EPIDEMIOLOGICAL STUDY OF INJURIES IN HIGHLAND DANCERS

A Thesis Submitted to the College of
Graduate Studies and Research in
Partial Fulfillment of the Requirements for the
Degree of Masters in the College of Kinesiology

University of Saskatchewan
Saskatoon
By

Patricia Marie Logan-Krogstad

PERMISSION TO USE

In presenting this thesis in partial fulfillment of the requirements for a Postgraduate degree from the University of Saskatchewan, I agree that the Libraries of this University may make it freely available for inspection. I further agree that permission for a copy of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by the professor or professors who supervised my thesis work or, in their absence, by the Head of the Department or the Dean of the College in which my thesis work was done. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of Saskatchewan in any scholarly use which may be made of any material in my thesis.

Requests for permission to copy or to make other use of material in this thesis in whole or part are addressed to:

Dean of the College of Kinesiology
University of Saskatchewan
87 Campus Drive
Saskatoon, Saskatchewan
S7N 5B2

ABSTRACT

EPIDEMILOGICAL STUDY OF

INJURIES IN HIGHLAND DANCERS

The repetitive ballistic movements in highland dancing, which occur at more than 100 beats/min while the dancers try to reach a maximal vertical height with each jump, could possibly develop chronic injuries similar to ballet and aerobic dance. This study aimed to determine the following: number of injuries/dancer, number of injuries/100 hours of training, the number of chronic injuries compared to acute, anatomical location of the injuries and possible predictors for sustaining an injury in highland dancers. The 76 participants, aged 7 through 22, were from two Saskatoon Dance Schools. The information was collected by retrospective and prospective questionnaires and data analyzed using a Chi-square, analysis of variance and a binary logistic regression. The six-month retrospective survey found a total of 6 dance-related injuries compared to the 42 dance-related injuries in the four-month prospective questionnaire. When analyzing only the injured dancers the CHD (competitive) had 1.62 injuries/dancer, RHD (recreational) had 1.86 injuries/dancer and the Control group (non-highland dancers) had 2.0 injuries/dancer. Significant differences were not found for the number of injuries sustained in these three dance groups ($X^2 = 0.72$, $p<0.70$). The injury rate per 100 hours of training for only the injured dancers in each group was as follows; CHD 2.59 injuries/100 hours, RHD 4.51 injuries/100 hours and the Control group 4.97 injuries/100 hours. The majority of the chronic versus acute injuries were sustained by the CHD (9 chronic, 8 acute), however they were not statistically different from the RHD (4 chronic, 7 acute) ($X^2 = 0.738$, $p<0.05$). Most of the injuries occurred to the lower leg, with the knee, shins/calf, ankles and the feet as the major sites. Significant differences were found for these four lower leg sites versus the rest of the body ($X^2 = 11.20$, $p<0.05$). There were also no differences for the number of lower leg injuries between the CHD and RHD ($X^2 = 4.605$, $p<0.05$). The three variables

associated with an increased risk for sustaining an injury were age, having a previous injury and the onset of menarche.

ACKOWLEDGEMENTS

The author wishes to thank my advisor, Dr. Keith Russell, for his constant support, words of wisdom and endless hours for helping me to complete this project. I would also like to thank my committee members: Dr. Adam Baxter-Jones, Dr. Robert Faulkner, and Professor Joan Krohn for all of their expertise and positive feedback on my paper. I also want to thank my external examiner Dr. Liz Harrison.

I would also like to acknowledge both the Wendy Wilson School of Highland Dancing and the University School of Dance for allowing me access to their schools, and all of the wonderful teachers and students that I worked with. I never could have done this without you.

A big thank you to Tekla Johnson and Norbert Krogstad for all of your help in performing the growth measurements, and for showing up every second week to collect data.

Finally, special thanks to my family for their support and encouragement and to my friends who kept me laughing and in touch with the world throughout this ordeal. Without this support I may not have made it this far. Thank you!

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND DEFINTIONS

Aerobic Dance = are organized fitness classes that are choreographed to music

CHD = Competitive Highland Dancers

Incidence = the number of new cases that occur in a particular population during a specific period of time

Muscle strain = is a stretch tear or rip in the muscle or its tendon

Prevalence = the total number of occurrences both new and old, that exist at a particular time

RHD = Recreational Highland Dancers

SCHDA = Southern California Highland Dance Association

Sprain = is an injury to the ligament that attaches two bones together

LIST OF APPENDICIES

CHAPTER 1

1.1 INTRODUCTION

Dancing has been a part of human society through the celebration of special events like weddings, through story telling or just for enjoyment. Scottish men used to dance in the military, as a way to predict the outcomes of war. This was the origin of highland dance. According to the Scottish Official Board of Highland Dancing (2002) the popularity of highland dancing is tremendous with 11,044 registered competitive dancers world wide in 2002. The popularity may possibly be due to the exposure from movies like Braveheart and Rob Roy, media coverage and cultural events. In the beginning, highland dancing was primarily an event for males and was used to show off the strength and power of the clan, whereas women danced only at social dances (celidhs) (Southern California Highland Dance Association (SCHDA), 2004). In the mid 1900's, when it was socially accepted for women to partake in more strenuous activities, the dancing roles reversed with the dancers becoming predominantly women. According to SCHDA (2004) and Kerkhof (2004) the ratio is approximately 100:1 with women now dancing both the male and female dances. Highland dancing is a combination of ballet like movements and aerobic dance like movements and has been described as an athletic, elegant and skillful art form. Highland dancing is similar to Scottish country dancing but is distinguished by a stronger emphasis on technique, height of the jumps and dancing individually, rather than as a couple or group (Kerkhof, 2004).

Like many sports, dancers are prone to sustaining injuries, many of which are chronic in nature and are predominantly located in the lower extremities. It has been shown in ballet dancers that the injuries occur due to the high intensity of training, numerous training hours in a week, the repetitive nature of the movements, inappropriate floor surfaces and increasing age. Dancers often begin their training at a very young age and continue the intensive training through their growing years. This is problematic as the majority of studies report that most of the injuries occur to the dancers during the time period of rapid growth (Krasnow, Mainwaring and Kerr, 1999; Poggini, Lasosso and Iannone, 1999; DiFiori, 2002; Outerbridge, Trepman and Micheli, 2002).

Currently, there is a paucity of published research on the etiology, nature, anatomical location, severity, total number of new and old injuries and injury rates (per 100 hours of training or per dancer) sustained by highland dancers. The absence of this information makes it difficult for dancers, teachers, sport therapists, health professionals and parents to understand how to prevent or treat injuries in highland dancers. Since ballet and aerobic dancing are similar to highland dancing, literature on both these forms of dance were reviewed to gain insight on possible related injury information. The aim of this study was to determine the prevalence, incidence, nature and etiology of injuries sustained as a result of highland dancing.

1.2 REVIEW OF LITERATURE

This literature review will look at injuries in ballet, aerobic dance and highland dance and how these three dance forms are related. It will review the many possible reasons why dancers are injured such as: long training hours, training during growth years, continuing to dance on a chronic injury, insufficient recovery of acute injuries, attempting skills beyond the dancers' ability and not enough time spent in both warm-up and stretching. In addition it will look at methodological aspects of epidemiological studies in dance.

1.2.1 Injury Characteristics in Similar Dance Forms

The scarcity of research specific to highland dancing resulted in the review of ballet and aerobic dance in order to develop the hypotheses. Ballet and highland dance share the same ancient roots from the time of the "Auld Alliance" between the French and Scots. The similarities between the two dance forms include maximal turnout of the hip, maximal vertical height on jumps, repetitive dynamic movements and the positions of the arms and feet. Another similarity is that dancers' in both dance forms (at the elite level) train year round with little time off. Watkins et al. (1989) and Garrick (1999) both found that pre-professional ballet dancers (ages 13-18) train between 20-30 hours per week but during high performance times the training time can double and reach up to 70 hours/week. It is presumed that highland dancers would only train approximately half the hours compared to professional ballet dancers due to the fact that highland dancers are only able to train after school and on weekends (there are no professional highland dance companies).

Aerobic dancing is similar to highland and ballet dancing in that there are numerous repetitions of movements, a large number of training hours and there are high impact landings from trying to reach a maximal vertical height on jumps. Clark et al. (1989) found that the peak vertical ground reaction forces for aerobic dancers was 2-3.5 times their body weight. Similar to ballet and highland dancing there is typically no "off season" in aerobic dance, however one would presume that during the summer months more of the time spent exercising would be spent outside rather than at the fitness studio.

Highland dancing is a highly aerobic activity that involves repetitive dynamic movements occurring at a tempo up to 100 beats/min (Potter & Jones, 1996). The dancer strives to reach a maximal vertical height on each jump while only landing on a plantar flexed foot with no heel contact (Potter et al., 1996). Unlike ballet, but similar to aerobic dance, there is ideally no movement of the trunk as only the upper extremities and the head move. The positions of the feet in highland dancing are the same as for ballet dancers; however, turnout of 45 to 90 degrees is acceptable upon all landings whereas it is not sufficient for ballet dancers. The working leg (non-hopping leg) is to be turned out to 90 degrees which is the same as for the technique in ballet. An inability to turnout to this degree leads to secondary injuries in ballet and therefore it is assumed that the same would be true for highland dancers. The repetitive landings in ballet and aerobic dancers are similar to the constant hopping actions performed by highland dancers. The similar movements and positions of the arms and feet used by ballet dancers provides a stronger comparative link between ballet and highland dancers, however the repetitive landings provides a strong comparison for aerobic and highland dancers. The only two studies on highland dancing that were found was a case study on plantar fasciitis by Potter et al., 1996 and Young and Paul's (2002) prospective survey of Achilles tendon injuries in competitive dancers.

1.2.2 Underreporting of Injuries in Dance

Participating in any form of physical activity increases the possibility of injury. Coaches, trainers and dancers are constantly trying to discover ways to reduce the occurrence of training related injuries in order to maximize performance. Researchers investigate the overall number of injuries, the injury rate and possible causes of dance injuries in hopes to decrease dance training related injuries by introducing new training methods. It has been reported (Teitz, 1982; Malone & Hardaker, 1990; Hald, 1992) that there is an unwillingness to stray from the traditional training techniques in ballet where the same training format has been used for centuries. It is assumed that similar rejection to new techniques would be present in highland dancing as their fundamental training methods were developed during the same time period as ballet. This unwillingness to try new training techniques means that the number of injuries currently being sustained will most likely continue. It has also been shown that not all dance-related injuries are reported in studies. McNeal, Watkins, Clarkson and Tremblay (1990) found that of the 350 ballet dancers prospectively surveyed (with an average age 17.4), only those dancers who had to take time off dancing sought medical treatment for their injuries. Therefore, the actual number of injuries sustained by the dancers in that study was likely under reported. For example, Askling, Lund, Saartok and Thorstensson (2001) found that 70% of the 98 ballet and modern dancers (age range 17-25), in a Swedish professional school, self-reported continuing problems to their hamstring while only 4 of the 98 dancers sought medical treatment. Luke, Kinney, D'Hemecourt, Baum, Owen & Micheli (2002) found that in a prospective cohort study of pre-professional dancers age 14-18 (35 females and 5 males) more injuries were reported when the dancers self-reported than when the injuries were reported to a medical professional. There were 0.47 injuries per 100 hours of dancing with the self-reported injuries compared to 0.29 injuries per 100 hours when medically reported. The reason for the unreported injuries, according to McNeal et al. (1990), is that the dancers have the perception that an injured dancer may lose his/her role or be replaced even if the injury can be rehabilitated before the performance deadline. Hald (1992) found similar results with the professional dancers' perceptive fear of losing their position in their dance company or having to cease their training completely. Bolin (2001) stated that with the enormous pressure to perform and intense competition for performance the dancers are likely to ignore symptoms and delay medical treatment. In the case of the highland dancers there is no fear of losing a position in the company, rather a strong competitive drive to be the best (winning first place) and applying the saying "don't let your competitors know you are injured". Another possible reason for the underreporting of injuries is that the injury may not have been severe enough for the dancer to seek treatment thus the injury was not reported. This insufficient reporting of dance related injuries or lack of medical diagnosis hinders researchers in developing new training techniques.

1.2.3 Dance epidemiology

Dance research that assesses injuries is predominantly epidemiological, that is, it examines the "frequencies and distributions of diseases and health conditions among population groups" (Thomas & Nelson, 1996). Descriptive epidemiology describes the distribution, frequency, severity and locations of the diseases or health concerns in a given population. Descriptive research is most commonly used when evaluating injury data. Three ways to assess injuries or time-at-risk are retrospective questionnaires, prospective questionnaires and interviews. Retrospective questionnaires rely on the participants' ability to recall information, this technique which can be inconsistent and unreliable depending on how far in the past the individual is asked to recall their injury (Van Mechelen, 2000). Prospective data collection is a more accurate way to collect injury information as it defines the risk of incidence by the close monitoring of the subjects (Van Mechelen, 2000). Interview data collection is more reliable than mail in questionnaires or surveys as the researcher can obtain more information and participants are able to ask questions relating to the questionnaire, rather than just read what is printed on the questionnaire. Another advantage to the interview method of collection is that the in-person style of obtaining the data leads to a greater number of questionnaires being returned to the researcher (Thomas & Nelson, 1996). A validity limitation to the interview method is that the interviewer tends to improve questioning techniques over time and thus some of the information from the individuals first surveyed may not be complete (Thomas & Nelson, 1996). This improved technique by the interviewer is called the learning effect. The researcher must be careful not to sway the individual to answering the questions in a way that will bias the results (Thomas & Nelson, 1996). The majority of dance research is prospective, but may also include some form of injury history or retrospective data (Garrick, Gillien & Whiteside, 1986; Rothenberger, Chang, & Cable, 1988; Bowling, 1989; Watkins, Woodhul-McNeal, Clarkson & Ebbeling, 1989; McNeal et al., 1990; Kerr, Krasnow, & Mainwaring, 1992; Carvajal, Evans, Evans, Nash & Carvajal, 1998; Krasnow, Mainwaning & Kerr, 1999).

A primary issue for researchers in epidemiology is the adoption of a common definition of an injury. Presently there is no universal health definition for an injury and this makes study comparisons problematic (see Table 1.0) (Van Mechelen, 2000). Some researchers define an injury as any event that requires medical attention (Van Mechelen, 2000). This is an ineffective definition, as the majority of dance injuries are not seen by medical professionals (Hald, 1992). This lack of medical diagnosis decreases the effectiveness of classifying dance-related injuries.

Table 1.0 Definitions of sports injuries used in research

Study	Definition
Rothenberger et al. (1988)	Any condition causing pain and/or limiting activity
Clark, Scott & Mingle (1989)	Any condition that caused the student to miss class
Kerr et al. (1992)	Any physical harm resulting in pain or discomfort
Garrick (1999)	An injury was any complaint that the dancer had which brought them to the clinic to have treated
Van Mechelen (2000)	Only injuries treated at a hospital or other medical departments
Luke et. al. (2002)	Any damaged body part that interfered with training or any complaint that the dancer had questions about
Bronner, Ojofeitimi and Rose(2003)	Any musculoskeletal complaint resulting in financial outlay

A more appropriate definition is given by Rothenberger, et al., 1988; Kerr et al., 1992 and Krasnow et al., 1999, who defined a dance injury as “a physical condition that causes pain or discomfort resulting in a limitation, restriction or cessation in participation in dance”. This broadens the definition to incorporate a greater number of injuries. This increased sensitivity still does not account for all injuries sustained by dancers as many of the competitive dancers continue to train while they are injured and/or in pain. These dancers ignore the limitations that the injury may have on their performance and dance their way through pain in order to achieve their goals. A way to account for injuries not being recorded by the dancers would be to observe training practices and competitions in order to watch for compensatory movements and for the researchers to have close contact with the instructor so that the instructor can inform the researcher of any injury complaints. Gaining information this way should allow a match between the instructors’ opinions, the observations and the information given to the researcher by the dancer.

The inconsistencies in defining what an injury is makes study comparisons difficult. A way to compare studies is by reporting injuries as either incidence rates or prevalence. Incidence rates are the number of new injuries per specified hours of training whereas prevalence is the total number of injuries (new and old) in a specific time period.

1.2.4 Training Hours

It has been estimated that over 30 million children between the ages of 5-17 participate in some form of organized athletic programming in the United States and that a large portion of this is outside of school based programs (NATA Research and Education Foundation, 2001; DiFiori, 2002; Adirim & Cheng, 2003). Many of these children train specifically for one or two sports and therefore are training at a greater intensity and duration than that of recreational athletes. Koutedakis, Pacy, Carson & Dick (1997) found that a similar trend existed in professional ballet dancers, who trained exclusively for one dance form compared to those training in multiple dance forms at the student level. Of the 324 professional ballet dancers surveyed (102 males and 222 females average age of 27.5) and 334 modern and ballet students (ages not given) it was found that the professional ballet dancers trained significantly more hours than the modern and ballet students (values were not given by the researcher). Even though this study surveyed a large population of UK dancers there is the limitation of missing information from a single collection period due to dancers who were not at the collection period because they had a debilitating injury. Teitz (1982) attributes the higher rate of injuries in ballet dancers to the exponential rise in popularity of ballet dancing in the last two decades. However, the author did not mention number of injuries to show the increase in injury frequency. The differences in training levels, intensity and duration are other limitations that exist in injury research. As the dancer's skill level increases so does the amount of training. Garrick (1999) found that 59 female ballet dancers, who were advanced students in a pre-professional school (aged 13-18), trained between 20-28 hours per week. This is similar to Watkins et al. (1989) who reported that young ballet dancers (females under the age of 13) trained 14 hours per week and pre-professional dancers trained 15 hours per week (157 females and 14 males with an average age of 15.6). However once the dancer was a professional, the dancers spent more time in rehearsal than training as shown by the 49 females and 50 males (average age of 22.2) who rehearsed (preparation for a performance) for 35 hours compared to the 10 hours spent in training (improving technique). The aforementioned studies lack the information of the intensity of the training, however to do this, classes would have to take place in a more clinical type of setting where levels of exertion could be measured. The previously mentioned studies are consistent with Kish, Plastino & Martyn-Stevens (2003) where 179 dancers (173 females and 6 males) aged 8-18 years old from private studios averaged 15.2 hours per week training in mostly ballet and jazz. Thirty-three percent of these dancers were taking between one and three classes per week and 53% were taking four-six classes per week. With the increased duration of training per week there is an increased risk of overuse (chronic) and trauma (acute) injuries (McNeal et al., 1990). It is commonly perceived that individuals who train at a higher level will train a greater number of hours in a week than recreational dancers and thus are at a greater risk of being injured (Watkins et al., 1989; McNeal et al., 1990). This was shown by Watkins et al. (1989) where the 99 (50 male and 49 female) professional ballet dancers trained approximately 45 hours per week (rehearsals and classes) compared to the 58 female college ballet dancers who trained only 12 hours per week (rehearsals and classes). A limitation in these two studies is that the questionnaire was administered only once and the dancers were asked to recall the number of rehearsals and classes in a week and the number of performances per year. The researcher didn't indicate whether the information collected on the number of hours spent in classes and rehearsals was an average taken from the whole year or just what occurred in the last week of dance classes and rehearsals. Similar results were found in a study by Bronner et al. (2003) where 42 modern dancers (21 males and females ages 19-40) in a professional company spent approximately 40hr/wk in class, rehearsal, performance, and lecture-demonstrations. A limitation to this study is that it only included dancers who performed more than 30 days annually. A second limitation was that there was an annual turnover rate of six dancers annually, which means that not all of the dancers were studied over the entire five-year period.

Scharff-Olsen, Williford & Brown (1999) reported that the amount of time spent on aerobic dance during a typical week is approximately 4 hours per week, which is only about a third of what college ballet dancers train. Comparable to ballet there is an increase in the incidence of injuries in aerobic dancers when the duration of the activities is increased. Rothenberger et al. (1998) in a prospective study of 726 aerobic dancers (116 male and 610 female age range 13-70) found that those who took four or more classes per week had an increased number of injuries compared to those who trained only once a week. Aerobic dance instructors, however, who trained approximately 13 hours per week, were 2.5 times more likely to be injured compared to their students. This is thought to be due to the multiple classes that they taught (Clark et al., 1989; Scharff-Olsen et al., 1999). Based on the information given on ballet and aerobic dance it was assumed that competitive highland dancers would train similar hours per week as the pre-professional ballet dancers and the aerobic dance instructors.

1.2.5 <u>Number of Injuries per Dancer and Number of Injuries per 100 Hours of Training</u>

Injuries can be reported in two ways; First as an average number of injuries per dancer or secondly as an average rate of injuries over time (100 hours). For example Garrick & Requa (1993) found that in 104 professional ballet dancers (ages not given) there were 2.97 injuries per dancer with a range of 1-12 injuries per dancer. It is difficult to compare the information from Garrick & Requa's study as it only encompassed dancers who had injuries that were reported to the workers compensation board. This means that many injuries were not evaluated because the injury was not severe enough to need financial assistance during the rehabilitation. In a study by Kerr et al. (1992) an injury rate of 2.4 injuries per dancer sustained by 38 dancers (between the ages of 19-25) over 8 months. Luke et al. (2002) surveyed 39 dancers (aged 14-18) and found that there was an injury rate of 1.6 injuries per dancer on the reported injuries, no values were given for the self-reported injuries. Injuries from a workers compensation reports found that there were 1.4 injuries/dancers in the 42 dancers (21 males and females aged 19-40) studied over 5 years (Bronner et al., 2003). Only injuries that resulted in time lost from training were analyzed and thus this rate may be lower that if all injuries were included.

In a prospective study of pre-professional dancers age 14-18 (35 females and 5 males) the incidence rate of injuries per 100 hours of dancing was 0.47 for the self-reported injuries and 0.29 for injuries reported to a medical professional (Luke et al., 2002). The incidence rate for the 351 aerobic dance students (average age 35.5) surveyed by Garrick et al. (1986) was 1.16 injuries per 100 hours and 0.93 injuries per 100 hours for the 60 instructors (average age 31.7). Dancers who had previously sustained an injury were twice as likely to have the injury re-occur (Garrick et al., 1986).

Due to the similar training regimes between both ballet and aerobic dancing it can be assumed that highland dancers could train anywhere from a minimum of four hours per week like the aerobic dancers or up to 70 per week like the professional ballet dancers. The recreational highland dancers would more likely be trained to the equivalent of the aerobic dancers whereas the competitive dancers may train more like the advanced ballet dancers. It is also assumed that highland dancers would see the same increases in injury rate (per 100 hours or per dancer) as the number of hours spent in training increases.

A study by Young and Paul (2002) investigated the length of time spent in training and the intensity of the training on highland dancers. Due to the paucity of research on highland dancers this was the only study comparing hours of training to injury rates. Young and Paul (2002) prospectively surveyed 33 female competitive highland dancers, who were older than 14 years of age at two major competitions to determine the incidence and perceived cause of only Achilles tendon injuries. Of the 33 dancers, 23 had never had an Achilles tendon injury and 10 had experienced an Achilles tendon injury. Dancers who were injured trained fewer hours per week than the non-injured dancers with 60% of the injured dancers and 48% of the non-injured dancers attending dance classes of greater than two hours in duration. The aforementioned study has two major weaknesses: having only included competitive dancers and the sample size was too small to generalize the results to all highland dancers. The intensity and the type of training may have an effect as those dancers who train at a high intensity for shorter periods of time may get injured more than those dancers who train at a lower intensity over a longer period of time.

1.2.6 <u>Injury Classifications</u>

While there are many classifications for how injuries occur, generally they can be broken down into either contact or non-contact resultant injuries. Dance injuries are part of the non-contact resultant injury classification as dance is an individual sport with little to no contact with other dancers. Non-contact injuries can be further divided into acute and chronic injuries. Acute injuries are described as sudden in onset, severe in intensity and brief in duration (Baxter-Jones, Maffulli, & Helms, 1993); more simply, the injury is a single, clearly remembered event. Generally acute injuries are more frequent in contact sports where there is a single major force macrotrauma to a specific area of the body. Typically acute injuries include sprains, strains, dislocations and fractures (Garrick, 1999). Chronic injuries are habitual or long-term injuries where there is repetitive microtrauma to specific areas (Baxter-Jones et al., 1993). Some examples of chronic injuries are stress fractures, plantar fasciitis, tendonitis and shin splints (Bowling, 1989; Rothenberger et al., 1988). The term "overuse injury" often replaces chronic injuries as and overuse injury is related to high levels of stress without sufficient time for recovery (Hogan and Gross, 2003). This paper will use the term chronic injuries.

Ballet injuries are usually chronic in nature due to the repetitive nature of the movements with musculoskeletal injuries, strains and stress fractures being the most common. Sprains were the most common acute injury. Bowling (1989) found that of the 141 modern and ballet professional dancers surveyed (80 females and 61 males between the ages of 18 and over 37) 50% were currently suffering from a chronic injury with 23 of these dancers reporting two or three chronic injuries occurring at the same time. This retrospective study found that 80% of the dancers had sustained an injury that affected their performance at one time during their dance training. These results are limited to the dancers' knowledge of the different types of musculoskeletal injuries and thus there may be the misclassification of the injuries due to the nature of self-reporting. Luke et al. (2002) surveyed 39 multiple disciplinary dancers (34 females and 5 males aged 14-18) who self-reported their injuries biweekly for nine months. If the dancers sought medical treatment from a physical therapist then the information was collected as reported injury data. The self-reports showed that 56.1% were currently suffering from an overuse (chronic) injury and only 14.0% sustained an acute strain, whereas the reported injuries had 49.3% suffering from a chronic injury and 39.4% having an acute strain. The difference between the self-reported and the reported injuries shows that dancers are likely to underestimate the number of acute injuries. For example, if the dancers missed a class because of an injury that injury was not recorded in the self-report. Also dancers may also not want to report the injuries for fear of a position change in the company. Similarities in the chronic nature of ballet injuries have been found in other studies. Macintyre (1994) found that out of the 16 female ballet dancers studied (12-19 years old) 12 had sustained 14 overuse injuries and 4 dancers had acute injuries.

Injuries in aerobic dancing are also predominately chronic in nature; with strains, tendonitis and shin splints being most common (Rothenberger et al, 1988; Michaud et al., 1993). In a prospective study of 39 female university dancers trained in modern and classical ballet (between the ages of 18-25) it was found that 97% had sustained an injury in the last eight months (Kerr et al., 1992). However the researcher did not indicate how many of these were chronic, acute or reoccurring and whether the data was self-reported or diagnosed by a medical professional. If the information was collected by self-reports then there would be both minor injuries (not treated by a health professional) and severe injuries that needed medical attention. This would mean that the percentage of injuries for self-reports would likely be similar to the above value but if the data was collected from medical reports then the above percentage might be a little low. A prospective study on 70 aerobic dance instructors (ages 19-50) found that 77% repeated at least one injury of either a new injury or an aggravated prior injury (du Toit & Smith, 2001). Some of the new injuries were a result of participation in other sporting activities, such as running, tennis and soccer, rather than from participation in aerobic dance class. The researcher did not give the totals for injuries sustained in just aerobic dance. The author also did not indicate whether the prior injuries were chronic or just injuries that occurred prior to the study. In Rothenberger et al. (1988) 49% of the 726 aerobic dancers (610 females and 116 males, age range 16-70) prospectively surveyed for one week had a history of sustaining an aerobic dancing injury at one time. The researchers only indicated the location and the classification of the injuries and thus it is not known if all of the injuries were chronic. Also, it is not known if the injuries were sustained in the aerobic class or if they occurred during other recreational activities. If the injuries were sustained during other activities and were not given enough time to heal before attending dance class then the percentage of injuries occurring in aerobic dance would be less.

1.2.7 Insufficient Recovery from Injury

Ballet and aerobic dance demands the aesthetic performance of complex movements which requires the action of muscular forces on a series of rigid limb segments joined by mobile linkages (Macintyre, 1994; Grant, 1999). This process is a kinetic chain and if the capacity of that chain is exceeded, tissues breakdown and injuries may occur (Macintyre, 1994, Grant, 1999). With inadequate recovery time there is likely an endless cycle of injury and re-injury or the occurrence of a secondary compensation injury. The trend for re-injury in professional ballet dancers is relatively common, simply because many of the dancers are unable to stop dancing due to performance commitments, loss of position in the company or for financial reasons. Luke et al. (2002) found that 43.7% of the injuries sustained by the 39 pre-professional dancers (aged 14-18) were re-occurring injuries. Dancers may experience new pain sites due to a secondary or underlying dysfunction or compensation from a preexisting injury. An example of an underlying dysfunction in ballet dancers would be trying to gain more external rotation by “turning out” at the knee, ankle or foot rather than at the hip. Inevitably, this tends to cause one or more of the following: pronation of the feet, external tibial torsion, valgus knee stress, lateral patellar tracking and increased lumbar lordosis (Macintyre, 1994). Dancers who suffer from chronic injuries usually dance with some degree of pain. The variety of pain thresholds between dancers makes comparing and measuring pain levels a difficult task. Due to the similarities between ballet and aerobic dancers to highland dancers it is assumed that highland dancers would also have more chronic injuries with a strong likelihood that some of the injuries would reoccur.

1.2.8 Anatomical Locations of Dance Injuries

The lower extremities are the most common sites for injuries to occur in both ballet and aerobic dancers. Kerr et al. (1992) found that 57.6% of the 39 female university student dancers (aged 18-25) prospectively surveyed had lower extremity injury. Garrick & Requa (1993) found similar results in the 104 professional ballet dancers (ages not given), 51.1% of the injuries were to the lower extremity. Groer & Fleming (1993) found that 88% of the 36 ballet dancers (23 female and 13 male, average age 25.3) surveyed reported an injury with 52 of these injuries occurring in the lower extremities. In the aerobic dance study by Rothenberger et al. (1988) similar results were found in the 726 dancers (610 females, 116 males, age 16-70) with 60% of the injuries sustained in the lower extremities. Du Toit et al. (2001) found that in 70 aerobic dance instructors (ages 19-50) 77% had at least one injury either new or an aggravated old injury of which 85.7% were sustained in the lower extremity.

1.2.8.1 Anatomical Locations for Ballet Injuries

Even though results from the aforementioned studies all agree that the lower extremity is where the majority of the injuries occur the results are inconsistent as to the most common anatomical site. The three most common sites for the injuries in the lower extremities were the foot, ankle and knee. In a three-year workers compensation study on professional ballet dancers (ages not given) Garrick et al. (1993) showed that the foot was the most common injury site with 23.9% of the lower extremity injuries. These results may be underestimated as injuries were based on only those that required financial assistance or the cost of rehabilitation and did not include those injuries that were not reported to a medical professional. Garrick (1999) examined pre-professional ballet students (ages 13-18) by the means of a free clinic and found a similar result, 64 of the 154 (41.5%) lower extremity injuries occurred in the foot. However they may have been underestimated, as the results were limited to upper year students as this was to whom the clinic was offered. It is interesting to note that when foot injuries at the free clinic were compared to ballet injuries (reported at two sport medicine centers) the percentage of foot injuries was smaller at the sport medicine centers. The difference in the results could be due to the smaller number of ballet students surveyed compared to the sports clinic reports, 194 students versus 1,353. It could also be that only dancers with a severe injury reported to the sport medicine centers whereas all injuries regardless of severity were more than likely being reported to the free clinic. Luke et al. (2002) found that the ankle was the most commonly injured site in both the self-reported and the medically reported injuries in the 39 pre-professional ballet dancers (34 female and 5 males, ages 8-18). There were 37 self-reported ankle injuries, consisting of 67% of the lower extremity injuries and 22 ankle injuries in the reported injuries. The ankle was also the most common lower extremity site with 20% of the total injuries in Bowling's (1989) retrospective study on 141 professional ballet dancers (80 females and 61 males, between the ages of 18 and over 37). This percentage of ankle injuries may be under-estimated, as this was a cross-sectional study, which does not account for students who may have been absent due to injury or missing class during the week of collection. In contrast to the above studies, Kerr et al. (1992) found that in the 39 self-reporting female university dance majors (ages 18-25) training in modern and classical ballet, the lower extremities sustained the majority of the injuries (57.6%). Of this 57.6% the knee was the most commonly injured site with 17.4% of the injuries.

McNeal et al., (1990) found differences in the location of the injuries based on the level of experience. Professional dancers (99 dancers, average age 23.2 years) had the highest percentage of injuries in all three sites, knee (57%), ankle (80%) and foot (51%). The college dancers (58 dancers, average age of 19.8 years) had fewer injuries compared to the professional dancers when grouped by approximately the same age. The injuries in the college dancers were as follows; knee (37%), ankle (38%) and foot (43%). In both of the groups some of the dancers sustained more than one injury at these three sites thus percentages are greater than 100%. Interestingly, dancers who reported knee injuries were more likely to also sustain a foot or ankle injury and 53% of the dancers with a knee injury also had an ankle injury and 59% also had a foot injury (McNeal et al., 1990). This study is limited by the recall of the dancers and by the cross-sectional nature of the study. The researchers believe that the results were underestimated due to the fact that some of the dancers may have dropped out of dance as a result of an injury.

1.2.8.2 Anatomical Locations for Aerobic Dance Injuries

Similar to ballet dancers, aerobic dancers more commonly injured the lower extremity, accounting for approximately 60-80% of the total number of injuries sustained (Garrick et al., 1986; Rothenberger et al., 1988). Even though these authors are in agreement that the lower extremity sustains the majority of the injuries, the specific anatomical sites differ among these studies. Rothenberger et al., (1988) found that of 726 aerobic dancers (610 females and 116 males, ages 16-70) the shins (24.5%) and the ankles (12.2%) were the most common sites accounting for 36.7% out of the 60% lower extremity injuries. The above study is limited to those dancers who were not injured at the time of the study and thus it is likely that the percentage of lower extremity injuries is an under-estimate. Garrick et al. (1986) found similar results with the shin being the most common complaint (19.5%) among the 155 students surveyed (average age 32.5) whereas the 45 instructors (average age 31.7) injured the foot more frequently (33.9%). The greatest variation in anatomical sites injured between the aerobic dance students and the instructors was the ankle with 10.7% and 22.9% of the injuries respectively. Du Toit & Smith (2001) found that in the 70 aerobic dance instructors (ages 19-50) prospectively surveyed, the upper leg (minus the ankle and foot) was the most common site for new injuries followed by the foot and ankle area, 52.9% and 32.8% of the respondents respectively. The aforementioned study did not indicate whether the injury occurred during the aerobic dance class or was a result from participation in a sporting activity (running, weight training and swimming were most common). The similarities in the movements between highland and aerobic dancers would lead this researcher to hypothesize that the injuries would be similar as well. The injuries would be located primarily in the lower extremities and the common anatomical locations would be the shins, knees, ankles and the feet.

1.2.9 Maturity Considerations

Like many highland dancers, some children specialize in their chosen sport at a very early age which exposes them to intense physical training prior to puberty (Baxter-Jones et al., 1993; Koutedakis et al., 1997; Poggini, Losasso, & Iannone 1999; DiFiori, 2002; Outerbridge, Trepman, Micheli, 2002). The intense physical training during the growth period increases the likelihood that overuse injuries may occur. The overuse injuries mainly occur at anatomical sites where there is rapid tissue growth and muscle imbalance around the joints (Koutedakis et al., 1997; Poggini et al., 1999; DiFiori, 2002; Outerbridge et al., 2002). During periods of rapid growth, where the bones grow faster than the soft tissues, there is increased tightness of the ligament and tendon attachments to both the bones and the muscles (Poggini et al., 1999; DiFiori, 2002; Outerbridge et al., 2002). The tightness may show apparent decreases in the dancer's coordination, which may increase the likelihood that the dancers will sustain an acute injury. In a dance medicine article Rist states that "the growth spurt does present many hazards for the dancer as the increase in technical demands coincides with the decrease in muscle strength". Many dancers do not allow sufficient recovery time for the injury and thus the probability of re-injury is increased. This is why new techniques should be introduced slowly to allow sufficient time for the soft tissue length to increase (Poggini et al., 1999).

1.2.9.1 Physiological changes during growth

As children progress through adolescence to maturity, physical changes occur to their body size and shape by the development of fat mass, lean mass and stature. In girls, fat mass is deposited around the hips and the gain in stature is mainly from trunk elongation. Other physiological changes during puberty include changes in motor performance, flexibility, balance, coordination and perception. These changes in growth affect physical attributes such as speed, flexibility, explosive strength, and local muscular endurance. Absolute strength increases linearly until approximately age 15 in girls, after which, muscle strength tends to level off. With strength training however, additional non-linear gains in strength may be achieved. Flexibility, speed, local muscular endurance and balance increase until 13 – 14 years of age. Flexibility and balance will generally level off or decrease with age after 13-14 years of age, however regular training can maintain the levels that were achieved during growth.

1.2.10 Predictors of Injuries

The mechanisms for an injury are often unclear, as there are many different physical processes that can take place. Many authors have suggested certain cause-effect relationships and/or mechanisms for the development of an injury. The risk indicators associated with possible mechanisms for an injury can be divided into two main categories: internal personal risk indicators or external environmental risk indicators.

Indicators for internal personal risk of sustaining injuries include: having sustained a previous injury, age, low body mass, muscle imbalances and flaws in technique. As previously mentioned, if inadequate time is given to the rehabilitation of an injury the chance of a re-injury is greater (Poggini et al., 1999; DiFiori, 2002). There is a greater possibility that an individual who had been injured may have either the injury re-occur or sustain a new injury compared to an individual who has never sustained an injury. This was consistent with a study done by McNeal et al. (1990) on ballet dancers (ages up to 13 and older than 17) where those who were injured were 59% more likely to be injured again. Wiesler, Hunter, Martin, Curl and Hoen (1996) found similar results in their study on 148 dance student (119 females and 29 males) 71% of students with a new injury reported a previous injury. Similar to ballet, Garrick et al. (1986) found that aerobic dancers (average age 32.5) were twice as likely to be re-injured as their healthy counterparts. Another internal indicator is age, as the dancers get older the potential for injury increases (Roach and Maffulli, 2003). Janis (1990) reported that the injury rate increased from 14% in 15-20 year old aerobic dancers to 63% in the 50-55 age group. A third indicator is muscle imbalances due to training errors, rapid growth or lack of flexibility in specific joints can cause excess strains to specific areas of the body resulting in an injury. In a review article by Roach and

Maffulli (2003) it was stated that with a rapid growth spurt there is a decrease in flexibility due to the lengthening of the bones which can increased risk of sustaining an injury. Muscle imbalances can occur when the antagonistic muscle groups are not as strong as the agonistic muscle group. Improper technique can cause other muscles to take on an additional load and thus the extra strain can cause injuries (Conti and Wong, 2001).

External injury indicators included: exposure time, type of floor surface and type of dance shoes. Dancers who are training at a higher level and at a greater intensity are more likely to be injured based on exposure time. There are three types of floor surfaces that are commonly used in dance: cushioned wood, floating wood and concrete floors (usually covered with linoleum). In aerobic dance studies no consistent injury patterns were found with any of the three floor surfaces mentioned above (Garrick et al., 1986). Inconsistent with Garrick's study, Teitz (1982) found that dancers were injured less often when working on a suspended floor. Highland dancers generally perform on various surfaces, some of which might be conducive to increased risk of injury. If a relationship between floor surfaces and injuries could be shown to exist, then restrictions on floors surfaces allowed for performing could be recommended to reduce the incidence of injury. Aerobic dancers do have the advantage of wearing shoes that are designed to absorb the landing shock however this only seems to have an effect on those dancers who train at the recreational level (Clark et al., 1989). Clark et al. (1989) found that there was a trend towards the reduction of injuries if a viscoelastic insole was worn inside the shoe to aid the shock absorption. The same cannot be said for ballet shoes, which have changed very little since the 18^{th} Century and are not designed to absorb the shock from repetitive jumps. Ballet and highland shoes are not designed to absorb the shock upon landings and have little or no room for orthotics which aid in shock absorption (Teitz, 1982; Jensen, 1998). The lack of shock absorption from the dancers' shoes means that the body must absorb all of the shock resulting repetitive microtraumas mostly occurring in the lower extremities (Koutedakis et al., 1997; Poggini et al., 1999; DiFiori, 2002).

1.2.11 Literature Review Summary

Young and pre-professional ballet dancers trained approximately 14-28 hours per week whereas professional ballet dancers train up to 70 hours per week. Recreational ballet dancers and aerobic dance instructors typically trained approximately 14 hours per week and the typical aerobic dance student only about 4 hours per week. The injury rates for ballet dancers are as follows: for ballet dancers there were 0.47 injuries per dancer in 100 hours of dance when the injuries were self-reported and 0.29 injuries per dancer when documented by a health care professional. For aerobic dance instructors there were 1.16 injuries per dancer for 100 hours of dance and the aerobic dance students had 0.93 injuries per student per 100 hours of dance. The majority of the injuries in both ballet and aerobic dance where chronic in nature and located in the lower extremities. The most common sites for injuries in ballet dancers were the knees, ankles and feet whereas for aerobic dancers it was the shins. Possible causes for sustaining an injury may be that: part of a kinetic chain has been overloaded; overtraining during the critical peak growth years; having sustained a previous injury; age of the dancer; floor surface and exposure time. This investigation into the nature, etiology, location, severity, prevalence and incidence rates of injuries in highland dancers will provide dance instructors and sport medicine professionals the necessary information to aid in the prevention of injuries in highland dancers.

1.3 Statement of the Problem and Hypotheses

1.3.1 Statement of the Problem

The purpose of this thesis is to examine the prevalence, incidence, types (chronic and acute), anatomical locations and predictors of injuries sustained in both competitive and recreational highland dancers.

1.3.2 Statement of the Hypotheses

Based on the results from similar dance forms (aerobic dance and ballet) it is hypothesized that:

Hypothesis 1: The CHD would sustain more injuries than either of the other two dance groups (RHD or the Control group).

Hypothesis 2: The injured CHD would have more injuries per 100 hours of dance training than the injured dancers in either of the other two dance groups.

Hypothesis 3: There would be more chronic than acute injuries for both the CHD and the RHD.

Hypothesis 4: A) In all the dancers in the study there would be more injuries to the lower part of the leg (knee, shin, ankle and foot) than the rest of the body

B) There would be more injuries to the lower part of the leg in the CHD than in the RHD.

Hypothesis 5: The following variables will be predictors of an injury: floor surfaces, age, previously sustained an injury, warm-up time, stretching time, and onset of menarche.

CHAPTER 2

METHODS

2.1 Research Design

The design was a descriptive epidemiological study based on results from written questionnaires. The first part was a retrospective examination of the dancers previous injuries and the second part was a prospective examination of the dancers current injuries. An injury was defined as “any event that (1) required assessment and/or treatment by a medical professional and /or (2) resulted in a restriction in training or performance”.

2.2 Participants

Approximately 200 females from two Saskatoon dance schools were approached and supplied with information on the study. Of these 200, 76 dancers gave their consent to participate, a response rate of 38.5%. Those dancers who where under the age of 18 also had to have parental consent. School A (n=38) was primarily a recreational school with instruction in ballet, tap, jazz, highland dance and musical theatre while School B (n=38) only taught highland dance to both recreational and competitive dancers. All of the highland dancers were split into two groups: a competitive highland dancing group (CHD) (n=20) and recreational highland dancing group (RHD) (n=27). CHD trained more than 5 hours biweekly and participated in regular dance competitions whereas the RHD trained less than 5 hours biweekly and did not regularly participate in dance competitions. Highland dancers primarily came from School B, with all of the CHD also training at this school; however there were 9 recreational highland dancers in School A. The Control group (n=29) was made up of non-highland dancers from School A, who participated in at least one of the four dance disciplines (ballet, tap, jazz or musical theatre). Approval for this project was obtained from the Human Experimental/Behavioural Sciences Ethical Review Committee at the University of Saskatchewan (2001-204). Written informed consent was obtained from the two teachers and from the participants and their parent/guardian, if under the age of 18, prior to the study (Appendix A).

2.3 Procedures

The General Information Form and the 6-month retrospective history questionnaire were administered during the first week of the study. The prospective biweekly questionnaires were administered just prior to or at the end of the dance class, and took between 5-15 minutes to complete. Data was collected for eight sessions starting in October and continuing until February, no data was collected for the last two weeks in December and the first two weeks in January as students were away for Christmas holidays. For the first data collection session the questionnaires were briefly explained to the dancers by either the researcher or her assistants and then were completed by the dancers. At all other collection sessions the dancers were given the questionnaire by the researcher to be completed without the explanations that were given on the first day. The researcher or the assistants remained in the room during the completion of the questionnaire to answer questions. When the dancers completed the questionnaire the researcher or the assistants checked to ensure that all questions were properly answered. On the questionnaire dancers indicated the number of hours trained during the week and whether an injury was sustained. If an injury was sustained then the following questions were asked: anatomical site, side of the body, when the injury occurred, injury classification, type of skill performed at the time of injury, was the injury acute, chronic or a repeat injury, pain level, modification of training and whether time was missed from training. If more than one injury was sustained in a week, then an injury report form was completed for each injury (see Appendix D). To ensure confidentiality the researcher distributed the questionnaire to the dancers by their identification number in a folder and then personally collected them when completed.

On the first and the last collection days the dancers completed their questionnaire(s) and were then measured for standing height, sitting height and weight by the primary researcher and an assistant. For both measurement occasions the dancers removed their street shoes but not necessarily their dance shoes. On the final day the dancers were also asked to indicate whether they had begun menstruation and if so at what age did this occur.

2.3.1 Standing Height

Standing height was measured by having the dancers stand against the stadiometer (Tanita) without street shoes, however dance shoes were permitted. The dancers stood with the heels together, arms relaxed beside the body and the head kept level looking straight ahead. The heels, buttocks, upper back and the back of the head were in contact with the stadiometer. The measurer applied traction to the dancer's head by the means of gently pulling up on the mastoid process while she exhaled. The headpiece was brought down to come in contact with the dancer's head after which the dancer stepped away from the stadiometer. The measurement was recorded in centimeters (cm) to the nearest 0.1 (cm) (Ross & Marfell-Jones, 1991).

2.3.2 Sitting Height

Sitting height was measured using a sitting stadiometer (Karimeter, Raven Equipment Ltd.). The sitting stadiometer was placed on an elevated surface, the dancer also sat on the same surface, and the measurement was taken from the base of the sitting surface to the top of the head. The same method of traction used in standing height was used of the sitting height, but the dancers were instructed to not tighten the muscles of the thighs and buttocks. The measurement was also recorded in centimeters (cm) to the nearest 0.1 (cm).

2.3.3 Leg Length

Leg length was calculated by subtracting sitting height from standing height.

2.3.4 Weight

Weight was measured by having the dancers stand on a portable scale (Toledo) with heavy clothing and street shoes removed. The dancers were to stand as still as possible and the weight was recorded in kilograms (kg) to the nearest 0.01 (kg).

The standing height, leg length, sitting height and weight were used to calculate the estimated age of PHV/maturity offset. The equations were as follows:

Maturity Offset = -9.376 + 0.0001882 * Leg Length and Sitting Height interaction + 0.0022 * Age and Leg Length interaction + 0.005841 * Age and Sitting Height interaction – 0.002658 * Age and Weight interaction + 0.07693 * Weight by Height ratio, where R= 0.94, R^2 = 0.890 and SEE = 0.569 (Mirwald et al., 2002). (2.1)

The value from these equations indicates the estimated number of years from PHV. A negative number represents the estimated number of years until PHV would be reached whereas a positive number would indicate that PHV had been reached and how many years prior. For example a “maturity offset” value of +3 would indicate that PHV was achieved three years prior.

2.4 Measures

To enhance content validity, experts in Kinesiology, Growth and Development and Physical Therapy reviewed the questionnaires and then the questionnaires were adjusted based on their recommendations. The measures used to determine the factors influencing the likelihood of sustaining an injury were: three questionnaires, standing height, sitting height, weight, age and menses. The three questionnaires administered by the researcher or her assistant (another graduate student at the college) were 1) The General Information Form, 2) The six month Retrospective Injury History and 3) The four month Prospective Injury History. The general information form and the six month retrospective injury history were administered at the beginning of the first data collection. Written instructions included on the questionnaire were read aloud to the subjects by the researcher or her assistants. A pilot study was conducted on 12 female dancers (aged 7-16) to assess the comprehensiveness of the questionnaire. Upon completing the questionnaires the students were asked to identify any items they found unclear or confusing. The questionnaires were then adjusted thereby making them easier to understand for the participants in the study.

2.4.1 The General Information Form

The General Information Form consisted of questions developed by the investigator from consultations with the advisory committee, textbooks, related questionnaires (Hobson, (2002), and epidemiological papers (as listed in references). This questionnaire involved the dancers to write responses to the following questions: age, current participation in other dance forms or sporting activities, the length of a dance class and how it was broken down (warm up, conditioning, cool down), leg dominance, whether participants were injured and floor surfaces. (See Appendix B.) The information collected from this questionnaire was used to test for predictor variables for an injury. The dependent variable was sustaining an injury and the independent variables were all of the other internal and external risk variables.

2.4.2 The Six Month Retrospective History of Injuries

Self-reports are the most widely used method to obtain physical activity data. They are relatively quick, easy to obtain, inexpensive, unobtrusive and non-reactive. Retrospective self-reporting questionnaires, however, rely on recall ability and are subject to memory errors. This 6-month Retrospective History of Injuries was modified from Hobson’s 2002 (unpublished thesis) epidemiological gymnastics study. The self-report questionnaire identified the following injury data: anatomical locations, side of body, nature of the injury, cause of the injury, timing of the injury, training missed due to injury and severity of injuries. There were 16 yes or no questions for each specific injury. It took between 5 - 15 minutes to answer the questionnaire; the length depended upon the number of injuries the participant had in the six months. In order to reduce errors and ensure the participants fully understood the questionnaire the researcher or her assistants were present while participants completed the questionnaire. (See Appendix C.)

2.4.3 The Prospective Biweekly Injury Report

This questionnaire was identical to the retrospective questionnaire but it was administered biweekly. (See Appendix D.) The prospective questionnaire was used to test hypotheses one, two and three. In hypotheses one, two and three the dependent variable was injury. The independent variables for hypothesis one were hours of training per dancer and the number of injuries per dancer, hypothesis two was the type of injury (chronic, acute or repeat) and hypothesis three was anatomical location of the injury.

2.4.4 Maturational Measures

A common trend in sports is to group children by their chronological age. However, two children of the same age will not necessarily have the same overall growth in body size and physiological maturation and thus may not be at the same biological age (Malina & Bouchard, 1991). Growth is the increase in size of the body (whole or parts) from conception to adulthood whereas maturation is the “tempo and the timing of the progress towards a mature biological state” (Malina & Beunen, 1996). Somatic growth is rapid during infancy, slows through middle childhood, and is rapid once again during the adolescent growth spurt. As children begin the adolescent phase of growth and maturation the timing and the tempo at which they precede through this phase is different for each child. Studies in the area of sport science usually assess maturity in one of four ways: skeletal age, secondary sex characteristics, menarcheal status and somatic characteristics.

Skeletal age assessment, via X-rays, is the best maturity indicator as it covers the entire period of growth (infancy to adulthood) (Malina & Bouchard 1991). In order to assess skeletal maturity one of three methods may be used: the Greulich-Pyle method

(Greulich & Pyle 1959), Tanner-Whitehouse method (Tanner, Whitehouse, Marshall, Healy & Goldstein, 1975; Tanner et al., 1983), and the Fels method (Roche, Chumlea & Thissen, 1988).

A second maturity indicator is the presence of secondary sex characteristics, which in females are breast and pubic hair development (from childhood to the mature adult state). The most commonly used assessment for these characteristics is Tanner's five stage rating scale (Tanner, 1962). These first two methods are intrusive and thus were not used in this study.

The third maturational indicator in females is the age of attainment of menarche, which is the first menstrual period. The most common method of acquiring this information is by retrospectively asking the girls to recall their age when menstruation began. The average age of menarche in North Americans is 13.1 years of age (Malina & Bouchard, 1996) and 12.8 years of age for Caucasian Americans (Danker-Hopfe, 1986). The fourth and final method for assessing maturity is by somatic indicators, the most common being age at peak height velocity (PHV). PHV is defined as the age at which the maximum rate of growth in stature occurs (Malina & Beunen, 1996). To obtain the age at PHV, stature measurements must be collected longitudinally. From this information individuals can be classified as early, average or late maturers based on their age at PHV compared to the mean age at PHV. For example, the mean age for PHV in girls is around 12 years of age and thus if a girl reached PHV before 11 she would be considered an early maturer.

The method for assessing maturity was by the use of anthropometric measurements (Mirwald, Baxter-Jones, Bailey & Beunen, (2002) was used. The "maturity offset", or the years from PHV, was calculated by subtracting the participants decimal age from measurements of sitting height, standing height and weight (see sections 2.4.1 – 2.4.4). These anthropometric measures were taken at the beginning and at the end of the study to ensure that the dance groups were similar. An advantage of this method is that it is quick, easy and non-invasive. The standing heights and sitting heights were measured to the nearest 0.1mm and weights to the nearest 0.1kg

(Bailey,1997; Mirwald, 1978). Each of the three anthropometric measures was taken twice and the mean was calculated (provided the difference between the two values was less than 3 mm or 0.3 kg). If there was a difference of greater than 4mm or 0.4kg a third measurement was taken and the median value was used (Bailey, 1997). The dancers were asked to recall when the onset of menstruation began to determine whether peak height velocity had been reached. This information was then used in hypothesis four and also used to determine if more injuries were occurring during the two years prior to PHV.

2.5 Data Analyses

Results from the questionnaires remained confidential and anonymous and only group results will be published. Before testing the hypotheses, the data were screened for missing data and outliers by Chi-square frequency distributions for each group to determine the number and percentage for a range of variables. These variables included: body part injured, nature of the injury, side of injury, classification of injury, training versus competition injuries, time period when the injury occurred, length of training, skill difficulty when injured, acute versus chronic injuries, missed or modified time from dance. A one way ANOVA was used to determine if there were differences among the three dance groups for age, estimated age at PHV, height, weight and training hours. The rate of injury was calculated by dividing the total number of injuries sustained by the number of hours trained, then multiplying by 100. This was calculated for: 1) all the dancers and 2) only the injured dancers in each of the three dance groups. Subjects were not randomly selected and therefore non-parametric statistics were used to examine the data at an alpha level of 0.05. Cross tabulations were used to analyze the first four hypotheses to determine if there were differences among the dance groups for rate of injury, type of injury and injury sites. A logistic regression analysis was used to test the fifth hypothesis, possible predictors of an injury based on an odds ratio, for floor surfaces, age, previous injury, warm-up time, stretching, sports and onset of menarche. The alpha level for all statistical analyses was set at 0.05.

CHAPTER 3

RESULTS AND DISCUSSION

3.1 General Information

Approximately 200 dancers were approached to participate in this study. Of those 200 dancers, 76 (38%) gave consent to participate and were monitored for a four-month period. Across the four-month span of the study 64.5% of the dancers had complete data. Some of the analyses were completed using a smaller number of dancers due to missing data. Missing data was due to subjects either being absent during collection times or leaving dance classes before information was given to the researcher or the assistants. Subjects with missing data were excluded from analyses in which the data was missing.

Table 3.0 shows the means and the standard deviations of the three dance groups for chronological age, predicted age at PHV (adjusted age), weight, height and training hours per week. Table 3.1 shows the means and the standard deviations for the above five variables for dancers who sustained a dance-related injury. For injured dancers in the three dance groups significant differences were found for the amount of training, however there were no significant differences for age, predicted age at PHV, weight or height.

The retrospective questionnaire data showed that there were only six dance-related injuries sustained by four dancers in the previous six months compared to the 42 dance related injuries sustained by 24 dancers in the four month prospective data collection. Due to the small number of injuries sustained retrospectively the analyses of the hypotheses were calculated only on the prospective data.

Table 3.0 Physical and Maturational Characteristics of the Dancers (mean ± SD)

	Recreational Highland Dancers (n = 27)	Competitive Highland Dancers (n = 20)	Control group (n = 29)
Age (yr.)	12.5 ± 3.7	14.4 ± 3.4	12.9 ± 3.7
Range	(5.0-22.3)	(9.4-19.7)	(6.9-19.9)
Age of Menarche (yr.)	11.6 ± 1.1	12.3 ± 0.9	12.2 ± 1.6
Range	(10-13)	(11-14)	(10-15)
Predicted age at PHV (yr.)	11.8 ± 0.3 (n=19)	12.0 ± 0.4 (n=12)	11.9 ± 0.3 (n=18)
Range	(9.7-16.4)	(10.8-15.0)	(10.9-15.1)
Weight (kg)	36.4 ± 3.0 (n=25)	39.6 ± 8.7	39.9 ± 12.8
Range	(30.1-40.8)	(32.7-73.4)	(21.5-75.8)
Height (cm)	152.3 ± 11.9 (n=25)	155.9 ± 11.1	151.0 ± 15.9
Range	(127.1-172.8)	(137.8-175.4)	(122.9-178.3)
Training (hrs/wk)	1.22 ± 1.1 (n=25)	3.62 ± 2.0	2.65 ± 2.9
Range	(1.15-8.0)	(4.5-11.0)	(0.82-20.0)

* The lower n in predicted age was due to having already reached menarche, the other differences in n are due to missing data.

Table 3.1 Physical and Maturational Characteristics of the Injured Dancers (mean ± SD)

	Recreational Highland Dancers (n = 7)	Competitive Highland Dancers (n = 13)	Control group (n = 4)
Age (yr.)	13.8 ± 1.6	15.4 ± 1.0	15.1 ± 2.1
Range	(5.0-22.3)	(9.4-19.7)	(7.9-19.9)
Age of Menarche (yr.)	11.6 ± 1.1	12.3 ± 0.9	12.8 ± 2.1
Range	(10-13)	(11-14)	(10-15)
Predicted age at PHV (yr.)	12.5 ± 0.7	13.1 ± 0.3	13.5 ± 0.7
Range	(9.7-16.4)	(11.5-15.1)	(11.6-15.0)
Weight (kg)	52.4 ± 3.3	66.0 ± 10.8	51.9 ± 7.6
Range	(30.1-75.0)	(32.7-41.7)	(33.1-61.1)
Height (cm)	158.3 ± 3.2	155.0 ± 4.0	157.5 ± 6.0
Range	(127.1-171.6)	(137.8-175.4)	(140.0-165.5)
Training (hrs/wk)	4.1 ± 0.6*	7.3 ± 0.6*	6.5 ± 2.3
Range	(2.0-6.5)	(4.5-10.0)	(2.5-12.0)

* denotes a significant difference between the groups at $p<0.05$ as shown by a Tukey post hoc test.

3.2 Hypothesis 1: Dance Injury Numbers and Rates

Hypothesis 1 stated that there would be more injuries in the competitive highland dancers (CHD) compared to either of the other two dance groups (recreational highland dancers (RHD) or the Control group). In the 4-month survey period (prospective data was collected for eight test periods in total) 90 injuries were reported, however only 42 were actually recorded as having occurred during dance training and/or dance competition. The injury rate per dancer for all the dancers in each group was 1.05 for the CHD (calculated as number of injuries (21) divided by number of dancers (20)), 0.48 for RHD and 0.28 for the Control group. For the injured dancers in the CHD the number of injuries sustained was 21 (1.62 injuries/dancer). In this group, eight dancers had one injury (38.1%), 3 dancers had two injuries (28.6%), one dancer had three injuries (14.3%), one dancer had four injuries (19.0%). The injured dancers in RHD sustained 13 dance-related injuries (1.86 injuries/dancer). In this group, four dancers had one injury (30.8%), two dancers had two injuries (30.7%) and one dancer had five injuries (38.5%). The injured dancers in the Control group sustained 8 dance-related injuries (2.0 injuries/dancer), with two dancers sustaining one injury (25.0%) and one dancer had two injuries (25.0%) and one dancer had 4 injuries (50.0%). There were no significant differences for the number of injuries sustained between the three dance groups for the injured dancers only ($X^2 = 0.72$, $p<0.05$) as shown in table 3.2. Based on the results, hypothesis 1 was rejected as more injuries were not sustained by the CHD compared to the either of the other two dance groups.

Table 3.2 Cross Tabulation for the Number of Injuries Sustained by Injured CHD, RHD and the Control group During the Four Months

	Injured	
	No	Yes
CHD	77	21
RHD	34	13
Control Group	24	8
	Value	Significance (2-sided)
Pearson Chi-square	0.72	0.70

3.3 Hypothesis 2: Injuries per 100 hours of Training

Hypothesis 2 stated that there would be a greater number of injuries per 100 hours of training for those dancers in the CHD compared to the RHD and the Control group. The CHD sustained 21 of the 42 dance-related injuries compared to the 13 sustained by the RHD and the 8 sustained by the Control group. The injury rate for all of the dancers in each group (injured and not injured) was 1.81 injuries per 100 hours of training for the CHD, 2.45 injuries per 100 hours of training for the RHD and 0.65 injuries per 100 hours for the Control group. The average injury rate per 100 hours of training hours for the injured dancers in the three dance groups are as follows: CHD sustained 2.59 injuries/100 hours, RHD had an injury rate of 4.51 injuries/100 hours and the Control group had 4.97 injuries/100 hours. There were no significant differences in the number of injuries per 100 hours of training between the injured dancers in CHD, RHD and the Control group ($F= 2.74$, $p<0.05$), thus rejecting hypothesis 2.

3.4 Hypothesis 3: Chronic Injuries

This hypothesis stated that there would more chronic versus acute dance injuries in the CHD and the RHD. In the 4-month prospective data collection there were 9 chronic and 8 acute injuries sustained by 13 CHD compared to the 4 chronic and 7 acute injuries sustained by 7 RHD. It was found that there were no significant differences between the chronic and acute injuries in the injured CHD and the RHD ($X^2 = 0.738$, $p<0.05$) as shown in table 3.3. Therefore hypothesis three is rejected; there is an equal chance of having either an acute or chronic injury in these two dance groups.

Table 3.3 Chronic and Acute Injuries Sustained by CHD and RHD in Four Months

	Chronic	Acute	
CHD	9	8	
RHD	4	7	
	Value	df	Significance (2-sided)
Pearson Chi-square	0.738	1	0.390

Note: three injuries were reported as "repeat" (2 in RHD and 1 in CHD) and these were included as chronic injuries

3.5 Hypothesis 4: Lower Leg Injuries

Hypothesis 4 A stated that there would be more injuries to the lower part of the leg than to the rest of the body for all of the three dance groups. In the four-month prospective questionnaire 20 dancers sustained 29 (69%) lower leg injuries out of the 42 dance-related injuries. Significant differences were found between the injured dancers in the three dance groups for lower leg injuries as shown in table 3.4. Part A of this hypothesis was accepted (X^2 =11.20, p<0.05). Table 3.5 gives a distribution of the injuries to the four lower leg sites and the rest of the body

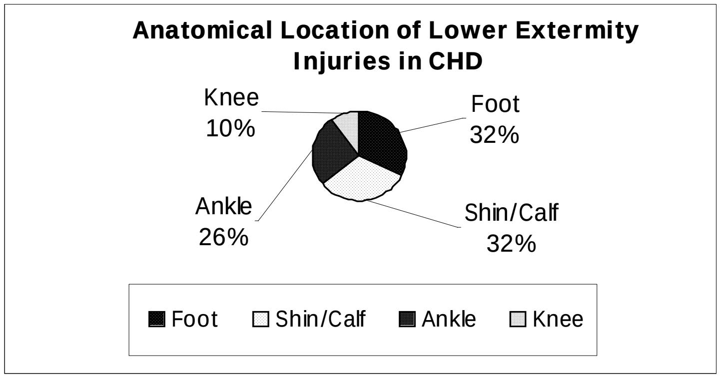
Table 3.4 Lower Leg versus the Rest of the Body Injuries Sustained by the Entire Group of Dancers in Four Months

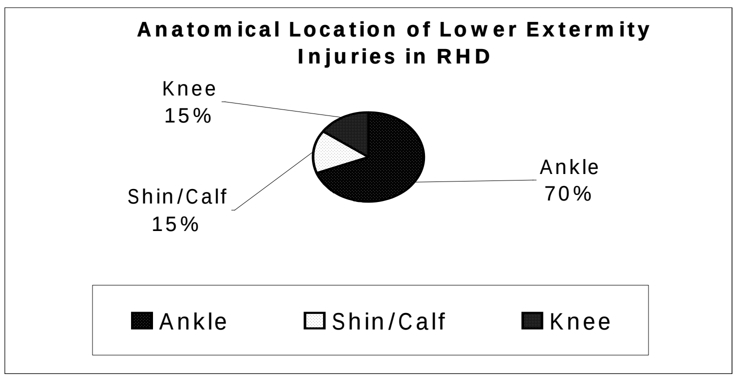
	Lower Leg	Rest of the Body	
	33	4	
	Value	df	Significance (2-sided)
Pearson Chi-square	11.20	5	0.048

Table 3.5 Distribution of Lower Leg Injuries in the CHD, RHD and the Control group in Four Months

	Lower Leg Injuries				Rest of the Body	
	Knee	Shin	Ankle	Foot	Groin	Hip
CHD	2	5	6	4		2
RHD	2	2	7			
Control Group	1		4		1	1

Hypothesis 4 B stated that there would be more dance-related injuries in the lower leg for the CHD compared to the RHD. The majority of the injuries in the CHD were sustained to the ankle with 6 cases (35.3% each). The RHD also had the ankle as the major injury site with 7 injuries to the ankle (63.6%) in the RHD. Figure 3.0 shows the anatomical distribution of the four lower leg injuries sites due to dance training and/or dance competition for each group. Table 3.6 shows the number of lower leg injuries between the CHD and RHD. There were no significant differences between the two highland dance groups for the number of injuries in the lower leg and therefore the second part of this hypothesis was rejected (X^2 = 4.605, $p<0.05$).





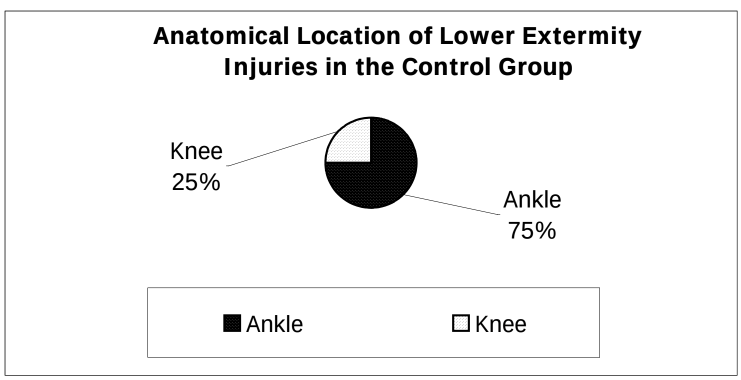


Figure 3.0 Anatomical Distributions of Injuries to the Lower Extremities for CHD, RHD and the Control Group over Four months

Table 3.6 Cross Tabulation of the Lower Leg Injuries in CHD and RHD in Four Months

	Lower Leg Injuries					
	Knees	Shins	Achilles	Ankles	Toes	Soles
CHD	2	4	1	5	2	2
RHD	2	2	2	5		
	Value	df	Significance (2-sided)			
Pearson Chi-square	4.605	5	0.466			

3.6 Hypothesis 5: Predictors of an Injury

Hypothesis 5 stated that there would be six factors that would increase the risk of sustaining an injury and they are as follows: floor surfaces, age, whether the dancer sustained a previous injury, the length of the warm-up, stretching time, participation in sports and menarche. A logistic regression was calculated and four of the seven hypothesized factors were significant. They were floor surface 1 (sprung floor with linoleum overlay), floor 4 (sprung floor with wood overlay and concrete floor), age, previous injury and menarche. The overall logistic regression model for predicting an injury was significant ($p<0.05$) based on the Chi-square statistic (X^2 = 42.588 (df=7)). The model predicted 83.1% of the responses correctly. The three significant predictors are shown in Table 3.9.

Table 3.7 Predictor Variables of an Injury

	B	SE	Wald	df	Sig.	Exp(B)	Confidence Interval Low – High
Floor (1)			4.04	1	0.05	0.19	0.04 - 0.96
Floor (4)			12.22	1	0.00	0.14	0.05 – 0.43
Age	0.08	0.04	5.14	1	0.02	1.09	1.01 – 1.17
Previous Injury	0.61	0.29	4.25	1	0.04	1.85	1.03 – 3.13
Begun Menses	1.02	0.48	4.52	1	1.03	2.79	1.08 – 7.16

The variable floor surfaces had two different floor surfaces that were significant. Floor (1) had a Wald statistic of 4.04 ($p<0.05$). The associated odds ratio was 0.19, therefore if the dancer trained and performed on sprung floors with linoleum overlay they had a decrease risk of sustaining an injury. Floor (4) had a Wald statistic of 12.22 ($p<0.05$). The associated odds ratio was 0.14, therefore if the dance trained and performed on sprung floors with wood overlay and concrete floors they had a decrease risk of sustaining an injury

The variable ‘age’ had a Wald statistic of 5.14 ($p<0.05$). The associated odds ratio was 1.09, therefore with an age increase of one year there would be a greater chance of being injured.

The variable ‘previous injury’ had a Wald statistic of 4.25 ($p<0.05$). The associated odds ratio was 1.85, thus if the dancer had an injury prior to the study they were 0.85 times more likely to sustain another injury.

The variable ‘onset of menarche’ had a Wald statistic of 4.52 ($p<0.05$). The associated odds ratio was 2.79, thus if the dancer had begun menses then they were 1.79 times more likely to sustain an injury.

Hypothesis 5 was accepted for four of the seven predictors of an injury; however, the variable ‘age’ had an increased relative risk for sustaining an injury, while ‘previous injury’ and the ‘onset of menarche’ decreased the likelihood that an injury would occur. Age and menarche were tested separately and both variables were independently significant.

3.7 Other Predictors for an Injury

There were two other significant differences between the dance groups, these were: dominant leg and which school the dancers attended. The logistic regression predictions for leg dominance and which school the dancer attended are shown in table 3.8.

Table 3.8 Regression Analysis for Leg Dominance and School

	B	SE	Wald	df	sig.	Exp(B)
Schools	1.08	0.26	17.76	1	0.00	2.94
Right Leg Dominant	-1.01	0.53	3.62	1	0.05	0.36

3.7.1 Dominant Leg

Results of the logistic regression showed that right leg dominance was a significant predictor for an injury. The model for predicting an injury was significant ($p<0.05$) for the Chi-square statistic ($X^2 = 24.27$ (df=1)). The model predicted 67.6% of the responses correctly. Right leg dominance variable had a Wald statistic of 21.68 ($p<0.05$). The associated odds ratio was 0.19, thus if the dancer was right leg dominant they were less likely to sustain an injury.

3.7.2 Which School the Dancer Attended

The school the dancers attended was a significant predictor for an injury. The model for predicting an injury was significant ($p<0.05$) for the Chi-square statistic ($X^2 =$

98.66 (df=1)). The model predicted 78.7% of the responses correctly. The school variable had a Wald statistic of 17.76 ($p<0.05$). The associated odds ratio was 2.94, thus if the dancers attended school B they were 1.94 times more likely to sustain an injury.

3.8 Discussion

The purpose of this study was to examine the prevalence, incidence, type (chronic and acute), anatomical location and predictors of injuries sustained in competitive and recreational highland dancers.

3.8.1 Hypothesis 1

Hypothesis 1 stated that there would be more injuries in the CHD compared to either of the other two dance groups (RHD or the Control group). Results showed no significant differences ($X^2 = 0.72$, $p<0.05$) in the number of injuries sustained by the three dance groups, thus hypothesis 1 was not supported.

The injury rates for the two highland dance groups were lower than the rates from the ballet and aerobic dance studies. A study by Kerr et al. (1992) on 39 female dance majors aged 19-25 (multiple dance forms) had an injury rate of 2.4 per dancer, which is similar to Garrick's study in 1993 on 104 ballet dancers which found 2.97 injuries per dancer. The aforementioned studies gave no indication as to whether the injuries were sustained during dance classes so it is difficult to say whether the 1.62 injuries per dancer for the CHD is consistent with their findings. Another concern in comparing to Kerr et al. (1992) is that they relied on retrospective recall data. Age ranges is also a concern in comparing the above studies as the dancers in Kerr's study are older than the majority of the dancers in this study and it has been shown that dancers sustain more injuries as they age. Luke et al. (2002) found that in the 39 dancers, aged 14-18, the injury rate was 1.6 per dancer. Due to the lack of longitudinal research in highland dancing, it is not known if the injury rates in the current study (1.62 injuries per dancer (CHD) and 1.86 injuries per dancer (RHD)) can be generalized to all highland dancers. The injury rates in the highland dancers in this study may be lower due to the fact that the collection of data occurred through the low competitive season. However, only the competitive dancers continue to train though the high competitive season.

3.8.2 Hypothesis 2

Hypothesis 2 stated that there would be a greater number of injuries per 100 hours of training for the CHD compared to the either of the other two dance groups, RHD and Control group. This hypothesis was also rejected, as there were no significant differences in the number of injuries between the three dance groups. The injury rates for the injured dancers in the three dance groups are as follows: CHD 2.59 injuries per 100 hours, RHD 4.51 injuries per 100 hours and the Control group 4.97 injuries per 100 hours. Current literature reports injury rates of 0.47 per 100 hours for pre-professional dancers age 14-18 (35 females and 5 males) and 1.16 per 100 hours for the 351 aerobic dance students (average age 35.5) (Luke et al., (2002); Garrick et al. (1986)). The higher injury rates in the current study might be due to interviewer method style of collecting data rather than recall of the subjects alone. A second possibility may be that more of the dancers in this study were either peri-pubescent or in the pubescent growth phase where the likelihood of injuries occurring is greater. It was surprising that the Control group had a higher rate of injury in which they reported that most of the injuries were due to practicing a skill. It could be that they were practicing skills beyond their dancing ability or there was a lack of concentration while performing these skills. The Control group also had the highest number of total training hours followed by the CHD and RHD. A possible reason for the Control group's higher total training hours could be that the majority of the dancers in this group trained in more than one dance discipline (the maximum was 5 disciplines) and some of the older dancers participated in school musicals and the Dare to Dance performance. The school musicals and the Dare to Dance performance resulted in some of the dancers individually practicing approximately 20 hours/week for these events. The training hours/week in the Control group seems to be typical of young professional ballet dancers. A study by Watkins

(1989) showed that young ballet dancers (under 13 years of age) trained more hours per week (23 hours) in both classes (10 hours) and performances (13 hours) than pre-professionals and college dancers. Garrick (1993) found that the professional ballet dancers trained more than this, with approximately 70 hours/week. This indicates that the CHD are training approximately 34% less than the typical young dancers in the Watkins study.

3.8.3 Hypothesis 3

The third hypothesis stated that there would be more chronic versus acute injuries in the CHD compared to the RHD. This hypothesis was rejected as there were no significant differences in the number of chronic or acute injuries in the CHD compared to the RHD ($X^2 = 0.738$, $p<0.05$). A ballet study on 141 professional dancers (61 males and 80 females) by Bowling in 1989 found that 50% of the current injuries were chronic in nature. Luke et al. (2002) found that in the 39 multi-disciplinary dancers 56.1% reported that they were currently suffering from a chronic injury compared to the 14% that sustained an acute injury. The CHD in this study did report more chronic injuries than acute (10 and 7 respectively). The lower number of chronic injuries in the current study could be due to the fact that many of these dancers continue to dance with a chronic injury and they consider it just part of dancing and thus they did not list the injury as new or reoccurring injury. The repetitive nature of the majority of the movements in highland dancing could explain the reason for these chronic injuries.

Typically chronic injuries are habitual or long-term injuries where there is repetitive microtrauma to specific areas (Baxter-Jones et al., 1993) and can be strains, stress fractures, plantar fasciitis, tendonitis and shin splints (Bowling, 1989; Rothenberger et al., 1988). The majority of the CHD injuries were strains whereas strains and tendonitis were the more common classifications for RHD. The difference between these two groups is unclear, but it could be due to floor surfaces because the CHD all danced on a sprung floor whereas the RHD danced on both concrete and sprung floors. As with all sports, a recovery period is needed to adequately rehabilitate the injury and it is possible that this is not occurring in these highland dancers, which resulted in a higher number of chronic injuries. Inadequate recovery time was found to be responsible for some of the chronic injuries sustained by young athletes and ballet dancers (Bowling 1989; DiFiori 2002).

Of the 47 highland dancers in this study 12 had not yet reached maturity based on PHV (eight RHD and four CHD); and only 7 of these 12 dancers sustained a dance injury. The lower than expected ratio between acute and chronic injuries could be due to the intensity and duration of training during growth. Poggini (1999) and DiFiori (2002) suggested that increasing training intensity and introducing advanced technical maneuvers should be done slowly after rapid growth spurts allowing for relative strength and coordination to return. Acute training injuries are thought to be caused by stress on the muscle-tendon attachment, bone-tendon attachment and ligament attachments when bone grows faster than the tendons and ligaments causing tightness and loss of flexibility (DiFiori, 2002, Koutedakis et al. 1997, Poggini et al., 1999). When these acute injuries are not given time to heal they can become chronic in nature due to the constant repetitive stress being put on the injury site. The older dancers in this study mostly sustained chronic injuries however, it is not known whether these injuries started as an acute injury during the growth period or afterwards. In the case of the younger dancers who have not reached PHV the majority of the injuries were acute, which follows the suggestions made by Poggini (1999) and DiFiori (2002).

3.8.4 Hypothesis 4

The (A) part of this hypothesis stated that there would be more dance-related injuries to the lower leg than to the rest of the body. This hypothesis was accepted (X^2 = 11.20, $p<0.05$). The (B) part of this hypothesis stated that there would be more dance-related injuries to the lower leg in the CHD than in the RHD. This hypothesis was rejected (X^2 = 4.605, $p<0.05$).

The most commonly affected area in this study was the lower leg, which accounted for 69% of the dance-related injuries. This result is consistent with previous studies in both ballet and aerobic dance participants (Rothenberger et al. 1988; Bowling 1989; Hald 1992; Garrick et al. 1993; Groer et al. 1993; Michaud et al., 1993). The reason for the high number of lower leg injuries in the highland dancers could be that they jump at a constant tempo of 100 beats per minute executing leaps, high-cuts and repetitive hop landings onto a plantar flexed foot during every training session (Potter et al., 1996). Ballet studies (Bowling 1989; Hald 1992; Garrick et al. 1993) found that the foot, ankle and the knees were the most common sites (not always in that order) whereas for aerobic dance (Rothenberger et al. 1988; Michaud et al. 1993) it was the shins that were most commonly injured. The CHD and RHD were similar to ballet with the ankle as the major injury site with 35.3% and 63.6% of the cases respectively.

3.8.5 Hypothesis 5

Hypothesis 5 stated that there would be seven predictors for sustaining an injury only four predictors were significant they were age, floor surfaces, previous injury and onset of menarche. Age increased the odds of sustaining an injury: the older the dancer was, the more likely she was to be injured. This is consistent with Janis (1990) who found that in aerobic dancers the percentage of injuries ranged from 14% for the 15-20 year olds to 63% in the 51-55 year olds. In the current study the older dancers sustained more of the injuries and had completed the growth spurt whereas only seven dancers that had injuries have not yet reached PHV. In the case of the younger dancers the injuries were mostly acute whereas in the older dancers the injuries were mostly chronic which may be caused by an increase in the hours and intensity of training rather than growth.

The predictor ‘previous injury’ did increase the relative risk for sustaining an injury, which concurs with previous research on other dance forms. For example, in a study done by McNeal et al. (1990) ballet dancers who sustained injuries, were 59% more likely to be injured again. Similarly, Garrick et al. (1986) found that aerobic dancers were twice as likely to be re-injured as their healthy counterparts.

Those dancers who had begun menstruation were more likely to be injured. This is consistent with previous literature on dance injuries. According to Koutedakis et al. (1997), Poggini et al. (1999), DiFiori (2002) and Outerbridge et al. (2002) intense physical training during the peak growth period increases the likelihood of overuse injuries which tend to occur at anatomical sites where there is rapid tissue growth and muscle imbalance around the joint. Another reason why there was a increase in the likelihood of injuries in these dancers is that age and menarche coincide with each other, as the dancers ages they get closer to menarche. A large number of dancers had begun menses, which on average is one-year post PHV and therefore the rate of growth is slowing but the likelihood that a chronic injury has already been sustained is a good possibility. Also only 67 dancers gave responses to this variable (9 dancers chose not to answer). Of the 35 dancers that had not started menstruation only 7 dancers had sustained a dance-related injury. It should be noted that the logistic regression was run using all injuries (dance and non-dance) the only variable not predicted to have an increased risk for sustaining an injury was if the dancer attended School B. Some possible reasons for the higher relative risk for sustaining an injury could be that School B had all of the competitive highland dancers, the intensity of the training may have been higher and more of the dancers were post pubescent.

CHAPTER FOUR

CONCLUSION

This current epidemiological study provides important information on the number of injuries per 100 hours of dance, the number of dance-related injuries per dancer, anatomical injury sites and predictors of injuries in a population of highland dancers. The majority of the findings are consistent with ballet and aerobic dance studies, which would lead us to believe that similar injury prevention strategies would also apply.

This current study's major strength is the fact that information was collected both retrospectively and prospectively. Retrospectively the dancers were asked to recall any injuries that occurred in the previous six-months. Prospectively the dancers filled out a questionnaire biweekly on the details of injuries they sustained and the number of hours that they spent in training over four-months. The retrospective and prospective data was vastly different in that there were 6 injuries in 4 dancers reported retrospectively and 42 injuries in 24 dancers prospectively. The information was collected on the same dancers for both the retrospective and prospective questionnaires, which shows how inaccurate the reporting of injuries is when the individual is asked to recall information.

A large number of injuries (90) was reported by all dancers in this study however only 42 of these injuries occurred during dance training and dance competition. Surprisingly, the competitive highland dancers did not have a higher number of injuries compared to the either the recreational highland dancers or the Control group. The competitive highland dancers also did not have a higher rate of injury per 100 hours of training than the other two dance groups. Upon comparing the number of chronic injuries between the competitive highland dancers and the recreational highland dancers there were more chronic injuries in the competitive highland dancers. The difference, however, was not statistically significant. There was a high number of chronic versus acute injuries that occurred to the lower part of the leg. A possible reason that the injuries are occurring to the lower part of the leg may be due to the repetitive high mechanical loading to this part of the body. Another possible reason for the higher number of chronic injuries could be due to an insufficient recovery period for the injury. Many of the dancers fail to provide sufficient amount of healing time for their injuries and thus the chronic injury persists or the acute injury may become a chronic injury. Even though the high number of chronic injuries occurred to the lower part of the leg there were no significant differences in the number of injuries per anatomical site for all the dancers in this study or between the competitive highland dancers and recreational highland dancers. The most common injury site in the lower leg was the ankle. A possible reason why the ankle was more common may be due insufficient ankle strength upon plantar flexion jump landings.

It was predicted that the following would be reasons for sustaining an injury: age, previous injury, floor surfaces, length of the warm-up, stretching time, participation in sports and menarche. The only one that positively increased the odds of sustaining an injury was age. Another variable that was not predicted but was a significant predictor for an injury was which school the dancer attended. If the dancer trained at School B they were more likely to sustain an injury.

Almost all of the injuries occurred during warm-up in the RHD and Control group. The competitive highland dancers were injured more often during the last half of practice. One would expect if injuries were occurring during warm-up it might be due to a lack of concentration or that the warm-up skills were too. Interestingly, the two most common skills that the dancers were performing when the injury occurred were "practicing a skill" they already knew rather than learning a new skill and "landing from a jump". A possible reason for this may be that familiarity of the skill resulted in the dancer paying less attention.

This current study had limitations that should be addressed in future studies. Firstly, the two questionnaires (retrospective and prospective) used closed questions, which don't give the participants freedom to expand on their answers. For example there may have been another underlying reason why the injury occurred such as a blister or ingrown toenail that caused a modification in the dancers' technique. Secondly, it was observed that a recall period of two weeks seemed to be even too long for dancers under the age of eight, and therefore the researcher, an assistant or the parent or guardian should have assisted those younger dancers in the completion of the questionnaire. Thirdly, 35.5% of the dancers gave incomplete data due to being absent from class, leaving early from class, or not sure how to answer a particular question. If the dancer was absent from class it could be due to an injury or another reason but the researcher is not able to know which one it is. The missing information could have been collected by a telephone interview with the dancer.

The following are some recommendations for future studies: It is recommended that the researchers ask the dancer to indicate whether the injury occurred during home practice, in class training, competition or performances. If the injury occurred at home, floor surface and warm-up times might be different than in the dance studio. The floor surface at home might be more conducive to sustaining an injury than at the studio and warm-up times may be insufficient. A second recommendation would be to separate the total number of training hours biweekly between home practice, class training, competitions or performances. Thirdly, the questionnaire should include the number of years in training, as the longer participation in an activity the more likely an injury may occur. Fourthly, it is recommended that a teacher's log be implemented. The names of all of the participating dancers would be on the log so that when an injury occurred during class training the teacher could record an injury. This would be a way to determine if the dancers were under-reporting or over-reporting the injuries on the self-reporting questionnaire. Finally, data should be collected on in the high competitive season, which occurs from January to July. This is the time when the dancers increase the number of hours of training and there are more competitions to take part in.

A possible follow-up to this study would be to look at only competitive highland dancers across Canada and see whether the injury patterns are different between geographical areas. Another area of research would be to look at the injury patterns of dancers during the peak growing years. This longitudinal study would be able to show whether more injuries are occurring during this period of rapid growth.

REFERENCES

Adirim, T. A. & Chang, T. L. (2003). Overview of injuries in the young athlete. Journal of Sports Medicine, 33(1): 75-81.

Armstrong, N. & van Mechelen, W. (2000). Paediatric exercise science and medicine. Oxford medical publications. Oxford University Press. New York.

Askling, C., Lund, H., Saartok, T., & Thorstensson, A. (2001) Self-reported hamstring injuries in student-dancers. Scandinavian Journal of Medicine and Science in Sports, 12: 230-235.

Bailey, D. A., (1997). The Saskatchewan pediatric bone mineral accrual study: bone mineral acquisition during the growing years. International Journal of Sports Medicine, 18: S191-194.

Baxter-Jones, A., Maffulli, N., & Helms, P. (1993). Low injury rates in elite athletes. Archives of Disease in Childhood, 68: 130-132.

Bolin D. J. (2001). Evaluation and management of stress fractures in dancers. Journal of Dance Medicine and Science, 5(2): 37-42.

Bowling, A. (1989). Injuries to dancers: prevalence, treatment and perceptions of causes. British Medical Journal, 298: 731-734.

Bronner, S., Ojofeitimi, S. and Rose, D. (2003). Injuries in a modern dance company: effect of comprehensive management on injury incidence and time loss. The American Journal of Sports Medicine, 31(3): 365-373.

Carvajal, S.C., Evans, R.I., Evans, R.W., Nash, S.G., & Carvajal, T.W. (1998). Risk factors for injury in the career female dancer: An epidemiologic study of a broadway sample of performers. Medical Problems of Performing Artists, 13: 89-93.

Clark, J. E., Scott, S. G., & Mingle, M. (1989). Viscoelastic Shoe insoles: their use in aerobic dancing. Archives Physical Medicine Rehabiliation, 70: 37-40.

Conti, S. F. and Wong, Y. S. (2001). Foot and ankle injuries in the dancer. Journal of dance medicine and science, 5(2):43-50.

Danker-Hopfe, H. (1986). Menarcheal age in Europe. Yearbook of Physical Anthropology, 29: 81-112.

DiFiori, J. P. (2002). Overuse injuries in young athletes: An overview. Athletic therapy today, 7(6): 25-29.

du Toit, V. & Smith, R. (2001). Survey of the effects of aerobic dance on the lower extremity in aerobic instructors. Journal of the American Podiatric Medical Association, 91(10): 528-532.

Garrick, J.G., Gillien, D.M., & Whiteside, P. (1986). The epidemiology of aerobic dance injuries. American Journal of Sports Medicine, 14(1): 67-72.

Garrick, J.G., & Requa, R.K. (1993). Ballet injuries: An analysis of epidemiology and financial outcome. American Journal of Sports Medicine, 21(4): 586-590.

Garrick, J. G. (1999). Early identification of musculoskeletal complaints and injuries among female ballet students. Journal of Dance Medicine and Science, 3(2): 80-83.

Grant, K. E. (1999). Dancing our feet off without injuring them, by linking our warm-ups to kinetic chain. Tactalk, 1-4.

Groer, S., & Flemming Falon Jr, L. (1993). Supplemental conditioning among ballet dancers: preliminary findings. Medical Problems of Performing Artists, 8:25-28.

Greulich, W. W. & Pyle, S. I. (1959). Radiographic atlas of sketetal development of the hand and wrist (2nd ed.). Stanford, CA: Stanford University Press.

Hald, R.D. (1992). Dance injuries. Sports Medicine: Musculoskeletal Problems, 19(2): 393-410.

Hobson, A. (2002). Epidemiological study of injuries in club-level rhythmic gymnastics. Unpublished thesis, University of Saskatchewan.

Hogan, K. A. and Gross, R. H. (2003). Overuse injuries in pediatric athletes. Orthopedic Clinics of North America, 34: 405-415.

Janis, L. R. (1990). Aerobic dance survey; a study of high-impact versus low-impact injuries. Journal of the American Podiatric Medical Association, 80(8): 419-423.

Jensen, J. (1998). Stress fracture in the world class athlete: a case study. Medicine and Science in Sports and Exercise, 30(6): 783-787.

Kerkhof, (2004). History of highland dancing. http://cluich.net/Hdhistory.htm

Kerr, G., Krasnow, D., & Mainwaring, L. (1992). The nature of dance injuries. Medical Problems of Performing Artists, 7: 25-29.

Kish, R. L., Plastino, J. G. & Martyn-Stevens, B. (2003). A young dancer survey. Medical Problems of the Performing Artists, 18: 161-165.

Koutedakis, Y., Pacy, P.J., Carson, R.J. & Dick, F. (1997). Health and fitness in professional dancers. Medical Problems of Performing Artists, 12: 23-27.

Krasnow, D., Mainwaring, L. & Kerr, G. (1999). Injury, stress, and perfectionism in young dancers and gymnasts. Journal of Dance Medicine and Science, 3(2): 51-58.

Luke, A. C., Kinney, S. A., D'Hemecourt, P. A., Baum, J., Owen, M. & Micheli, L. J. (2002). Determinants of injuries in young dancers. Medical Problems of Performing Artists, 17: 105-112.

Macintyre, J. (1994). Kinetic chain dysfunction in ballet injuries. Medical Problems of Performing Artists, 9: 39-42.

Malina, R. M. (1994). Physical growth and biological maturation of young athletes. Exercises and Sport Science Reviews, 22: 389-433.

Malina, R. M. & Beunen, G. (1996). Monitoring growth and maturation in The Child and Adolescent Athlete, O. Bar-Or, ed., Blackwell Science, Oxford, UK, pp. 647-672.

Malina, R. M. & Bouchard, C. (1991). Growth maturation and physical activity. Champaign, Il.: Human Kinetics, pp 231-272.

Malone, T. R. & Hardaker, W. T. Jr. (1990). Rehabilitation of foot and ankle injuries in ballet dancers. Journal of Orthopaedic and Sports Physical Therapy, 11(8): 355-361.

McNeal, A. P., Watkins, A., Clarckson, P. M. & Tremblay, I. (1990). Lower extremity alignment and injury in young, pre-professional, college and professional ballet dancers. Medical Problems of Performing Artists, 5: 83-88.

Michaud, T.J., Rodriguez-Zayas, J., Armstrong, C., & Hartnig, M. (1993). Ground reaction forces in high impact and low impact aerobic dance. The Journal of Sports Medicine and Physical Fitness, 33(4): 359-366.

Mirwald, R. L., Baxter-Jones, A. D., Baiely, D. A. & Beunen, G. P. (2002). An assessment of maturity from anthropometric measurements. Medicine and Science in Sports and Exercise, 34(4): 689-694.

Mirwald, R. L. (1978). The saskatchewan growth and development study. In: Kinanthropometry II, M. Ostyn, G. Beunen and J Simons (Eds). Balitimore: University Park Press.

NATA Research and Education Foundation (2001). Request for proposals: Epidemiological study pediatric sports health care. www.natafoundation.org/rfp/epidemiological.html

Outerbridge, A. R., Trepman, E. & Micheli, L. J. (2002). Ankle instability in children and adolscents in the unstable ankle, Champaign, Ill., Human Kinetics pp 260-269.

Poggini, L., Losasso, S., & Iannone, S. (1999). Injuries during the dancer's growth spurt etiology, prevention and treatment. Journal of Dance Medicine & Science, 3(2): 73-79.

Potter, P.J., & Jones, I. (1996). The effect of plantar fasciitis on ground reaction forces in scottish highland dancers. Medical Problems of Performing Artists, 11: 51-55.

Rist, R. (1994). Children and exercise: training young dancers, a dance medicine perspective. Sports Care Journal, 1(6): 4-7.

Roach, R. and Maffulli, N. (2003). Childhood injuries in sport. Physical Therapy in Sport, 4: 58-66.

Roche, A. F., Chumlea, W. C. & Thissen, D. (1988). Assessing the skeletal maturity of the hand-wrist: Fels Method. Springfield, Il: Charles C Thomas.

Ross, W. D. & Marfell-Jones, M. J. 1991. "Kinanthropometry" in physiological testing of the high-performance athlete, 2nd ed. J. D. MacDougall, H. A. Wenger & H. J. Green, eds., Human Kinetics Books, Champaign, Illinois, pp 223-308.

Rothenberger, L.A., Chang, J.I., & Cable, T.A. (1988). Prevalence and types of injuries in aerobic dancers. The American Journal of Sports Medicine, 16(4): 403-407.

SCHDA Southern california highland dance association (2004). http://lsrandell.tripod.ccom/schda.com

Scharff-Olson, M. R., Williford, H. N. & Brown, J. A. (1999). Injuries associated with current dance-exercise practices. Journal of Dance Medicine and Science, 3(4): 144-150.

SOBHD Scottish official board of highland dancing (1999). Annual Report. http://sobhd.org

Tanner, J. M. (1962). Growth at adolescence (2nd ed.) Oxford: Blackwell Scientific.

Tanner, J. M., Whitehouse, R. H., Cameron, N., Marshall, W. A., Healy, M. J.R. & Goldstein, H. (1983). Assessment of skeletal maturity and prediction of adult height (2nd ed.). New York: Academic Press.

Tanner, J. M., Whitehouse, R. H., Marshall, W. A., Healy, M. J.R. & Goldstein, H.(1976). Assessment of skeletal maturity and prediction of adult height (TW 2 method). New York: Academic Press.

Teitz, C. C., (1982). Sports Medicine concerns in dance and gymnastics. Pediatric Clinics of North America, 29(6): 1399-1421.

Thomas, J. R., & Nelson, J. K., (1996). Research methods in physical activity. (3rd ed.) Canada: Human Kinetics, Chapters 7 & 15.

Watkins, A., Woodhull-McNeal, A.P., Clarkson, P.M., & Ebbeling, C. (1989). Lower extremity alignment and injury in young, preprofessional, college, and professional ballet dancers. Medical Problems of Performing Artists, 4: 148-153.

Wiesler, E. R., Hunter, M., Martine, D. F., Curl, W. W. and Hoen, H. (1996). Ankle flexibility and injury patterns in dancers. The American Journal of Sports Medicine, 24(6): 754-757.

Young, A. & Paul, L. (2002). Incidence of achilles tendon injuries in competitive highland dancers. Journal of Dance Medicine and Science, 6(2): 46-49.

APPENDIX A

Participant Inform Consent Form

Consent Form

Title: Etiology of Highland Dancing Injuries in Females

Patricia Logan
Master of Science Student
College of Kinesiology
University of Saskatchewan
Saskatoon, SK
Home: (306) 384-6084

We would like to ask for your daughter's assistance with a study that is being carried out in the College of Kinesiology. The purpose of the study is to determine the type, severity and location of injuries among competitive and non-competitive Highland Dancers. The findings from this project may provide valuable information and assist dance teachers in this field of dance to structure their classes for the prevention of injuries.

If your daughter decides to volunteer, her role is to complete a brief 5-10 minute questionnaire every two weeks for four months. The questionnaires will be completed just prior to or after her scheduled dance class. Female dancers, aged 6 through 24, in your daughter's dance school and in three other dance schools will be participating in the study and will also complete the same questionnaires. It is hoped that all the females in the Highland Dance classes will agree to complete the questionnaire. Participation in this study will not cause any foreseeable harm or discomfort to the individual or the school. The questionnaires have been designed to determine the number of injuries, either new or reoccurring and to find out which injuries are most common. The data collected from the results of the questionnaire will be the basis for my thesis project. This research project has been reviewed and approved on ethical grounds by the University of Saskatchewan Advisory Committee on Ethics and Behavioural Science research on January 5, 2002 if you or your daughter have any questions regarding your rights as a participant you may be addressed to that committee through the Office of Researcher Services (306-966-4053).

The decision to participate or not to participate in this study will not affect the dancing instruction that your daughter receives in any of her dance classes. Results are completely anonymous and only the overall results will be published in peer-reviewed journals and selected dance conferences. All the information provided to me through the questionnaire will be confidential and stored in a locked office when not in use. You and your daughter will be given a copy of the questionnaire to peruse. If your daughter wishes, she may withdraw from the study at any time. Withdrawal from the study will not affect her dance instruction in any way. If a participant misses filling out more than four questionnaires her data will not be included in the study.

If you and your daughter decide that she would like to be a part of this study, please complete the attached form. Also, please ask your daughter to read this letter and indicate her consent as well. If you or your daughter has any questions or concerns about this study, please do not hesitate to contact either Patricia Logan (384-6084 graduate student) or Dr. Keith Russell (966-6470 – Advisor) at any time.

PARENTS/GUARDIANS PLEASE READ and SIGN YOUR CONSENT

I have read and understand the purpose of this study and my daughter's involvement in this study. I am aware that my daughter's participation will remain anonymous throughout the study and in any written results from the data collection. I am aware that my daughter has the right to withdraw from the study at any time. I acknowledge that I have received a copy of the consent letter for my records. If I have any questions or concerns I can contact Patricia Logan (306-384-6084) or Dr. Keith Russell (966-6470). If I wish to clarify the rights of my daughter as a research participant, I may call the Office of Research Services (966-4053).

I, ____________________give permission to allow ____________ to participate in the study conducted by Patricia Logan.

Signature ___________________________ Date ______________

Students Please Read and Sign Your Consent

I have discussed this study and consent with Patricia Logan, and my parents/guardians. I understand the purpose of my involvement in the study. I understand that I have the right to withdraw at any time from the project, or ask to have any of the information that I have given eliminated from the final document.

Signature _____________________ Date _____________________

APPENDIX B

The General Information Form

Highland Dancing Research Project

General Information

Name: ______________________________ Club: ____________________

Address: ____

Age: _________________

Current Level in highland dancing: __________________________________

Number of years in Highland Dance: ________________________________

Number of years at this current level: ________________________________

Is highland dancing the only sport you participate in? Yes No

If no, what other sports or dance forms do you participate in?

____

Which is your dominant leg? Right Left

What is your floor surface? eg. Sprung wood, concrete, wood overlay

____

Are you injured right now? Yes No

Details ____

Complete the following table for a typical week. The time I spend on:

	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
Warm up							
Stretching							
(passive)							
(active)							
Conditioning							
Training Length							

APPENDIX C

The Retrospective Questionnaire

Injury History –last 6 months

An injury is any event that (1) requires medical attention or (2) restricts the individual from training or competition

ID code ______________

Have you had an injury in the last six months? ☐**Yes** ☑**No**

1. **Body Part**

5. Upper Body

Head	**Spine**	**Trunk**	**Arm**	**Forearm.**
Head	Neck	Upper back	Shoulder	Wrist
Face	Upper	Lower back	Upper	Hand
Eye	Lower	Abdomen	Elbow	Finger
Dental	Sacral/ SI			

5. Lower Body

Pelvis	**Upper Leg**	**Lower Leg**	**Foot**
Hip Bone	Quadricep	Shin	Toes
Hip Joint	Hamstring	Calf	Arch
Groin	Knee	Achilles	Metatarsals
		Ankle	Sole
			Heel

2. **Location of Injury** ☐Left ☐Right

3. Cause of Injury

☐Loss of balance ☐Insufficient warm up ☐Loss of concentration
☐Fatigue ☐Attempting skill beyond ability ☐Other ____________

4. Injury Classification

☐Fracture ☐Stress Fracture ☐Dislocation ☐Concussion
☐Strain (Mus.) ☐Sprain (Lig.) ☐Tendonitis ☐Bruise
☐Swelling ☐Scrape/Cut ☐Other ________

5. Did the injury occur during practice ☐Yes ☐No
If yes when, ☐Warm up ☐First half ☐Second half ☐Cool down

6. Was the injury an acute injury? ☐Yes ☐No
(occurred from a single, clearly remembered event)
If no go to question 8

7. Has this acute injury repeated itself since recovery? ☐Yes ☐No

8. Was the injury a chronic (overuse) injury? ☐ Yes ☐ No

9. When did it happen?

a. Training — Warm up / 1^{st} half / 2^{nd} half/ Cool Down
b. Competition
c. Other (please specify) ____________________________

10. Were you injured while

☐Learning skill ☐Practicing skill ☐Passive stretching ☐Active stretching
☐Take off ☐Landing ☐Other __________

11. Length of Practice >1 hr >2 hrs >3 hrs >4 hrs >5 hrs

12. Were you injured during another activity ☐Yes ☐No
If yes participating in what? ______________________________

13. Did you have pain associated with this injury ☐No ☐Yes
(if yes, mark severity) ☐Low ☐Moderate ☐Severe

14. Time Missed from Activity
Training days ____________ Modified for ______days

15. Did you receive any treatment for your injury?
☐RICE ☐Doctor ☐Physiotherapist ☐Chiropractor

APPENDIX D

The Prospective Biweekly Questionnaire

Biweekly Injury report Form

An injury is any event that (1) requires medical attention or (2) restricts the individual from training or competitions

ID Code: ____________ **Date:** ________ **Hours trained the last two weeks:** ________

Have you had an injury this week: ☐Yes ☐No ✓
If no, go to question 15

1. Body Part:

A. Upper Body

Head	**Spine**	**Trunk**	**Arm**	**Forearm**
Head	Neck	Upper back	Shoulder	Wrist
Face	Upper	Lower back	Upper	Hand
Eye	Lower	Abdomen	Elbow	Finger
Dental	Sacral/ SI			

B. Lower Body

Pelvis	**Upper Leg**	**Lower Leg**	**Foot**
Hip Bone	Quadricep	Shin	Toes
Hip Joint	Hamstring	Calf	Arch
Groin	Knee	Achilles	Metatarsals
		Ankle	Sole
			Heel

2. **Location of Injury** ☐Left ☐Right

3. **Cause of Injury**
   ☐Loss of balance ☐Insufficient warm up ☐Loss of concentration
   ☐Fatigue ☐Over use ☐Previous Injury
   ☐Attempting skill beyond ability ☐Other ________

4. **Injury Classification**
   ☐Fracture ☐Stress Fracture ☐Dislocation ☐Strain (Mus.)
   ☐Sprain (Lig.) ☐Tendonitis ☐Bruise ☐Swelling
   ☐Scrape/Cut ☐Other _________

5. **Was the injury an acute injury?** ☐Yes ☐No
   (occurred from a single, clearly remembered event)
   If no go to question 8

6. **Has this acute injury repeated itself since recovery?** ☐Yes ☐No

7. **Was this injury an overuse injury?** ☐Yes ☐No

8. **When did it happen?**
   - **Training** Warm up / 1st half / 2nd half/ Cool Down
   - **Competition**
   - **Other (please specify)**________________________________

☐Learning Skill ☐Practicing skill ☐Passive stretching
☐Active stretching ☐Take off ☐Landing

10. Length of Practice >1 hr >2 hrs >3 hrs >4 hrs >5 hrs

11. Were you injured while participating in another activity **☐Yes** **☐No**
If yes which activity? ______________________________

12. Do you have pain with the injury? **☐Yes** **☐No**
If yes, mark severity ☐Low ☐Moderate ☐Severe

13. Did the injury cause you to modify training **☐Yes** **☐No**

14. Approximately how many days did you miss?

____

These two questions will be asked once a month

15. Please specify your height: **cm/m** **feet/inches**

16. Please specify your weight: **kg** **lbs**

This question will be asked at the end of the study
17. Have you had your first menstrual period? **☐Yes** **☐No**
If yes, at what age did you start at? ______________

APPENDIX E

The Teacher Consent Form

DANCE INSTRUCTORS: PLEASE READ and SIGN YOUR CONSENT

I have read and understand the purpose of this study and I am clear on my students' involvement. I am aware that dancers involvement will remain anonymous throughout the study and in any written results. I am aware that my dancers have the right to withdraw from the study at any time. I acknowledge that I have received a copy of this consent letter for my records. If I have any questions or concerns I can contact Patricia Logan (306-384-6084) or Dr. Keith Russell (966-6470). If I wish to clarify the rights of my dancers as research participants, I may call the Office of Research Services (966-4053).

I, ____________________give permission to allow my dancers in ____________________ school to participate in the study conducted by Patricia Logan.

APPENDIX F

Maturity Offset: A Working Equation

Maturity Offset = -9.376 + 0.0001882 * (Leg Length and Sitting Height interaction) + 0.0022 * (Age and Leg Length interaction) + 0.005841 * (Age and Sitting Height interaction) – 0.002658 * (Age and Weight interaction) + 0.07693 * (Weight by Height ratio)

= -9.376 + 0.0001882 * (70.00 * 79.20)+ 0.0022 * (10.15 * 70.00) + 0.005841 * (10.15 * 79.20) – 0.002658 * (10.15 * 35.84)+ 0.07693 * (35.84 * 149.20)

=-9.376 + 0.0001882 * (5544)+ 0.0022 * (710.50) + 0.005841 * (803.88) – 0.002658 * (363.77)+ 0.07693 * (34.88)

= -9.376 + 1.04 + 1.56 + 4.69 – 0.96 + 2.68

= -0.36

APPENDIX G

Ethics Approval Sheet

UNIVERSITY ADVISORY COMMITTEE
ON ETHICS IN BEHAVIOURAL SCIENCE RESEARCH

NAME: Keith Russell, Kinesiology
P. Logan

BSC: 2001-204

DATE: 19-Dec-2001

The University Advisory Committee on Ethics in Behavioural Science Research has reviewed the Application for Ethics Approval for your study "An Epidemiological Study of Injuries in Highland Dancers" (2001-204).

1. Your study has been APPROVED.
2. Any significant changes to your proposed study should be reported to the Chair for Committee consideration in advance of its implementation.
3. The term of this approval is for 5 years.
4. In order to maintain ethics approval, a status report must be submitted to the Chair for Committee consideration within one month of the current expiry date each year the study remains open, and upon study completion. Please refer to the website for further instructions: http://www.usask.ca/research/ethics.shtml

I wish you a successful and informative study.

Valerie Thompson, Chair
University Advisory Committee
on Ethics in Behavioural Science Research

Office of Research Services, University of Saskatchewan
Kirk Hall Room 210, 117 Science Place, Saskatoon SK S7N 5C8 CANADA
Telephone: (306) 966-8576 or (306) 966-2084 Facsimile: (306) 966-8597 http://www.usask.ca/research/

TOTAL P.02