affect their University performance.
3. The period of data collection was not enough (16 weeks) and the last month was closer to the examination time which the student dancers were busy preparing for their theory exams and not attending the classes daily.
4. A multi-center study can be carried out to better assess risk factors on a larger dance population. Further research should aim to standardize injury definitions and classifications.
5. The study did not go into details on preventative measures as the researcher was not given enough opportunity to be hands on the student dancers who got injured while data was collected.
6. The current study was limited to a single small art school and a multi-task study would improve validity.

6.3 Recommendations

1. One of the possible methods for preventing injuries in aesthetic sports is regular monitoring of the performers' pain status using the Self- Estimated Functional Inability because of Pain (SEFIP) questionnaire (Miletic 2000, Ramel et al., 1999).
2. The SEFIP questionnaire is a simple and valuable tool in defining the pain status in certain body regions in aesthetic athletic and it has been shown to be of high applicability in professional ballet dancers and students
3. To effectively reduce dance injury rates, a consistent and systematic way of documenting injury occurrence is necessary.
4. Liederbach and Richardson (2007) stated that, without uniformly kept records showing the type, nature, frequency, and circumstances surrounding dance injury events, it is difficult – if not impossible – to distinguish between variables that influence their occurrence.
5. The issue of non-reporting injuries will affect all measures of injury frequency and risk for dancers (Jacobs, 2007).

6. Luke (2002) suggested that early identification of injuries is considered important to prevent worsening injuries.
7. Hamilton (2005) suggested that dance schools can devote to conditioning exercises, stretching, and set warm-ups, rather than adding extra classes.
8. Micheli, (2007) suggested that attention to the anatomy and biomechanics of the spine during dance training should be a top priority for both students and teachers. Such attention should decrease the incidence and severity of spine and lower extremity dance injuries.
9. Bronner et al (2006) in the study of comprehensive surveillance of dance injuries recommended that dance instructors reduce the potential risk of injuries to dancers by encouraging students to limit their functional turnout to a position that does not markedly exceed the total amount of outward rotation present at the hips.
10. Teachers should encourage students with compensated turnout to decrease their turnout, and to increase their stretching and strengthening regime with the goal of improving their hip outward rotation as much as possible over time. Many dancers will never achieve the ideal turnout, yet can still enjoy the practice and performance of ballet.

11. Science daily (2000) suggested that to teach dancers how to increase levels of social support and to learn coping skills to deal with day to day stressors, such as interpersonal conflict and dealing with traffic that put them at risk of injuries.
12. Future studies are needed to collect data on the severity of dance injuries, extent of disability from injuries, and prognosis. More studies are needed on dance styles other than ballet.
13. Finally, the analysis of many possible risk factors is needed to help identify ways to educate dancers about reducing risk factors to prevent injuries
14. Dance screens provide healthy baseline data, uncover existing pathology, and help define population characteristics. Adoption of a common system should result in improved understanding of injury incidence and risk factors with potential to increase the effectiveness of injury prevention interventions and rehabilitation.
15. To prevent dance injuries, proper technique and flexibility is crucial. Rest is essential to prevent overuse injuries. Proper nutrition with adequate calories and calcium is necessary to prevent stress fractures. Abdominal or core strengthening should be done at least three times weekly to prevent back pain and injury.

16. The use of an injury reporting surveillance system within a dance school is critical to the prevention of the dance injuries because it catalogs conditions associated with each injury event and offers an epidemiologically sound method of measuring annual injury incident by body region and exposure-based injury rate for time or factor comparison.

17. Future studies are needed to collect data on the severity of dance injuries, extent of disability from injuries, and prognosis. More studies are needed on dance styles other than ballet. And analysis of many possible risk factors is needed to help identify ways to educate dancers about reducing risk factors to prevent injuries.

As the dancers are much more in demand in terms of entertainment and career to others, the onus is on the instructors to ensure that their valuable resources, their dancers, have the necessary preventative and rehabilitative resources to recover appropriately from injuries sustained while they are still learning. This study underscores the need for Physiotherapy to be part of the health care profession involved in dance.

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The logo of the University of the Western Cape, featuring a stylized building with columns and a pediment, with the text "UNIVERSITY of the WESTERN CAPE" below it.

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Annexures:

Appendix 1

Questionnaire

Demographic data

Date of birth (years).....

Height (cm).....

Weight (kg).....

Gender.....

BMI

Previous injuries

Have you ever have any injury while dancing? Yes..... No.....

Type of injury

Area of the body where injured.....

Mechanism of injury (how did it happen).....

Did you continue practicing after you felt the injury? Yes No.....

Did you ever consult the medical practitioner because of dance injury? Doctor

Physiotherapist.....

In your opinion, do you think that your injury could have been prevented? Please explain
.....
.....

Training routines

How many days a week do practice ballet dancing?.....

How many hours a day do you practice ballet dancing?.....

Do you do warm up before dancing? Yes..... No.....

If yes for how long.....

Do you do cool down after dancing Yes..... No.....

If yes for how long.....

Psychological factors

University and rehearsal conditions

- Is your theory workload interfering with your rehearsal load?

Daily ___ often ___ sometimes ___ seldom ___ never ___

- Do you think other dancing techniques interfering with the ballet dancing?

Daily ___ often ___ sometimes ___ seldom ___ never ___

Social support

- Family is very supportive of my dancing career:

Strongly agree ___ agree ___ disagree ___ strongly disagree ___

- Friends are very supportive of my dancing career

Strongly agree ___ agree ___ disagree ___ strongly disagree ___

- Teachers are very supportive and encouraging of my dancing career

Strongly agree ___ agree ___ disagree ___ strongly disagree ___

University influence

- Are your studies affecting your rehearsal performance?

Strongly agree ___ agree ___ disagree ___ strongly disagree ___

- Are the practice hours influencing your performance?

Strongly agree ___ agree ___ disagree ___ strongly disagree ___

Possible risk factors

Factors related to the daily training

Warm up period is too short Yes ___ No ___

Hours of practicing a day are too long Yes ___ No ___

Cool down period is too short Yes ___ No ___

Dancing timetable is too overcrowded Yes ___ No ___

Factors related to organization and planning

Ballet training need to be practiced daily Yes ___ No ___

Ballet training need to be practiced in the Mornings ___ afternoon ___

Environmental factors

The dance floor is too slippery Yes ___ No ___

My dancing shoes are not comfortable Yes ___ No ___

The dancing room is too small Yes ___ No ___

The heating conditions in the dancing room are not conducive Yes ___ No ___

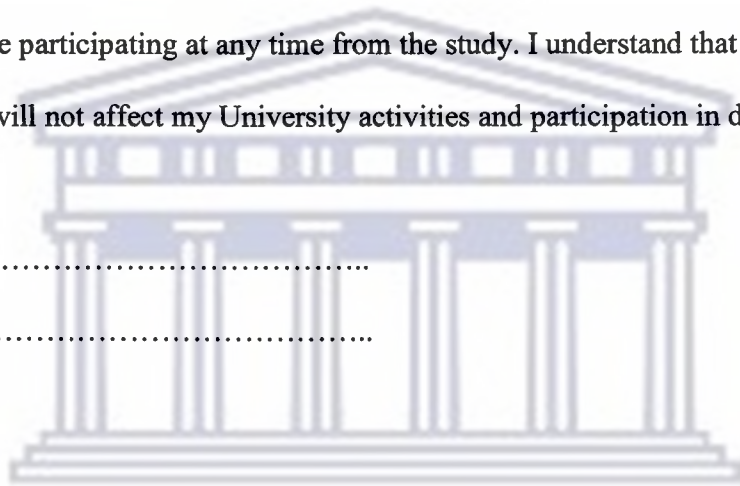
Appendix 2

Consent form for participants

Ihave read the information sheet and agree to take part in the study conducted by Nontembiso Magida. All the questions have been answered to my satisfaction. I understand that my participation is voluntary and that I can discontinue participating at any time from the study. I understand that withdrawal from the study will not affect my University activities and participation in dancing.

Signed.....

Date.....



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Appendix 3

Letter to the head of department Tshwane University of Technology

Re: Permission to conduct a research study

I am a Physiotherapy post graduate student from the University of the Western Cape in Cape Town. As part of my requirements to fulfill the degree I need to conduct a research study of my choice in any field. The field that I have chosen is sport/dance. The title of my study is “CUMULATIVE INCIDENCE OF MUSCULOSKELETAL INJURIES AMONG STUDENT DANCERS AT TSHWANE UNIVERSITY OF TECHNOLOGY”.

The aim of my study is to establish the prevalence of musculoskeletal injuries among student ballet dancers in Tshwane University of Technology. This study will also be able to identify possible risk factors associated with injuries therefore that will assist in possible preventative measure.

I would therefore hereby wish to request permission to conduct the study among the TUT student ballet dancers. I assure you that the study will not interfere with studies of the students. The results of the study will be made available to the University.

Yours sincerely

Nontembiso Magida

Appendix 4

Letter to the students

Dear Student

My name is Nontembiso Magida. I am doing my Masters in Physiotherapy in the University of the Western Cape. As part of my requirements to fulfil the Masters in Physiotherapy is to conduct a research study. My research title is “prevalence of musculoskeletal injuries among ballet dancers in Tshwane University of Technology (TUT)”. The primary aim of this study is to investigate the prevalence of musculoskeletal injuries among the ballet dancers in TUT. The objectives of the study are:

- To establish the location and type of injuries among TUT student dancers
- To analyze the prevalence, location and recurrence of musculoskeletal injuries
- To investigate possible preventative strategies

I, therefore, request to conduct the study among student dancers and request your participation. You are assured that all information will be confidential and anonymous.

You have the right to withdraw from the study anytime without explanation.

Yours sincerely

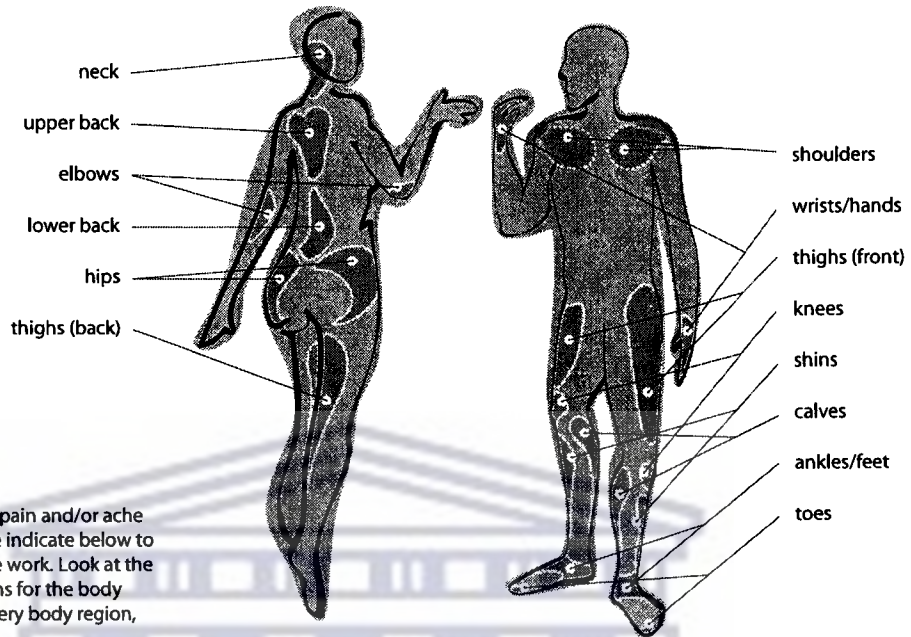
Nontembiso Magida

SEFIP

Self-Estimated Functional Inability because of Pain

Date

Name (optional)



How do you feel just now?

Do you have any musculoskeletal pain and/or ache right now (today), and in that case indicate below to what extent it disturbs your dance work. Look at the picture above to see the definitions for the body regions, and check one box for every body region, please. Thank you.

- Very well
- Some pain but not much problem
- Pretty much pain but I can handle it
- Much pain, must avoid some movements
- Can not work in the production because of pain

Body region	Comments (optional)					
neck	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
upper back	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
elbows	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
lower back	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
hips	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
thighs (back)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
shoulders	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
wrists/hands	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
thighs (front)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
knees	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
shins	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
calves	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
ankles/feet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
toes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

SEFIP

Self-Estimated Functional Inability because of Pain

Pain scale

Here is a presentation of the scale for the dancer's subjectively perceived pain as used in Eva Ramel's research. It can be used to measure the effect of different training methods/repertoires on pain and injury.

Directions for the use of the questionnaire SEFIP

Self-Estimated Functional Inability because of Pain

For dancers

The SEFIP form is intended primarily for professional dancers but can also be used for dance students on various courses, dance teachers and others who dance regularly and with relative high intensity. Certain words may then perhaps have to be adjusted, e.g. "production" may be replaced with another suitable term better reflecting the activity concerned.

Indication of work load

The SEFIP form may suitably be distributed to all the dancers in the company and should be completed individually. To obtain an impression of the work load on the whole company about 80 % of the dancers should have completed the form. SEFIP may also be used for individual assessment, and may then help to make dancers conscious of the extent and intensity of the problems. When measurements are repeated it should be borne in mind that measurements should be taken at the same time on each occasion, e.g. in connection with conclusion of daily morning training (school).

Points calculation

Points on the SEFIP scale are calculated as follows:

I am entirely free of pain =	0 points.
I have slight pain but it is no problem =	1 pts.
I have quite a bit of pain but I can dance if I am careful =	2 pts.
I have a lot of pain and have to avoid certain movements =	3 pts.
I have great difficulty and cannot take part in the production =	4 pts.

The maximum points total is therefore $14 \times 4 = 64$. All pain > 2 should first of all lead to thorough examination by a physiotherapist, doctor or other person very familiar with a dancer's work, and further action should be taken. Pain of lower intensity may also be an indication of shortcomings in the work situation, especially if several dancers show similar symptoms or if (in connection with repeated measurements) sudden changes in the symptomatic picture arise.

User-friendly

The SEFIP form is easy to fill in, takes little time and is an inexpensive way of taking the temperature of dance activity. Used on a single occasion it may give a picture of both the prevalence of the injuries and how serious (restricting) they are in a dance company. The form can then be filled in anonymously. As the instrument measures the current problems ("just now") it is particularly suitable for taking repeated measurements, when the intention is to study the fluctuation in the load on a company throughout a season, for example, or in connection with a particular production or training period. It is then appropriate to be able to identify the same person's repeated measurements with the help of some kind of coding. In this way it is possible to take measurements of a preventive nature both for the individual dancer and for the company as a whole, in order to limit the extent and intensity of the pain. Such measures may for example be adjustments to choreography, costumes, quantity of training and methods.

SEFIP has been tested

The form is an instrument for subjective estimation and is constructed from the Nordic Council of Ministers questionnaire concerning pain from the limbs (Kourinka et al 1987) but with a more specific division of the body into fourteen regions instead of nine, to suit dancers better. The instrument has been validated (Ramel et al 1999) against a constructed "gold standard". The mean sensitivity for all regions of the body was 78% and the average specificity 89%. Correspondance between SEFIP and the test battery had a mean value of 88%, and varied between 78% (hip region) and 96% (neck region). The dancers included in the study were all professional dancers at two of Sweden's largest ballet companies. The different pain provocation tests and functional tests which were included in the "gold standard" instrument had been chosen by an "expert group" consisting of physiotherapists and naprapaths with great experience of injuries to dancers' limbs. The majority of the tests had previously been tested for reliability and validated and were reported in the literature. A few more of the tests have been tested for reliability later (Christiansson et al 2000).

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Instrument designed by: Eva Ramel, reg. Physiotherapist, Dr Med.Sc. Department of Clinical Neuroscience.
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