Musculoskeletal pain and injury in elite adult Irish dancers

UNIVERSITY of LIMERICK

OLLSCOIL LUIMNIGH

Musculoskeletal Pain and Injury in Elite Adult Irish Dancers

by

Róisín Máire Cahalan

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy at the University of Limerick

Supervised by Dr. Kieran O'Sullivan and Prof. Peter O'Sullivan

Submitted to the University of Limerick October 2014

Tall and straight my Mother taught me, this is how we dance.

Tall and straight my Father taught me, this is how we dance.

"Trading Taps", Theo Dorgan

Declaration

My submission as a whole is not substantially the same as any that I have previously made or currently am making, whether in published or unpublished form for a degree, diploma or similar qualification at any university or similar institution. I am the author of this doctoral thesis and the principal author of the six articles which form its core.

Signature: ___________________

Róisín Máire Cahalan

Abstract

Musculoskeletal Pain and Injury in Elite Adult Irish Dancers. Róisín Máire Cahalan

Background: The popularity of Irish dancing (ID) has increased enormously since the success of "Riverdance, The Show". The last two decades have seen the evolution of ID to professional status as well as the elongation and intensification of competitive careers. However, scant investigation of musculoskeletal pain and injury among this cohort has been undertaken.
Aims: To establish the incidence, type and causes of musculoskeletal pain and injury among current and former elite adult Irish dancers. To investigate the impact of job-satisfaction on the health and well-being of professional Irish dancers. To prospectively identify factors predisposing elite adult Irish dancers to pain/injury, and to propose guidelines for an evidence-based screening program to attempt to minimise the impact of same.
Methods: A systematic review was conducted to examine existing research in this area. An online questionnaire was used to establish retrospective rates and perceived causes of pain/injury, as well as job satisfaction in a cohort of 178 professional Irish dancers. A different cohort of 104 elite adult Irish dancers completed a questionnaire investigating diverse biopsychosocial factors and 84 of these subjects underwent an extensive physical screening. Eighty-four subjects were followed up at monthly intervals for one year using an online questionnaire. Data regarding injury, illness, general physical and psychological health were recorded.
Results: The systematic review demonstrated that there is a lacuna of pre-existing research into pain and injury in Irish dancers. This thesis has identified that pain/injury rates in elite adult ID cohorts were high and comparable to rates in elite ballet and contemporary dance. Perceived contributory factors to pain/injury identified by subjects include accidents, fatigue/overwork, repetitive movements, and unsuitable stages/floors. Professional Irish dancers largely expressed job satisfaction in their career but reported physical and psychological challenges to dancer wellbeing. Foot and ankle pain/injury were most common among elite adult Irish dancers with a host of biopsychosocial factors associated with pain/injury to the foot and ankle specifically, and to the whole body generally. A history of more severe pain/injury at baseline, greater daily pain and pain when dancing, and a higher number of bodily pain sites, a higher number of general subjective and psychological health complaints, lower mood and insufficient sleep, appeared to predispose subjects to greater levels of future pain/injury.
Conclusion: Pain and injury in ID are commonplace and comparable to rates in other elite genres. Lower limb injuries, particularly to the foot and ankle are highly prevalent with numerous interrelated biopsychosocial factors found to be significantly associated with subjects more at risk of pain/injury. While physical factors have been focus of many screening tools in other genres, in ID pain issues, general health and psychological factors appear to be more related to pain/injury. Screening protocols and interventions embodying these factors should be developed to identify Irish dancers at risk for pain/injury going forward.

Acknowledgements

First and foremost, to Dr. Kieran O'Sullivan, for his endless patience, generous support and eternal good humour. This piece of work would never have been started, never mind completed, without you. To Professor Peter O'Sullivan for your wisdom and kindness, and to Dr. Helen Purtill, and Dr. Norma Bargary who navigated the unintelligible seas of statistics with me. To Sean McAuliffe and Mary O'Keeffe who helped a very heavily pregnant researcher to screen endless subjects.

My sincere gratitude to the Faculty of Education and Health Sciences for their financial support of this research. My thanks also to the Mid-Western branch of the Irish Society of Chartered Physiotherapists for their support. I would also like to thank the Chartered Physiotherapists in Manipulative Therapy group for their support of this project. My thanks to everyone in the Department of Clinical Therapies at the University of Limerick for their help and advice.

To all the dancers, teachers and choreographers who facilitated this study. It simply would not have been possible without you. To all at Riverdance, past and present, you are largely the inspiration and motivation for this piece of work. To everyone at the Mary Duffy Foundation, Lord of the Dance, and Take the Floor, I thank you all sincerely. Special appreciation goes to Dr. Orfhlaith Ní Bhriain at the Irish World Academy of Music and Dance, and to the completely wonderful and irrepressible Shane McAvinchey and Paula Goulding from Take the Floor.

To my fabulous friends and siblings who helped with kind words and proof reading – any errors are theirs alone. To my family and my wonderful parents - there are none better in the entire world. No words will ever be sufficient to thank you. To my brother John who acted as a guinea pig for my testing, nice job! To my husband Mario, for the chocolate biscuits and the hot water bottles when I would lock myself away to do battle with this monster, for building props for testing and transforming my mad ideas into practical realities. For the belief and the pride you always show, and the love we share with our darling daughter Faith. This is for you both.

Table of Contents

List of Tables **Pg**

List of Figures **Pg**

List of Appendices

List of Publications

Principal journal articles used in the main body of this doctoral thesis are as follow:

Cahalan, R. and O'Sullivan, K. (2013a) 'Injury in Professional Irish Dancers', *Journal of Dance Medicine & Science,* 17(4),150-158.

Cahalan, R. and O'Sullivan, K. (2013b) 'Job Satisfaction of Professional Irish Dancers: Implications for Performer Health and Well-being', *Journal of Dance Medicine & Science,* 17(4), 139-149.

Cahalan, R. and O'Sullivan, K. (2013c) 'Musculoskeletal pain and injury in Irish dancing: A systematic review', *Physiotherapy Practice and Research,* 34(2), 83-92.

Cahalan, R., O'Sullivan, K., Purtill, H. and O'Sullivan, P. (2014) 'A cross-sectional study of elite adult Irish dancers: traits, pain & injury', *Journal of Dance Medicine & Science,* In print.

Cahalan, R., O'Sullivan, K., Purtill, H. and O'Sullivan, P. (2014). Foot and ankle pain and injuries in elite adult Irish dancers. *Medical Problems of Performing Artists.* In print

List of Abbreviations

% HRmax	Percentage of maximum heart rate
%LL	Percentage of leg length
ACSI28	Athletic Coping Skills Inventory-28
BHS	Beighton Hypermobility Score
BMI	Body Mass Index
CHAID	Chi-squared Automatic Interaction Detector
CI	Confidence Interval
CLRG	An Coimisiún le Rincí Gaelacha
cm	Centimetre
CRN	An Cumann Rince Naisiunta
CSQ	Coping Strategies Questionnaire
DASS	Depression Anxiety Stress Scale
FA	Foot and Ankle
FMS	Functional Movement Screen
GJH	Generalised joint hypermobility
GSES	General Self-Efficacy Scale
HPA	Hypothalamic-Pituitary-Adrenal
Hrs	Hours
IADMS	International Association for Dance Medicine & Science
ICD-10	International Classification of Diseases Version 10
IOC	International Olympic Committee
ID	Irish dancing
IQR	Interquartile range
kg/m^2	Kilograms per square metre
Lbs	Pounds
LTA	Less Time Absent
mm	Millimetre
MRI	Magnetic resonance imaging
MT	Most Troublesome
MTA	More Time Absent
NSI	Not Significantly Injured
NT	Never Troublesome
PFPS	Patellofemoral pain syndrome
PID	Professional Irish dancer
POMS	Profile of Moods State
PPT	Pain Pressure Threshold
OR	Odds Ratio
RED-S	Relative Energy Deficiency in Sport
ROM	Range of Motion
SCOFF	Sick, Control, One stone, Fat, Food
SD	Standard deviation
SEBT	Star Excursion Balance Test

SHCI	Subjective Health Complaints Inventory
SI	Significantly Injured
SNQ	Standardised Nordic Questionnaire
SPARQ	Speed, Power, Agility, Reaction and Quickness
WHO	World Health Organisation
WIDA	World Irish Dancing Association

CHAPTER 1: INTRODUCTION

1.1 A Brief History of Irish Dance

Internationally there are few traditional dance forms that can match the fascinating evolution of Irish dancing (ID). From humble roots as 4th century circle dances to the internationally acclaimed art form it is today, ID represents a rich historical legacy. As an island nation the culture, language and dance of Ireland has been influenced and augmented by successive invasions from neighbouring nations throughout the centuries. The Normans are credited with formally introducing dance to Ireland in the 12th century, with historical accounts of ID made by English social historians as early as the 16th and 17th centuries (Breathnach 1971). In the early 1700's travelling dance masters introduced "step dancing", so called because it was executed in eight bar "steps" (Brennan 2004). During this period, the distinctive erect posture of the Irish dancer evolved, marked by an unmoving torso, with arms held firmly by the sides of the body (Cullinane 1987). With the foundation of "An Coimisiún le Rincí Gaelacha (CLRG)", The ID Commission, by Conradh na Gaeilge (The Gaelic League) in 1931, an unprecedented period of formalised ID competitions ("feiseanna") was initiated. Gradually, ID schools in Ireland and Irish centres around the world (CLRG 2012) were established to formally bringing ID to the native Irish and the Irish diaspora. The inaugural World ID Championships in 1970 heralded the modern era of ID on an international scale. Nevertheless, until recent decades, ID was mainly confined to the "feis" (competition) hall and traditional Irish cabaret performance.

The original ID production of "Riverdance, The Show" in 1994 and other similar productions heralded an important development in the evolution of ID. Prior to the genesis of the touring ID production, Irish dancers rarely danced beyond their late teens or early twenties, with any later involvement in ID limited usually to teaching or adjudication. Now, for the first time, Irish dancers were presented with the possibility of a sustainable professional career in dance, thus allowing them to continue to perform into their thirties and beyond. In an important parallel development, ID for the first time came to the attention of individuals unconnected with Ireland or the Irish diaspora. Currently, the official register of the largest governing body for ID teachers and adjudicators (the CLRG) lists Irish dance academies in over 30 countries throughout five continents (CLRG 2012). In addition, thousands of Irish dancers worldwide are affiliated to a number of smaller governing bodies including "An Comhdhail" and "An Cumann Rince Naisiunta" (CRN) and more recently the "World Irish Dancing Association" (WIDA). The success of "Prodijig", 2012 winners of the British dance competition "Got to Dance" and the recent stage show "Heartbeat of Home" has seen a further metamorphosis of ID to incorporate elements from other dance traditions. The continuing popularity of shows such as "Riverdance", now entering its third decade, underscores ID as an enduring and important dance genre, worthy of its place on the world stage.

1.2 Features of Irish Dance

Solo ID may be divided into "light" and "heavy" dancing. In heavy dancing, the emphasis is on strength, rhythm and power. As a major influence on the development of African-American tap dance in the United States in the 19th century (Hill 2010), both art forms emphasise syncopation and creativity. Light dancing shares some common ground with ballet with dancers high on their toes and performing large, elegant leaps. However, the Irish dancer lands on an extended leg as opposed to the plié position of the ballet dancer, and the light ID shoe has no toe box, being composed entirely of pliable leather. Additional unique features of ID include the trademark erect posture of the dancer with arms held by the sides of the body and the over-crossed position of the legs. The impact of these elements on dancer balance, muscle power and length asymmetries, and greater and more poorly dispersed ground reaction forces has received little attention in the literature. The rapid evolution of ID to professional status has offered dancers the opportunity to perform for several decades. Similarly competitive careers now endure for longer than previously and are marked by ever-increasing chorographical, training and touring demands. While this has been an exciting development for ID, it has placed vastly increased physical and psychological demands on performers.

1.3 Pain and Injury in Dance

In other genres of elite dance, a substantial amount of high quality research into musculoskeletal pain and injury has been conducted (Garrick and Requa 1993, Thomas and Tarr 2009, Baker et al. 2010). Studies examining a multiplicity of dance traditions have established a high overall rate of injury, with a lifetime prevalence of pain and injury on professional ballet dancers varying from 40% to 84% (Hincapié et al. 2008). An annual injury rate of 82% in professional modern dancers has also been recorded (Shah et al. 2012). However, comparison of injury rates within and between genres is greatly complicated by the lack of a uniform definition of injury in the literature (Liederbach et al. 2012). In this thesis, a time loss definition of pain and injury is used. This has been described as "a physical complaint sustained by a dancer resulting from performance, rehearsal, or technique resulting in a time-loss" from dancing (Bronner et al. 2006, p 69). Although acknowledged as conceptually different, the terms "pain" and "injury" are used interchangeably by dancers (Tarr and Thomas 2011). Research further suggests that dancers frequently work with multiple definitions of pain and injury, with many of these definitions being in contradiction to each other (Tarr and Thomas 2011). The use of the terms pain and injury in this thesis will also allow for situations where it may be impossible to determine whether a reported musculoskeletal complaint was an acute injury or simply pain.

Evidence-based screening and injury prevention programs have been advocated to identify at-risk dancers and deal with weaknesses accordingly (Solomon et al. 1999, Bronner et al. 2003b). There is marked heterogeneity in the content of many screening interventions with some focussing primarily on the physical attributes of the dancer (Allen et al. 2013), while others adopt a more holistic approach, examining a range of intrinsic and extrinsic factors (Luke et al. 2002). The success of various screening protocols remains indeterminate with a recent systematic review finding insufficient evidence of the efficacy of such protocols to identify and modify risk factors for injury (Hincapié et al. 2008). However a White Paper produced by the International Association for Dance Medicine & Science (IADMS) (Liederbach et al. 2012) provides guidelines for more homogenous and evidence-based injury surveillance and screening systems based on a broad range of biopsychosocial factors. A further role of screening is to provide healthy baseline data and to amass information on a specific dancer population (Bronner et al. 2006). Although lacking in ID, substantial research in ballet and modern dance has collated such baseline information on the demographic, anthropometric and physical characteristics of professional dancers in these genres (Hamilton et al. 1992, Koutedakis and Jamurtas 2004, Weiss et al. 2008).

The bodily areas most commonly affected by musculoskeletal pain and injury have been found to vary according to the chorographical demands of the dance genre in question. The foot and ankle region is frequently cited as the area most prone to pain and injury in professional ballet (54%) (Nilsson et al. 2001), contemporary (34%) (Bronner et al. 2003a) and tap dancers (41%) (Mayers et al. 2003). However the knee (30%) in professional flamenco dancers (Pedersen and Wilmerding 1998), and the knee (18.8%) and spine (16.1%)

in professional breakdancing (Kauther et al. 2009), appear to be most often affected. This is most likely due to chorographical differences between genres.

Two recent systematic reviews have attempted to synthesise the best available evidence in dance literature (Hincapié et al. 2008, Jacobs et al. 2012). An initial systematic review involving 29 high quality studies confirmed a high rate of injury across genres and identified a heterogeneous pool of risk factors for injury. These included musculoskeletal factors such as previous injury or fatigue, psychological factors such as stress, anxiety and work dissatisfaction, as well as extrinsic factors such as stage type and working conditions (Hincapié et al. 2008). A subsequent review conducted by several of the same authors investigated the best available dance literature from 2004 to 2008 (Jacobs et al. 2012). Similar conclusions regarding the prevalence and risk factors for pain and injury were reported and recommendations were made supporting a standardised definition of injury and the development of evidence-based screening programs and interventions. Neither review included any studies involving ID.

High quality research into the incidence and aetiology of musculoskeletal pain and injury in ID is lacking. Given the distinctive features of ID choreography, it is unknown how much can be inferred from research findings in other dance forms. In sporting populations, a number of systematic research models aimed ultimately at reducing sports injury have been developed (Van Mechelen et al. 1992, Finch 2006) (Figure 1.1). These models procedurally gather data on injury epidemiology and aetiology, identify mechanisms of injury, propose remedial measures and re-assess outcomes based there-upon. This doctoral thesis will embody a similar approach in order to add meaningful data to the limited research currently available regarding pain and injury in elite adult Irish dancers.

Figure 1.1: Two proposed research frameworks: The TRIPP and van Mechelen framework models of injury prevention research

Model		Translating Research into Injury Prevention Practice (TRIPP)	Van Mechelen et al 4 stage approach
Stage:	**1**	Injury surveillance	Establish the extent of the problem
	2	Establish aetiology and mechanisms of injury	Establish aetiology and mechanisms of injury
	3	Develop preventative measures	Introduce preventative measures
	4	"Ideal conditions"/scientific evaluation	Assess their effectiveness by repeating stage 1
	5	Describe intervention context to inform implementation strategies	
	6	Evaluate effectiveness of preventative measures in implementation context	

(Van Mechelen et al. 1992, Finch 2006)

1.4 Study Aims and Objectives

The objective of this thesis is to establish and build upon the existing research regarding musculoskeletal pain and injury in an elite adult Irish dancing population. The aims of this study include the following:

- To investigate and critically appraise the existing relevant research concerning the incidence, type and perceived causes of musculoskeletal pain and injury in an ID population (Chapter 2).
- To investigate the incidence, type and of causes of musculoskeletal pain and injury in ID in a professional adult cohort (Chapter 3).
- To examine the career experience of a professional ID cohort and the impact of ID on quality of life, dancer health and wellbeing (Chapter 4).

- To investigate the epidemiology of, and factors associated with, musculoskeletal pain and injury in ID in a cross-sectional study of an elite adult ID population (Chapter 5).
- To gather baseline data to better understand the typical characteristics of this cohort of Irish dancers (Chapter 5)
- To identify factors associated with foot and ankle pain/injury in an elite adult ID cohort, the most troublesome bodily region in elite dancers across several genres (Chapter 6).
- To prospectively establish the factors associated with musculoskeletal pain and injury in an elite cohort of adult Irish dancers (Chapter 7).
- To then develop an evidence-based screening program based upon a twelve month follow-up of this ID cohort (Chapter 7 and 8).

1.5 Study Hypotheses

- It is anticipated that there will be a paucity of existing research in this field, particularly in relation to adult and professional ID cohorts.
- It is hypothesised that there will be a significant incidence of lower limb pain/injury incurred, particularly involving the foot and ankle.
- It is anticipated that a complex combination of intrinsic and extrinsic psychological and physical factors will be associated with pain and injury in elite adult Irish dancers.
- A further hypothesis of this study is that a predisposition to ankle and foot injuries in particular will exist in the presence of a number of physical and psychosocial factors.
- It is anticipated that elite Irish dancers will share some biopsychosocial features with dancers from other genres, but will also differ in some regards due to the chorographical specificities of ID.
- The final hypothesis is that any screening program will need to be multifaceted, and will require consideration of a variety of biopsychosocial factors.

CHAPTER 2: MUSCULOSKELETAL PAIN AND INJURY IN IRISH DANCING: A SYSTEMATIC REVIEW

Published: Physiotherapy Practice and Research, Volume 34, Number 2, 2013.

Roisin Cahalan, Kieran O'Sullivan

Abstract

The popularity of Irish dancing has increased enormously since the success of "Riverdance, The Show". The evolution of Irish dance to professional status has placed increased demands on dancers, yet scant investigation of musculoskeletal pain and injury among Irish dancers has been undertaken. This review examined the evidence regarding the rate of injury among Irish dancers, and the factors associated with injury risk. Electronic databases were searched by two independent assessors. Studies were included if they examined the rate of musculoskeletal pain or injury among Irish dancers, and/or the factors associated with musculoskeletal pain or injury among Irish dancers. Study quality was assessed using the Oxford levels of evidence scale. Only two retrospective studies met the eligibility criteria, with no prospective studies on injury rate having been published. These studies indicate that lower limb injuries, especially in the foot and ankle, are most common in Irish dancers. There is preliminary evidence that dancers who did not complete a warm-up and cool-down, who did not use split-shoe sneakers while training, and who perform at higher levels of competition may be at greater risk of injury. No high quality prospective studies of injury have been completed in Irish dance. The existing retrospective studies demonstrate that foot and ankle injuries are the most common, and some potential contributing factors to injury have been identified. However, prospective studies which evaluate these risk factors for injury, as well as common injury risk factors identified in other forms of dance, are required.

2.1 Introduction

The evolution of Irish dance from 4th century Druidic circle formations to the highly athletic and intricate performances familiar to audiences today has been influenced greatly by the ebb and flow of various civilisations on the island nation of Ireland. The Normans are credited with introducing dance to Ireland in the 12th century, with formal accounts of Irish dancing made by English social historians as early as the 16th and 17th centuries (Breathnach 1971). In the early 1700s travelling dance masters introduced 'step dancing', so called because it was executed in eight bar "steps" (Brennan 2004). Over time, the characteristic erect posture of the Irish dancer evolved with the hands and arms held firmly by the side of the body (Cullinane 1987). The foundation of "An Coimisiún le Rincí Gaelacha (CLRG)", The Irish Dancing Commission, by Conradh na Gaeilge (The Gaelic League) in 1931 saw the advent of formalised Irish dance competitions and the establishment of Irish dance schools in Ireland and in Irish centres around the world (CLRG 2012). Nevertheless, until recent decades, Irish dancing was mainly confined to the "feis" (competition) hall and cabaret performance.

The inaugural World Irish Dancing Championships in 1970 heralded the modern era of Irish dancing on an international scale. The original Irish dance production of "Riverdance, The Show" in 1994 and subsequent productions including "Lord of the Dance", "Feet of Flames" and "Rhythm of the Dance" initiated an important departure in the evolution of Irish dance. Previously, Irish dancers rarely continued to compete beyond their late teens or early twenties, with any later involvement in Irish dance limited broadly to teaching or adjudication. Now Irish dancers could mould careers as professional performers and continue to dance into their thirties and beyond. For the first time, Irish dancing moved beyond the remit of the native Irish and the Irish diaspora in traditional emigrant destinations in Britain, North America and Australia. The global success of shows such as "Riverdance" saw the establishment of Irish dancing schools and academies all over the world. At the time of writing, the official register of Irish dancing teachers and adjudicators compiled by the CLRG lists Irish dance academies in over 30 countries throughout five continents (CLRG 2012). Of late, the success of “Prodijig”, winners of the British dance competition “Got to Dance” has seen further metamorphosis of Irish dance to assimilate other dance traditions. It also is likely that this will imbue fresh impetus into the place of Irish dance on the international stage.

The rapid progression of Irish dance to professional status has offered dancers the opportunity to perform as an Irish dancer for several decades. While this has been an exciting development for Irish dancing, it has placed vastly increased physical and psychological demands on performers. In other forms of dance, a large amount of high quality research into musculoskeletal pain and injury has been undertaken (Garrick and Requa 1993, Thomas and Tarr 2009, Baker et al. 2010). Studies encompassing a variety of dance traditions have established a high overall rate of injury, with estimates varying from 17% (Bronner et al. 2003a) to over 90% (Ryan and Stephens 1987, Kerr et al. 1992, Berlet et al. 2002). Evidence-based programmes to reduce the risk of injury among dancers have also been designed and implemented (Solomon et al. 1999, Bronner et al. 2003b). Anatomical location of injury may vary significantly between dance forms with ballet, contemporary and tap dance frequently citing the foot and ankle as most often injured (Bronner et al. 2003b, Mayers et al. 2003), whilst the knee in flamenco (Pedersen and Wilmerding 1998), and knee and spine in breakdancing (Kauther et al. 2009), were most often affected. A recent systematic review of dance injury risk factors has identified a heterogeneous pool of factors including musculoskeletal factors such as previous injury or fatigue, psychological factors such as stress, anxiety and work dissatisfaction, as well as extrinsic factors such as stage type and working conditions (Hincapié et al. 2008). However, the extent of research into musculoskeletal pain and injury among Irish dancers is unclear, limiting the potential to implement suitable injury prevention and management programmes. Therefore the aim of this literature review was to investigate existing studies into the rate of musculoskeletal pain and injury in Irish dancing, and the factors associated with musculoskeletal pain and injury in Irish dancing.

2.2 Methods

2.2.1 Search Strategy and Inclusion Criteria

The following databases were searched during January 2012; MEDLINE, SPORTdiscus, CINAHL, AMED, Academic Search Complete, Biomedical Reference Collection, Embase, Web of Science and JSTOR. Two assessors (KOS, RC) independently searched these databases using the following agreed range of keywords; “Irish” AND "Danc*" AND "Pain* OR Injur*". The keyword search was limited to the abstract or topic, as appropriate on each database. Studies were limited to those involving humans, published in English, after 1980. After the removal of duplicates, the titles and abstracts of the articles which met these criteria were then screened for suitability. If no abstract was available, or when it was not clear if the study should be included, full-text articles were retrieved in order to determine inclusion or exclusion. Studies were included if they evaluated the rate/frequency of musculoskeletal pain or injuries among Irish dancers and/or examined the factors associated with musculoskeletal pain or injury among Irish dancers. Studies were excluded if they were simply case reports of injuries among Irish dancers (Kivel et al. 2011, O'Halloran et al. 2011), or if they were focussed on the biomechanics of dancing rather than pain or injury (Shippen and May 2010). Furthermore, only full-text journal articles were eligible for inclusion. Conference proceedings (Magee 1999) were excluded because they are not consistently peer reviewed, and often lack sufficient information to adequately assess methodological quality. The reference lists of the selected articles were also manually searched for any further relevant articles.

2.2.2 Assessment of Methodological Quality

Methodological quality was assessed using the Oxford Centre for Evidence–Based Medicine levels of evidence guidelines (OCEBM 2011) where study types are ranked to determine the usefulness and validity of a study. Issues including study bias, confounding factors, strength of the results, and clinical applicability were also examined separately in the assessment of methodological quality.

2.2.3 Data Extraction and Synthesis

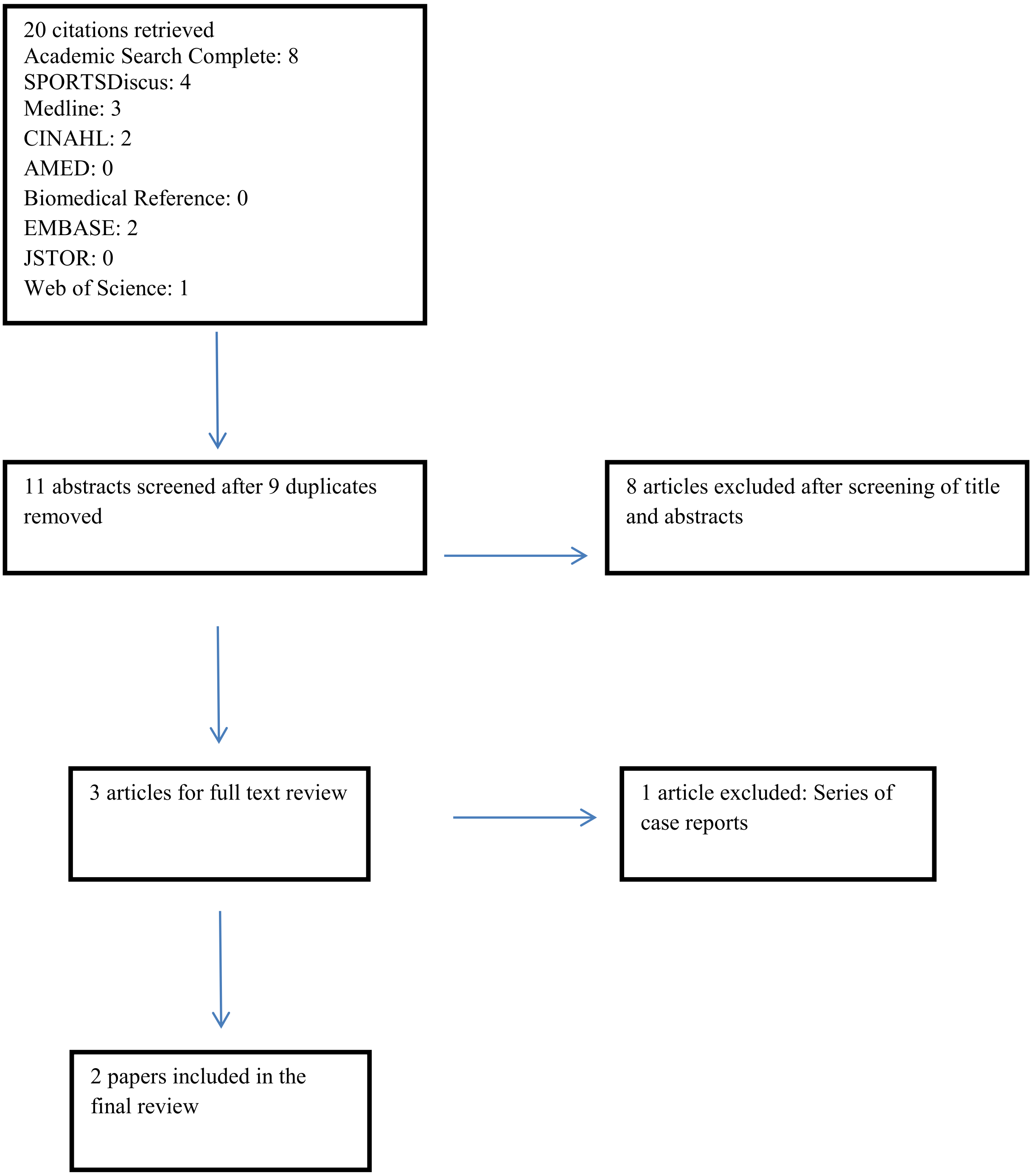
Data regarding each study were extracted and cross-checked by two assessors (KOS, RC). This included data on (1) sample size (2) participant gender, (3) participant age, (4) dance experience, (5) study design, (6) injury definition (7) outcome measures, (8) inclusion/exclusion criteria, (9) summary of main results, (10) most common injuries and (11) factors linked with musculoskeletal pain or injury (Tables 2.1 and 2.2). Pooled analysis of the data was not possible due to heterogeneity of data between the studies.

2.3 Results

2.3.1 Identification of Studies

The results of the search strategy are outlined in Figure 2.1. The electronic search resulted in a total of 20 potentially relevant papers, which was reduced to 11 after the removal of duplicates. After screening of the title and abstract of each article, three articles were identified as being potentially relevant. After reviewing these full-text articles, two articles met the inclusion and exclusion criteria. Searching the reference lists of these articles did not add any further articles. Therefore, the final number of articles included in this review was two (McGuinness and Doody 2006, Noon et al. 2010). Both studies were retrospective investigations into the frequency of injury, and factors associated with injury risk in competitive Irish dancers. Study characteristics are detailed in Table 2.1.

Figure 2.1 Flow chart of study selection procedure



McGuinness and Doody (2006) performed a cross-sectional retrospective study into previous injury sustained among 159 Irish dancers competing at a large international event.

Table 2.1 Description of each study

Study	Sample size	Gender	Mean age	Mean years Dancing	Study design	Injury Definition	Outcome measure	Inc/ Exc criteria
McGuinness & Doody	159	142F /17M	17.8	10.8	Retrospective self-administered questionnaire	Any injury that led to absence from training and competition for two weeks or more	Injury location, severity, frequency, and use of injury prevention strategies --- 3 worst injuries in last 5 years	Irish dancers presenting to sports injury clinic. Irish dancing related injuries.
Noon et al	69	69F/0M	13.1	Not reported	Retrospective chart review	No definition given	Injury location Injury type Number of injuries per dancer. Relationship between injury and age, menarche, skill level.	Not reported

Table 2.2 Most common injuries among Irish Dancers, and the proposed factors contributing to them

Study	Results summary	Most common injuries	Significant relationships to injury	Non-significant relationships to injury
McGuinness & Doody	•79% of dancers sustained injury •63% of injuries take 21days or more to recover •Foot/ankle most often affected (56) •Most injury occurred prior to major competition (58%) or with new choreography (21%)	• Ankle (31%) • Foot (25%) • Hip (12%) • Knee (10%) • Back (5%) • Upper limb (2%) • Other (14%)	Ankle injury rate higher if; •No warm-up •No cool-down •Not using shock absorbent dance shoes (split-sole sneakers)	Ankle injury unchanged with; •Age •More years dancing •More practice •More classes •More competitions •Use of shock absorbing floor, pomps or hardshoes
Noon et al	•79.9% dancers had multiple injuries •Foot/ankle most often affected (68.3%) •Stress fractures of sesamoids main injury (29.9%) •94.4% all injuries in the lower limbs	•Stress fractures (29.9%) •PFPS (11.1%) •Severs Condition (6%) •Ankle sprains (5.1%) •Plantar Fasciitis (4.6%) •Posterior tibialis tendonitis (4.6%)	No statistical analysis presented, but a trend for higher overall injury rate if; •Increased skill level •More practice	No statistical analysis presented, but no evidence of relationship between menstrual abnormalities and stress fractures

Dancers were asked to consider their three most recent injuries over the previous five years, as well as their use of injury prevention strategies, using a self-administered questionnaire. Demographic data including the dancers' age, years of dancing experience and hours spent both at classes and private rehearsal per week were collected. The authors also gathered information on the frequency of competitions per year and type of footwear used, as well as use of warm-up, cool-down, type of floor and dance shoes used by subjects.

Noon et al. (2010) performed a retrospective chart review of injuries to 69 female Irish dancers over a seven year period (2002 – 2007), and considered factors which may have been related to injury risk including age, menarche, hours spent practicing and level of competition. The included dancers were from a single Irish dance company in the American Mid-West who presented for treatment at an academic sports medicine clinic where they were evaluated and diagnosed by the same physician.

2.3.2 Description of Results

McGuinness and Doody (2006) investigated the rate and type of injury in 159 competitive Irish dancers aged from 15 to 24 years (mean 17.8 years). Dancers were of a comparatively high standard as they were participating in the North American Irish Dance Championships. Results found that 79% had experienced at least one dance related injury in the last three years, with the ankle (31%) and foot (25%) most frequently injured (Table 2.2). Ankle sprains (29%) and foot stress fractures (12%) were found to be the most common types of injury. The authors also reported that 63% of dancers took at least 21 days to recover from their injuries. Most injuries occurred either prior to a major competition (58%) or with the introduction of new choreography (21%). In this study, the definition of injury was any incident that caused absence from practise and/or classes for a period of at least two weeks. The implication is that many less serious injuries or painful episodes were not considered. 95% (151) of subjects in this study performed a warm-up and 35% (56) dancers completed a cool down. Eight dancers (5%) performed neither a warm-up nor cool-down. Performing regular warm-up and cool-down routines as well as the use of sturdier, shock absorbing footwear were significantly associated with a decreased level of injury. A number of other study variables including shock absorbent surfaces and dance pumps, age, number of years dancing, weekly practice rates and number of annual competitions were not shown to be significantly related to levels of injury.

Noon et al. (2010) conducted a retrospective study into injury patterns in 69 female Irish dancers aged from eight to 23 years. The mean age of subjects was 13 years, and all were competitive dancers of varying standard. The majority of injuries reported were lower limb injuries (94.9%), with the foot and ankle identified as the structures most often affected comprising 68.3% of reported injuries (Table 2.2). The main injuries identified in this cohort were stress fractures (29.9%), predominantly of the foot, Patellofemoral Pain Syndrome (PFPS) (11.1%), Severs lesions (6%) and ankle sprains (5.1%). Nearly 80 % of subjects reported multiple injuries. The authors hypothesised that the majority of injuries incurred were related to overuse, and identified some trends for the rate of injury to increase in line with higher levels of competition and increased practice. There was no association between menstrual abnormality and stress fracture.

2.3.3 Critical Appraisal

Under the Oxford Centre levels of evidence paradigm described above, both studies would be considered level three studies, consisting of local, non-random samples which examined the frequency of injury and preliminary examination of some of the factors associated with injury.

2.3.4 Bias

In the study by Noon et al. (2010), there is a selection bias, as only those dancers who had sustained an injury were considered in the research. Therefore, it is impossible to ascertain whether non-injured dancers exhibited any of the same patterns or predisposing risk factors as those investigated in the study. It may be argued that there is also selection bias in the McGuinness and Doody (2006) study as only more elite dancers (i.e. those competing at international championship level) were investigated, although this can be justified on the basis of their greater dance and training volume. This study has an element of information bias, as injuries leading to an absence from performance of less than two weeks were not recorded. Focussing on the most significant injuries enhances the relevance of the findings, although it is likely that the prevalence of more minor injuries was consequently under-reported. Prospectively, the importance of any injury that causes absence from performance or rehearsal should be considered. There is no definition of injury in the Noon et al. (2010) study, apart from that implied from the clinical findings of the physician. No information on length of time away from dance to recover from injury is discussed, which limits the usefulness of the findings, and may be a source of information bias. In the study by McGuinness and Doody (2006), there is potential for recall bias as dancers were asked to report details of injuries sustained up to five years previously. This is particularly relevant given the young age of the subjects (mean = 17.8 years). Recent research advocates standardised real–time recording of dance injury in conjunction with contributing biopsychosocial influences (Liederbach and Richardson 2007). Such a system, it is argued, will best develop evidence-based injury prevention models. However, many studies in this area rely on dancers retrospectively recalling injuries from various times in the past (Mayers et al. 2003, Kauther et al. 2009).

2.3.5 Confounders

The study by Noon et al. (2010) only considered a limited number of potential risk factors for injury, although McGuinness and Doody (2006) considered a wider array of factors. Without consideration of other factors widely established in dance literature as being associated with injury, their findings may be overstated. These other factors include (but are not be limited to) psychological distress (Brinson and Dick 1996), physical fitness and strength (Koutedakis and Jamurtas 2004) and attitudes to pain and injury management (Thomas and Tarr 2009). Other potential confounders which were not discussed include the treatment, if any, received for reported injuries, and whether this was a new or recurring injury.

2.3.6 Strength of Results

Of the two aforementioned studies, only McGuinness and Doody (2006) used any statistical analysis. However these tests were only applied in regard to data on ankle injuries, thus narrowing the strength of the overall study findings. For example, the use of strategies such as warm-up and cool-down was compared between those who injured their ankle and those who never injured any body part, rather than those who simply never injured their ankle. Their other data, including demographical and injury distribution, were recorded as percentages. Noon et al. (2010) simply reported percentages of various injury types and some basic demographical data including level of dancer and number of injuries sustained per year. All data were reported in percentage terms. A power analysis was performed for neither study, although McGuinness and Doody (2006) alluded to comparable cohort sizes in similar research in other dance forms.

2.3.7 Clinical Applicability

A key issue with both of these papers is their lack of generalisability to Irish dancing injury as a whole, and to professional Irish dance in any way. The study by Noon et al. (2010) is narrowly focussed with the cohort comprised solely of injured female competitive dancers all attending the same academy. There was no comparative investigation made into pain-free matched dancers. In addition, the findings of the study are largely limited to providing an inventory of injuries identified by a single practitioner. There is no real investigation of injury severity or the mechanism of injury. The study by McGuinness and Doody (2006) provides more information regarding injuries of the elite competitive dancer and also examines a number of the potential underlying factors. However by limiting the main discussion to the ankle, the applicability of the study as a whole is tempered. Neither paper investigated injury in the professional Irish dancer nor the myriad of other intrinsic and extrinsic causes of injury alluded to previously (Bronner et al. 2003b, Hincapié et al. 2008). As such the clinical applicability of both of these studies is limited.

2.4 Discussion

No prospective studies on rates of dancing injury, or the factors associated with musculoskeletal pain or injury, were found. Only two retrospective studies were eligible for inclusion, which greatly limits the ability to derive conclusions from the study results. Notwithstanding this limitation, this review highlights some important findings which are worthy of consideration in the design of prospective studies into musculoskeletal pain or injury among Irish dancers. Going forward, any such prospective study would need to be cognisant of the myriad of biopsychosocial risk factors associated with injury (Hincapié et al. 2008). Additionally, the scope of such a study would need to be broadened to encompass not only competitive Irish dancers, but also the more mature professional cohort, the elite dancer, and perhaps the retired Irish dancer.

Of the two studies in this review, only the study by McGuinness and Doody (2006) reports an overall injury rate of 79%. As previously discussed, injury rates amongst elite dancers of various traditions vary from 17% (Bronner et al. 2003a) to over 90% (Ryan and Stephens 1987, Kerr et al. 1992, Berlet et al. 2002). A similar rate of 74% was reported amongst a heterogeneous cohort of university and professional ballet dancers, contemporary and theatre dancers (Chmelar et al. 1987). A lifetime injury prevalence of between 26% and 51% has been recorded in University and pre-professional dancers (Hincapié et al. 2008). Magee (1999) reported an injury rate of 60% in a cohort of professional Irish dancers. As mentioned, this was a conference presentation and was therefore not eligible for inclusion in this review.

In both of the studies included in this review, lower limb injuries were found to be most prevalent, with foot and ankle the structures most often involved. Cumulatively, foot and ankle injuries accounted for 56% and 68.3% of reported injuries in the studies by McGuinness and Doody (2006), and Noon et al. (2010) respectively. The specific type of injuries identified were stress fractures, predominantly of the foot, ankle sprains, Severs lesions, and PFPS. This is largely in line with trends reported in ballet where the foot and ankle are frequently identified as most often injured. Rates of foot and ankle injury in ballet of 54% (Nilsson et al. 2001) and 90.4% (Byhring and Bø 2002) have been recorded in elite cohorts. The research in contemporary and tap dance shows the foot and ankle to be affected in 34% and 37% (Bronner et al. 2003a, Mayers et al. 2003) respectively. In both of these dance mediums, foot and ankle were again the most frequently injured structures, albeit at a lower rate than in ballet. This is explained potentially by the greater stress through the foot and ankle in the en-pointe position common to ballet and Irish dance, but absent in many other forms of dance. In a study of 144 amateur and elite break-dancers (Kauther et al. 2009), the foot and ankle accounted for 10.4% of injuries. In this cohort, the spine and knee were the most commonly injured anatomical structures each at 16.9%.

Due to the retrospective nature of the included studies, causation cannot be implied in examining the risk factors examined in those studies. However, there is some preliminary evidence from McGuinness and Doody (2006) to suggest that the risk of injury could be reduced significantly through use of a warm-up (68% reduction), cool-down (86% reduction) and the use of split-sole sneakers when practicing (87% reduction). Additionally, a number of factors did not appear to be associated with injury risk. These included the use of shock absorbent surfaces and dance pumps, number of years dancing, weekly practice rates and number of annual competitions. In contrast, Noon et al. (2010) identified a trend towards increased injury risk in line with hours of practice undertaken and advancing proficiency. These contradictions reflect the disagreement within the literature on the role of intensity and volume of training in injury. A number of studies have identified a greater risk of injury associated with increased intensity of practice, increased ability level, and more years of training (Hamilton et al. 1989, Watkins et al. 1989). Other studies have found no such link between incident of injury and years of training (Wiesler et al. 1996). Several studies have found previous injury to be predictive of future injury (Bowling 1989, Evans et al. 1996, Wiesler et al. 1996). This risk factor was omitted by both studies in the current review. The influence of warm-up and cool-down on injury risk is also a source of debate in the literature. Whilst supported by many authors as important to promote superior performance and prevent injury (Pope et al. 2000, Malliou et al. 2007), stretching during warm-up and cool-down has not always been found to prevent injury (Van Mechelen et al. 1992, Shrier 2001). Finally, a systematic review on the impact on footwear in dance injury reported a relationship between pointe shoes and foot and nail trauma, but reported a lack of good experimental research in the area (Yan et al. 2011) .

The lack of research into injury in the professional Irish dancer is marked. A conference paper by Magee (1999) identified an overall injury rate in a professional cohort of 60%. This study also noted a drop to an injury rate of 20% over a 15 month period following a preventative warm-up program. However, as with the studies included in this current review, failure to consider a host of potentially confounding factors, particularly those in the psychosocial area limit the predictive value of this study. A further study examined overuse injuries of the right ankles using magnetic resonance imaging (MRI) among 18 actively performing Irish dancers who also completed foot and ankle self-report questionnaires (Walls et al. 2010). Of the ten female and eight male dancers, only three had radiographically normal ankles, but there was a poor correlation between MRI findings and self-reported levels of pain and dysfunction. For example, eight of the dancers were pain-free with another nine subjects reporting only mild pain, despite the appearance of their MRI scans. The authors contended that many ankle injuries are sub-clinical, and that the findings in this small study were representative of ankle injuries in the general professional population. However, it is possible that the changes observed on the MRI scans are relatively normal tissue responses to high load, and not indicative of significant pathology.

One considerable omission in both of the reviewed papers is the failure to consider the role of psychosocial risk factors for injury. A number of intrinsic personality traits including heightened ambition (Hamilton et al. 1989), poor coping and confidence levels (Noh et al. 2005) and greater perceived levels of stress (Adam et al. 2004) have all been linked to increased levels of injury amongst dancers. Furthermore social support and global sleep quality have been found to impact positively on reduced levels of injury in professional ballet dancers (Adam et al. 2004). Additionally, in both studies, the majority of subjects were adolescents or younger children. The implication for injury in this age group is significantly different to an adult subject population. The manifestation of injury in an immature skeleton with vulnerable epiphyseal plates and chondro-osseous immaturity may be quite distinct from the injuries an adult would typically suffer. For instance, the high incidence of Severs lesions cited in Noon et al. (2010) would not be representative of an adult population. In addition, as with any athletic pursuit, the difference between amateur and professional demands on the body and mind of the dancer has significant implications for injury. The commitment of a competitive Irish dancer, while undoubtedly demanding, is very distinct from that of an individual who may work uniquely as a professional Irish dancer, and endure the rigours of year-round touring and performance.

A future prospective study into risk factors for injury in Irish dance should consider a clear definition of injury. Bronner and colleagues (Bronner et al. 2006) proposed a definition of injury as a

> "physical complaint sustained by a dancer resulting from performance, rehearsal, or technique… resulting in a physical complaint, medical injury, time-loss and/ or financial injury". (Bronner et al. 2006, p 69)

In addition, widening the dancing cohort to include skeletally mature adults, both male and female, at elite and professional levels should be considered. As well as biomechanical and demographic characteristics, other factors associated with injury with other dance populations such as sleep quality, nutrition, injury history and in particular psychosocial characteristics, should be recorded. The investigation of the impact of menstrual status conducted by Noon et al. (2010) should be expanded to consider the other elements of the female triad of menstrual dysfunction, inadequate calorie intake and decreased bone density in female dancers. Research in modern and ballet dance has identified female dancers to be at increased risk of eating disorders and menstrual dysfunction (Potter et al. 1996), with an associated increased risk of injury (To et al. 1995). Levels of physical strength and fitness as well as attitudes to pain and injury would also be important components of a prospective injury study. As previously discussed, these factors are essential to establish a reliable baseline profile of the dancer. A follow-up surveillance period over the medium to long term should also be performed.

The era of the career Irish dancer is less than two decades old. However, the dearth of relevant research into musculoskeletal pain and injury is surprising given the enduring popularity of the dance form and its exponential growth on a global scale. High quality, prospective research into injury cause and prevention is therefore warranted.

2.5 Conclusion

Irish dancing is an evolving art form with unprecedented and evolving physical and psychological demands on the dancer. Existing research into Irish dance injury is sparse and of limited clinical applicability. The evidence from two retrospective studies demonstrates that lower limb injuries, especially in the foot and ankle, are most common in Irish dancers. Several factors such as not including a warm-up or cool-down, not using split-shoe sneakers for training, and performing at higher competitive levels, have been linked to increased injury frequency. However, further prospective evaluation of the risk factors for injury among Irish dancers is required to clarify these preliminary findings. This scarcity of research contrasts with other dance forms, where a wealth of high quality studies is available. There is a need for high quality research in this area to assist dancers, choreographers and health care professionals better anticipate and manage injuries in Irish dance.

2.6 Addendum

Since the publication of this systematic review, a further relevant study has been produced (Stein et al. 2013). In an eleven year chart review of Irish dancers presenting to a number of orthopaedic and sports clinics, the injuries of 255 Irish dancers were reviewed. 95% of subjects were nineteen years of age or younger and 97% were female. As in the previous study by McGuinness and Doody (2006), the foot (33.2%) and ankle (22.7%) were most commonly affected, and 80% of injuries were due to overuse. The main conditions reported were tendon injury (13.3%), apophysitis (11.4%), patellofemoral pain or injury (10.8%), stress injury of bone (10.1%), and muscle injury (7.8%). A statistically significant association was noted between age at diagnosis and the nature of diagnosis. Dancers diagnosed with apophysitis were on average three years younger than those diagnosed with stress injury (p

=0.007). In this study, injury was defined as “any dance-related pain or disorder that led to evaluation in the clinics” (Stein et al. 2013, p159). As such, minor injuries and pain not considered sufficiently serious to consult a heath professional were not examined. A further limitation was the lack of standardisation of clinic charts, many of which lacked key pieces of information such as the length of time the subject had been suffering with symptoms prior to presentation. Similar criticisms may be levied at this paper as the two studies in the systematic review concerning retrospective errors of omission, and a narrowly focussed subject group. Once again, potential factors impacting on rates and severity of injury were not considered. However, this study by Stein et al. (2013) does provide robust support for the findings of the previous studies and is a useful resource in charting the rate and types of ID injury in a female child/adolescent population.

CHAPTER 3: INJURY AND PAIN IN PROFESSIONAL IRISH DANCERS

Published: Journal of Dance Medicine and Science, Volume 17, Number 4, 2013.

Roisin Cahalan, Kieran O'Sullivan

Abstract

Despite the evolution of Irish dance to professional status in recent decades, only scant investigation of musculoskeletal pain and injury among professional Irish dancers (PIDs) has been undertaken. This study investigated the rate of injury and associated factors among 178 PIDs, using an online questionnaire. One hundred and thirty-seven PIDs (76.7%) reported a previous injury, with the foot (67.9%) and ankle (60.6%) most commonly affected. A mean career rate of 2.25 injuries per dancer was computed. The majority of injuries were minor in nature, and almost half occurred midway through a tour. Sixty subjects (33.7%) reported that they often or always danced in pain. The main contributory factors to injury were accidents, fatigue/overwork, repetitive movements, and unsafe stages. Warm-up (98.8%) and cool-down (84.3%) were almost universally practised, with cross-training engaged in by 124 PIDs (74.7%). Popular treatments used to prevent and manage injuries were massage (n=137, or 83.0% of PIDs), stretching (n=117, or 70.1%) and physiotherapy (n=105, or 62.9%). There was a moderate level of psychological distress among the participants, with "interpersonal difficulties" and "tension with people" the main problems cited. PIDs who were older (p=0.008) and more experienced (p=0.002) reported missing a greater number of performances due to injury. There were no other significant relationships between injury and factors including gender, frequency of dancing in pain, use of warm-up, cool-down, or cross-training. Further prospective studies of PIDs should consider both physical and biopsychosocial elements to generate an appropriate screening process to predict those at risk of injury.

3.1 Introduction

The emergence of “Riverdance” in 1994 and subsequent productions including “Lord of the Dance” and “Gaelforce Dance” initiated an important departure in the evolution of Irish dance. For the first time Irish dance moved beyond Ireland and the Irish diaspora in such traditional emigrant destinations as Britain, North America and Australia. As of this writing the official registry of Irish dance teachers and adjudicators compiled by the main governing body, An Coimisiun le Rinci Gaelacha (CLRG), listed Irish dance academies in over 30 countries throughout five continents (CLRG 2012).

Solo Irish dancing may be divided into “light” and “heavy” styles. The former shares some common ground with ballet, with dancers high on their toes and performing large, elegant leaps. However, the Irish dancer lands on an extended leg as opposed to the plié position of the ballet dancer, and the Irish dancing shoe has no toe box, being composed entirely of pliable leather. In heavy dancing the emphasis is on strength, rhythm and power. As a major influence on the development of African-American tap dance in the United States in the 19th century (Hill 2010), it emphasizes syncopation and creativity. However, the uniqueness of Irish dancing is in the posture of the dancer, with arms controlled loosely by an erect torso (Hall 1996).

Despite its growing popularity, research into musculoskeletal pain and injury among Irish dancers is limited. As evidenced from the literature review, study in the professional cohort is particularly scant with the focus of the few relevant studies being on competitive, amateur dancers (McGuinness and Doody 2006, Noon et al. 2010). These retrospective studies, which examined predominantly female child and adolescent Irish dancers, reported a significant level of injury (79%) overall, particularly to the foot and ankle. Footwear, poor compliance with warm-up and cool-down, and higher competitive levels were associated with increased injury frequency. Only two studies have been identified which dealt specifically with a professional subject group (Magee 1999, Walls et al. 2010) Magee 1999, Walls et al. 2010), in a conference paper, identified an overall injury rate in a PID cohort of 60%, which decreased to 20% following a 15 month long preventative warm-up program. However, this study included no discussion of underlying risk factors or precipitating causes of injury. Walls et al. (2010) examined overuse injuries of the right ankles of 18 actively performing PIDs, and discovered only a poor correlation between MRI findings and self-reported levels of pain and dysfunction. Unfortunately the narrow focus and small subject pool limit the clinical usefulness of this study.

Therefore, the current study was designed to establish retrospectively the rate of musculoskeletal pain and injury among current and former PIDs, how pain and injury impacted their performance, and the aetiological factors perceived to be associated with these injuries. The utilization of cross training and support services such as physiotherapy and massage was also investigated.

3.2 Materials & Methods

3.2.1 Subjects

Ethical approval for this study was granted by the University of Limerick Research Ethics Committee. Study participants were current and retired PIDs, male and female, aged 18 years or older (there was no upper age limit). To qualify as a PID, participants had to have spent at least eight months of a consecutive 12-month period working exclusively as a paid Irish dancer. Participants were required to have a good understanding and command of written English.

3.2.2 Data collection

Data was gathered by online questionnaire using "SurveyMonkey™". Questionnaires were distributed via Irish dance academies, performing productions and the CLRG. Recipients were asked to complete the survey or forward it to other PIDs in their organisation as appropriate.

Gender, current age, and details of dancing background prior to becoming a PID were collected. Baseline psychological characteristics were established using the General Self-Efficacy Scale (GSES) (Luszczynska et al. 2005). This ten-item psychometric scale assesses coping strategies employed in difficult situations, with a higher score indicative of greater self-efficacy. Dancers were also asked if they had suffered from any of a variety of psychological problems either throughout their PID career, or specifically when they were injured (if applicable) (Brinson and Dick 1996).

Participants were asked if they ever danced in pain. The response options were "never", "rarely", "sometimes", "often" or "always". They were also asked whether they had ever been injured during their career. Injury was defined as any physical insult that caused absence from one or more rehearsal or performance days (Bronner et al. 2003b). For injured PIDs, an injury profile was established, including body part(s) affected, and the severity of the injury in terms of performance/rehearsal days missed. Severity was classified as minor (1-7 days), moderate (8 – 21 days), severe (longer than 21 days) (Byhring and Bø 2002) or career-ending. PIDs were asked to describe how they reacted to the warning signs of an injury from the following options; tell someone else e.g. dance captain, take own preventative steps, seek professional treatment, and/or soldier on (Brinson and Dick 1996). Similarly, regarding pacing recovery after injury, PIDs were asked to choose from the following options; take it slowly following professional advice, return as quickly as possible, or follow your own instinct (Brinson and Dick 1996). Injured PIDs were asked to discuss in further detail their most serious injury, with regard to body part and specific musculoskeletal structure involved. The stage of the tour when the injury occurred was noted, namely during rehearsal stage, early, mid or late tour stage (Bronner et al. 2003b). Injured PIDs were asked to rank perceived causes of injury (Table 3.3). Amended by the addition of "accident", this question on perceived causes of injury was drawn from the 1996 UK national "Fit to Dance" study (Brinson and Dick 1996).

In relation to the production where they had spent most time, participants identified any support structures provided, and if warm-up and cool-down were performed. They also outlined any additional cross-training undertaken and interventions available to manage their physical well-being.

3.2.3 Statistical Analysis

Results were analysed using SPSS 19.0. Statistical significance for all tests was set at $p<0.05$. Descriptive statistics and frequencies were initially calculated. Data was tested for normality of distribution (Kolmogorov-Smirnov; $p<0.05$). PIDs who missed a performance as a result of injury were compared to those who did not for categorical (gender, use of injury prevention strategies such as warm-up, cool-down and cross training), ordinal (age group, frequency of dancing in pain) and interval (years of experience as a dancer, psychological health) data. Categorical and ordinal data were analysed using Fisher's exact test, while interval data were analysed using Mann-Whitney u-tests. Finally, the total number of injuries reported by each individual was correlated (Spearman's signed rank: r_s) with years of experience as a dancer and psychological health.

3.3 Results

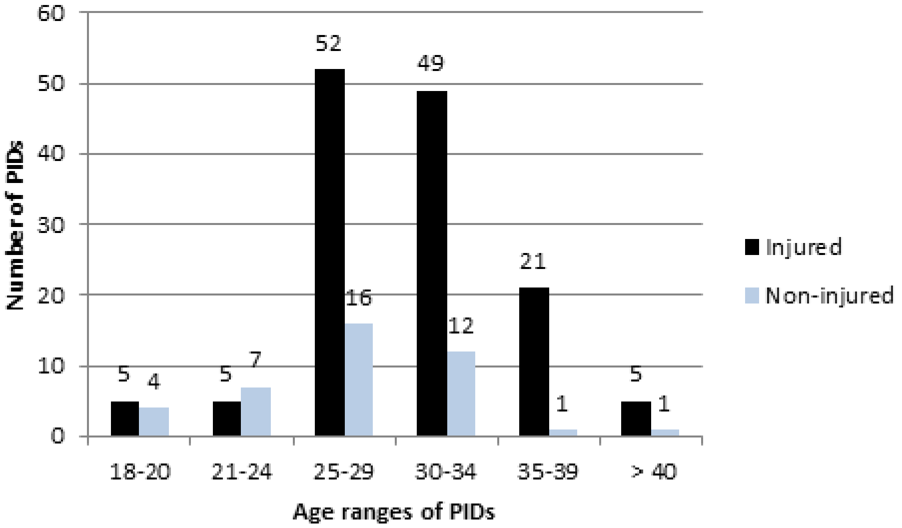
One hundred and eighty nine surveys were returned, with 178 surveys being completed in full and included in the analysis. Due to the method of survey distribution, it was impossible to establish a response rate.

3.3.1 Demographics and Dance History

One hundred and eleven (61%) female and 67 (39%) male PIDS responded. The majority of subjects (72%) were between 25 and 34 years of age. Mean previous dance experience was 13.2 years (standard deviation ± 3.4 years). The mean age at becoming a PID was 18.5 (± 3.0) years. Dancers spent a mean of 7.5 (± 4.6) years employed as a PID. Throughout their career most PIDs performed in only one (37.1%) or two (29.2%) productions. Sixteen dancers (8.9%) had been involved in five or more different productions. The mean length of time spent with one company was 5.1 (± 3.0) years. One hundred and twenty-nine PIDs (78%) performed in seven or more shows per week, with the remainder performing less frequently.

Those who missed a performance due to injury were significantly older (p=0.008) and more experienced (p=0.002) than those who had not. PIDs older than 25 years, particularly those aged over 35 years, had the greatest proportion of injuries relative to non-injured PIDs (Figure 3.1). Gender was not significantly related to injury (p=0.463). There was a weak correlation between the number of years' experience as a PID and the total number of injuries incurred (r_s=0.251, p=0.001).

Figure 3.1 Number of injured and non-injured professional Irish dancers at various age intervals.



3.3.2 Dance injury history

A total of 396 injuries were recorded. One hundred and thirty-seven PIDs (76.9%) reported a previous injury, with 41 (23.1%) reporting no injury, producing a mean career injury rate for all dancers of 2.25 (±2.04). Of those previously injured, 83 (60.5%) were female and 54 (39.5%) male, while 25% of females and 19% of males reported no career injury. Of injuries sustained, 223 (56.3%) were minor, 90 (22.7%) were moderate, 77 (19.4%) were severe, and six (0.2%) were career ending. The most commonly injured structures were the foot and ankle, with 93 (67.9%) and 83 (60.6%) PIDs respectively reporting injuries at those sites. In the case of both foot and ankle, most injuries (52.7% and 47.0%, respectively) were mild in nature. The lower limb accounted for 296 (74.7%) of all injuries. Location and severity of injuries are illustrated in Table 3.1.

Table 3.1 Injury rate, location and severity.

Body Part Injured	Minor	Moderate	Severe	Career Ending	Total
Head/Face	6	0	1	0	7
Neck	21	2	1	1	25
Arms/Hands	4	4	0	0	8
Shoulders	8	1	1	0	10
Elbow	0	0	0	0	0
Upper Back	4	2	1	0	7
Lower Back	17	7	4	1	29
Pelvis	4	2	0	0	6
Ribs	5	0	3	0	8
Hip	13	5	0	0	18
Groin	5	6	5	0	16
Thigh	9	5	1	0	15
Knee	19	11	8	0	38
Calf	20	6	7	0	33
Ankle	39	23	21	0	83
Foot	49	16	25	3	93
Unspecified	0	0	0	1	1
Total	**223**	**90**	**77**	**6**	**396**

Three participants (1.7%) reported that they never danced in pain, while 35 (19.7%) rarely did. Eighty PIDs reported pain while dancing sometimes (44.9%), and 60 (33.7%) often or always danced in pain. When the frequency of dancing in pain was dichotomised into "never, rarely or sometimes" and "often or always," there was a non-significant trend for those who "often or always" danced in pain to miss more performances (p=0.09).

One hundred and thirty previously injured PIDs provided information on their most serious career injury. Forty-five (34.6%) of these injuries were reported to be minor in nature, 34 (26.1%) were moderate, 45 (34.6%) severe, and six (4.6%) were career ending. Of this sub-set of dancers, 43 (33.1%) stated that they had previously injured the body part in question. Forty (30.8%) identified the ankle and 37 (28.5%) the foot as the location of their most troublesome injury. Anatomical structures injured were split evenly between muscle (27%), bone (25%), ligament (24%), and tendon (22%), with cartilage and nerve injuries accounting for less than 2% of the self-reported injured structures cumulatively.

3.3.3 Timing of Injury

Sixty-four (49.2%) PIDs had been injured mid-way through a production run, while 27 (20.8%) and 26 (20.0%) respectively sustaining their most serious injury near the end of tour and in the early stages of touring. Only 14 PIDs (10.8%) stated that they had become injured in the rehearsal period of the production run. Of the six career-ending injuries, one occurred during the rehearsal period, two in the early stages of the tour, and three near termination of the production run.

3.3.4 Psychological Health

The GSES mean value for all participants was 32.9 (±3.7). Sixty-nine PIDs (39%) recorded a GSES of 35 or above. Situations involving interpersonal difficulties were most challenging for respondents (mean 2.8 out of 4). Among the 169 PIDs who responded to our questions regarding psychological problems experienced throughout their career, the mean number of reported problems was 2.1 (±1.9). Forty (24%) had no psychological problems, while 34

(20%) reported either one or two. The main problems were tension with people (47.3%), stress due to external factors (30.8%), general anxiety (29%), and performance anxiety (26.6%); (Table 3.2).

There were no significant differences on GSES scores ($p = 0.925$) or the number of psychological issues reported while dancing ($p = 0.634$) between those who had or had not missed a performance due to injury. Nor were there any significant correlations between the total number of injuries incurred and either the GSES scores ($r_s = 0.063$, $p = 0.402$) or the number of psychological issues reported while dancing ($r_s = 0.12$, $p = 0.12$).

One hundred and twenty-eight PIDs who had sustained an injury also responded to questions regarding psychological problems at the time of their injury. Of these, 75 (59.0%) reported no psychological problems at that time, 26 (14.3%) experiencing only a single issue, and 53 (41.7%) identified a number of problems. The main problem cited by PIDs when injured was general anxiety (19.5%), followed by performance anxiety (17.2%) and tension with people (14.8%; see Table 3.2). There was a statistically significant, but weak**,** correlation between the number of psychological problems reported at time of injury and total number of injuries incurred (r_s=0.215, p=0.015).

Table 3.2 illustrates the comparative psychological inventory of subjects at the time of injury (if applicable) and when working in general as a PID. Results are reported in percentages for ease of comparison. There are elevated levels of all defects when working as a PID. Specific issues such as “tension with people,” “stress due to external factors,” “overuse of drugs/alcohol,” and “eating problems” were reported approximately three to six times more frequently while dancing.

Table 3.2 Psychological issues when injured, and when working as a professional Irish dancer.

Psychological Issue	When Injured (%)	Working as a PID (%)
General anxiety	19.5	29.0
Performance anxiety	17.2	26.6
Tension with people	14.8	47.3
General low self-confidence	7.0	13.0
Stress due to external factors	6.3	30.8
Depression	4.7	11.8
Sudden drop in self-confidence	4.7	14.2
Consistent difficulty concentrating at work	4.7	6.5
Over-use of drugs/alcohol	3.9	24.9
Eating problems	3.1	13.0
Other	0.8	0.6
	N = 128	N = 169

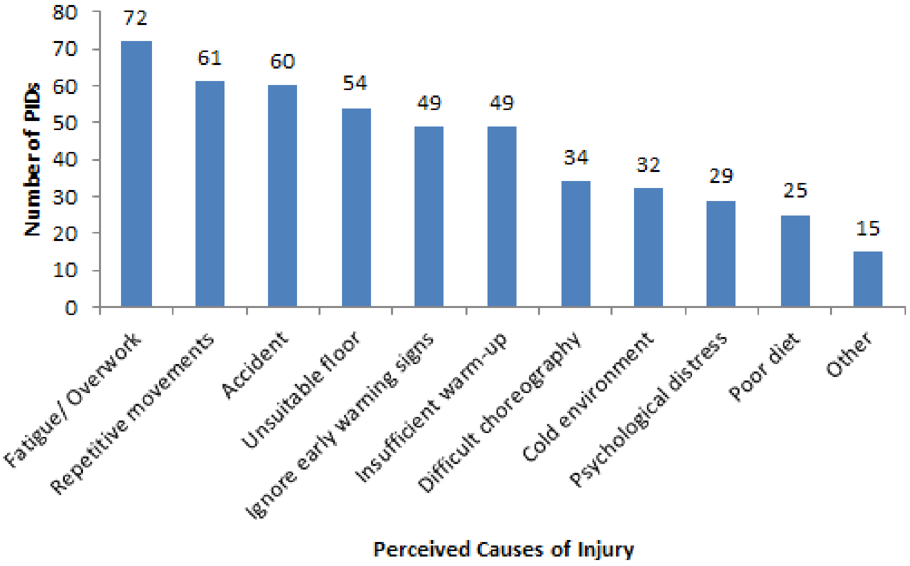
3.3.5 Risk Factors

Potential underlying causes of injury were ranked by 130 PIDs from 1–11 in terms of decreasing severity. Table 3.3 illustrates the number of times each factor was rated as the first, second, or third most important contributor to injury. For the sake of completeness, the total number of PIDs identifying each particular underlying risk factor is shown in Figure 3.2. Accident was perceived by 32 participants (24.6%) to be the main risk factor for injury, with 60 (46.2%) considering accidents as contributing to injury to some degree. In total, 72 PIDs (55.4%) cited fatigue/overwork as a cause of injury, with 34 (26.2%) naming it as either the first or second most likely cause. As no definition of "accident" was specified, it is unclear if there was a link between rates of accident and fatigue/overwork reported. Sixty-one (46.9%) PIDs identified repetitive movements as problematic, and 54 (41.5%) found an unsuitable floor to be a factor. Poor diet and psychological distress were considered relatively unimportant, with only one PID in each case suggesting these to be the major cause of injury. "Other" causes mentioned included insufficient strength and stretching, poor massage technique, jet lag, and bad luck.

Table 3.3 Number of professional Irish dancers identifying each risk factor as 1st, 2nd or 3rd perceived cause of injury.

Leading cause of Injury	1st	2nd	3rd
Accident	32	7	4
Fatigue/ Overwork	16	18	10
Unsuitable floor	14	8	8
Repetitive movements	12	12	11
Ignore early warning signs	9	11	6
Insufficient warm-up	5	4	11
Difficult choreography	3	4	3
Cold environment	3	5	0
Poor diet	1	0	1
Psychological distress	1	4	2
Other	6	1	1

Figure 3.2 Total number of professional Irish dancers identifying each risk factor as a perceived cause of injury.



3.3.6 Injury Prevention strategies

Of the 166 subjects who completed questions on warm–up and cool down, the vast majority participated in either a group or individual warm-up and cool-down. Only two (1.2%) respondents performed neither a warm-up nor a cool-down. 26 (15.6%) PIDs performed no cool-down (Table 3.4). As only two dancers (1.2%) did not use any warm-up, it was not possible to assess the impact of this factor on injury. Those who completed a cool-down were more likely to have missed a show through injury, although this did not reach statistical significance (p=0.08).

Table 3.4 Warm-up & Cool-down participation rates and format

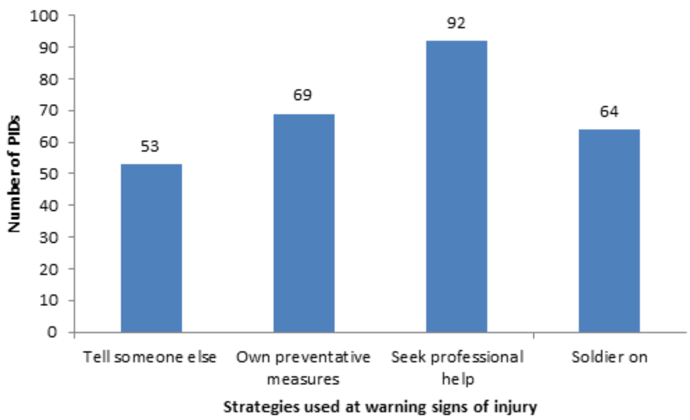
	Warm-up	Cool –down
None	2	26
Formal group	99	82
Individual	61	58
Both	4	0
Total	166	166

Cross training was utilized by a mean of 1.7 (± 1.5) PIDs. One hundred and twenty four dancers (74.7%) engaged in at least one supplemental training activity, while 42 (25.3%) undertook no cross training whatsoever. Of this latter number, 13 (31%) had no history of injury, while the remaining 29 dancers (69%) had recorded previous injury. Three of these 29 dancers had been injured multiple times, with one recording 11 injuries (the most of any respondent), and the remaining two listing seven injuries each. Among the most popular cross-training regimens were gym-based aerobic activities, Pilates, and stretch classes, which were undertaken by 42 (25.3%), 40 (24.1%) and 40 (24.1%) dancers respectively. There was no significant difference in the use of cross training between those who had and had not missed a performance as a result of injury ($p = 0.219$).

3.3.7 Response to Injury

All 137 previously injured dancers took at least one of the aforementioned steps at the warning signs of an injury. Fifty-three (38.7%) chose to tell someone else, and 69 (50.4%) took their own preventative measures. The most popular measure taken was to seek professional help, with 92 dancers (67.1%) choosing this option. There was no definition of "professional help" provided, but availability of a range of medical and ancillary support services was established, and is discussed below. Sixty-four dancers (46.7%) opted to soldier on with their injury (Figure 3.3). Seventeen took all four steps, with 60 dancers opting for only one preventative strategy.

Figure 3.3 Strategies employed by professional Irish dancers in response to the warning signs of injury.

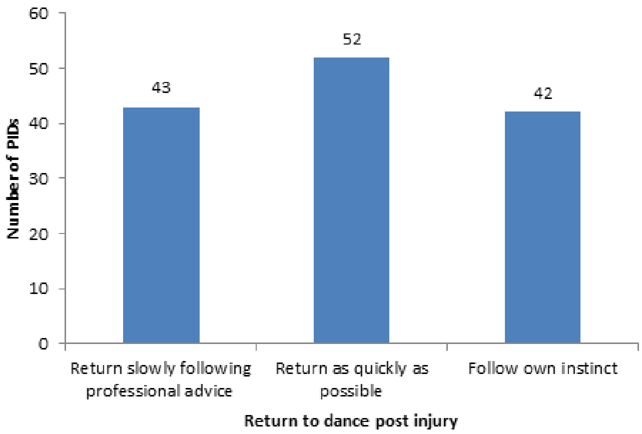


The most popular treatment employed to prevent and manage injury was massage, used by 137 PIDs (83.0%). Stretching was favoured by 117 (70.1%), and 105 (62.9%) used the services of a physiotherapist. One hundred and forty (83.8%) of the dancers had access to a massage therapist, and almost three quarters (74%) to physiotherapy. Only one respondent reported the availability of a counsellor or a podiatrist. Twenty dancers (12.0%) had no support services at all available on tour. No data were collected on the frequency of service usage by PIDs.

Various forms of cryotherapy, including ice packs, sprays, and ice buckets were used by 102 (61.1%), 14 (8.4%) and six (3.6%) PIDs respectively. There was also relatively high use of anti-inflammatory medication and painkillers, which were taken by 49.1% (82) and 43.7% (73) of all dancers. No data regarding the type or administration of medications were collected.

Regarding return to dance post-injury, there was a relatively even split in responses, with 43 (31.4%), 52 (38.0%) and 42 (30.6%) PIDs opting to take it slowly following professional advice, return as quickly as possible, or follow their own instinct, respectively (Figure 3.4).

Figure 3.4 Strategies employed by professional Irish dancers to judge speed of returning to dance post injury.



3.4 Discussion

Professional Irish dancing is a relatively new phenomenon, as yet less than two decades old. Hence, the research regarding pain and injury in this cohort is extremely limited. The current study recorded an injury rate of 77% among the PIDs surveyed. Comparison with injury rates in other dance forms is problematic due to the heterogeneity, or indeed absence, of a standardized definition of injury. This was reflected in a 2008 systematic review of musculoskeletal pain and injury in dancers that reported levels among various genres ranging from 3% to 95% (Hincapié et al. 2008). However, a recent update of this review has found that researchers in this field are now employing a specific definition of injury more consistently (Jacobs et al. 2012).

A 2009 national survey of a heterogeneous cohort of professional and student dancers by Dance UK reported an injury rate of 80% (Thomas and Tarr 2009). Injury in modern, theatrical, and classical dance has been found to range from 67% to 95% (Bronner et al. 2003b). A rate of 74% was reported among a heterogeneous cohort of university and professional ballet, contemporary and theatre dancers (Chmelar et al. 1987), which is in line with the current findings. Seventy-six per cent of professional ballet dancers in a Norwegian company reported injury, with a career prevalence of 3.2 injuries per dancer (Byhring and Bø 2002). This compares to a prevalence of 2.25 injuries per career for each dancer in the current study.

Pain in dancers is an equally elusive quality, due to the complex interplay of subjective psychological and physical components (Anderson and Hanrahan 2008). Andersen and Hanrahan proposed a distinction between performance pain and injury pain, with the former described as acute, of short duration, and under the voluntary control of the dancer. Comparatively, injury pain is a more negative sensation that can precipitate self-protection and reduced confidence. These authors found that dancers were more likely to continue dancing when experiencing performance pain as opposed to injury pain. Elsewhere, dealing with pain has been found in 78% of a mixed cohort of professional and amateur dancers from a variety of traditions (Thomas and Tarr 2009). This contrasts with the current study, where less than 2% of PIDs reported dancing pain-free. This finding is weakened, however, by the lack of a precise definition of pain in the current study.

Most injuries in this cohort were minor in nature, requiring a week or less to resolve. Similar findings were reported among Norwegian professional ballet dancers (Byhring and Bø 2002), where 40% of injuries required less than seven days absence from performance. Another study reported that almost 50% of a large cohort of professional modern and ballet dancers incurred a musculoskeletal injury requiring between one and six days to resolve (Koutedakis and Jamurtas 2004). Difficulties arise when comparing the findings of some studies due to varying definitions of injury severity. For instance, a 1997 study of Broadway dancers defined a minor injury as one which allowed the dancer to perform some parts of the choreography, while a major injury meant the dancer was entirely unable to participate in the performance (Bronner and Brownstein 1997). Similarly, 74% of injuries in a diverse group of university and professional ballet, modern, and theatrical dancers were reported to be "minor," but no uniform definition of "minor" was furnished (Hincapié et al. 2008).

This study found the foot, followed by the ankle, to be the most commonly injured anatomic structures, with lower limb injuries accounting for 75% of all injuries reported. Similarly, Bronner and colleagues found a lower limb injury rate of 57%-75% among a group of professional dancers from various dance traditions, with the ankle and foot most often affected (26%-57%) (Bronner et al. 2003b). Gamboa reported a cumulative lower limb injury rate in excess of 90% in elite pre-professional ballet dancers (Gamboa et al. 2008). Rates of foot and ankle injury in ballet of 53% (Gamboa et al. 2008), 54% (Nilsson et al. 2001), and 90.4% (Byhring and Bø 2002) have been recorded in elite cohorts. The research in contemporary and tap dance shows the foot and ankle to be affected in 34% and 37% of total injuries, respectively (Bronner et al. 2003b, Mayers et al. 2003). In both of these dance genres, foot and ankle were again the most frequently injured structures, albeit at a lower rate than in ballet. This may be explained by the greater stress through the foot and ankle in the en-pointe position common to ballet and Irish dance, but absent in most other forms of dance. In a study of 144 amateur and elite break-dancers, the foot and ankle accounted for only 10.4% of injuries (Kauther et al. 2009) (the spine and knee were the most commonly injured anatomical structures, each at 16.9%). This difference is probably accounted for by the distinctive nature of breakdance choreography.

Almost half (49%) of the injured dancers in this study suffered their most serious injury mid-way through a production run, with only 14% becoming injured during the rehearsal period. This contrasts with previous studies in ballet (Solomon et al. 1995, Solomon et al. 1999) which found the greatest incidence of injury among ballet dancers during the first third of the season (Bronner et al. 2003a). Similarly, 37% of injuries happened in the first quarter of a contemporary dance company's season. Explanations posited include difficulties transitioning from a period of relative inactivity to intense rehearsal, and the emergence of overuse injuries due to learning and practising new choreography. Possible reasons why PIDs tend to sustain injuries at mid-season may be two-fold. First, as shown previously, most PIDs identified accident and fatigue/overwork as the main underlying causes of injury. As performance becomes more automatic and mundane over the course of a tour, attentional deficit coupled with physical and psychological fatigue may leave dancers at greater risk of injury due to accident or repetitive strain. Second, with many Irish dance productions the choreography does not change greatly from year to year. Rehearsal would therefore focus on perfecting existing choreography and maximizing fitness. There are obvious exceptions, as in the case of a troupe dancer progressing to a lead role or moving to another production. However, as cited above, approximately two-thirds of surveyed dancers limited their career to either one or two productions.

Of the six dancers who experienced career ending injuries, four worked in one production only, one in three different shows, and one in five shows. It is worth noting that while most injuries in the current study did not occur in the rehearsal/early stages, this was the time when most career ending injuries were incurred. The reasons for this are unclear, and warrant further investigation.

The role of psychological stress as a factor in injury has been identified by many commentators (Jacobs et al. 2012). A number of intrinsic personality traits including heightened ambition (Hamilton et al. 1989), poor coping, and loss of confidence (Noh et al. 2005), and greater perceived levels of stress (Adam et al. 2004) have all been linked to increased injury in dancers. In a professional ballet cohort 78% of dancers reported “negative stress” related to their work (Byhring and Bø 2002). The results of the current study reflect the findings of the “Fit to Dance” inquiry (1996),(Brinson and Dick 1996) in which between 57% and 67% of professional dancers reported “tension with people” to be an issue. This is particularly representative of touring companies, where there is minimal respite from colleagues once the working day is done. Further, the current study is supported by the findings of the GSES, where dancers were seen to struggle most with situations involving interpersonal relationships. This is despite an overall GSES, 32.9, well in excess of established adult norms (previously, mean scores of 29.48 and 29.28 have been recorded in large groupings of American and German adults) (Luszczynska et al. 2005). In the current study, only one dancer identified psychological distress as a significant contributor to injury. This may indicate that although dancers are aware of various psychological stressors associated with work, they have yet to realize and appreciate the connection between those stressors and injury.

Once again, the main contributory factors to injury identified by PIDs were accident, fatigue/overuse, repetitive movements, and an unsafe floor. This study did not ask dancers to distinguish between traumatic and overuse injuries, but the identification of accident as the major factor would suggest a high incidence of traumatic injury. Forty-three per cent of injuries were caused by trauma in a group of Swedish professional ballet dancers, with the remainder being overuse in nature (Nilsson et al. 2001). A recent study of accidents among theatre dancers reported that 69.7% had a clearly defined cause, with 30.5% by props, 17.2% by the dance partner, and 12.7% by the floor (Wanke et al. 2011). Over 30% of the accidents had multi-factorial causes, including the social situation, state of training, and nutrition.

Fatigue/overuse was identified by between 57% and 61% of a mixed cohort of professional dancers in the original UK “Fit to Dance” study, making it the major cause of recorded injuries (Brinson and Dick 1996). Overuse injuries have been said to cause 60%–76% of all dance injuries (Ryan and Stephens 1987, Solomon et al. 1999, Bronner et al. 2003b). Unfamiliar stages have been reported as a risk factor in touring companies, where raked stages in particular necessitate a change in the balance strategy of dancers and can lead to injury (Evans et al. 1996, Howse and McCormack 2010). Also of note is the high rate of drug and alcohol use (24.9%) in the lifestyle of the PID, which is three-fold greater than that reported among professional ballet dancers (8%) (Brinson and Dick 1996). Other contributory factors identified in the literature include prior injury (Wiesler et al. 1996). the female athlete triad (Koutedakis and Jamurtas 2004), and insufficient warm-up (McGuinness and Doody 2006).

Regarding the reaction to warning signs of injury, the current results contrast markedly with those of the 1996 “Fit to Dance” study (Brinson and Dick 1996). In the current study, 67% of PIDs chose to seek professional treatment, in contrast to 37% of ballet/contemporary dancers. Fifty per cent of PIDs took matters into their own hands, compared to 76% of subjects in the earlier study, where difficulties accessing services and prohibitive cost of treatment were identified. A trend towards self-diagnosis and management was highlighted previously in the literature (Mainwaring et al. 1993, Krasnow et al. 1994) and is predicated on dancers' belief that practitioners are not fully conversant in the vocabulary and physicality of dance, financial limitations, and the fear of losing time to injury.

Physiotherapy was available to 63% of PIDs, in comparison with musical theatre (65%) (Kitchen 1994), ballet (78%), and contemporary (52%) dancers (Brinson and Dick 1996). The use of massage in the current study (83%) exceeds that reported by other professional dancers (46%, 30%, and 26% in ballet, contemporary, and other professional dancers, respectively) (Brinson and Dick 1996). Access to a counsellor was uniformly low in this and other studies, being negligible in the ballet cohort and 3% in the contemporary and "other professional dancer" groups (Brinson and Dick 1996). There was greater compliance with warm–up and cool-down between these PIDs and other professionals; only 77% of ballet dancers reported use of a warm-up prior to rehearsal. Rates of cool-down among the professional ballet/contemporary cohort ranged from 11% to 59%, with cool-down by ballet professionals post-performance least utilised.

The importance of cross training to prevent injury is well established in the world of sport (Finch and Owen 2001, Knapik et al. 2004). In dance, too, there is strong evidence to support this principle. Cross training was part of the primary injury prevention initiative of the Alvin Ailey modern dance company, which saw a 60% decrease in the number of days lost to injury over a 5-year period (Bronner et al. 2003a). Another study reported that a supplementary 12-week strengthening program for thigh muscles reduced fatigue and addressed strength deficits not met with traditional dance training (Koutedakis and Sharp 2004). Cross training as a tool to fend off or address chronic fatigue or burnout is also supported in the literature

(Koutedakis 2000). Professional dancers on average have been found to spend an average of eight hours per week on cross training activities (Weiss et al. 2008). Despite overall greater access to support services and compliance with warm-up, cool-down, and cross training, all of which have been linked to lower injury rates, no significant correlation could be found between these factors and PID injury rates. Detailed investigation into the intensity, duration, and elements of cross training, warm-up, and cool-down is warranted.

3.4.1 Limitations of Study

In common with other retrospective studies, this investigation is limited by errors and omissions of subject recall. As noted, the absence of a definition of "accident" and any associations with fatigue/overuse injuries and/or trauma were not established. Furthermore, the number of PIDs seeking professional evaluation, rates of service utilization, and details of medication use were not thoroughly explored. Several other important potential causes of injury not fully addressed in this study are worthy of further exploration, including age at time of injury, sleep quality, the role of footwear, several physical characteristics, and the female athlete triad. Such factors are being considered as part of an on-going prospective investigation.

3.5 Conclusion

Professional Irish dance is a new and demanding activity, but there is a marked absence of literature regarding injury and pain in this area. The current study recorded an injury rate of 76.7%, with the lower limb, particularly the foot and ankle, being most often affected. Older and more experienced dancers experienced greater levels of injury. Most injuries were minor, and occurred midway through a tour. Accident, fatigue/overuse, and repetitive movements were identified as the main causes of injury. Psychological distress was common among

PIDs, with “general anxiety” and “tension with other people” the biggest issues faced. Warm-up and cool-down were widely practised, with cross training engaged in by the majority of PIDs. Massage and physiotherapy were widely accessed by PIDs. Further investigations should focus on prospective studies of PIDs, involving physical and psychosocial elements, with a view to generating an appropriate screening process and general model to predict those at risk of injury.

CHAPTER 4: JOB SATISFACTION OF PROFESSIONAL IRISH DANCERS: IMPLICATIONS FOR PERFORMER HEALTH AND WELL-BEING.

Published: Journal of Dance Medicine and Science, Volume 17, Number 4, 2013.

Roisin Cahalan, Kieran O'Sullivan

Abstract

This study investigates for the first time whether experienced former and current professional Irish dancers (PIDs) would recommend a career in Irish dance, and their perceived positive and negative attitudes toward this occupation. One hundred and sixty-five (71 current, 94 retired) PIDs participated in an online survey. Additional focus group interviews of six current and three retired PIDs were conducted to validate survey findings. PID comments were examined independently by the two authors using thematic analysis, and then cross-indexed and coded into the most common positive and negative themes. Ninety-four percent of surveyed PIDs and 100% of focus group participants stated that they would recommend a career in professional Irish dance. The main positive attributes identified included the opportunity to travel and experience diverse cultures, the development of enduring friendships, the pursuit of a hobby as a financially lucrative career, evolving personal life skills, and the maintenance of good physical health and fitness. The main negative themes included the insecure and short-term nature of the career, physical consequences in terms of pain and injury, potentially damaging psychological consequences, and practical difficulties inherent in a touring lifestyle. The effects of dancer job satisfaction on health, wellbeing and performance are discussed, and recommendations for company managers and dance captains are developed based on findings.

4.1 Introduction

Professional Irish dancing is a novel development in the world of dance, as yet less than two decades old. Engendered by the interval act of the Eurovision Song Contest of 1994, "Riverdance" and subsequent shows such as "Lord of the Dance" and "Rhythm of the Dance" initiated an important departure in the evolution of Irish dance. Previously, Irish dancers rarely continued to perform beyond their teenage years or early twenties; thereafter involvement in Irish dance was usually restricted to teaching or adjudication. Now Irish dancers can pursue careers as professional performers into their thirties and beyond. Simultaneously, an important cultural phenomenon has emerged; for the first time Irish dance has spread beyond the native Irish and emigrant communities in Britain, North America and Australia. Currently the official registry of Irish dance teachers and adjudicators compiled by the main governing body, An Coimisiun le Rinci Gaelacha (CLRG), lists Irish dance academies in over 30 countries throughout five continents (CLRG 2012).

Despite its growing popularity research in the professional cohort is particularly scarce, with the few available studies limited to the incidence of musculoskeletal pain and injury in Irish dancers. The evidence from two retrospective studies, which were conducted in young female competitive dancers, demonstrated that lower limb injuries, especially to the foot and ankle, are most common in Irish dancers. Several factors, such as not including a warm-up or cool-down in the normal routine, not using split-shoe sneakers for training, and performing at higher competitive levels were found to be linked to increased frequency of injury (McGuinness and Doody 2006, Noon et al. 2010). There are no prior studies that have investigated the job satisfaction of professional Irish dancers (PIDs). Job satisfaction (Hoppock 1935) has been defined as

> “any combination of psychological, physiological and environmental circumstances that cause a person truthfully to say I am satisfied with my job” (Hoppock 1935, p 47).

More recently it has been defined as “a combination of positive or negative feelings that workers have towards their work” (Aziri 2011),p.77). Empirically, in professions outside of the performing arts, a complex relationship has been established between job satisfaction, workplace performance, financial remuneration, and commitment to the employer (Ahmad et al. 2010). A number of studies have found job satisfaction to correlate positively with both level of job performance (Zimmerman and Darnold 2009) and health (Faragher et al. 2005). Other research has found only a marginal relationship between pay and job satisfaction (Judge et al. 2010). Rates of absenteeism, company loyalty, and productivity have also been found to correlate positively with job satisfaction (Clark 2009). Within the performing arts there is limited research available into the subjective career experience of workers. Despite the wealth of research in professional ballet concerning the personality and psychology of elite dancers (Hamilton et al. 1989, Hamilton et al. 2006, Walker and Nordin-Bates 2010) comparatively little is known about their attitudes regarding their choice of profession, either during or post dance career.

It is acknowledged that the performing arts, particularly for those in touring companies, present unique challenges to the employee. The Strategic National Arts Alumni project undertaken recently in the United States provides useful insight into the career experience of a large cohort of performing and visual arts graduates, including dancers (SNAA 2012). In this study dancer job satisfaction was found to be the highest of all groups, with 97% of choreographers and dancers at least somewhat satisfied with their jobs (SNAA 2012). Contrastingly, job satisfaction among international orchestral musicians was found to be lower than that of federal prison guards and only slightly higher than industrial production workers (Allmendinger et al. 1996). In a similar Danish cohort job satisfaction was less than that of the Danish workforce in general (Holst et al. 2012).

Several studies have examined a number of diverse elements that may contribute to job satisfaction. The impact of interpersonal relationships, both positive and negative, has been investigated among elite ballet dancers (Wulff 1998) and a heterogeneous cohort of professional dancers, respectively (Brinson and Dick 1996). Some of the challenges and benefits particular to a touring lifestyle have previously been noted in studies of elite touring musicians (Scott 2007) and ensemble singers (Apfelstadt 2011). The gratification of instant audience feedback unique to live performance is also discussed in the literature (Laird 2003). There is plentiful research into the double-edged sword of physical fitness and injury among several genres of professional dancers (Wyon et al. 2007, Thomas and Tarr 2009, Jacobs et al. 2012). Potential for personal growth and transferable life skills, essential to positive job satisfaction, was examined extensively in a study of over 1,100 international professional dancers across multiple disciplines (Jeffri 2005). Related concerns surrounding the brevity of a dance career, educational opportunities, and successful transitioning to a career after dance have been explored in professional ballet (Jeffri 2005, Roncaglia 2006, Van Staden et al. 2009, SNAA 2012).

The current study forms part of a survey that earlier examined epidemiology, incidence and factors associated with pain and musculoskeletal injury in PIDs (Cahalan and O'Sullivan 2013a). This study reports the views of the same group of participants in the survey. Additionally, focus groups involving nine current and former PIDs were conducted to allow for a more comprehensive understanding of the themes identified. The aim of this study was to investigate the job satisfaction of former and current PIDs, whether they would recommend a career in Irish dance, and the positive and negative attributes of such a career. The findings are intended to inform practice to optimize the job satisfaction and ultimately the performance and health of Irish dancers.

4.2 Methods

4.2.1 Subjects

Study participants were current or retired PIDs, male and female, aged 18 years or older. There was no upper age limit. To qualify as a PID participants had to have spent at least eight months of a consecutive 12-month period working exclusively as a paid Irish dancer. They were required to have a good understanding and command of written English. Informed consent was obtained from all participants and ethical approval for this study was granted by the ethics committee of the local university.

As part of a larger study into pain and injury in PIDs, survey participants provided information regarding their gender, current age and dancing experience (Cahalan and O'Sullivan 2013a). Details of professional experience, including number of productions and time spent with each, were gathered. PIDs were asked to indicate if they were employed by a touring or non-touring production. One hundred and sixty-five PIDs, 103 (62.4%) female and 62 (37.6%) male, responded to this section of the questionnaire. The majority (71.5%) were between 25 and 34 years of age (see Table 4.1). Mean previous dance experience was 13.2 years (standard deviation [SD] 3.4 years). The mean age at becoming a PID was 18.5 (SD 3.0) years. Dancers spent a mean of 7.4 (SD 4.6) years employed as a PID. Throughout their career, most PIDs performed in only one (35.7%) or two (30.3%) productions (mean 2.3, SD 1.4). Sixteen PIDs (9.7%) were involved in five or more different productions. The mean length of time spent in one company was 5.1 (SD 3.0) years. One hundred and twenty-nine

PIDs (77.8%) performed in seven or more shows per week, with the remainder performing less frequently. Ninety-six dancers (58.2%) were retired, while 69 (41.8%) were still working as PIDs (Table 4.1). The mean time since retirement was 6.03 years (SD 3.7). One hundred and forty-five PIDs (87.9%) performed in a touring production, with 20 (12.1%) working in a show in permanent residence (Table 4.1).

Participants were asked whether they would recommend a professional career in Irish dance to aspiring young dancers. They were instructed to make this recommendation based on the impact of their own career on their physical and psychological wellbeing and to provide reasons for their answer. There was no limitation on the length of answer or number of reasons dancers could provide in their response.

Table 4.1 Survey group demographics: Age, gender, current career status, touring status of professional Irish dancers (PIDs), n = 165

Age	Gender		Career Status		Tour Status	
	Male	Female	Current	Retired	Touring	Non-Touring
18-20	3	6	8	0	6	3
21-24	6	6	10	1	10	2
25-29	21	39	33	28	49	11
30-34	19	39	13	46	56	2
35-39	11	9	4	16	19	1
40+	3	3	1	5	5	1
Total	**63**	**102**	**69**	**96**	**145**	**20**

Two focus groups involving nine participants provided details on their age, when they commenced working as a PID, and years spent as a PID (Table 4.2). Two of these PIDs had participated in the initial survey, seven had not. The mean age of the nine focus group PIDs, five males and four females, was 27.3 (SD 6.0) years. Six dancers were currently working as

PIDs, and three were retired. A mean career length of 8.8 (SD 6.5) years was reported. The focus groups were conducted by a single investigator using a semi-structured interview technique. Participants were invited to discuss their personal levels of job satisfaction through an exploration of positive and negative career experiences, and whether they would recommend a professional career in Irish dance to other dancers. Themes identified from the initial survey group data were introduced for discussion if not raised spontaneously by the focus group participants. Focus group responses were audio-recorded for verbatim transcription.

Table 4.2 Focus group demographics: Age, gender, current career status, number of years working as a professional Irish dancer (PID) n = 9

Subject	Age	Gender	Career Status	Years as PID
1	25	Female	Retired	10
2	31	Male	Current	15
3	27	Male	Retired	7
4	21	Female	Retired	1
5	37	Female	Current	18
6	34	Male	Current	15
7	23	Male	Current	2
8	19	Male	Current	1
9	29	Female	Current	10

4.2.2 Data Collection

Survey data were gathered by online questionnaire using "SurveyMonkey™". The questionnaires were distributed via Irish dance academies, performing productions, and the CLRG. Recipients were asked to complete the survey or forward it to other PIDs in their organization as appropriate. This method of data collection was chosen due to the diverse international spread of the target population and the associated prohibitive costs of face to face or telephone interviews required to attain a large sample group. It was felt that a larger, more representative sample could be reached in this manner.

4.2.3 Data Analysis

A bottom-up thematic analysis was conducted on data garnered from the original survey (Braun and Clarke 2006). Comments were reviewed independently by both authors and lists of themes and sub-themes developed separately. A codebook of themes and sub-themes was then decided upon collaboratively by the authors, based on a comparison of the theme lists assembled individually. Themes were listed based on the frequency of similar responses (Table 4.3).

Table 4.3 Positive & negative themes and sub-themes in order of frequency

Positive	
Theme	**Subthemes**
Global travel	Exposure to diverse cultures, international travel
Hobby/passion as a career	Thrill of performance, feedback from audience, continue dancing after competition, artistic outlet, expand dance knowledge, technique and repertoire.
Development of personal life skills	Confidence, self-belief, discipline, people skills and team-working, life experience, exposure to diverse beliefs and points of view, street smarts.
Friendships/relationships	Meeting like-minded people with similar interests
Physical Fitness	Health benefits, insight into injury management
Financial remuneration	Ability to save money
Negative	
Theme	**Subthemes**
Career insecurity	Brevity of career, limited job availability and opportunity, difficulty transitioning to career after dance, educational issues, false sense of reality
Physical strain	Short and long-term injury, lessening of support structures and education for physical health.
Psychological strain	Loneliness, homesickness, self-esteem and confidence, bullying, propensity for drug & alcohol abuse, eating disorders.
Logistical/touring difficulties	Long travel days, lessening lengths of stay in one place, access to appropriate food, exercise and laundry facilities, cultural difficulties.

A random sample of 40% of survey responses was then broken into text segments (Hruschka et al. 2004), which were coded independently by the two authors to establish inter-rater reliability. A kappa value of 0.927 ($p < 0.001$) indicated that an excellent level of inter-rater reliability was achieved (Cicchetti 1994, Miles and Huberman 1994). The remainder of the data were then coded using established themes. Upon initial review of focus group data the authors agreed to add one more theme, namely “logistical/touring difficulties,” to the existing codebook, as these issues were reported to have a substantial impact on PID wellbeing. As there was comparatively less focus group data, all responses were broken into text segments for analysis. The kappa value for the focus group data was 0.966 ($p < 0.001$).

4.3 Results

4.3.1 Career Recommendation

One hundred and eighty-nine surveys were returned, 165 of which were completed in full and included in this analysis. Due to the method of survey distribution, it was impossible to establish a response rate. One hundred and fifty-five (93.9%) PIDs were satisfied with their career choice. Ten (6.1%) stated that they would not recommend the career to a young dancer. All ten of these PIDs provided consistently negative feedback to support their recommendation. All nine focus group participants endorsed the career choice of PID. In the case of the 155 surveyed PIDs who would recommend a career in professional Irish dance, 118 (76.1%) provided uniformly positive comments, with the remaining 37 (23.9%) reporting a mix of positive and negative sentiments. Typical of this mixed type of comment is the following:

> “Touring was the best thing I ever did! It matured me, I experienced the world in a unique way, I made the best friends and had the most amazing experiences. I now have memories to last me a lifetime. There is a down side though; you have to wake up from your dreams, and getting back to reality is the hardest part of tour. I would take the injuries and the pain any day though for one more tour!” *Current, non-touring PID, aged 21-24*

Five (3%) PIDs gave non-specific reasons for their recommendations, all of which were positive. These included comments such as "amazing life" and "great opportunity," which did not allow for specific thematic categorization. One PID did not provide supporting reasons for his positive recommendation. Age, retirement status, and recommendations of surveyed PIDs are displayed in Table 4.4.

Table 4.4 Surveyed PIDs: retirement status and recommendation stratified by age

	Recommend		**Not Recommend**	
Age	**Current**	**Retired**	**Current**	**Retired**
18-20	9	0	0	0
21-24	9	1	1	1
25-29	33	25	1	1
30-34	13	42	0	3
35-39	4	14	0	2
40+	0	5	1	0
Total	**68**	**87**	**3**	**7**

A number of positive and negative themes as outlined in Table 4.3 were identified. Themes are listed in order of frequency, although the authors acknowledge that frequency does not necessarily equate to the import of themes in relation to job satisfaction. Examples of subject comments are quoted below with respect to each specific theme identified. Comments are drawn from responses of both the focus group and surveyed PIDs.

4.3.2 Positive

1. Global travel

Identified by 91 (55.2%) of the surveyed PIDs and all nine focus group participants, the most commonly cited positive comment regarded opportunities to travel and see the world. A common sub-theme was the development of an insight into unfamiliar cultures and societies:

> "An incredible experience for a young Irish dancer. A chance to experience a variety of world cultures." -*retired PID, aged 30-34*
>
> "Get to travel the world, meet different people from different parts of the world." - c*urrent PID, aged 21-24*

2. Enjoyment of pursuing a hobby as a career in performance

Among surveyed participants 32 PIDs (19.4%) expressed satisfaction at being able to pursue their hobby or passion as a professional performer. A further 14 PIDs (8.5%) identified the benefit of having an additional outlet for their passion for Irish dance after ceasing involvement in competition. A related comment made by 22 (13.3%) of the PIDs was the positive feedback received through performing for an appreciative audience. Six (66.6%) focus group PIDs identified the thrill of performance and audience feedback as a career positive. Comments regarding audience and performance were often made interchangeably, and frequently cited in tandem with the satisfaction derived from taking the art form beyond the rewards of hobby or competition.

> "There is no feeling quite like the one you have on stage. At the end of a show you have people standing up and clapping for you. In what job can you get that at the end of a working day?" -*current PID, aged 30-34*

"You get to do what you love and share your talent with people all over the world. It's worth the pain at the end of every performance when you see the smiles on the audiences' faces." -*current PID, aged 25-29*

3. Development of transferable personal life skills

A theme expressed by many of the surveyed PIDs involved personal enhancement, growth, and the development of a skill set useful outside the world of professional performance. Thirty-four PIDs (20.6%) referred to the augmented life experience garnered through their careers, with another 29 (17.7%) similarly noting their own personal growth. Enhanced team-building skills were identified by 7 PIDs (4.2%), with improved confidence and discipline specifically highlighted by 11 (6.7%) and five (3%) PIDs respectively. Growing self-awareness was also cited by five PIDs (3%). As previously, PIDs listed many of these sub-themes interchangeably. Among the focus group participants improved personal skills was not raised spontaneously; however, when asked specifically about personal development, five PIDs (55.6%) regarded enhanced interpersonal dealings as a positive aspect of the profession. One other dancer stated that he felt that he had become more than just a performer, and had evolved into a cultural ambassador for the promotion of elite Irish dance:

"(You) get a well-rounded look at life, people, places through the travelling you do and variety of personalities you meet. Learn how to deal with a wide variety of situations as you encounter a lot of different personalities and situations on tour." -*current PID, aged 25-29*

"Allows you to develop skills that enable you to work with a large team of people successfully." -*retired PID, aged 25-29*

4. Friendships/relationships

Fifty-three surveyed PIDs (32.1%) and all nine focus group PIDs identified the development of long-lasting friendships or relationships as a positive career consequence. A number of PIDs referred to establishing positive relations with like-minded individuals who shared a common interest in Irish dance:

> "…to be part of a team and foster relationships with friends - friends who remain great friends despite the distance apart now that working in a show has ended. The bonds you make with people on tour will remain for life." *-retired PID, aged 25-29*
>
> "Friendships formed (I met my husband in a show) " *-retired PID, aged 35-39*

5. Physical Fitness

The physical benefits of a professional career in Irish dance were highlighted by 34 surveyed PIDs (20.6%). These included an improved insight into the management of injury and augmented body awareness, enhanced physical appearance, and a higher level of physical fitness. Eight focus group dancers (88.9%) felt that a career in professional dance had made them fitter, healthier performers, with a better insight into management of their physical wellbeing. Several dancers in both survey and focus groups observed that PID knowledge regarding injury avoidance and the maintenance of physical fitness had improved markedly since the genesis of Irish dance shows two decades ago:

> "Helps you learn a lot about dance form and how to keep fit and improve flexibility and take care of your body in a demanding environment." *-retired PID, aged 35-39*
>
> "We've all learned to take better care of ourselves.… Watching everybody take care of themselves now, it's night and day to what it was like 18 years ago." *-current PID, aged 35*

6. Financial Remuneration

Financial benefits were cited by 20 (12.1%) of the surveyed PIDs. Many participants alluded to the fact that they were being compensated for a job that was pleasurable and inherently beneficial. While one focus group PID echoed this sentiment, another felt that PIDs were largely underpaid:

> "Amazing opportunity to travel and get paid to do what you love." -*current PID, aged 25-29*
>
> "Get paid to get fit, travel the world and perform for appreciative audiences the world over! It's amazing." -*retired PID, aged 25-29*

4.3.3 Negative Themes

1. Job insecurity & longevity

Among surveyed PIDs several inter-related issues arose with regard to the unsustainable nature of the career (n = 9: 5.5%), unpredictable availability of work (n = 4: 2.4%), and limited career opportunities in other dance forms (n = 3: 1.8%). Difficulties transitioning to a conventional lifestyle post-career, exacerbated by a false sense of reality created while working as a PID, were mentioned by ten PIDs (6.1%). Concerns regarding the educational status of young PIDs and related potential difficulties following a career in dance were also raised by six PIDs (3.6%). Focus group PIDs echoed several of these issues, including difficulty leaving the profession (n = 2), problems surrounding a lack of relevant education to draw upon in transitioning to a new career (n = 3), and the temporary nature of a career in professional dance (n = 1):

> "…dancing in a show can be a good way to earn money, make friends from around the world, and have an exciting time, but it can also be difficult transitioning to a 9-5 job which can seem dull in comparison." -*retired PID, aged 40+*

> "…make sure you get an education first, as it is much harder to settle after without one. It is a temporary career choice" -*retired PID, aged 30-34*
>
> "It's an unsteady lifestyle because there often is not work the whole year round."
> -*current PID, aged 18-20*

2. Physical Consequences

The immediate and longer term impact on the physical wellbeing of the individual, with particular reference to musculoskeletal pain and injury, was highlighted by 25 of the surveyed PIDs (15.2%). Six of the ten PIDs who stated that they would not recommend the career mentioned this issue as a major contributing factor. Poor medical support and/or advice, and declining conditions to support PID wellbeing, were also described by eight (4.8%) surveyed and two focus group PIDs (22.2%):

> "…It's so hard on your body. I danced on awful injuries.... In later years the injuries still haunt you…; the price you pay is damaging your body for good. I do feel that as a young dancer there was no real advice given to dancers to prevent injuries, not even somebody to tell us what to eat and drink to recover after and before exercise." -*retired PID, aged 30-34*
>
> "I would caution young dancers that…support structures are gradually being removed (warm-up/stretch, massage, physiotherapy, increased work and travel schedule) and extra diligence is needed to avoid injury." -*current PID, aged 25-29*

3. Psychological Consequences

Fourteen of the surveyed PIDs (9.3%) reported on the psychological challenges and difficulties inherent in the career. Interpersonal problems and stress, loneliness, bullying, and frustration and boredom associated with injury are included under this theme. Difficulties encountered by younger, more vulnerable dancers, were cited by five PIDs (3%). Increased risk of alcohol and drug abuse and the development of eating disorders were reported by three PIDs (1.8%). Missing important people and events at home, and issues around bullying, were also cited by four (44.4%) surveyed and three (33.3%) focus group PIDS, respectively:

> "You are not prepared for the psychological impacts of working and living with the same group of people for a period of 4 months or more; and young people are at the mercy of dance captains who use their authority in an inappropriate manner." *-retired PID, aged 25-29*
>
> " I just used to hate missing friends and family at home. You would get wrapped up in this big bubble. When you got back, all life had moved on. And then you were back with a show always playing catch up in real life." *-retired PID, aged 21*

4. Logistical/touring

All nine focus group PIDs objected to long travel days on buses, frequently changing location, and difficulties accessing basic needs such as laundrettes, healthy food, and exercise facilities. This was exacerbated by cultural and language difficulties when touring in unfamiliar places. Dancers stated that as companies become smaller and more mobile a greater amount of time is spent travelling between destinations, allowing for less rest and downtime to recuperate. It seems likely that this theme emerged strongly among the focus group PIDs, who were on tour at the time of interview and actively struggling with the perceived shortcomings of touring:

"The lifestyle now is much more difficult than years ago. Previously we used to stay in a venue for one or two weeks. Now you do a show and move on, so that makes our job much more difficult." -*Current PID, aged 35*

"Depending on where you are touring in the world, that can be a big thing. Food and health can be a problem, and that can impact on everything across the board." -r*etired PID, aged 37.*

4.4 Discussion

The influence of job satisfaction on a plethora of career factors and personal wellbeing has been established in many fields of industry and the commercial world (Clark 2009, Ahmad et al. 2010). However, there has been limited investigation in the world of the performing arts, and even less so in the specific sphere of professional dance. This study aimed to explore the level of job satisfaction among current and former PIDs, whether the study participants would recommend this career to aspiring young Irish dancers, and what reasons they would provide to support their recommendation. It also aimed to identify factors that enhance or detract from the health, performance, and general wellbeing of the dancer, and to make recommendations based on these insights.

Overwhelmingly the feedback regarding life as a PID was positive, from current and retired dancers of both genders and all ages. There were a slightly larger proportion of retired PIDs who did not recommend the career of a PID in comparison to current PIDs. This is perhaps to be expected, given the greater likelihood of recalcitrant physical injury and the broader experience of life outside dance available to retired PIDs. Intuitively, it seems likely that having dedicated a long time to being a PID, most participants would recommend the profession.

International travel and the experience of diverse global cultures was the most frequently cited positive aspect of a career as a PID. This was not surprising, given the youthfulness of the cohort and the fact that the vast majority of subjects were affiliated with touring productions. Travel as a window to cultural understanding has been previously acknowledged as one of the rewards of ensemble choral touring (Apfelstadt 2011) and touring as part of a ballet company (Parker 2011). Consistent with our findings, a 2003 study of youth travel reported that the main associated benefit according to participants was an increased understanding and appreciation of other cultures (Richards and Wilson 2003). It has been reported that approximately 58% of the average travel budget of youth tourism is consumed by accommodations and transportation (Moisa 2010). In the case of the PID, these costs would be borne by the employer, therefore allowing for increased disposable income and an enhanced travel experience.

However, difficulties such as loneliness and absence from important family events at home have been cited by PIDs as the price paid for extended international touring. Similar problems relating to the maintenance of family and relationship ties, in particular with regard to children and important family milestones, have been identified previously by cohorts of touring musicians and professional ballet dancers (Scott 2007, Robson 2010). Research among young ballet dancers has uncovered feelings of low self-esteem, apathy, anxiety, depression, and hopelessness (Robson 2010), all of which are likely to be exacerbated by loneliness and isolation. It is unknown if the same characteristics exist among young PIDs, but that is likely the case, given the vulnerable age profile and the fierce competition and demanding practice schedules of both cohorts. The consequences for the psychological wellbeing of the dancer are potentially devastating, and dance captains and other persons in authority must be mindful in perceiving and managing these issues, particularly among younger dancers.

A potential antidote to the aforementioned difficulties is the development of close and enduring friendships, which was a common theme reported by a large proportion of PIDs. Research has found that despite the competitive nature of professional ballet, bonds of friendship forged between fellow artists can be as strong as those of family members (Wulff 1998). Three factors, namely proximity, consistency, and self-disclosure, have been identified as the main characteristics underpinning the formation of enduring friendships (Glover 2009). It is easy to see how a prolonged tour—living, travelling, and working in close proximity with a limited number of individuals—would provide an ideal setting for the creation of such friendships. Many of the PIDs stated that having a shared passion for Irish dance was also helpful in this regard, a theme that is generally reflected in the literature of psychology (Karbo 2006). It might be helpful if senior dancers were encouraged to use this shared emotional attachment to ameliorate the problems of loneliness and anxiety in new, at-risk performers.

Contrastingly, a number of PIDs identified interpersonal difficulties as a negative career consequence. These comments reflect the findings of the 2006 "Fit to Dance" inquiry (Brinson and Dick 1996) in which between 57% and 67% of professional dancers reported tension with people to be an issue. This is particularly representative of touring companies, where there is minimal respite from colleagues once the working day is done. Similarly, our recent study into psychological problems experienced by PIDs found the main difficulties to be tension with people, followed by stress due to external factors, and general anxiety (Cahalan and O'Sullivan 2013a). There was also a significant correlation between the number of psychological problems reported when the dancer was injured and the total number of career injuries sustained (Cahalan and O'Sullivan 2013a). Management of these issues is a delicate matter, and not always appropriate for involvement by a third party. However, monitoring for potentially destructive behaviours such as bullying or intimidation, which have been found to reduce job-satisfaction and increase depression and anxiety, is to be encouraged (Quine 1999). Research in industry has found that the establishment of support structures to deal with interpersonal conflict can have benefits for both employers and staff (Quine 1999).

As with interpersonal relationships, the physical impact of a career in dance appears to be a double-edged sword. For the majority of PIDs in this study, dancing professionally was an agreeable, healthy experience, with positive implications for physical fitness and appearance. There is no information currently available on the cardiovascular fitness or strength of PIDs. However, research into elite ballet dancers has found them to have aerobic fitness levels similar to non-endurance athletes, with variability between corps and solo dancers (Wyon et al. 2007). A systematic review of the body composition of female ballet, contemporary and flamenco dancers found that dancers generally fall well below age-matched norms for percentage body fat, with professionals having lower body fat levels than their amateur contemporaries (Wilmerding et al. 2005).

Even for those 25 PIDs who acknowledged the risk of injury and the strenuous nature of Irish dance, the majority (19) remained favourably disposed toward their career. However, for six PIDs the impact of pain and musculoskeletal injury was sufficiently debilitating to cause them not to recommend the career to aspiring dancers. Our recent study into pain and injury in PIDs reported an injury rate of 76.6%, mainly to the lower limb, with most resolving within one week (Cahalan and O'Sullivan 2013a). This was comparable to a 2009 national survey of a heterogeneous cohort of professional and student dancers by Dance UK that reported an injury rate of 80% (Thomas and Tarr 2009). Measures found to reduce injury rates included warm-up and cool-down (McGuinness and Doody 2006), cross-training (Bronner et al. 2003a), access to support services (Weerapong et al. 2005), and sufficient rest days (Orlando et al. 2011) uniformly employed by dance companies. While it is encouraging that the PIDs in our current study report improved injury awareness and management in comparison to when professional Irish dance began less than two decades ago, it is troubling that they also complain of less down–time and more performances than previously, with long travel days on buses, and less access to professional injury support.

A further consequence of touring in unfamiliar places was difficulty accessing healthy food and the requirements of day-to-day life. The impact of poor nutrition on dancer health is of particular importance given the high energy expenditure inherent in elite dance and the increased risk of eating disorders in this cohort (Koutedakis and Jamurtas 2004, Ringham et al. 2006). Studies have found eating disorders to be significantly more prevalent in elite athletes generally than in controls (Sundgot-Borgen and Torstveit 2004), with levels of pathology as high as 83% reported in elite ballet dancers (Ringham et al. 2006). The associated phenomenon of the female athlete triad has been well documented in elite dancers (Koutedakis and Jamurtas 2004). In a recent study of 22 elite ballet dancers, 18% had one component, 45% had two components, and 18% had all three components of the triad (Hoch et al. 2009). In one small study of 16 professional ballet dancers, binge alcohol drinking was reported in a third of male dancers, with 25% of dancers using illegal drugs to enhance performance (Sekulic et al. 2010). This equates well with our research, which found overuse of drugs and alcohol in 24.9% of PIDs (Cahalan and O'Sullivan 2013a). Dance captains, choreographers, and others in authority should consider ways to recognize and deal effectively with any of the aforementioned problems. Education, counselling, and practical measures such as locating appropriate food outlets in advance of arriving in a new city would all be beneficial.

A popular theme alluded to by PIDs was their passion for Irish dance and the joy of doing something they loved. This theme has been echoed in professional ballet, where performing is perceived as a vocation as opposed to a job or occupation (Wainwright and Turner 2006). A related factor was the instant gratification from an appreciative audience. In ballet, the immediate positive feedback of rapturous applause has been found to be highly addictive, engendering self-confidence and elevated ego (Laird 2003). It has been identified as one of the main reasons many dancers find it difficult to transition to "normal life" after a career in dance (Laird 2003). In a study of older retired and active performing artists, passion was found to be associated with continued and active participation in one's chosen field (Mullen et al. 2012).

The passion for dance has been defined as either harmonious or obsessive, with diverse potential outcomes (Rip et al. 2006). In a study of 81 student dancers, those exhibiting a harmonious passion for dance incurred fewer acute injuries and employed better health and injury prevention practises. Conversely, those performers with an obsessive passion for dance were more prone to chronic injury, as they were less likely to seek help or take time off from dance to recover from injury. In the current study many PIDs acknowledged the intrinsic physical challenges of Irish dance, but stated that once appropriate care was taken they were able to continue to indulge their passion for dance. However, one dancer who did not endorse the career of a PID stated that she had continued to dance through severe injury and not sought professional help in time, perhaps displaying the obsessive passion for dance so detrimental to a long, healthy career. Persons of authority, including medical staff, need to be aware of those dancers who are continuing to perform with injuries that may have short- and long-term adverse consequences for their health. Such dancers should be reassured that allowing appropriate time to recuperate from injuries will improve their well-being, performance, and ultimately career longevity. The findings of this study suggest that among a number of professional Irish dance companies there is a gradual erosion of appropriate medical support services, in addition to a cultural ethos that pressures dancers to return to performance while still injured. Both these factors pose a threat to the creation of an optimally healthy environment for dancers, and are sources of concern.

The area of financial compensation in the arts is a thorny issue for dancers, who are the lowest paid group of all professional artists (Jeffri 2005). Financial fragility, coupled with the inherent job insecurity of the profession, is a major concern for many in the performing arts. No data were collected on wage levels in the current study. Interestingly, only one PID reported dissatisfaction with the level of remuneration, while 20 dancers were positive about the sal aries they received. However, it is unclear if dancers were satisfied with the wage itself, or simply that it was a bonus to be paid to do something they loved. PIDs are currently not unionized, and there is no information available about industry standards of pay. Although challenging, this is an area that should be addressed in order to protect dancers from exploitation.

The reported personal evolution and development of transferable life skills in dancers is a finding that has been evidenced in previous studies. Since initial research into the personality of creative individuals began in 1965 (Mackinnon 1965), a relatively stable set of traits in performers has been identified. When compared to ballet professionals contemporary/modern dancers exhibit more willingness to break with conventional or traditional modes of thinking, are less conscientious, score higher on neurosis, and are more open to experience (Fink and Woschnjak 2011). A study of over 1,100 professional dancers across multiple disciplines and nationalities found that they developed a number of significant transferable life skills over the course of their careers (Jeffri 2005). These included stamina, team orientation, and self-discipline, themes echoed by the PIDs in the current study. Many of the PIDs in this study reported an evolving sense of self- confidence and an ability to deal with a variety of situations. Personality has been found to change throughout the life span, most notably in youth and later years, with change partly attributable to social demands and experiences (Specht et al. 2011). In contrast to ballet, where many dancers enter pre-professional academies in their early adolescence, PIDs are generally not exposed to a comparable hothouse environment until the late teenage years or early 20s, when they enter a professional dance company. Therefore, it is to be expected that this significant change in their environment would predispose them to personality changes at that time.

Careers in professional dance are generally brief, with many dancers ceasing to perform after their mid to late 30s (Jeffri 2005). Despite the opportunities a career change after dance may present for new and positive social and lifestyle development, studies have found that retiring dancers rarely recognize this potential (Roncaglia 2006). Instead, the transition is perceived as challenging, with associated physical and emotional problems, including loss of income, status, and support networks (Jeffri 2005). Post-performance careers appear to vary internationally. Approximately one-third of Australian and American former dancers work outside of dance and the arts, in comparison to 16.3% of Swiss dancers (Jeffri 2005). The post-dance career data for retired PIDs in the current study were not collected, which would be an area for future study.

A paucity of educational experience outside of dance has been identified as placing performers at a disadvantage when seeking work in the larger labour market (Hamilton et al. 2002). In the current study completion of higher-level education was emphasized by several PIDs as desirable to smooth the transition to a career after dance. In the aforementioned international study (Jeffri 2005), only 30% of professional dancers held a bachelor's degree despite the enormous investment made in education throughout their careers. The educational status of PIDs in this study was not recorded, and is another subject that warrants further investigation. Opportunities exist at a number of levels to ensure that the trauma of career transition for dancers is eased. Many professional Irish dance companies have a minimum age of 16 years at which dancers may join. However, at that age many adolescents would not have completed a second level/high school education, and dance companies are currently under no obligation to provide any form of mainstream education. Unlike many professional ballet and contemporary companies where on-going education is provided in tandem with dance instruction (EuroFIA 2011), Irish dance does not have any such convention. The PIDs in this study emphasize the importance of having a good education, preferably to undergraduate level, prior to starting work as a PID. This places the onus not only on dance companies but also dance teachers and parents to consider when it is best for a child to start work as a PID. Mature PIDs should also be educated about planning for a new career after retirement and maximizing the transferable life skills developed on tour. Although many programs to support career transition for professional ballet and contemporary dancers are widely available across Europe (EuroFIA 2011), there is currently no provision for this in professional Irish dance.

Many of the positive aspects of life as a PID — international travel, enduring friendships, audience gratification, physical fitness, etc.—may be considered to develop organically. Others, such as good nutrition, injury management, and preparation for life after dance, should be nurtured and supported by senior company members. These individuals should be suitably educated and supported by professional staff where appropriate. In this way job satisfaction, and ultimately the health, wellbeing, and performance of the dancer will be maximized. As discussed, professional Irish dance lags somewhat behind other more established dance forms in a number of these areas, particularly education and career transitioning. It is also a concern that a number of matters beyond the control of the dancer, such as medical support, financial remuneration, and general touring conditions, are perceived by some PIDs as being in decline.

4.4.1 Limitations

This study has a number of limitations. As stated, the response rate is unknown due to the method of survey distribution, and thus it is unclear to what extent the results are representative of PIDs generally. The responses of surveyed participants are based on one open-ended question; a larger, more structured questionnaire might have provided more explicit detail and should be considered in any future study. Although a number of focus groups were conducted, a more in-depth probing of the issues raised would strengthen findings. It is also acknowledged that the frequency with which themes were cited does not necessarily equate to their importance. In addition, the reasons for PID retirement were not sought from those dancers no longer performing. Data regarding wage levels and educational status of PIDs would also have been useful to inform the results of the study.

4.5 Conclusion

Professional Irish dance is a relatively new development with a paucity of investigation into the career experience of the PID. This study found a high level of job satisfaction in a cohort of 174 current and retired adult PIDs. The overwhelming majority of these participants stated that they would recommend the career of a PID to an aspiring young Irish dancer. The main themes reported by PIDs in favour of a career in Irish dance included world travel and cultural exposure, enduring personal relationships, the transition of a hobby to performance producing audience appreciation, personal development and life experience, physical health, and financial benefits. Negative themes concerned difficulties regarding career longevity, security and development, physical and psychological problems, and logistical and practical issues associated with life on the road. Persons of authority, including company managers, dance captains, choreographers, and parents need to be aware of difficulties in relation to psychological well-being, interpersonal tensions, nutrition, and injury prevention and management. There may also be a need for support structures to assist PIDs in dealing with career transitions and deficits in education prior to retirement.

CHAPTER 5: A CROSS-SECTIONAL STUDY OF ELITE ADULT IRISH DANCERS: BIOPSYCHOSOCIAL TRAITS, PAIN & INJURY

In print: Journal of Dance Medicine and Science, July 2014

Roisin Cahalan, Dr. Helen Purtill, PhD, Prof. Peter O'Sullivan, PhD, Dr. Kieran O' Sullivan, PhD

Abstract

Despite its growing popularity, scant research exists concerning musculoskeletal pain and injury in Irish dancing (ID). This study aimed to record the biopsychosocial characteristics of elite adult Irish dancers, and to investigate potential relationships between these characteristics and musculoskeletal pain and injury. One hundred and four professional Irish dancers, elite competitive Irish dancers, and dancers in full time education studying ID completed a questionnaire providing data on dance and activity levels, physical and psychological health, and pain and injury history. Of these subjects 84 underwent 1) a physical screening of lower limb flexibility, balance and endurance, 2) a number of functional tests, and 3) anthropometric and biomechanical/anatomical assessments. Subjects were divided into "significantly injured (SI)" and "not significantly injured (NSI)" categories based on the severity and impact of self–reported pain and injury. Thirty-three (31.7%) subjects were classified as SI and 71 (68.3%) as NSI. The factors significantly associated with being SI were female sex (p=0.036), higher number of subjective general health (p=0.001) and psychological (p=0.036) complaints, low mood (p=0.01), heightened catastrophising (p=0.047), and failure always to complete a warm-up (p=0.006). A self-reported injury rate of 76.9% over the previous five years was reported. The mean number of injuries sustained to all body parts over the previous five years was 1.49, with a mean of 126.1 days lost annually to injury. Foot and ankle injuries were most prevalent. It was concluded that there is a significant level of musculoskeletal pain and injury in elite adult ID.

A complex combination of biopsychosocial factors appears to be associated with pain and injury.

5.1 Introduction

Irish Dancing (ID) is a highly athletic and technically demanding art form practised by growing numbers internationally (Tregouet and Merland 2013). The genesis of elite adult ID is attributed to renowned international productions such as "Riverdance" which has led to the emergence of the professional Irish dancer. Similarly, for the competitive Irish dancer, increasingly challenging choreography is placing unprecedented demands on the physical and aesthetic resources of the performer. ID predisposes the dancer to preferentially select one lower limb for weight bearing consistently over the other (Cromie et al. 2007). Biomechanical modelling has estimated that certain ID steps generate contact forces of up to 14 times body weight at the ankle joint (Shippen and May 2010). Research has identified that significant plantar forces are sustained by ID shoes, particularly around the vulnerable forefoot region (Tregouet and Merland 2013). A retrospective electronic survey of 178 professional Irish dancers reported an injury rate of 76.6%, with lower limb injuries accounting for 74.7% of the total (Cahalan and O'Sullivan 2013a). The main factors perceived to contribute to injury in that study were accidents, fatigue/overwork, repetitive movements, and unsuitable floor surfaces (Cahalan and O'Sullivan 2013a). Another study of young competitive Irish dancers found that lower limb injuries, especially stress fractures and soft tissue pathologies in the foot and ankle, were most frequent (Cahalan and O'Sullivan 2013c). That research indicated that foregoing a warm-up or cool-down, not using split-shoe sneakers for training, and performing at higher competitive levels, were potentially linked to increased injury frequency (Cahalan and O'Sullivan 2013c).

Amongst an elite population of heterogeneous dance forms, studies have identified many similar risk factors for injury, with comparable injury rates being reported, particularly in ballet and contemporary dance (Jacobs et al. 2012). Psychological difficulties such as stress, anxiety and work dissatisfaction which have also been identified as risk factors for injury in dancers (Jacobs et al. 2012) have yet to be investigated in ID. The significant level of injury sustained across multiple dance traditions prompted the International Association for Dance Medicine & Science (IADMS) (Liederbach et al. 2012) to provide guidelines for standardised, evidence-based injury surveillance and screening. These guidelines cite the dual aim of identifying dancers at risk for injury as well as collecting healthy baseline data on specific dancer populations. Substantial research in ballet and modern dance has produced robust physical and psychosocial dancer profiles in both elite and amateur cohorts (Liederbach et al. 2012). No such profiles have been developed in ID to date.

There is a limited but growing body of literature examining pain and injury in an ID cohort. Much of it however relies on clinic data such as retrospective medical charts, which could not determine overall rates or underlying causes of injuries recorded (Noon et al. 2010, Stein et al. 2013). Factors including psychological health (Cumming and Duda 2012) and physical attributes (Russell 2013), both of which have been shown to impact upon rates of injury in other forms of dance, have been poorly investigated in ID. In ballet, negative life stressors such as worry and poor confidence in one's dance ability are shown to increase a performer's susceptibility to injury (Noh et al. 2005). Paradoxically, appropriate coping strategies (Noh et al. 2007) and strong social support (Hamilton et al. 1989) have been found to provide a buffer against lost time due to injury. Low levels of muscle strength and power (Koutedakis et al. 2005) in addition to poor cardiovascular fitness and endurance (Angioi et al. 2009) have also been found to be predictive of injury in dance. Joint hypermobility syndrome places dancers at a greater risk for pain and injury than their peers with generalised joint hypermobility (GJH),(Ruemper and Watkins 2012) and recent research suggests a trend linking rearfoot pronation and lower limb injury in dancers (Cimelli and Curran 2012).

This study builds upon previous research by examining unexplored biospsychosocial features of Irish dancers. The main objectives of this study, which forms part of a larger prospective investigation into risk factors for pain and injury in ID, were to collect baseline data on the biopsychosocial characteristics of elite adult Irish dancers and to investigate any relationships between these characteristics and incidence of musculoskeletal pain and injury.

5.2 Methods

5.2.1 Subjects

The study cohort was composed of professional Irish dancers, elite competitive Irish dancers, and student Irish dancers in full-time university education studying ID. Subjects of both sexes, aged 18 years or older were invited to participate. Recruitment was facilitated through the contacts of the first author through her background as an ID teacher and former professional Irish dancer. Ultimately, dancers from twelve countries including Ireland participated in the study. Written informed consent was obtained from all subjects and ethical approval was granted by the research committee of the local university.

One hundred and four subjects completed a questionnaire of whom 84 also underwent a physical assessment using portable equipment at multiple locations in Ireland. Of the 104 dancers, 36(34.6%) were professionals, 28(26.9%) were students and the remaining 40(38.5%) were competitive dancers. Where dancers were involved at more than one level, for instance both a competitive and student dancer, they were instructed to list the category representing a greater proportion of time spent dancing. The physical screening was completed by 23(27.4%) professional, 28(33.3%) student, and 33(39.3%) competitive dancers. The mean ages of the 74(71.2%) female and 30(28.8%) male dancers were 21.2(±3.1) years and 23.0(±4.0) years respectively. The three groups were significantly

($p<0.05$) different from each other in terms of age ($p<0.001$), male/female composition ($p=<0.002$) and years of dancing experience ($p<0.001$) (Table 5.1). These demographics are summarized in Table 5.1 (the 1:1 male:female ratio in the professional group reflects the greater number of male dancers required proportionately in performance dancing relative to males at the other levels of ID).

Table 5.1. **Differences between dance groups and descriptive statistics as means ±SD, %, or median (Interquartile range)**

	Professional	Student	Competitive	p Value
	(n=36)	**(n=28)**	**(n=40)**	
%Female/ %Male	50/50	85.7/14.3	80/20	0.002 *
Age [a,b]	23 (21, 27.5)	20 (19,22)	20 (18.5, 20)	<0.001†
	(n=34)	**(n=29)**	**(n=39)**	
Years Dancing [a,b]	17.51 ± 5.61	13.75 ± 5.31	13.00 ± 3.79	<0.001‡

* χ^2 test, † Kruskal-Wallis Test ([a] significant between Professional and Competitive groups, [b] significant between Professional and Student groups), ‡ ANOVA ([a] significant between Professional and Competitive groups, [b] significant between Professional and Student groups)

5.2.2 Data Collection: Questionnaire

Dance and Activity Levels

Data collected included hours of practice, frequency of warm-up and cool-down, footwear worn, type of stage or practice floor normally available, and type/frequency of any cross-training undertaken. Warm-up was divided into those who did or did not always complete a warm-up.

Physical and Psychological Health

Subjects provided baseline demographic data, details of any general subjective health complaints (Tschudi-Madsen et al. 2011), any medication taken, smoking status and levels of drug/alcohol consumption. Any psychological issues experienced by subjects in the preceding month were selected from a list of common psychological ailments (Brinson and Dick 1996). These complaints included episodes of general anxiety, tension with people, performance anxiety, depression, externally mediated stress such as home-sickness, overuse of drugs/alcohol, disordered eating, issues of self-confidence, difficulties concentrating during performance/rehearsal, and sleep problems. Female subjects provided data on the onset and frequency of their menses and recorded any pregnancy in the previous twelve months. Sleep quality and quantity in the prior month was recorded (Auvinen et al. 2010).

A selection of valid and reliable psychometric tools was used to examine a number of psychosocial issues. These included the Catastrophising subscale of the Coping Strategies Questionnaire (CSQ), which assesses the frequency of patients' use of pain coping strategies (Rosenstiel and Keefe 1983). Three subscales of the Profile of Moods State (POMS), namely tension-anxiety, anger-hostility and confusion-bewilderment were completed (McNair et al. 1971) as were the stress subscale of the Depression Anxiety Stress Scale (Lovibond and Lovibond 1995) and the Athletic Coping Skills Inventory-28 (ACSI-28)(Smith et al. 1995) which examines coping and self-efficacy under seven domains. The risk of eating disorders was analysed using the Sick, Control, One stone, Fat, Food (SCOFF) questionnaire (Morgan et al. 1999).

Pain and Injury

Subjects were asked to report any pains or injuries which had caused absence from dancing for more than one week over the previous five years (Van Mechelen et al. 1992). Using the Standardised Nordic Questionnaire (SNQ) (Dickinson et al. 1992) subjects identified any body parts where they had experienced physical difficulties over the previous year. Difficulty was defined as any aches, pains, discomfort, numbness or tingling which had affected their normal activity or changed their daily routine for more than one day. For the most troublesome body area the perceived cause of injury, related diagnosis if known and number of days of performance/rehearsal consequently missed over the previous five years were collected. Subjects were asked how often they danced in pain, how often they experienced pain generally, and how bothersome that pain had been over the previous month (Dunn and Croft 2005). They were also asked to specify if any of a range of psychological difficulties were present at the time of their most severe injury (Brinson and Dick 1996). Under a "time-loss" description of injury, minor injuries were defined as requiring up to seven days to resolve, moderate injuries between eight and 21 days, with severe injuries taking longer than 21 days to resolve (Van Mechelen et al. 1992).

5.2.3 Data Collection: Physical Screening

Based on IADMS recommendations (Liederbach et al. 2012) with amendments reflecting the specificities of ID, testing was performed by qualified physiotherapists always in the same order (Table 5.2). To minimise bias, a coin toss decided which lower limb would be assessed first. Consecutive subjects commenced testing on opposite legs to previous subjects. In all screening elements where active performance was required, this was demonstrated and subjects were allowed a consistent, predetermined amount of practice for familiarisation. All screening elements were conducted in the same order for each participant to ensure uniformity.

Table 5.2 Test elements of physical screening protocol

Test Element	**Outcome Measure**	**Procedure**
Anthropometric Measures	Body Mass Index (BMI) (kg/m^2) Waist: Hip Ratio	Height and weight, and waist and hip measures were taken to calculate BMI and waist:hip ratios respectively (Ljung et al. 2012).
Tissue Sensitivity	Pain Pressure Threshold (lbs)	Upper trapezius (UTr) and tibialis anterior (TA) muscles tested bilaterally using a calibrated handheld digital algometer (J-Tech Commander). An overall PPT score was calculated from the mean value of the four locations.
Gastrocnemius flexibility	Active ankle dorsiflexion (°)	Measured with knee extended using a handheld goniometer. The mean value of two trials was recorded.
Hamstring flexibility	Active hip flexion (°)	Measured with a Speedflexer^{TM} device – subjects required to actively sustain a maximal straight leg raise for three seconds bilaterally. The subject was supine with the contralateral hip and knee. The mean value of two trials was recorded.
Subtalar pronation	Navicular drop (mm)	The distance between the floor and the navicular tuberosity was compared in a seated, unloaded foot position and a loaded, standing foot position using an index card demarcated in millimetres (Charlesworth and Johansen 2010).
Balance	Star excursion balance test (SEBT) postero-medial axis (Hertel et al. 2006).	The mean of three trials was recorded with results normalised to leg length measured in standing from the iliac crest to the medial malleolus (Gribble and Hertel 2003).
General joint hypermobility (GJH)	Beighton Hypermobility Score (BHS)	The 9-point BHS - scores of four or more are considered to indicate GJH (Beighton et al. 2012).
Cardiovascular fitness and endurance	Speed, Power, Agility, Reaction and Quickness (SPARQ) rating system (TopEndSports 2013). Percentage of maximum heart rate (% HRmax)	Dancers were required to repeatedly jump over a 12 inch soft hurdle with both feet and land on both feet on the other side of the hurdle for 30 seconds. Number of jumps, resting heart rate, heart rate immediately following the test and 30 seconds following the test were also recorded using a finger pulse-oximeter (Nonin Onyx^{TM}). %HRmax was calculated based on 208- (subject age*0.7) (Tanaka et al. 2001).
Functional tests	Functional Movement Screen (FMS)	Deep squat and bilateral in-line lunge test elements of the FMS were used to identify any lower limb range limitations and side to side movement asymmetries (Cook 2003). The best attempt of three trials was recorded. A maximal score of three was attainable in each test (range 0-9).

Lower limb power	Vertical leap (cm)	The difference between the maximum height reached during a double-footed countermovement jump and standing reach height (Wikstrom et al. 2007). Standing reach was measured with subjects' preferred arm elongated against a wall-mounted tape measure with feet flat on the ground. The best score of three trials was recorded.

Hrs= hours, kg/m^2 = kilograms per square metre, lbs = pounds, mm = millimetres, ° = degrees, %LL = percentage of leg length, cm = centimetres, yrs = years

5.2.4 Pain and injury Group stratification

Subjects were stratified into two groups based on the severity and impact of their pain and injury. Two criteria were used to discriminate between these groups – (i) the number of performance/rehearsal days the dancer missed due to pain/injury, and (ii) how severe their pain was. Pain severity was dichotomised into severe and less severe categories based on existing literature (Dunn and Croft 2005, Damush et al. 2008, Shega et al. 2010) with dancers who experienced pain when dancing often/always, who reported everyday pain at least several times a week, and reported their pain was at least moderately bothersome, classified as "severe" (Dunn and Croft 2005, Damush et al. 2008, Shega et al. 2010). Participants were identified as significantly injured (SI) if the dancer missed at least one day from performance/rehearsal due to their injury AND were categorised as "severe" in at least two of the three pain criteria. Those who did not meet the above criteria were classified as not significantly injured (NSI).

5.2.5 Statistical analyses

Descriptive statistics are reported using mean ± standard deviation (SD) for symmetrically distributed variables, median (interquartile range) for skewed variables and percentage for categorical variables. The distributions of all numeric variables were assessed for skewness using formal tests and through visual inspection of histograms. Differences in demographic, psychosocial and physical variables between SI and NSI subjects were tested using the independent samples t-test, the Mann-Whitney U test for skewed variables and the χ^2 test of independence for categorical variables. A significance level of 0.05 was used throughout the between group analyses. A classification tree, using the Chi-squared Automatic Interaction Detector (CHAID) method, was constructed to identify risk factors jointly associated with being in the SI group from those variables found to be significant in the between group analyses. The CHAID algorithm assessed the statistical significance of the bivariate association between each variable and the dichotomous outcome measure – SI. The algorithm identified the variable with the most statistically significant value of χ^2 and the sample was partitioned according to the values of that variable. The procedure was then repeated for each of the sample partitions creating a tree structure with parent and child nodes. The minimum sample sizes for parent and child nodes were set to be 10 and 5 respectively. The percentage of correctly classified cases in both the SI and NSI groups was used as a measure of the success of the selected tree in discriminating between the groups and the 0.05 significance level was used as a necessary condition for variable selection.

A logistic regression model was fitted to the data to determine the variables independently associated with the SI group. A two-step approach was taken to fitting this model. Firstly, the variables found to be significant in the between group analyses were considered as potential explanatory variables. The model was then fitted using the forward selection and the model fit was assessed using the χ^2 likelihood ratio test. Statistical analyses were performed using IBM SPSS® Statistics V 20 (Armonk, New York, USA).

5.3 Results

5.3.1 Baseline data

Sex specific baseline physical data generated from the physical screening protocol and self-reported psychosocial data are presented below (Tables 5.3 & 5.4).

Table 5.3 Group comparisons of physical variables by sex, descriptive statistics as means ±SD or median (Interquartile range)

	Female (n=66)	**Male (n=18)**
Body Mass Index (kg/m^2)	22.03 ± 2.37	21.60 ± 2.53
Waist:Hip Ratio	0.76 (0.73,0.80)	0.81 (0.80,0.85)
Pain Pressure Threshold (lbs)	32.27 (25.4, 40.3)	40.23 (30.6, 52.1)
Navicular Drop (mm)	6.5 (4.5, 8.5)	8.0 (3.5, 10.0)
Functional Movement Screen Total	7 (6,8)	8 (7,8)
Hamstring Flexibility (°)	93.51 ± 9.23	83.88 ± 9.01
Gastrocnemius Flexibility (°)*	14.70 ± 4.02	14.74 ± 3.46
Balance (% LL)	90.80 ± 8.4	92.67 ± 8.67
Vertical Leap (cm) †	34.83 ± 8.69	41.72 ± 10.93
Beighton Hypermobility Scale †	2.63 ± 1.99	1.67 ± 1.81
Number of Jumps ‡	38.42 ± 9.18	47.59 ± 9.79
Percentage Max Heart Rate §	77.98 ± 6.19	76.55 ± 7.76

kg/m^2 = kilograms per square metre, lbs = pounds, mm = millimetres, ° = degrees, %LL = percentage of leg length, cm = centimetres. *female = 65, male = 17, †female =65, male = 18, ‡ female = 62, male = 17, §female = 58, male = 16

Table 5.4 Group comparisons of subjective variables by sex: Descriptive statistics as means ±SD or median (Interquartile range), categorical data also shown.

Descriptive Data		Female (n=74)	Male (n=30)
Age		20 (19,22)	22.5 (20,25)
Years dancing		14.74 ± 4.77	14.69 ± 6.33*
Number of subjective health complaints		4 (2, 7)	3 (1, 6)
Number of psychological complaints		1 (0, 2)	1 (0, 2)
Cross Training per week (hours)		4 (2, 6)	5 (2,7)
Number of body parts affected		3 (2, 4)	3 (1, 4) †
Catastrophising		6 (2, 12)	4 (2, 10)
Stress		8 (4, 14)	8 (4, 14)
Profile of Moods Scale			
Anger- hostility		2 (0,5)	2 (1,5)
Tension-anxiety		5.5 (3,9)	3.5(1,6)
Confusion -bewilderment		2 (1,5)	1.5 (0,4)
Athletic Coping Skills Inventory 28			
Coping with adversity		5.73 ± 2.71	6.27 ± 2.84
Coachability		9.86 ± 2.20 ‡	8.7 ± 2.89
Concentration		6.99 ± 2.55	7.47 ± 2.33
Confidence and achievement motivation		7.01 ± 2.44	7.80 ± 2.67
Goal setting and mental preparation		5.85 ± 2.84	6.47 ± 2.84
Peaking under pressure		4.76 ± 2.63	6.07 ± 3.35
Freedom from worry		5.82 ± 2.96	4.43 ± 2.79
Alcohol Units		5 (4, 8) §	10 (4, 20) ||
Categorical Data		**Count**	**Count**
Warm Up	Always	36	16
	Not Always	38	14
Smoking	Yes	10	4
	Previously, not now	5	1
	No	59	24
SCOFF	At risk	13	4
	Not at risk	61	25
Sleep quality	Insufficient	37	6
	Moderate	36	23
	Sufficient	1	1
Previous injury ¶	Yes	25	8
	No	41	19
Dance in pain	Less severe	46	24
	Severe	28	6
General everyday pain	Less severe	38	11
	Severe	36	19

Bothersomeness of pain #	Less severe	36	19
	Severe	37	11
General health	Very good/Good	59	29
	Neither/Poor/Very Poor	15	1
Energy	Very much/Quite a lot	54	23
	Some/Little/none	20	7

. * n =27, † n = 29, ‡ n =73 , § n = 46, | |n= 22, ¶female= 66, male =27, # female = 73, male = 30. Profile of Moods scale composed of tension-anxiety, anger-hostility and confusion-bewilderment subscales.

5.3.2 Pain and Injury Data

Pain data were dichotomised into severe and less severe categories as described previously (Dunn and Croft 2005, Damush et al. 2008, Shega et al. 2010). When pain severity was considered in conjunction with days lost to injury, 33 (31.7%) subjects were classified as SI, with the remaining 71 (68.3%) subjects falling into the NSI category. Twenty eight (37.8%) female and five (16.7%) male subjects met the criteria for the SI category. The mean(SD) number of injuries sustained to all body parts over the previous five years was 1.49(1.2) with a mean(SD) of 126.1(193.3) days lost to injury over that period. The mean(SD) number of days lost to injury over the previous five year period due to the most troublesome body area was 82.5(139.5) days. Under the aforementioned "time-loss" definition of injury (Van Mechelen et al. 1992), 24 (23.1%) subjects were uninjured during the previous five years. The remaining 80 (76.9%) subjects incurred a total of 153 injuries over that period. 24(15.7%) were minor, 42(27.4%) were moderate, and the remaining 87(56.9%) were severe (Byhring and Bø 2002) .

Three hundred and thirty seven complaints of troublesome bodily areas over the previous 12 months were reported. One hundred and one subjects identified which body part had proved most troublesome in the previous year. Three (3%) subjects reported no troublesome body region in the previous year. Foot and ankle injuries were most common, with injuries to the knee, calf/shin and lower back also prevalent (Table 5.5). Subjects were most likely to be unaware of their diagnosis with muscle strain and joint sprain the most commonly reported diagnoses by subjects aware of the nature of their complaint (Table 5.5).

Subjects reported a total of 130 perceived causes of pain/injury. Overuse (30%), accident (14.6%), and inadequate warm-up and stretching (12.3%) were the leading causes of injury. Other perceived intrinsic causes of pain/injury cited included muscle weakness (10.8%), generalized fatigue (6.2%), and lapses in concentration (2.3%). Perceived extrinsic causes included unsuitable floor surfaces (7.7%), footwear (3.8%), and difficulties with choreography (2.3%).

Table 5.5 Anatomical location of all pain/injuries sustained over the previous five years with diagnosis if known. Troublesome bodily areas over the previous one year.

Self-reported anatomic location of pain/injury (5 years) (Injured n=80 (76.9%))		**Self-reported troublesome complaints (1 year, n=337)**
Body Part (%)	**Diagnosis (%)**	**Body Part**
Foot/ankle (48.8%)	Unaware of diagnosis (19.2%)	Foot/ankle (23.1%)
Calf/shin (11.3%)	Muscle strain (17.4%)	Calf/shin (19.0%)
Knee (10.8%)	Joint sprain (12.6%)	Lower back (14.2%)
Hip/thigh (9.4%)	Fracture (10.2%)	Knee (12.5%)
Lower back (6.4%)	Ligament (9.6%)	Hip/thigh (11.0%)
Head/neck (4.3%)	Tendonitis (6.0%)	Head/neck (9.2%)
Elbow/wrist/hand (2.5%)	Stress fracture (6.0%)	Shoulder (4.7%)
Groin (2.0%)	Joint trauma (6.0%)	Upper back (4.5%)
Ribs (2.0%)	Cartilage (1.2%)	Elbow/wrist/hand (1.8%)
Coccyx (1.0%)	Unspecified bony injury (1.2%)	
Pelvis (0.5%)	Other* (10.6%)	
Abdomen (0.5%)		
Upper back (0.5%)		

*Other: Nerve injury, laceration, infection, chronic instability, avulsion, bone spur.

5.3.3 Factors Significantly Associated with Injury

There were no significant differences in any of the physical screening tests between the SI and NSI groups. Factors significantly associated with SI group membership were female sex, higher number of subjective health complaints and psychological health complaints, lower mood (tension-anxiety and confusion-bewilderment subscales), higher catastrophising and reported failure to complete a warm-up (Table 5.6). Analysis between subjects according to dance status (professional/competitive/student) was not performed as groups were identified as significantly different in their demographic composition and of small size. The CHAID classification tree (Figure 5.1) partitioned the sample on the variable Warm-Up ($\chi^2(1)$ =7.5, p=0.025) followed by Sex (female) in the Warm-Up (Not Always) group ($\chi^2(1)$ =4.038, p=0.044) and Catastrophising in the Warm-Up (Always) group ($\chi^2(1)$ =18.932, $p<0.001$).

Female dancers who did not always warm-up were identified as the subgroup with highest SI percentage (52.6%). The tree correctly classified 78.8% of the SI group and 71.8% of the NSI group. A classification tree that included the number of subjective health complaints was explored but this tree was found to have poor classification results for the SI group, classifying only 46% correctly. The variables associated with lower mood and psychological health complaints were not found to be significant in the CHAID analysis. The results of the exploratory logistic regression model are shown in Table 5.7. This model found Warm-Up (Not Always) (OR = 2.69, 95% CI: 1.05, 6.92), high number of subjective health complaints (OR = 1.21, 95% CI: 1.04, 1.40) and female sex (OR = 3.12, 95% CI: 0.98, 9.94) to be associated with being in the SI group. The Nagelkerke pseudo R^2 value for the model was 0.202.

Table 5.6 Group comparisons of subjective variables: Descriptive statistics as means ±SD or median (Interquartile range), categorical statistics also shown.

Descriptive Data	SI	NSI	p Value
	(n=33)	**(n=71)**	
Age	20(19, 22)	20(19, 24)	0.474
Years dancing	14.53 ± 4.74	14.82 ± 5.44†	0.792
Number of subjective health complaints	7(4, 9)	3 (2, 6)	0.001*
Number of psychological complaints	1(0, 3)	1(0, 2)	0.036*
Cross training per week (hours)	4(2, 6)	4(2, 6)	0.969
Number of body parts affected	4(3, 6)	3(1, 4)	<0.001*
Catastrophising	9(3, 13)	4(2, 10)	0.047*
Profile of Moods Scale	13(7, 20)	7(4, 15)	0.010*
Anger- hostility	3(1, 7)	1(0, 5)	0.122
Tension-anxiety	6(4, 9)	4(2, 8)	0.019*
Confusion -bewilderment	3(1, 7)	1(0, 4)	0.040*
Stress	10(6, 14)	8(4, 14)	0.442
Athletic Coping Skills Inventory 28			
Coping with adversity	5.58±2.41	6.03±2.89	0.437
Coachability	9.82±2.54	9.39±2.43	0.409
Concentration	7.45±2.03	6.97±2.37‡	0.315
Confidence and achievement motivation	6.82±2.16	7.44±2.66	0.246
Goal setting and mental preparation	5.42 ±2.87	6.31±2.80	0.140

Peaking under pressure		5.00±2.70	5.20±3.01	0.749
Freedom from worry		5.45±2.80	5.41±3.06	0.942
Alcohol units		5(4, 9) §	6(4, 10) ǀǀ	0.937
Categorical Data		**Count**	**Count**	**p Value**
Sex	Female	28	46	0.036*
	Male	5	25	
Warm Up	Always	10	42	0.006*
	Not Always	23	29	
Smoking	Yes	6	8	n/a
	Previously, not now	4	2	
	No	23	60	
SCOFF	At risk	8	9	0.146
	Not at risk	25	61	
Sleep quality	Insufficient	18	25	n/a
	Moderate	15	44	
	Sufficient	0	2	
Previously injury: most troublesome body part	Yes	12	21	0.769
	No	20	40	
Dance in pain	Less severe	5	65	<0.001*
	Severe	28	6	
General everyday pain	Less severe	0	55	<0.001*
	Severe	33	16	
Bothersomeness of pain	Less severe	5	50	<0.001*
	Severe	28	20	
General health	Very good/ Good	23	65	0.004*
	Neither/Poor/Very Poor	10	6	
Energy	Very much/Quite a lot	22	55	0.242
	Some/Little/none	11	16	

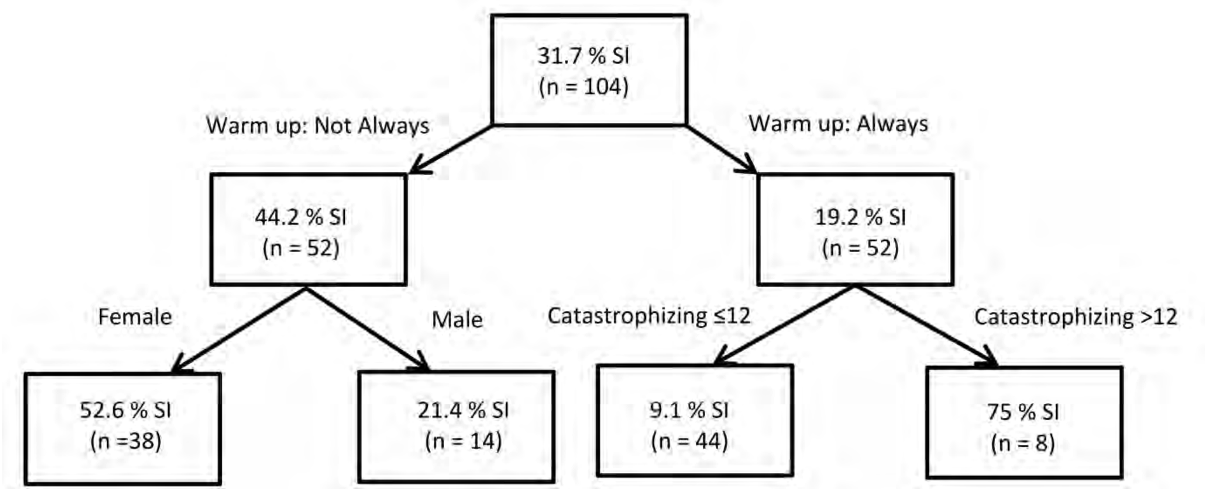
SI: Significantly injured. NSI: Not significantly injured. *Statistically significant at p<0.05. † n = 68, ‡ n = 70, § n = 17, ǀǀ n = 51. SCOFF: Sick, Control, One stone, Fat, Food

Table 5.7 Odds ratios, 95% CIs and p-values from logistic regression model

	Odds ratio	95% CI	p Value
Female Sex	3.12	0.98– 9.94	0.054
Failing to always warm-up	2.69	1.05 – 6.92	0.040
Higher number of subjective health complaints	1.21*	1.04 – 1.41	0.011

* The odds ratio for a quantitative variable represents the proportional increase in the odds of being in the SI group for one unit increase in the independent variable.

Figure 5.1.Classification tree allocating Significantly Injured (SI) and Not Significantly Injured (NSI) group members



5.4 Discussion

This study has found that musculoskeletal pain and injury is extensive in elite adult ID. The lower limb, in particular the foot and ankle, is most commonly affected with dancers frequently being unaware of their diagnoses. Female sex, a high number of subjective general and psychological health complaints, low mood, higher catastrophising, and a reported failure to always warm-up were significantly associated with musculoskeletal pain and injury in this cohort. Perceived causes of injury identified by the subjects included overuse, fatigue and weakness, inappropriate footwear, stages or floors, and challenging choreography.

5.4.1 Incidence of Pain and Injury

The findings of this study regarding the epidemiology and incidence of pain and injury in ID correlate well with reports from other forms of elite dance (Thomas and Tarr 2009). The reported injury rate of 76.9% in the current study is similar to that recorded previously in a cohort of professional Irish dancers (76.6%) (Cahalan and O'Sullivan 2013a). The mean career injury rate of 2.25 injuries recorded previously in professional Irish dancers (Cahalan and O'Sullivan 2013a) exceeds the five year injury rate of 1.49 injuries reported in the current cohort. This is possibly due to the younger age profile and comparatively shorter careers of the current study group. As in other genres, injuries to the lower limb, particularly the foot and ankle were most prevalent (Hurley and John 2013). In this study, where a diagnosis was known, dancers were more likely to sustain soft tissue injuries to muscle or tendon as opposed to bony insults. This is also reflective of findings across many forms of elite dance (Hincapié et al. 2008).

5.4.2 Physical Factors

Although none of the physical traits investigated in this study were found to be significantly associated with injury, comparison with other dancing and non-dancing populations merits some discussion. According to the World Health Organisation classification of body mass index (BMI), the majority of subjects in this study had healthy BMI values and waist:hip ratios (WHO 2000). A mean waist:hip ratio of 0.73 has previously been reported in a cohort of 40 pre-professional dancers (38 female, 2 male), which compares closely to the female subjects in this study (0.76) (Mistiaen et al. 2012). Mean BMI values in this study were greater for females than males, which contrasts to a number of studies in elite ballet and contemporary dance. A study of 41 Norwegian professional ballet dancers reported BMI values of 21.9 and 18.6 for male and female dancers respectively (Byhring and Bø 2002). In a cohort of 184 professional contemporary dancers, the average BMI for males was 23.6 and 20.5 for females (Weiss et al. 2008). BMI values for female Irish dancers exceed that of both their ballet and contemporary peers. This may be explained by the fact that female Irish dancers tend to have strong and large muscular lower limbs. Additionally as female Irish dancers are not lifted, a low BMI is perhaps less important than in ballet or contemporary dance.

Subjects exhibited approximately 28-34º more hip flexion than values for age matched non-dancing individuals (Fabunmi and Akaraiwe). Much of the research in elite ballet focusses on internal and external range of motion (ROM) of the hip based on the importance of turnout in that genre (Khan et al. 1997). However one study measuring hamstring flexibility in a similar manner as this study reported a comparable mean(SD) of 96.0(9.8)º of hamstring flexibility in a mixed dance cohort of late adolescent dancers (Walker et al. 2011). Values for passive dorsiflexion in the non-dancing population vary between 5 and 10º (DiGiovanni and Justin Greisberg 2007), approximately 5º less than that demonstrated by the subjects in the current study. Limited ankle dorsiflexion has been found to increase vulnerability to injury in paediatric and sporting populations (Tabrizi et al. 2000, Malliaras et al. 2006). However a link between ankle ROM and injury has not been supported empirically in dance (Wiesler et al. 1996).

Excessive rearfoot pronation has been linked to injury in pre-professional ballet dancers (Gamboa et al. 2008) with hyper-pronation of the foot implicated in injuries in dancers up the kinetic chain from the foot to the lower back (Nowacki et al. 2012). However subjects in the current study fell within normal values for navicular drop which is estimated to be between six and nine millimetres (Loudon et al. 1996). Recent research comparing posterior-medial reach and balance in female modern dancers versus active non-dancers recorded mean(SD) values of 92.6(5.6)% versus 87.0(6.4)% and 93.9(6.3)% versus 87.9(6.3)% for right and left lower limbs respectively (Ambegaonkar et al. 2013). The current study reveals that average posterior-medial reach in Irish dancers lies somewhere within this range. It is unclear whether repeating a balance test in other axes of the SEBT would affect these findings, given the sagittal plane in which Irish dancers primarily perform. GJH was more prevalent amongst female subjects than male subjects in this study, and at 22% was in excess of the 6%-17% reported in the general population, as would be expected (Day et al. 2011). Depending on the criteria used to assess for GJH, rates of up to 44% have been identified in dancers, with GJH particularly prevalent among student dancers (Day et al. 2011). The female mean Beighton score in this study of 2.6/9 compares to 4.6/9 in contemporary dance (Ruemper and Watkins 2012) and 4.4/9 and a mixed cohort of dancers and gymnasts of varying levels of accomplishment (Gannon and Bird 1999).

Pain pressure thresholds (PPTs) for elite dancers in any genre are unavailable to the best of our knowledge. Normative values in healthy non-dancers are also unavailable due to the wide variability of individual results such as evidenced in this study (Ylinen 2007). Empirically, in healthy subjects, males have been found to have higher PPTs than females (Garcia et al. 2007). This was the case also in this study.

Professional dancers have previously been reported to demonstrate similar fitness values to aged-matched healthy sedentary individuals (Rafferty 2010) The SPARQ test used in this study is designed to assess lower limb agility and endurance. Originally designed for soccer and basketball players, it mimics the highly explosive and relatively brief duration of Irish dances. The mean percentage of HRmax achieved indicated that subjects were performing in a maximal, anaerobic zone (Alexandre et al. 2012) closely simulating the anaerobic, short burst nature of Irish dance. Subjects dropped back into an aerobic zone within 30 seconds, but no information was collected on time required to recover to resting heart rate. This information would provide greater clarity on the cardiovascular fitness of this cohort and is an area for further study.

As in ballet, males recorded higher vertical leap jump heights than females (Wyon et al. 2006). Double footed vertical leap values for elite male ballet dancers have varied from 50.5cm in principal dancers to 56.0cm in first artists (Wyon et al. 2006). The mean value of 41.7cm achieved by male subjects in this study reflect the differing techniques in ID where the leaps are of a smaller magnitude and more power is expended in grounded rhythm and syncopation. Values for elite female ballet dancers ranging from 33.0cm in principal dancers to 39.0cm in first artists compare more closely with the subjects in this study (34.8cm) (Wyon et al. 2006). As the majority of leaps in ID involve a single leg take off, a protocol reflecting this strategy would have been more appropriate and is a limitation of the study.

5.4.3 Factors Associated with Pain and Injury

In this study, several statistically significant and inter-related biopsychosocial factors were found be significantly associated with being SI. These factors, listed above, have previously been associated with greater pain and injury in many mainstream populations. An Australian study of over 17,500 subjects found a significant association between levels of chronic pain, female sex, socioeconomic disadvantage, high levels of psychological distress and poor self-rated health (Blyth et al. 2001). In ballet, an increased risk of injury has been positively correlated with high stress and low mood, but ameliorated with good social support (Adam et al. 2004). Sociological studies have identified how the culture in elite dance and associated risk-taking behaviours may affect the physical and emotional health of dancers (McEwen and Young 2011). Research has shown that dancers display higher levels of distress than the general population when suffering a musculoskeletal injury (Air 2013) and also that stress and coping strategies impact upon injury frequency and duration in elite and student dancers (Rip et al. 2006, Jacobs et al. 2012). A distinction has been drawn by elite dancers between performance pain and injury pain, with the former described as acute, of short duration and under the voluntary control of the dancer (Anderson and Hanrahan 2008). Comparatively, injury pain is a more negative sensation which can precipitate guarding and reduced self-confidence. Additionally, catastrophising has also been found to be prevalent in ballet when the dancer interprets pain as potentially threatening (Anderson and Hanrahan 2008).

In this study, being female was significantly associated with being in the SI group. This is in contrast to previous research in a cohort of professional Irish dancers where the sex of the dancers was not significantly associated with a higher rate of injury (Cahalan and O'Sullivan 2013a). The reasons for this are unclear but may possibly be explained by the greater heterogeneity of dancer experience and occupation in the current study. In comparison to males, females in the general population have been found to have lower pain thresholds and pain tolerance, experience greater pain intensity and have different analgesic sensitivity (Popescu et al. 2010, van Hecke et al. 2013, Etherton et al. 2014). Additionally, a number of studies have found that female dancers suffer a higher rate of injury than their male counterparts (Allen et al. 2012, Shah et al. 2012). Numerous factor including the female athletic triad may contribute to this conclusion (Motta-Valencia 2006). Although it was not possible to measure bone density in this study, neither of the other two elements of the triad, namely amenorrhea or disordered eating, were found to be significantly associated with being SI. Although not significantly different between the SI and NSI groups, mean pain pressure thresholds among males (40.23 lbs) significantly exceeded that of females (32.27 lbs) in this study (Table 5.3). This may support the previously cited findings that sex-regulated factors including tissue sensitivity and pain thresholds may have an important role to play in injury vulnerability.

A reported failure to consistently perform a warm-up was also significantly linked to becoming SI. A 2009 study of injury in hip-hop dancers found that a failure to perform a warm- up was identified as the primary cause of injury by 62% of participants (Ojofeitimi et al. 2012). Amongst aerobic dance instructors, a reduced injury rate was attributed to an appropriate warm-up length (Malliou et al. 2007). In a previous study of injury in professional Irish dancers, warm-up was not found to be associated with injury (Cahalan and O'Sullivan 2013a). However as 98.8% of that cohort consistently performed a warm-up, this finding is unsurprising. Similarly in many fields of elite dance, warm-up is an intrinsic and often mandatory part of preparing to rehearse or perform and would not be omitted. It is to amateur and less-experienced cohorts that the impact of dispensing with a warm-up may be more applicable.

The significance of the non-physical components undoubtedly reflects the necessity of adding demographic, lifestyle and psychosocial components to any screening protocol. Mindfulness tools including relaxation, cognitive restructuring, and imagery training to improve mental preparedness have been found to reduce injury rates and catastrophising in sport (Galambos et al. 2006). Such strategies may prove equally valuable in dance to ameliorate the risk of injury and pain in at-risk performers, but this hypothesis requires further study. Undeniably, all the available research suggests a high rate of injury in ID with the current study providing an initial indication of the pivotal role of general and psychosocial health. ID organisations and teachers would be well advised to replicate the calls made by other genres of dance, the performing arts and sport for psychosocial screening (Galambos et al. 2006, Hamilton et al. 2006, Clark et al. 2013).

5.4.4 Limitations

Firstly, as this retrospective study required subjects to recall events over a five-year period, errors of omission and recall are inevitable, and the frequency of minor injuries is most likely understated. However, the main function of the retrospective data is simply to allocate subjects to SI and NSI groups. A prospective study of injury and pain is currently underway to address this issue. Secondly, due to the method of recruitment it is impossible to calculate an accurate response rate, which may be indicative of volunteer bias and a study cohort that is potentially non-representative of the wider elite Irish dance population. Thirdly, some elements of the functional screening were basic and generic, and would benefit from greater specificity to ID. Fourthly, anonymity of the questionnaire data could have allowed for more candid responses, particularly regarding drug and alcohol use and food consumption. Finally, greater detail of the type and duration of warm-up and cool down routines would have been beneficial.

5.5 Conclusions

Despite the growing popularity of ID, limited data are available on the physical and psychosocial characteristics of elite adult Irish dancers, and the association, if any, between these features and levels of pain and injury. This study found that there is a significant level of pain/injury in ID, with the foot and ankle most often affected. These findings are largely consistent with the current literature in other forms of elite dance. SI dancers were defined based on a time-loss definition of injury and the severity and impact of pain experienced.

Statistically significant factors related to SI group membership were female sex, poor subjective and psychosocial health, a high level of catastrophising, and a reported failure always to perform a warm-up prior to dancing. This biopsychosocial melange of factors represents a significant challenge to dancers and those healthcare providers who oversee the management of their pain and injury. Screening programs should consider demographic, lifestyle, and psychosocial factors as well as the physical traits that affect performance. A prospective study presently being undertaken by the current authors will elaborate on these findings.

CHAPTER 6: FOOT AND ANKLE PAIN AND INJURIES IN ELITE ADULT IRISH DANCERS

Accepted for publication: Medical Problems of Performing Artists. September 2014.

Roisin Cahalan, Dr. Helen Purtill, PhD, Prof. Peter O'Sullivan, PhD, Dr. Kieran O' Sullivan, PhD

Abstract

Study design: An observational study examining the factors linked to foot and ankle (FA) pain and injury in elite adult Irish dancers.

Background: In Irish dance, the FA are the structures most commonly injured, but there is scant research examining the potential factors placing Irish dancers at risk of sustaining FA pain and injury.

Methods: The biopsychosocial characteristics of 29 subjects with no previous FA problems were compared to 53 subjects who cited the FA as their most troublesome bodily area. These 82 subjects were allocated to "Never Troublesome" (NT) and "Most Troublesome" (MT) groups respectively.

Results: Factors found to be statistically significant for membership of the MT group included female gender ($p = 0.004$), greater gastrocnemius flexibility ($p = 0.021$), better single leg balance ($p = 0.019$) and a higher number of endurance jumps ($p = 0.009$). The MT group reported more severe levels of day to day pain ($p = 0.038$) greater bothersomeness of daily pain ($p = 0.005$), more subjective health complaints ($p = 0.024$), more psychological complaints ($p = 0.030$), and a greater number of bodily areas experiencing pain and injury (0.025).

Conclusions: FA pain and injury in elite adult Irish dancers is commonplace and comparable to levels of injury in other elite forms of dance. A complex mix of biopsychosocial factors is associated with FA pain and injury in this cohort.

6.1 Introduction

Musculoskeletal pain and injury in dance is commonplace, with the foot and ankle region (FA) typically cited as the area most prone to injury (Motta-Valencia 2006). Levels of FA injury in elite ballet and modern dance have been found to range from 34% to 62% (Kadel 2006). In Irish dance (ID), FA pain and injury is also significant with one study reporting an incidence of 55.9% (Stein et al. 2013). Similar findings were reported in a cohort of 159 elite competitive Irish dancers (McGuinness and Doody 2006) and in a group of 178 professional Irish dancers (Cahalan and O'Sullivan 2013a).

In ID, the FA may be vulnerable to pain and injury for numerous genre-specific reasons. Solo ID may be divided into “light” and “heavy” dancing. In heavy dancing, the emphasis is on strength, rhythm and power. Heavy dancing emphasises syncopation and rhythmic creativity. Light dancing shares some common ground with ballet with dancers high on their toes and performing large, elegant leaps. As in ballet, extreme ranges of ankle plantarflexion are necessary in ID to achieve the en-pointe position. Significant neuromuscular control at the FA is fundamental in ID, as most elements are executed on the toes. Unlike ballet where the dancer pliés upon landing to help dissipate ground reaction forces, the Irish dancer lands on a plantarflexed foot with an extended knee. Considerable plantar forces are incurred by ID shoes, particularly around the forefoot region (Tregouet and Merland 2013) with certain steps generating contact forces of up to 14 times body weight at the ankle joint (Shippen and May 2010). Additional challenges to balance are presented by the characteristic ID posture where the arms are held firmly by the side of the torso.

In contrast to the dearth of relevant research in ID, studies in other dance genres have posited numerous risk factors for FA pain and injury including poor biomechanics (Ahonen 2007), previous ankle injury (Jacobs et al. 2012) and maladaptive muscular activation (Ritter and Moore 2008). The importance of factors including psychological health (Cumming and Duda 2012) and physical attributes (Russell 2013), both of which have been shown to impact upon rates of pain and injury in other forms of dance, have been poorly investigated in ID. The impact of psychological factors including low mood on the prevalence and severity of musculoskeletal pain and injury have been highlighted in other athletic populations (Galambos et al. 2006), but no research investigating these non-physical factors and their relationship to FA pain and injury in ID has been performed.

This study involved a cohort of 104 elite Irish dancers who were previously investigated for the incidence and aetiology of musculoskeletal pain and injury (not specific to the FA region) (Cahalan et al. 2014b) and compared Irish dancers with no previous FA complaint with those who cited the FA as their most troublesome bodily areas over the previous five years. Several biopsychosocial variables were investigated to establish what differences, if any, existed between these two groups. The former study (Cahalan et al. 2014b) found that the factors significantly associated with severe levels of self-reported pain and injury (not specific to the FA) were female gender, more subjective general health and psychological complaints, low mood, higher catastrophising and a failure to always complete a warm-up. The aim of this study was to establish the factors specifically associated with a higher rate of FA pain and injury in this cohort, given the substantial level of FA problems amongst Irish dancers.

6.2 Methods

6.2.1 Subjects

The total study cohort was comprised of 104 professional Irish dancers, competitive Irish dancers and student Irish dancers. Professional Irish dancers were required to have spent at least eight months of a consecutive 12 month period working as a paid Irish dancer. Competitive Irish dancers were required to have competed in solo competition within the previous five years at the World Championships or relevant national Championships. Student Irish dancers were those in full-time university education studying ID. Subjects were sourced through the contacts of one author who is an ID teacher and former professional Irish dancer. Subjects of both sexes, aged 18 years or older were invited to participate. Invitation to participate was issued via ID schools, ID productions and social media. Due to the nature of recruitment, the participation rate in this study cannot be established. Subjects from 12 countries participated. Written informed consent was obtained from all subjects.

6.2.2 Data Collection

One hundred and four subjects completed a questionnaire and 84 of those subjects completed an additional physical assessment using portable equipment at multiple locations. The questionnaire collected data on subjective physical and mental health, pain and injury history (Table 6.1), smoking status, dancing history, performance of pre-dance warm-up, and levels of participation in other athletic activities. In addition, validated questionnaires were employed to gather information on the subjects' characteristics in areas including pain beliefs and management, performance, levels of stress, catastrophising, mood, nutrition and sleep (Table 6.1). The physical examination was based on the screening recommendations of the International Association for Dance Medicine & Science (IADMS)(Liederbach et al. 2012) and included measures of anthropometry, lower limb flexibility and power, foot pronation, single leg balance, hypermobility, endurance, pain pressure thresholds, and several functional tests (Table 6.2). Testing was performed by four qualified physiotherapists with screening elements conducted in the same order. To minimise bias, a coin toss decided which leg was assessed first. Consecutive subjects commenced testing on opposite legs to previous subjects.

In screening elements where active performance was required, this was demonstrated and subjects were allowed a predetermined amount of practice for familiarisation.

Table 6.1 Questionnaires used in subjective screening

Test Element	Outcome Measure	Description
Subjective Health Complaints	Subjective Health Complaints Inventory (SCHI) (non-musculoskeletal items)	The SCHI concerns subjective somatic and psychological complaints experienced during the previous 30 days. Thirteen items including palpitations, chest pain, breathing difficulties, heartburn, stomach discomfort, diarrhoea, constipation, eczema, tiredness, dizziness, anxiety, depression/sadness and sleep problems were assessed (Tschudi-Madsen et al. 2011). Higher scores indicate a greater level of subjective health complaint.
Subjective Psychological Complaints	List of common psychological complaints drawn from the "Fit to Dance" study of 1996 (Brinson and Dick 1996).	Subjects identified if they had suffered from any of the following common psychological complaints over the previous 30 days: general anxiety, tension with people, performance anxiety, depression, externally mediated stress such as home-sickness, overuse of drugs/alcohol, disordered eating, issues of self-confidence, difficulties concentrating during performance/rehearsal, and sleep problems. Higher scores indicate a greater level of subjective psychological complaint.
Troublesome Bodily Areas	Standardised Nordic Questionnaire (SNQ) (body map)	The SNQ is used to record musculoskeletal complaints. A body map was used by subjects to indicate nine symptom sites including neck, shoulders, upper back, elbows, low back, wrist/hands, hips/thighs, knees and ankles/feet (Tschudi-Madsen et al. 2011).
Pain Catastrophising	Coping Strategies Questionnaire (CSQ) Catastrophising subscale	The CSQ (catastrophising subscale) is a seven-item questionnaire which assesses the frequency of patients' use of pain coping strategies. A higher score indicates greater levels of catastrophising (Rosenstiel and Keefe 1983).
Mood	Profile of Moods State (POMS)	The POMS assesses transient, fluctuating feelings, and enduring affect states (McNair et al. 1971). Three subscales of the POMS

		namely tension-anxiety, anger-hostility and confusion-bewilderment were completed. Higher scores indicate greater levels of anxiety, anger and confusion.
Stress	Depression Anxiety Stress Scale (DASS)	The DASS is designed to measure depression, anxiety and stress.The stress subscale only was completed (Lovibond and Lovibond 1995). A higher score indicates greater levels of stress.
Performance	Athletic Coping Skills Inventory-28 (ACSI-28)	The ACSI-28 (Smith et al. 1995) examines coping and self-efficacy under seven domains including coping with adversity, peaking under pressure, goal setting/mental preparation, concentration, freedom from worry, confidence and achievement motivation, and coachability
Disordered Eating	Sick, Control, One stone, Fat, Food (SCOFF)	SCOFF is a five-item questionnaire used to assess the possible presence of an eating disorder (Morgan et al. 1999). A score of two or more indicates disordered eating.
Sleep	Sleep quality and quantity	Sleep quantity and quality were categorised into sufficient, intermediate or insufficient, based on average hours spent sleeping, prevalence of nightmares, tiredness and sleeping problems (Auvinen et al. 2010).

Table 6.2 Test elements of physical screening protocol

Test Element	Outcome Measure	Procedure
Anthropometric Measures	Body Mass Index (BMI) (kg/m^2) Waist: Hip Ratio	Height and weight, and waist and hip measures were taken to calculate BMI and waist:hip ratios respectively (Ljung et al. 2012).
Tissue Sensitivity	Pain Pressure Threshold (lbs)	Upper trapezius (UTr) and tibialis anterior (TA) muscles tested bilaterally using a calibrated handheld digital algometer (J-Tech Commander). An overall PPT score was calculated from the mean value of the four locations.
Gastrocnemius flexibility	Active ankle dorsiflexion (°)	Measured with knee extended using a handheld goniometer. The mean value of two trials was recorded.
Hamstring flexibility	Active hip flexion (°)	Measured with a Speedflexer™ device – subjects required to actively sustain a maximal straight leg raise for three seconds bilaterally. The subject was supine with the contralateral hip and knee. The mean value of two trials was recorded.
Subtalar pronation	Navicular drop (mm)	Foot pronation was compared in a seated, unloaded foot position and a loaded, standing foot position using an index card demarcated in millimetres (Charlesworth and Johansen 2010).
Balance	Star excursion balance test (SEBT) postero-medial axis (Hertel et al. 2006).	The SEBT is a measure of dynamic balance. The mean of three trials was recorded with results normalised to leg length measured in standing from the iliac crest to the medial malleolus (Gribble and Hertel 2003).
General joint hypermobility (GJH)	Beighton Hypermobility Score (BHS)	The 9-point BHS - scores of four or more are considered to indicate GJH (Beighton et al. 2012).
Cardiovascular fitness and endurance	Speed, Power, Agility, Reaction and Quickness (SPARQ) rating system (TopEndSports 2013). Percentage of maximum heart rate (% HRmax)	Dancers were required to repeatedly jump over a 12 inch soft hurdle with both feet and land on both feet on the other side of the hurdle for 30 seconds. Number of jumps, resting heart rate, heart rate immediately following the test and 30 seconds following the test were also recorded using a finger pulse-oximeter (Nonin Onyx™). %HRmax was calculated based on 208- (subject age*0.7) (Tanaka et al. 2001).
Functional tests	Functional Movement Screen (FMS)	Deep squat and bilateral in-line lunge test elements of the FMS were used to identify any lower limb range limitations and side to side movement asymmetries (Cook 2003). The best attempt of three trials was recorded. A maximal score of three was attainable in each test (range 0-9).

Lower limb power	Vertical leap (cm)	The difference between the maximum height reached during a double-footed countermovement jump and standing reach height (Wikstrom et al. 2007). Standing reach was measured with subjects' preferred arm elongated against a wall-mounted tape measure with feet flat on the ground. The best score of three trials was recorded.

Hrs= hours, kg/m^2 = kilograms per square metre, lbs = pounds, mm = millimetres, ° = degrees, %LL = percentage of leg length, cm = centimetres, yrs = years

Pain and injury were individually examined in this study. Using a "time-loss" definition of injury which specifies an inability to dance for at least one day due to physical impairment(Van Mechelen et al. 1992), subjects identified any body parts injured, the diagnosis (if known) and time missed due to injury over the previous five years (Dickinson et al. 1992). It was not recorded whether the diagnosis where known was made by a medical professional or self-diagnosed by the subject. This is a limitation of the study. Using the SNQ body chart (Tschudi-Madsen et al. 2011), subjects identified bodily areas that had been most troublesome (caused ache, pain, discomfort, numbness, tingling etc.) over the previous five years. 22(21.1%) subjects had sustained some pain and injury to their FA but had not reported same as their most troublesome or most injured bodily area. To minimise recall bias and to enhance the clarity of the analysis, these 22 subjects were omitted from this study as their "time-loss" was likely to reflect other areas of pain and injury. Among the remaining 82 IDs, twenty nine (27.9%) subjects who reported no previous pain and injury with their FA and 53 (51.0%) subjects who cited the FA as their most troublesome/injured bodily area were allocated to "Never Troublesome" (NT) and "Most Troublesome" (MT) groups respectively. MT subjects reported which FA was more problematic.

6.2.3 Statistical Analysis

The distribution of each numeric variable was assessed for normality using histograms and formal tests. Descriptive statistics were calculated as mean ± SD, median [interquartile range] or frequency (percentage), as appropriate. Binomial logistic regression was used to examine univariate differences in the demographic, psychosocial and physical variables between the MT and NT groups. Age and gender were included as covariates in the analyses of the psychosocial and physical variables. Differences in balance measurements and gastrocnemius flexibility between the injured and non-injured legs for the MT group were examined using the paired t-tests or the Wilcoxon signed-rank where data was found to be skewed. A 5% level of significance was used for all statistical tests. Statistical analyses were performed using IBM SPSS® Statistics V 20 (Armonk, New York, USA).

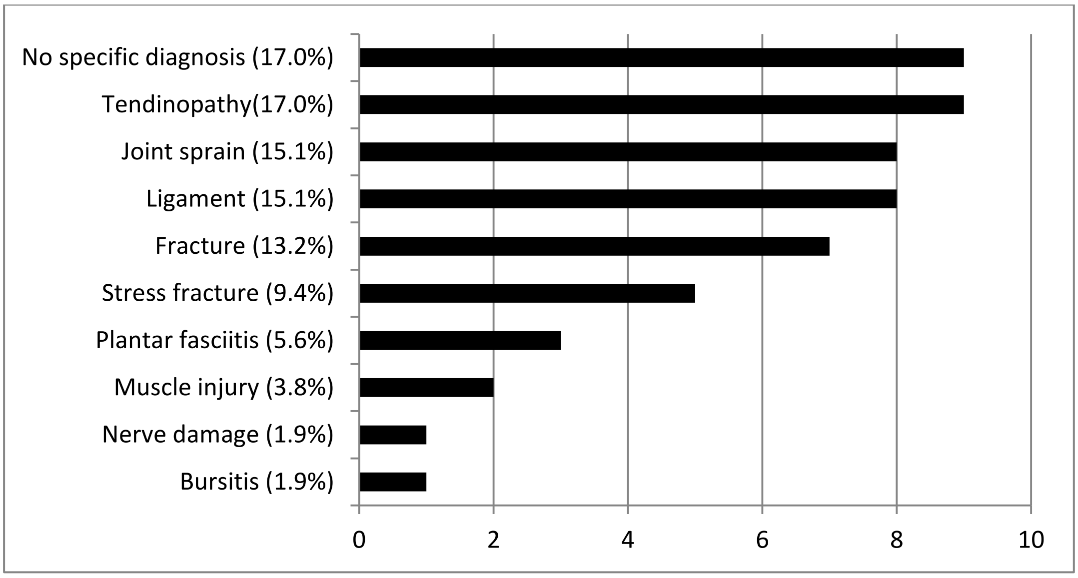
6.2.4 Ethical Approval

Ethical approval was granted by the research ethics committee of the local University.

6.3 Results

The types of FA injury diagnosis reported in the MT group are presented in Figure 6.1. Of the 44 subjects who provided a specific diagnosis for their FA injury, 40.9% complained of overuse problems (tendinopathies, plantar fasciitis, stress fractures, bursitis) and 52.3% of traumatic injuries (ligament damage, joint sprain, fractures). Muscle and nerve injury (6.8%) could not definitively be attributed to either overuse or traumatic category. The median (IQR) number of days lost to FA injury over the previous five years in the MT group was 30(64) days.

Figure 6.1 Foot and ankle injury in the MT group by diagnosis (n= 53).



Gender, age and dancer status composition for NT and MT subject groups are shown below (Table 6.3). Female gender was strongly associated with belonging to the MT group (OR = 4.56, 95% CI: 1.64 – 12.68, p=0.004), and the groups had similar age and dance status profiles. After controlling for gender and age, the physical factors found to be significantly associated with membership of the MT group were greater gastrocnemius flexibility (OR = 1.2, 95% CI: 1.03 – 1.40, p=0.021), better single leg balance (OR = 1.09, 95% CI: 1.01 – 1.17, p=0.019) and a greater number of jumps (OR = 1.10, 95% CI: 1.02 – 1.12, p=0.009), and having higher scores on the Beighton hypermobility scale was close to significance (OR = 1.33, 95% CI: 0.99 – 1.79, p = 0.059) (Table 6.4). Differences in balance measurements between the injured and non-injured legs for the MT group were found to be non-significant for single leg balance (p=0.269) and gastrocnemius flexibility (p=0.605). The MT group reported significantly more subjective health complaints (OR = 1.22, 95% CI: 1.03 – 1.46, p=0.024), psychological complaints (OR = 1.51: 95% CI: 1.04 – 2.19, p = 0.030), and more body parts experiencing pain and injury (OR = 1.37: 95% CI: 1.04 – 1.81, p=0.025) (Table 6.5). NT subjects reported lower levels of general everyday pain (OR = 0.34, 95% CI: 0.12 –

0.94, p=0.038) and less bothersomeness of daily pain (OR = 0.21, 95% CI: 0.07 – 0.63, p=0.005) (Table 6.6).

Table 6.3 Univariate group comparisons of demographic variables (n (%) or median [IQR])

		NT (n = 29)	MT (n = 53)	Odds Ratio	95% CI	p-value
Dance Status§	Professional	10 (34.5)	20 (37.7)	1.053	0.36 – 3.09	0.926
	Student	9 (31.0)	14 (26.4)	0.819	0.26 – 2.55	0.730
	Competitive	10 (34.5)	19 (35.8)	*reference*		
Gender	Female	15 (51.7)	44 (83.0)	4.56	1.64 – 12.68	**0.004***
Age		20 [19, 24]	21 [19, 23]	0.98	0.86 – 1.11	0.760

* = statistically significant, § Odds ratios compare injury in professional and student IDs to competitive IDs

Table 6.4 Univariate group comparisons of physical variables, adjusted for gender and age (mean ±SD or median [IQR])

	NT (n=22)	MT (n=43)	Odds Ratio	95% CI	p-value
Body Mass Index	21.24 [19.95, 23.37]	21.97 [20.20, 23.23]	1.08	0.85 – 1.36	0.546
Waist Hip Ratio	0.79 [.76, .81]	0.76 [.73, .82]	0.971	0.896 – 1.051	0.818
Pain Pressure Threshold	33.62 [28.03, 49.42]	31.84 [24.42, 45.73]	0.99	0.96 – 1.04	0.946
Navicular Drop	7.25 [5.00, 10.00]	6.50 [4.00, 9.50]	0.97	0.83 – 1.15	0.749
Functional Movement Screen Total	7.00[6.00, 8.00]	7.00 [6.00, 8.00]	1.16	0.81 – 1.68	0.420
Hamstring Flexibility	90.26±9.30	92.69 ±9.91	1.01	0.95 – 1.07	0.726
Gastrocnemius Flexibility	13.16±3.73	15.63±3.80♠	1.20	1.03 – 1.40	**0.021***
Balance	88.25±7.65	93.18±9.02	1.09	1.01 – 1.17	**0.019***
Vertical Leap	35.82±6.55	36.39±10.99	1.02	0.96 – 1.08	0.537
Beighton Hypermobility Scale	1.90±1.95♦	3.05±1.95	1.33	0.99 – 1.79	0.059
Number of Jumps	36.50±9.29♦♦	42.00±10.01♠	1.10	1.02 – 1.17	**0.009***
Percentage Max Heart Rate	76.41±5.87◊	77.94±7.10♠♠	1.02	0.94 – 1.12	0.601

♦ n=21, ♦♦ n = 18, ◊ n=16, ♠ n = 42, ♠♠ n=39, * = statistically significant

Table 6.5 Univariate group comparisons of subjective variables, adjusted for gender and age (mean ±SD or median [IQR])

	NT (n = 29)	MT (n = 53)	Odds Ratio	95% CI	p-value
Years Dancing	14.63± 5.53♦♦	14.69±5.03♠	0.99	0.89 – 1.10	0.860
Number of Health Complaints	3 [1, 5]	5 [3, 8]	1.22	1.03 – 1.46	**0.024***
Number of Psychological Complaints	1 [0,1]	1 [0, 3]	1.51	1.04 – 2.19	**0.030***
Cross Training per Week (hours)	5 [2, 7]	4 [2, 6]	0.97	0.88 – 1.07	0.530
Number of Body Parts Affected	2 [1, 3]♦	3 [2, 5]	1.37	1.04 – 1.81	**0.025***
Coping Strategies Questionnaire (CSQ)	3 [1, 9]	6 [2, 12]	1.07	0.99 – 1.16	0.102
Profile of Moods Scale (POMS)					
Anger-Hostility	1 [0, 4]	3 [1, 5]	1.10	0.93 – 1.31	0.270
Tension - Anxiety	4 [1, 8]	5 [3, 9]	1.05	0.94 – 1.18	0.387
Confusion-Bewilderment	1 [0, 2]	3 [1, 6]	1.16	0.99 – 1.36	0.062
Depression Anxiety Stress Scale (DASS -stress subscale)	8 [4, 14]	8 [4, 12]	0.99	0.94 – 1.06	0.840
Athletic Coping Skills Inventory-28 (ACSI-28)					
Coping with Adversity	6.55±2.73	5.62±2.75	0.91	0.76 – 1.09	0.294
Coachability	8.83±2.69	9.83±2.20	1.17	0.95 – 1.45	0.139
Concentration	7.21±2.35	7.06±2.15	0.97	0.78 – 1.21	0.784
Confidence and Achievement Motivation	7.38±2.93	7.19±2.47	1.04	0.86 – 1.26	0.708
Goal Setting and Mental Preparation	6.55±2.89	5.81±2.86	0.95	0.80 – 1.13	0.551
Peaking under Pressure	5.21±3.13	5.13±2.59	1.03	0.86 – 1.22	0.785
Freedom from Worry	4.72±2.79	5.47±2.83	1.06	0.89 – 1.26	0.546

♦ n = 28, ♦♦ n = 27, ♠ n = 52, * = statistically significant

Table 6.6 Univariate group comparisons of subjective categorical variables, adjusted for gender and age (n (%))

	NT (n = 29)	MT (n = 53)	Odds Ratio	95% CI	p-value
Warm Up (% Always)	11 (37.9)	29 (54.7)	2.39	0.87 – 6.59	0.146
Smoking (% Yes)	3 (10.3)	7 (13.2)	1.47	0.32 – 6.89	0.623
SCOFF (% At Risk)	1 (3.6) ♦	10 (18.9)	6.49	0.73 – 57.3	0.094
Sleep quality (%Insufficient)	9 (31.0)	27 (50.9)	1.55	0.55 - 4.68	0.406
Previously injured (%Yes)	6 (27.3) ♦♦	22 (44.0) ♠	1.88	0.59 – 5.98	0.283
Dance in pain (%Never/rarely/sometimes)	24 (82.8)	34 (64.2)	0.46	0.14 – 1.50	0.196
General everyday pain (%Never/rarely/sometimes)	21 (72.4)	24 (45.3)	0.34	0.12 – 0.94	**0.038***
Bothersomeness of pain (%Not at all/Slight)	22 (75.9)	21 (40.4)	0.21	0.07 – 0.63	**0.005***
General health (% Very good/Good)	27 (93.1)	42 (79.2)	0.38	0.07 – 1.97	0.251
Energy (% Very much/quite a lot)	22 (75.9)	37 (69.8)	0.84	0.28 – 2.50	0.750

♦ n = 28, ♦♦ n = 22, ♠ n = 50, * = statistically significant

6.4 Discussion

6.4.1 Pain and Injury

This study is the first examination of the biopsychosocial factors associated with FA pain and injury in elite adult Irish ID. The few relevant studies investigating ID pain and injury focus predominantly on physical factors, potentially overlooking important general health and psychosocial factors. In our previous study investigating whole-body pain and injury, a number of psychosocial, but no physical, factors were found to be significantly associated with time-loss from ID due to pain and injury (Cahalan et al. 2014b). In the current study, a number of physical factors were linked MT group membership including greater gastrocnemius flexibility, better single leg balance and a higher number of endurance jumps.

In addition, subjects in the MT group were statistically more likely to be female, to have a greater number of subjective general health and psychological complaints, reported more bodily parts affected by pain and injury, and complained of more severe and more bothersome levels of day to day pain.

FA injury is pervasive in many dance genres (Macintyre and Joy 2000). Ankle sprain is the most common traumatic injury in dance (Kadel 2006) with previous injury found to predispose the dancer to a twofold risk of injury reoccurrence within one year. The musculoskeletal complaints reported in this ID cohort are frequently suffered in ballet, with tendinopathies, stress fractures, and other soft tissue pathologies being particularly commonplace (Kennedy et al. 2007). These pathologies have been attributed to the immense pressure on FA structures due to the extreme joint positions required to achieve the en-pointe position (Ritter and Moore 2008). Recent research has also highlighted the link between lateral ligament complex sprain, tendinopathy and residual instability (Ritter and Moore 2008).

6.4.2 Gender and Dance

A convergence of biopsychosocial factors has empirically been found to predispose dancers in other genres to injury (Hincapié et al. 2008). Females in the general population have been found to possess lower pain thresholds, experience greater pain intensity and have different analgesic sensitivity comparison to males (van Hecke et al. 2013). Female gender has also been identified as a risk factor for FA injury in professional ballet dancers (Nilsson et al. 2001). In comparison, male ballet dancers are more likely to injure the knee and spine (Wanke et al. 2013). Role differences whereby the male ballet dancer may be required to lift his partner, while the female spends more time en-pointe potentially contribute to these injury patterns. In ID, the female dancer also spends more time en-pointe than her male counterpart. Unlike a ballet slipper, the light leather pump worn only by the female ID has no toe box meaning the dancer essentially carries their full body weight on the hallux with no external support. Additionally, female dancers have historically been at greater overall risk for pain and injury than males for several physiological reasons including the female athletic triad (Motta-Valencia 2006). Although bone density was not measured in this study, and BMI was not found to be significantly related to FA pain and injury in the current study (p=0.546), it is notable that those reporting disordered eating were more likely to belong to the MT group (p = 0.094).

6.4.3 Physical Factors

A number of physical factors in this study were significantly linked to a risk of belonging to the MT group. It appears counterintuitive that subjects with better balance would be more prone to FA injury. It is well established that ankle proprioception disimproves following ankle sprain in dancers (Leanderson et al. 1996) and postural sway is also greater in injured versus non-injured dancers in balance tests (Lin et al. 2011). There are several potential explanations for this finding. Firstly, this study concerns FA pain and injury globally, and not specific pathologies. Therefore, it may be stated that not all FA complaints are functions of balance and good balance is not equally relevant among all FA problems. Additionally, it is unknown whether subjects rehabilitated their FA post injury, and is conceivable that a well-rehabilitated ankle may display better proprioception than the contralateral joint. It is also conceivable that improved balance may be an adaptive response to pain and injury, with the possible negative implication of reduced variability of load distribution, with one study reporting that nurses with lower back pain have better repositioning sense than those who are pain-free (Mitchell et al. 2009). The potentially protective mechanism of loading variability requires further investigation in this population.

A more flexible gastrocnemius muscle is illustrated by greater ankle dorsiflexion range. The contribution of dorsiflexion range to FA injury is complex. Plantarfasciitis (Patel and DiGiovanni 2011) and achilles tendinopathy (Gurdezi et al. 2013) are problems often reportedly associated with limited gastrocnemius length. Similarly, studies report compromised tissue repair and compensatory motions at other joints of the FA due to limited ankle dorsiflexion following a sprain (Denegar and Miller III 2002). However, studies have also found that greater musculotendinous stiffness may enhance spinal stretch reflex sensitivity potentially improving joint stability (Blackburn et al. 2008). Values for passive dorsiflexion in the non-dancing population varies between 5 and 10º (DiGiovanni and Justin Greisberg 2007), approximately 5º less than that demonstrated by the subjects in the current population (Cahalan et al. 2014b). Limited ankle dorsiflexion has been found to increase predisposition to injury in paediatric and sporting populations (Tabrizi et al. 2000, Malliaras et al. 2006). However a link between ankle ROM and injury has not been supported empirically in dance (Wiesler et al. 1996). The majority of ID steps are performed on the toes, with the heels rarely in contact with the floor. Complaints of calf pain and injury in this cohort are unsurprisingly common, second only to FA problems (Cahalan et al. 2014b). It is feasible that more flexible gastrocnemius musculature and greater ankle dorsiflexion results from efforts made to avoid or address calf or shin pain and injury.

Professional dancers have been previously been reported to demonstrate similar fitness values to aged-matched healthy sedentary individuals (Rafferty 2010), The SPARQ test used in this study is designed to assess lower limb agility and endurance. Originally designed for soccer and basketball players, it mimics the highly explosive and relatively brief duration of Irish dances (TopEndSports 2013). In this study, those in the MT group performed on average 7.5 more jumps than those subjects in the NT group. It is acknowledged that due to the retrospective nature of this study, it is impossible to ascertain if levels of physical fitness have been altered as part of rehabilitation of a previous injury. However, the current findings may indicate that a higher level of physical fitness may not be protective against injury. It may also suggest that those subjects willing to push themselves to the limits of their endurance are more likely to become injured due to the higher level of their exertions.

6.4.4 Health and Psychosocial Factors

Several general health and psychosocial factors were also significantly linked to MT group membership. Large population studies have previously identified significant associations between levels of chronic pain, female gender, high levels of psychological distress and poor self-rated health (Tschudi-Madsen et al. 2011). Many of these factors have also been associated with greater total body pain and injury in sporting populations with a recent consensus paper in high-intensity athletes endorsing existing research that psychological and socio-cultural factors do affect sport injury risk, response and recovery (Wiese-Bjornstal 2010). In dance, poor social support combined with high life stress has long been recognised as contributing to the risk of sustaining pain and injury generally (Patterson et al. 1998). There is a paucity of evidence linking FA pain and injury specifically with psychosocial factors. However studies report that dancers display higher levels of distress than the general population when suffering a musculoskeletal pain or injury (Air 2013) with stress and coping strategies impacting injury frequency and duration in elite dancers (Jacobs et al. 2012). The findings of this study provide initial indications that elite Irish dancers share many of the biopsychosocial traits that may predispose their counterparts in other genres to pain and injury. However given the cross-sectional and retrospective nature of this study, no clear conclusions can be drawn regarding causation of FA pain and injury in this population.

6.4.5 Limitations

As a retrospective study, some errors of omission and recall are likely, and the frequency of minor FA pain and injury may be understated or overstated. Injuries in this study were self-reported and not diagnosed by medical personnel which may suggest diagnostic inaccuracies and reporting bias. As this study examined FA pain and injury generally, no conclusions may be drawn about risk factors for specific FA disorders. The heterogeneous definition of pain and injury which exists in the literature historically makes comparisons between studies difficult if not impossible. The level of statistical significance was not adjusted for multiple comparisons. Finally, the relatively small sample size, particularly in the NT group, is an additional limitation.

6.5 Conclusion

The level of FA pain and injury sustained in elite adult ID is significant and comparable to pain and injury rates in other dance genres, particularly ballet. Several biopsychosocial factors are associated with the Irish dancers' risk of FA pain and injury. Female gender, more subjective general health and psychological complaints, more bodily parts being affected by pain and injury, more severe and bothersome levels of day to day pain were all significantly related to MT group membership. Additionally, greater gastrocnemius flexibility, better single leg balance and a higher number of endurance jumps were significantly related to belonging to the MT group. This study examined factors predisposing Irish dancers to FA pain and injury in general and did not examine specific FA conditions. Further prospective research in this area is necessary in order to determine the exact relationship between these findings and FA pain and injury in ID.

CHAPTER 7: INABILITY TO PERFORM DUE TO MUSCULOSKELETAL PAIN AND INJURY IN ELITE ADULT IRISH DANCERS: A PROSPECTIVE INVESTIGATION OF CONTRIBUTING FACTORS

Submitted to British Journal of Sports Medicine, October 2014.

Roisin Cahalan, Dr. Helen Purtill, PhD, Prof. Peter O'Sullivan, PhD, Dr. Norma Bargary, Dr. Orfhlaith Ni Bhriain, Dr. Kieran O' Sullivan, PhD

Abstract

Background: Previous research in Irish dancing (ID) has reported high levels of pain and injury in this cohort. Screening protocols in other genres have been developed to identify and address the needs of at-risk dancers.

Aim: To examine the factors which relate to absence from dancing due to musculoskeletal pain and injury in ID. To inform guidelines for the development of an evidence-based screening protocol

Methods: Baseline subjective data (n=85) and physical data (n=84) were collected by experienced physiotherapists. Subjects completed a monthly online questionnaire for one year providing data on general physical and psychological health and rates of pain/injury. Subjects were allocated to a "More Time Absent (MTA)" or "Less Time Absent (LTA)" category depending on their duration of absence from performance over the year.

Results: Eighty-four subjects completed the year-long follow up (MTA: n= 32, LTA: n=52). 278 complaints of pain/injury were recorded with only 15(17.9%) subjects recording no dance absence throughout that period. Binomial logistic regression was used to examine differences in the baseline demographic, psychosocial and physical variables between the MTA and LTA groups. Factors significantly associated with membership of the MTA group included lower mood (anger-hostility subscale) (p=0.003), more severe previous pain/injury(s) (p=0.017), a higher level of general everyday pain (p=0.020), a higher number of subjective health complaints (p=0.026), more body parts affected by pain/injury (p=0.028), always or often dancing in pain (p=0.028) and insufficient sleep (p=0.043). No physical factors were significantly associated with membership of the MTA group.

Conclusions: While pain/injury in ID is commonplace, several inter-related biopsychosocial factors appear to be associated with more absence from dancing due to pain/injury in this population. Screening protocols and prevention strategies should examine an extensive range of biopsychosocial factors to best identify at-risk dancers.

7.1 Introduction

Few traditional dance forms have achieved the levels of international participation and awareness enjoyed by Irish dancing (ID) (Brennan 2004). As in other dance genres however (Thomas and Tarr 2009) the accompanying risk of musculoskeletal pain and injury in ID can be substantial. Studies have reported rates of injury ranging from 55.9% (Stein et al. 2013) in adolescent amateur Irish dancers to 76.6% (Cahalan and O'Sullivan 2013a) in adult professional Irish dancers. Previous cross-sectional research has identified that a combination of biopsychosocial and individual factors were associated with pain and injury in elite adult Irish dancers (Cahalan et al. 2014b). These factors included female sex, more subjective general health and psychological complaints, lower mood, higher catastrophising, and failure to always complete a warm-up.

In other more established genres of elite dance, the use of evidence-based screening protocols has been recommended to identify dancers at greater risk for sustaining injury (Liederbach et al. 2012). Historically the success or otherwise of such screening programs to identify and reduce risk factors for pain/injury in dancers has varied (Weigert and Erickson 2007, Allen et al. 2013). Additionally the content of screening protocols has been highly variable with some programs examining only physical characteristics of the dancer (Weigert and Erickson 2007) while others examine a diverse range of intrinsic and extrinsic factors (Luke et al. 2002). The applicability of balletic screening protocols to ID may be limited due to the stylistic elements unique to ID. The distinctive stationary torso and arms, and lower limbs which move predominantly in the sagittal plane present particular challenges to the balance, flexibility and strength of the Irish dancer. Additionally, all the published research conducted in the area of ID to date has been retrospective, and therefore limited by the inherent possibility of errors of recall and omission, and cross-sectional studies by their nature cannot imply causation.

Therefore, this study prospectively examined the factors which relate to absence from dancing due to musculoskeletal pain and injury in ID, to inform guidelines for the development of an evidence-based screening protocol.

7.2 Methods

7.2.1 Subjects

Eighty five elite adult Irish dancers were recruited through the contacts of one author (RC) who is an ID teacher and former professional Irish dancer. The study cohort was comprised of professional dancers, competitive Irish dancers and student Irish dancers. Professional dancers were required to have spent at least eight months of a consecutive 12 month period working as a paid Irish dancer. Competitive dancers must have competed in solo competition within the previous five years at the World Championships or relevant national Championships. Student dancers were those in full-time university education studying ID. Subjects of both sexes, aged 18 years or older, were invited to participate. Invitation to participate was issued via ID schools, ID productions and social media. Due to the nature of recruitment, the participation rate in this study cannot be established. Written informed consent was provided by all subjects.

7.2.2 Study procedure

Baseline subjective data (n=85) and physical data (n=84) were collected by experienced physiotherapists. One subject was not available for physical screening due to time constraints. This cohort was part of a larger subject group of 104 dancers. Nineteen subjects did not wish to participate in the 12 month follow-up period. The subjective questionnaire (Table 7.1) collected data on physical and psychological health, dance and pain/injury history, and levels of participation in other athletic activities. Validated psychometric tools were used to gather information on the subjects' characteristics in areas including pain beliefs and management, performance, levels of stress, catastrophising, mood, self–efficacy, nutrition and sleep. The physical examination (Table 7.2) was based broadly on the screening recommendations of the International Association for Dance Medicine & Science (IADMS) (Liederbach et al. 2012). The physical screen included measures of anthropometry, lower limb flexibility and power, foot pronation, single leg balance, hypermobility, endurance, pain pressure thresholds, and several functional movement tests (squat and bilateral lunge). Full details of the precise subjective and physical screening measures are reported elsewhere (Cahalan et al. 2014b). Subjects baseline pain/injury status had already been categorised as "Significantly Injured (SI)" or "Not Significantly Injured (NSI)" based on self–reported absence from dance and pain frequency and severity over the year (Cahalan et al. 2014b).

Subjects completed a brief online questionnaire every month over the subsequent year. Subjects were asked to rate their general overall health and energy levels over the previous month. Subjects reported whether or not they suffered from any of the health complaints on the Subjective Health Complaints Inventory (SHCI) each month (Tschudi-Madsen et al. 2011). Similarly subjects recorded whether or not they suffered from a range psychological problems each month (Table 7.2) (Brinson and Dick 1996). Subjects recorded the details of any rehearsal/performance time missed through illness or musculoskeletal pain/injury. Absences due to illness and/or pain/injury were recorded separately. Pain/injury was defined as any physical complaint that caused absence from one or more rehearsal or performance days. Illness was categorised using the World Health Organisation's International Classification of Diseases Version 10 (ICD-10) (WHO 2010).

Table 7.1: Questionnaires used in subjective screening

Test Element	Outcome Measure	Description
Subjective Health Complaints	Subjective Health Complaints Inventory (SCHI) (non-musculoskeletal items)	The SCHI concerns subjective somatic and psychological complaints experienced during the previous 30 days. Thirteen items including palpitations, chest pain, breathing difficulties, heartburn, stomach discomfort, diarrhoea, constipation, eczema, tiredness, dizziness, anxiety, depression/sadness and sleep problems were assessed (Tschudi-Madsen et al. 2011). Higher scores indicate a greater level of subjective health complaint.
Subjective Psychological Complaints	List of common psychological complaints drawn from the "Fit to Dance" study of 1996 (Brinson and Dick 1996)	Subjects identified if they had suffered from any of the following common psychological complaints over the previous 30 days: general anxiety, tension with people, performance anxiety, depression, externally mediated stress such as home-sickness, overuse of drugs/alcohol, disordered eating, issues of self-confidence, difficulties concentrating during performance/rehearsal, and sleep problems. Higher scores indicate a greater level of subjective psychological complaint.
Troublesome Bodily Areas	Standardised Nordic Questionnaire (SNQ) (body map)	The SNQ is used to record musculoskeletal complaints. A body map was used by subjects to indicate nine symptom sites including neck, shoulders, upper back, elbows, low back, wrist/hands, hips/thighs, knees and ankles/feet (Tschudi-Madsen et al. 2011).
Pain Catastrophising	Coping Strategies Questionnaire (CSQ) Catastrophising subscale	The CSQ (catastrophising subscale) is a seven-item questionnaire which assesses the frequency of patients' use of pain coping strategies. A higher score indicates greater levels of catastrophising (Rosenstiel and Keefe 1983).
Mood	Profile of Moods State (POMS)	The POMS assesses transient, fluctuating feelings, and enduring affect states (McNair et al. 1971). Three subscales of the POMS namely tension-anxiety, anger-hostility and confusion-bewilderment were completed (McNair et al. 1971). Higher scores indicate greater levels of anxiety, anger and confusion.
Stress	Depression Anxiety Stress Scale (DASS)	The DASS is designed to measure depression, anxiety and stress.The stress subscale only was completed (Lovibond and Lovibond 1995). A higher score indicates greater levels of stress.

Performance	Athletic Coping Skills Inventory-28 (ACSI-28)	The ACSI-28 (Smith et al. 1995) examines coping and self-efficacy under seven domains including coping with adversity, peaking under pressure, goal setting/mental preparation, concentration, freedom from worry, confidence and achievement motivation, and coachability. Scores range from a low of 0 to a high of 12 on each subscale, with higher scores indicating greater strengths on that subscale
Disordered Eating	Sick, Control, One stone, Fat, Food (SCOFF)	SCOFF is a five-item questionnaire used to assess the possible presence of an eating disorder (Morgan et al. 1999). A score of two or more indicates disordered eating.
Sleep	Sleep quality and quantity	Sleep was categorised into sufficient, intermediate or insufficient Insufficient sleep was defined as sleeping 6 hours or less per day, or often having nightmares, tiredness or general sleep problems; Intermediate sleep was defined as sleeping 7 hours or 10 hours or more per day, or having nightmares, tiredness or general sleep problems to some extent or sometimes; Sufficient sleep was defined as sleeping 8–9 hours per day and having no nightmares, tiredness or general sleep problems (Auvinen et al. 2010).

Table 7.2: Test elements of physical screening protocol

Test Element	Outcome Measure	Procedure
Anthropometric Measures	Body Mass Index (BMI) (kg/m^2) Waist: Hip Ratio	Height and weight, and waist and hip measures were taken to calculate BMI and waist:hip ratios respectively (Ljung et al. 2012).
Tissue Sensitivity	Pain Pressure Threshold (lbs)	Upper trapezius (UTr) and tibialis anterior (TA) muscles tested bilaterally using a calibrated handheld digital algometer (J-Tech Commander). An overall PPT score was calculated from the mean value of the four locations.
Gastrocnemius flexibility	Active ankle dorsiflexion (°)	Measured with knee extended using a handheld goniometer. The mean value of two trials was recorded.
Hamstring flexibility	Active hip flexion (°)	Measured with a Speedflexer™ device – subjects required to actively sustain a maximal straight leg raise for three seconds bilaterally. The subject was supine with the contralateral hip and knee. The mean value of two trials was recorded.
Foot pronation	Foot pronation (mm)	Foot pronation was compared in a seated, unloaded foot position and a loaded, standing foot position using an index card demarcated in millimetres (Charlesworth and Johansen 2010).
Single leg balance	Star excursion balance test (SEBT) postero-medial axis. (Hertel et al. 2006)	The SEBT is a measure of dynamic balance. The mean of three trials was recorded with results normalised to leg length measured in standing from the iliac crest to the medial malleolus (Gribble and Hertel 2003).
General joint hypermobility (GJH)	Beighton Hypermobility Score (BHS)	The 9-point BHS - scores of four or more are considered to indicate GJH (Beighton et al. 2012).
Cardiovascular fitness and endurance	Speed, Power, Agility, Reaction and Quickness (SPARQ) rating system. 30 second endurance jump (TopEndSports 2013) Recovery heart rate (Tomlin and Wenger 2001).	Dancers were required to repeatedly jump over a 12 inch soft hurdle with both feet and land on both feet on the other side of the hurdle for 30 seconds. Number of jumps, resting heart rate, heart rate immediately following the test (maximal heart rate) and heart rate 30 seconds post-test were also recorded using a finger pulse-oximeter (Nonin Onyx™). Recovery heart rate was calculated was calculated by subtracting heart rate at 30 seconds post-test from maximal heart rate.
Functional tests	Functional Movement Screen (FMS)	Three test elements (deep squat and bilateral in-line lunge) of the FMS were used to identify any lower limb range limitations and side to side movement asymmetries (Cook 2003). The best attempt of three trials was recorded. A

		maximal score of three was attainable in each of three tests (total score range 0-9).
Lower limb power/strength	Vertical leap (cm)	The difference between the maximum height reached during a double-footed countermovement jump and standing reach height (Wikstrom et al. 2007). Standing reach was measured with subjects' preferred arm elongated against a wall-mounted tape measure with feet flat on the ground. The best score of three trials was recorded.

Hrs= hours, kg/m^2 = kilograms per square metre, lbs = pounds, mm = millimetres, ° = degrees, %LL = percentage of leg length, cm = centimetres, yrs = years

7.2.3 Statistical Analysis

Subjects were allocated to a "More Time Absent" (MTA) group or a "Less Time Absent" (LTA) group based on the median number of days missed (n=14) and median number of months during which they reported absence due to pain/injury (n=2) over the one year follow-up period. Subjects were allocated to the LTA group if they missed 14 days or less dancing due to pain/injury, or they reported pain/injury during two months or less over the year. Thirty two (38.1%) subjects were allocated to the MTA group and the remaining 52(61.9%) subjects were allocated to the LTA group (Table 1). Baseline descriptive statistics are reported using mean (standard deviation (SD)) for symmetrically distributed variables, median [interquartile range [IQR]] for skewed variables, and frequency (percentage) for categorical variables. Binomial logistic regression was used to examine differences in the baseline demographic, psychosocial and physical variables between the MTA and LTA groups. A 5% significance level was used throughout the analyses. Statistical analysis was performed using IBM SPSS® Statistics V 20 (Armonk, New York, USA).

Table 7.3: Univariate group comparisons of demographic variables (n (%) or median (25th percentile, 75th percentile))

		MTA (n = 32)	LTA (n = 52)	Odds Ratio (95% CI)	p-value
Dance Status	Professional	8 (15.4%)	7 (21.9%)	1.68 (0.50, 5.68)	0.402
	Student	19 (36.5%)	12 (37.5%)	1.22 (0.45, 3.25)	0.699
	Competitive	25 (48.1%)	13 (40.6%)	*reference*	
Sex	Female	41 (78.8%)	25 (78.1%)	0.96 (0.33, 2.79)	0.938
Age		20 (19, 22)	20 (19, 23.5)	1.08 (0.93, 1.26)	0.337

MTA: More Time Absent. LTA: Less Time Absent

7.2.4 Ethical Analysis

Ethical approval was granted by the research ethics committee of the local University.

7.3 Results

Of the 85 initial subjects, one subject only provided two partially completed follow-up questionnaire over the 12 months of the study subsequent to the initial baseline testing. The data of this subject were omitted from this study. Seventy nine (92.9%) subjects completed all 12 follow-up questionnaires with monthly compliance ranging from 96.4% to 98.8%. In total, 278 different complaints of pain/injury were recorded in the year-long follow up period. The median [IQR] number of dancing days lost to pain/injury over the year was 14 [3.8, 30.3] with a mean(SD) of 20.4(9.90) subjects missing days dancing through pain/injury each month. The median [IQR] number of days missed over the year due to illness (other than musculoskeletal pain and injury) was 5.5 [0, 13.3], with a mean(SD) of 10.67(4.94) subjects suffering from illness each month. Only 15(17.9%) subjects missed no days of dancing throughout the one year follow-up period.

The bodily areas most often affected by pain/injury are outlined in Table 7.4. Of the 275 reports of pain/injury provided, subjects identified perceived contributory factors for 212(77.1%) of these complaints. Among the main perceived causes of pain/injury reported by subjects themselves were overuse and fatigue (32.5%), accidents (15.6%), previous injury (13.2%), poor stretch/warm-up (11.3%) and a number of biomechanical factors such as muscle weakness and growth spurts (11.3%). Other factors cited less often included unsuitable floors, older age, difficult choreography, stress, and cold ambient conditions.

Table 7.4: **Pain/injury locations**

	Pain/injury locations (n=275)	Irish dancers reporting each pain/injury(n=84)
Foot and Ankle	154 (55.8 %)	53 (63.1 %)
Knee	41 (14.9 %)	20 (23.8 %)
Shin	16 (5.8 %)	12 (14.3%)
Calf	15 (5.4 %)	10 (11.9 %)
Thigh	15 (5.4 %)	9 (10.7 %)
Lower back	5 (1.8 %)	5 (6.0 %)
Hip	8 (2.9 %)	8 (9.5 %)
Groin	1 (0.4 %)	1 (1.2 %)
Other	21 (7.6 %)	14 (16.7 %)

Baseline factors found to be significantly associated with membership of the MTA group included lower mood (anger-hostility subscale) (p=0.003), being SI at baseline (p=0.017), a higher level of general everyday pain (p=0.020), a higher number of subjective health complaints (p=0.026), more body parts affected by pain/injury (p=0.028), always or often dancing in pain (p=0.028) and insufficient sleep (p=0.043). While not statistically significant a trend (p=0.054) of more psychological complaints was seen in the MTA group. No physical factors were significantly associated with membership of the MTA group.

Table 7.5: Group comparisons of subjective variables: categorical data shown as count (percentage).

	LTA (n=52)	MTA (n=32)	Odds Ratio (95% CI)	p-value
Severity of previous injury(s) (% Severely Injured (SI))	14 (26.9)	17 (53.1)	3.08 (1.22, 7.77)	**0.017***
Warm Up (% Always)	28 (53.8)	14 (43.8)	0.67 (0.28, 1.62)	0.370
Smoking (%Yes)	8 (15.4)	5 (15.6)	1.02 (0.30, 3.44)	0.976
Disordered eating (% At risk)	9 (17.3)	4 (12.5)	0.68 (0.19, 2.43)	0.556
Sleep (% Insufficient)	19 (36.5)	19 (59.4)	2.54 (1.03, 6.27)	**0.043***
Injured previously (%Yes)	17 (36.2)	11 (37.9)	1.08 (0.41, 2.81)	0.877
Dance in pain (% Always/often)	15 (28.8)	17 (53.1)	2.80 (1.12 (7.00)	**0.028***
General everyday pain (%Yes)	22 (42.3)	22 (68.8)	3.00 (1.19, 7.59)	**0.020***
Bothersomeness of pain (% Not at all/slight)	30 (57.7)	13 (40.6)	0.50 (0.21, 1.23)	0.131
General Health (% Very good/Good)	43 (82.7)	26 (81.3)	0.91 (0.29, 2.84)	0.867
Energy (% Very much/Quite a lot)	38 (73.1)	22 (68.8)	0.81 (0.31, 2.13)	0.670

*Statistically significant, ♠ Chi-square test

Table 7.6: Group comparisons of subjective variable: descriptive statistics as mean (SD) or median (25th percentile, 75th percentile).

	LTA (n=52)	MTA (n=32)	Odds Ratio (95% CI)	p-value
Age				
Years dancing ♠	14.37 (4.40)	13.20 (5.68)	0.95 (0.87, 1.04)	0.294
Number of subjective health complaints	3 [2, 7]	5.5 [4, 8]	1.18 (1.02, 1.37)	**0.026***
Number of psychological complaints	1 [0, 2]	1 [1, 3]	1.31 (0.99, 1.72)	0.054
Cross training per week (hours)	3.8 [1.5, 6.0]	3.3 [2.0, 6.3]	1.04 (0.96, 1.34)	0.324
Number of body parts affected	3 [1.5, 4.0]	3.5 [2.5, 5.5]	1.32 (1.03, 1.68)	**0.028***
Coping Strategies Questionnaire				
Catastrophising subscale	6.5 [2.0, 12.0]	6.5 [2.0, 13.5]	1.00 (0.95, 1.07)	0.914
Profile of Moods State				
Anger-hostility	1 [0.5, 4.0]	4 [1, 7]	1.27 (1.08, 1.48)	**0.003***
Tension-anxiety	6 [2.5, 9.0]	5 [3, 8.5]	1.01 (0.90, 1.21)	0.922
Confusion-bewilderment	2 [1.0, 4.5]	3.5 [1, 8]	1.12 (0.99, 1.27)	0.066
Depression Anxiety Stress Scale (stress subscale)	8 [4.0, 14.0]	10 [6, 15]	1.02(0.97, 1.08)	0.434
Athletic Coping Skills Inventory-28				
Coping with Adversity	5.63 (2.80)	5.56 (2.35)	0.99 (0.84, 1.17)	0.902
Coachability♦	9.98 (2.31)	9.23 (2.32)	0.87 (0.72, 1.06)	0.158
Concentration	7.02 (2.02)	6.97 (2.48)	0.99 (0.81, 1.21)	0.918
Confidence and achievement motivation	6.87 (2.23)	7.41 (2.42)	1.11 (0.91, 1.34)	0.307
Goal setting and mental preparation	6.13 (2.75)	6.03 (2.81)	0.99 (0.84, 1.16)	0.867
Peaking under pressure	4.35 (2.65)	5.34 (2.67)	1.16 (0.97, 1.37)	0.101
Freedom from worry	5.42 (3.11)	5.97 (2.79)	1.06 (0.92, 1.24)	0.415

*Statistically significant, ♠ n = 51 in LTA group, ♦ n = 31 in MTA group

Table 7.7: Group comparisons of physical variables: descriptive statistics as means (Standard Deviation) or median (Interquartile range)

	LTA (n=52)	MTA (n=32)	Odds Ratio (95% CI)	p-value
Body Mass Index	21.3 [20.2, 23.5]	22.1 [20.2, 23.1]	0.98 (.81, 1.18)	0.832
Waist Hip ratio	0.78 [.73, 0.81]	0.77 [0.74, 0.82]	1.01 (0.94, 1.08)	0.875
Pain Pressure Threshold	22.8 [16.3, 27.2]	18.9 [15.4, 27.5]	1.00 (0.97, 1.04)	0.885
Navicular drop	6 (4, 9)	7 (4.5, 9.8)	1.05 (0.91, 1.21)	0.520
Functional Movement Screen	7 (6, 8)	8 (6.5, 8)	1.35 (0.99, 1.86)	0.062
Hamstring flexibility	90.25 (9.74)	92.65 (9.62)	1.03 (0.98, 1.08)	0.274
Gastrocnemius flexibility	14.66 (3.60)	13.95 (5.28)	0.96 (0.87, 1.07)	0.468
Balance	78.40 (7.87)	80.05 (7.83)	1.03 (0.97, 1.09)	0.350
Vertical leap	36.32 (9.54)	37.44 (7.55)	1.02 (0.96, 1.07)	0.576
Beighton Hypermobility Scale	2.22 (2.14)	3.03 (1.96)	1.21 (0.97, 1.50)	0.090
Number of Jumps	39.73 (10.14)	41.45 (10.01)	1.02 (0.97, 1.07)	0.465
Percentage heart rate max	83.90 (6.73)	82.25 (7.53)	0.97 (0.90, 1.04)	0.331
Recovery heart rate	12.5 (7, 20)	12 (10, 18)	0.99 (0.95, 1.03)	0.627

7.4 Discussion

7.4.1 Epidemiology and aetiology of pain and injury

This is the first study in ID to prospectively monitor subjects for incidence and perceived causes of pain/injury. The findings of this study support many previous retrospective findings in this and similar cohorts (Cahalan and O'Sullivan 2013a, Cahalan et al. 2014b). As in earlier studies, pain/injury was markedly more common in the foot and ankle region, with the knee, shin and calf also commonly affected (Cahalan et al. 2014b). In comparison to a retrospective study of professional Irish dancers, where 76.9% of subjects reported an injury at some stage in their career (Cahalan and O'Sullivan 2013a), 82.1% of the current cohort reported some level of pain/injury throughout the year of this study. Comparisons with rates of pain/injury in dance literature generally is fraught with difficulty due to an empirical lack of a uniform definition of pain/injury (Jacobs et al. 2012). However studies in elite populations of heterogeneous dance genres, have reported similar pain/injury rates (Jacobs et al. 2012). Consistently in the literature, overuse, fatigue and weakness, unsuitable floors/stages, and inadequate warm-up/stretching have been identified by dancers in studies as the main perceived predisposing risk factors for pain/injury (Bowling 1989, Brinson and Dick 1996, Murgia 2013). Similarly, subjects in this study highlighted many of the above factors as causative in their pain/injury.

7.4.2 Pain/injury history

Factors significantly associated with belonging to the MTA group included lower mood (anger-hostility), more severe previous injury(s), a higher level of general everyday pain, more subjective health complaints, more body parts affected by pain/injury, always or often dancing in pain and insufficient sleep. More psychological complaints also appeared to slightly increase the likelihood of being in the MTA group. The biopsychosocial model of pain states that one's experience of pain results from a combination of pathophysiology, psychological and sociocultural factors (Turk et al. 2011), and supports the intimate interconnection of many of the aforementioned risk factors. This model also elucidates how beliefs about pain can further serve to modulate both pain duration and intensity, and behaviours related to avoidance of work and activity (Turk et al. 2011, Crombez et al. 2012).
A novel finding of this study is that previous injury was not associated with membership of the MTA group ($p=0.877$). However being SI at baseline was significantly associated with higher levels of pain/injury. Several studies have found previous injury to be predictive of future injury (Bowling 1989, Evans et al. 1996, Wiesler et al. 1996). Indeed, many subjects in this study perceived previous injury to be a contributory factor in subsequent problems. In this study, SI at baseline was defined as a combination of time lost to dance in addition to substantial levels of pain when dancing, day to day pain levels and bothersomeness of daily

pain (Cahalan et al. 2014b). It is perhaps unsurprising then that greater levels of day to day pain, as well a higher number of pain sites in the body were also associated with membership of the MTA group. Subjects in the MTA group were also more likely to often or always dance in pain in comparison to their LTA counterparts. Of all the factors found to be statistically significant, these pain domains had the strongest association with membership of the MTA group as reflected by the higher Odds Ratios (OR) observed for these variables (Table 7.5).

It is well established that within dance subculture, performers are encouraged to conceal or minimise their pain/injury (McEwen and Young 2011). In a cohort of professional Irish dancers, 78.6% of subjects reported that they sometimes, often or always danced in pain (Cahalan and O'Sullivan 2013a). Frequently dancers will return to dance while still in pain due to the pressure from peers and/or management (Rivera et al. 2012). The consequent risk for dancers of developing persistent pain and concomitant psychological distress is well established (Anderson and Hanrahan 2008, McEwen and Young 2011). However, it is clear from this study that subjects suffering most from the aforementioned pain complaints were also those missing the most time from dance. Training load was not examined in this study, and therefore no clear conclusion can be drawn about the impact of load burden on pain domains. However the potential role of factors such as fear-avoidance behaviours (Turk and Wilson 2010) and personality type (Franklin et al. 2014) on the development of chronic pain and disability should be acknowledged. Also as subjects in the MTA group suffered more day to day general pain, as well as more subjective health complaints, physiological factors including a compromised immune system, greater central sensitisation and the Hypothalamic-Pituitary-Adrenal (HPA) axis may potentially be implicated (Buckley and Schatzberg 2005, Capuron and Miller 2011, Smart et al. 2011).

7.4.3 Sleep

As in the current study, research in large populations has shown sleep problems to be a pre-cursor to chronic widespread pain (Mundal et al. 2014) and closely associated with a higher number of pain sites in the body, mood disorders and tissue sensitivity (Okifuji and Hare 2011, Tschudi-Madsen et al. 2011, Salazar et al. 2013). Insufficient sleep in this study has the strongest association with membership of the MTA group after the aforementioned pain domains (OR = 2.54). In dance cohorts, absence due to injury has been found to be positively correlated with stress, sleep disturbances, daytime sleepiness, and negative mood states including anger, depression and tension (Adam et al. 2004), In a professional ballet cohort, sleep quality was found to be poorer than their aged matched counterparts, as was mental acuity and concentration. Sleep duration and efficiency further deteriorated prior to an important production premiere. The intense training regimes inherent in the dance profession have also been shown to lead to persistent fatigue, psychological distress and injury in the absence of sufficient recovery time (Galambos et al. 2005, Grove et al. 2012).

7.4.4 General medical and psychological health

A recent systematic review reported preliminary findings that social and psychological issues may adversely affect injury frequency and duration in dancers (Jacobs et al. 2012). In ballet, an increased risk of injury has been positively correlated with high stress and low mood, but ameliorated with good social support (Adam et al. 2004). In the current study, higher rates of anger/hostility were identified as the elements of mood significantly associated with pain/injury. In athletic cohorts, injury severity has been shown to be linked to levels of anger/hostility (Lavallée and Flint 1996) with anger found to be amongst the top three responses of athletes to injury occurrence (Clement et al. 2013). A large prospective study of young collegiate athletes showed that low mood, in particular anger, fatigue, tension and confusion, was a major contributor to life stress and was strongly predictive of future injury (Galambos et al. 2005). Hostility, particularly inter-personal difficulties, has been identified by several diverse cohorts of professional dancers as one of the main psychological problems encountered in their working lives (Brinson and Dick 1996, Byhring and Bø 2002, Cahalan and O'Sullivan 2013a).

However, as is clear from the aforementioned list of perceived risk factors, dancers themselves fail to identify the majority of factors found to contribute to pain/injury. In this study, no subject identified poor general health or anger/hostility as potential contributors to injury. Although fatigue was widely cited as problematic by subjects, sleep was not mentioned as a perceived risk factor for pain/injury by any dancer. This would suggest that although dancers are cognisant of the presence and negative impact of impaired general health and psychosocial factors, they do not see these as being causative in the occurrence of musculoskeletal pain/injury. This mismatch between dancers perception of what contributes to their pain/injury and the factors suggested by the data, highlight an area where appropriate education may help to inform dancers of potential risk factors not previously considered.

Subjective well-being is inextricably linked with psychological health and it is well established that somatic complaints may be manifestations of underlying psychological issues (Afari et al. 2014). In elite dancers, increased occupational stress has been linked to a host of somatic complaints similar to the subjective health complaints investigated in this cohort (Hernandez 2012). Furthermore, increased levels of illness (symptoms of upper respiratory tract infection and/or gastrointestinal discomfort) and sleep disturbance have been reported in endurance athletes suffering from symptoms of fatigue and over-reaching during intensive training periods (Hausswirth et al. 2013). Empirically, dance literature has focussed on recording levels of pain/injury, with illness rates rarely recorded. A novel surveillance system in elite Norwegian ballet dancers has reported illness rates of 9%, in comparison to injury prevalence of 64% in the same cohort (Fredriksen and Clarsen 2014). This compares well with the illness (exclusive of musculoskeletal pain/injury) prevalence rate of 10.67% in the current study. In this and our previous research (Cahalan et al. 2014b, Cahalan et al. 2014c) a higher number of subjective health complaints has consistently been associated with more pain/injury, suggesting this is an area that should not be overlooked when screening Irish dancers for pain/injury vulnerability.

7.4.5 Considerations for Screening

This study supports recent calls advocating for multifaceted screening programs which adopt a biopsychosocial approach when assessing dancers and indeed other active/athletic populations (Liederbach et al. 2012). It is becoming clear that biopsychosocial factors in disparate genres including ID not only play a key role in time missed from dancing though musculoskeletal pain and injury, but are likely to be intimately interrelated with each other. The recent white paper by IADMS (Liederbach et al. 2012) provides guidelines for more homogenous and evidence-based injury surveillance and screening which would be applicable to the ID community. Although physical factors in this study were not associated with membership of the MTA group, better performance on the Functional Mobility Screen (FMS) ($p=0.062$) and greater hypermobility ($p=.090$) showed trends towards significance and are worthy of further investigation.

7.4.6 Limitations

The small sample size is the primary limitation in this study. Clinical applicability to the ID community as a whole is not supported. Days absent from dancing due to illness were not factored into the analysis as it was not possible to establish if those days overlapped with days injured or not. The appropriateness of a number of the physical tests including may be questionable. Examining the role of physical factors specific to each bodily area may show greater predictive ability. Finally, this study did not identify those subjects who may have had pain but continued to dance regardless. Going forward, precise and discrete definitions of pain and injury would be beneficial.

7.5 Conclusion

Pain and injury in ID are commonplace and comparable to rates in other elite genres. Lower limb injuries, particularly to the foot and ankle are highly prevalent. Higher rates of subjective health complaints, more severe previous injury, more painful bodily sites, more day-to day pain and pain when dancing, disordered sleep and increased anger/hostility were found to be significantly associated with membership of the MTA group. Screening protocols embodying these factors should be developed to identify Irish dancers at risk for pain/injury going forward. An absence of physical factors significantly related to membership of the MTA group supports a transition from an injury model of mechanical triggers and pathoanatomical change to a more pain driven model with a complex biopsychosocial foundation.

CHAPTER 8: DISCUSSION

8.1 Summary of Main Findings

This doctoral thesis of musculoskeletal pain and injury in elite adult Irish dancers has recorded several novel findings. Pre-existing research in this area was sparse, generally of limited quality and retrospective in nature (Cahalan and O'Sullivan 2013c). The evidence from the two studies included in the systematic review conducted in Chapter 2 (McGuinness and Doody 2006, Noon et al. 2010) identified that lower limb injuries, especially to the foot and ankle (FA) region, were common in Irish dancers. The systematic review also identified that factors such as not including a warm-up or cool-down, not using split-shoe sneakers for training, and performing at higher competitive levels, were associated with increased injury frequency (Cahalan and O'Sullivan 2013c). Amongst professional Irish dancers (PIDs) the FA was also the bodily region most often affected (Cahalan and O'Sullivan 2013a). Older and more experienced PIDs experienced greater levels of injury, with accident, fatigue/overuse and repetitive movements identified by PIDs as the main causes of injury. The qualitative study in Chapter 4 demonstrated that job satisfaction amongst this cohort was generally very high with the overwhelming majority of subjects happy to recommend a career in professional Irish dancing (ID) to aspiring young dancers (Cahalan and O'Sullivan 2013b). A wide range of positive and negative consequences of this career choice may inform guidelines for health professionals, choreographers and dance captains to optimise life on tour for these performers. The main positive attributes identified included the opportunity to travel and experience diverse cultures, the development of enduring friendships, the pursuit of a hobby as a financially lucrative career, evolving personal life skills, and the maintenance of good physical health and fitness. The main negative themes included the insecure and short-term nature of the career, physical consequences in terms of pain and injury, potentially damaging psychological consequences, and practical difficulties inherent in a touring lifestyle.

This thesis was then expanded to consider pain and injury in competitive Irish dancers and student Irish dancers in addition to PIDs (Cahalan et al. 2014b) to enhance generalisability of the research findings and facilitate ease of recruitment. The biopsychosocial screening of 104 dancers described in Chapter 5 identified several statistically significant factors which were cross-sectionally associated with a higher and more severe level of pain and injury. These factors included female sex, poor subjective and psychological health, a high level of catastrophising, and a reported failure to always perform a warm-up prior to dancing. This study also provided an initial physical and psychosocial profile of dancers in this cohort, which had never previously been described. As seen in Chapters 2 and 3 of this thesis, the FA region was the most commonly injured bodily area (Cahalan et al. 2014c) . Factors found to be significantly associated with a history of previous pain and injury in the FA region included female sex, greater gastrocnemius flexibility, better single leg balance and a higher number of endurance jumps. Affected subjects also reported more severe levels of day to day pain, more bothersome daily pain, a greater number of body parts experiencing pain and injury, more subjective health complaints and more psychological complaints.

In Chapter 7, the results of a one year prospective study of 85 subjects were discussed (Cahalan et al. 2014a). These subjects, with the exception of one dancer, were the same cohort previously discussed in Chapters 5 and 6. The findings of this paper, which is the first prospective study examining pain and injury in ID, reinforced many of the previous cross-sectional findings. As previously, a high rate of pain/injury was reported, with the lower limb, in particular the FA, most often affected. Factors associated with belonging to the MTA group included more severe previous injury(s), a higher level of general everyday pain, more body parts affected by pain and injury, always or often dancing in pain, insufficient sleep, higher number of subjective health complaints and lower mood (anger-hostility subscale). Physical screening factors were not significantly associated with membership of the "More Time Absent (MTA)" group, although a good performance on the Functional Movement Scale (FMS) and more hypermobility trended towards significance.

8.2 Developments in ID

Over the last twenty years, ID has experienced an unprecedented evolution. Formerly an insular art form, practiced only by the Irish and those of Irish descent, ID was overwhelmingly an amateur pastime. In the two decades since "Riverdance" debuted, dozens of ID productions have been developed, providing employment for thousands of Irish dancers. Although the World ID Championships run by "An Coimisiun le Rinci Gaelacha" (CLRG) has been an annual event since 1970, up until the past decade, the competitors were overwhelmingly drawn from the native Irish or Irish diaspora. In a monumental shift, the World Championships are now a truly international event with many dancers having no Irish heritage or claiming any ancestral link to Ireland whatsoever. The CLRG, which is only one of a number of governing bodies for ID, recognises ID schools from more than 30 countries in five continents (CLRG 2012).

As possibilities to forge a career as a PID evolved, choreography in competitive ID became increasingly intricate and demanding. With the internationalisation of ID, the influences of other dance forms are to be seen in the choreography of modern ID. In particular, a number of ballet steps such as the "entrechat" and the "cabriole" have been modified and adopted by Irish dancers. PIDs furthermore frequently use their arms, with the men creating strong, sharp lines and the women favouring more graceful ballet influenced upper limb movements.

However in competitive ID, the typical upright torso with the arms controlled firmly by the sides is still all important. A number of other chorographical features are quite unique to ID. These include the movements of the legs which are predominantly in the sagittal plane. Any hip abduction is limited and internal hip rotation should never be seen. It is unsurprising given the postural peculiarities of ID that lower limb asymmetry has been found in one of the few studies examining the biomechanics of this form of dance. (Cromie et al. 2007). Despite the growing international popularity of ID, research into musculoskeletal pain and injury remains sparse in the area.

8.3 Subject Recruitment

Subjects were recruited through the contacts of the author who is an ID teacher and a previous PID. An email was sent to several ID bodies explaining the aims and objectives of the study. The author then distributed the initial survey questionnaire (Chapters 3 and 4) via a number of channels. Professional touring ID companies including Riverdance, Lord of the Dance, Hammerstep, Rhythm of the Dance, and Magic of the Dance were contacted. Representatives of the two main governing bodies involved in ID (An Coimisiun le Rinci Gaelacha (CLRG) and An Comhdhail) were sent the questionnaire as was The Marie Duffy Foundation, which is a body supporting novel initiatives in ID. The survey was also sent to key staff in the Irish World Academy of Irish Music and Dance (IWAMD) at the University of Limerick. Personnel at the institutions contacted were advised of the inclusion/exclusion criteria governing the recruitment of subjects. The author asked that dancers matching these criteria be sent the survey questionnaire and requested to complete it. In addition, the author distributed the questionnaire to former dance colleagues and requested that they complete the survey and forward it to other appropriate dancers known to them. No additional feedback from the organisations/individuals contacted was sought or received by the author. It is unknown how many dancers in total received the survey, and what percentage of that number actually completed and returned the questionnaire. In addition, it was impossible to know if the same dancer received the survey questionnaire from multiple sources several times. As such, it was impossible to accurately calculate the response rate of this survey questionnaire.

8.4 Development and Choice of Research Tools

With the completion of the systematic review investigating pre-existing research in ID (Chapter 2), it was clearly established that a there was a substantial lack of relevant studies or data available in this field. The decisions regarding how to progress were based on pre-existing protocols in injury prevention in sport (Van Mechelen et al. 1992, Finch 2006), balanced with the most expedient and practical method of gathering pertinent information. In line with the first step in the aforementioned protocols, it was decided to conduct injury surveillance to establish the extent of the problem using an online survey tool (Chapters 3 and 4). This tool was chosen in light of the potential geographical spread of subjects and the efficiency and cost-effectiveness this approach would allow. As little comparable research in ID was available, the questionnaire was modelled on pre-existing sources from other genres of dance (Hincapié et al. 2008, (Jacobs et al. 2012) and informed by comparable studies in the world of sport. Much of the initial online questionnaire was based on the "Fit to Dance" study (Brinson and Dick 1996), which sought to establish the epidemiology and aetiology of injury across a range of dance genres and levels in the United Kingdom. Questions pertaining to bodily location of injury, perceived causes of injury, psychological issues suffered while dancing, support services available and management of injury and return to dance post injury were all closely based on the "Fit to Dance" study. A notable addition made in this study to the "Fit to Dance" questionnaire was the inclusion of the General Self-Efficacy Scale (GSES)

(Luszczynska et al. 2005). This ten-item psychometric scale assesses coping strategies employed in difficult situations, with a higher score indicative of greater self-efficacy. Recent findings in dance (Noh et al. 2005)) and sport (Wiese-Bjornstal 2010) had both highlighted the importance of coping and psychosocial factors in the incidence of pain/injury in these populations. The question providing the basis for Chapter 4 which investigated job satisfaction of PIDs was a final addition to this questionnaire. Although the detailed level of response received to this question was unanticipated, the decision to include this question was based on findings in mainstream life that job satisfaction influences a plethora of career factors and personal wellbeing (Clark 2009, Ahmad et al. 2010).

The inherent limitation of over-reliance on one open-ended question as the basis for an entire study was recognised and addressed by the use of focus group. Focus groups have been found to be appropriate research tools for the introduction and development of themes particularly at the preliminary or exploratory stages of a study (Kreuger 1988). The use of focus groups allowed for confirmation of many of the themes raised by the subjects who responded to the questionnaire. One additional theme generated by the focus groups was the practical difficulties of day to day life when on tour in an unfamiliar location with cultural and language obstacles. It is theorised that this theme emerged as focus group members were experiencing those issues at the time of interview.

The design of the questionnaire used in the cross-sectional studies (Chapters 5 and 6) and as the source of baseline data for the prospective study (Chapter 7) was based on findings yielded from the initial survey and on-going developments from the world of dance research. It was recognised that the time-loss definition of injury was problematic in that it did not potentially reflect the experience of subjects who continued to perform despite considerable levels of pain. In addition, research had indicated that dancers will often use the words “pain” and “injury” interchangeably (Tarr and Thomas 2011) and there was a need to account for this complexity. To address this, a greater number of pain domains including number of bodily sites experiencing pain, levels of day to day pain, and bothersomeness of daily pain were investigated. Findings in the PID cohort (Chapter 3) had not yielded any significant findings regarding coping and injury using the GSES, so this outcome measure was replaced by the Athletic Coping Skills Inventory-28 (ACSI-28) (Smith et al. 1995) which examines coping and self-efficacy in a sporting population. Factors identified in dance literature such as eating disorders in females (Ringham et al. 2006), negative mood (Adam et al. 2004), catastrophising (Anderson and Hanrahan 2008) and sleep (Grove et al. 2012) were also investigated in the elite cohort.

The elements of the physical screening program were based largely on the recommendations of the International Association for Dance Medicine & Science (IADMS) (Liederbach et al. 2012). There were some amendments made including the use of the Speed, Power, Agility, Reaction and Quickness (SPARQ) rating system (TopEndSports 2013) fitness test and the Functional Movement Screen (FMS) (Cook 2003). These tools were used in an attempt to more closely match the chorographical nature of ID, in addition to time constraints imposed by the limited availability of subjects. The limitations of some of these measures are recognised and recommendations for further research into more appropriate tools are made. As it became clear that general health measures and psychological issues appeared to be closely associated with levels of pain/injury, these factors were chosen as key components of the follow-up online survey. Specific questions on training load and illness were also included. This online questionnaire was necessarily brief to encourage compliance and allow ease of completion.

8.5 Epidemiology of pain and injury

Several findings in this thesis correlate well with the results of similar studies both in ID and other genres. As in previous retrospective ID studies, substantial rates of pain/injury were incurred by dancers, with the lower limb, particularly the FA region most commonly affected (McGuinness and Doody 2006, Noon et al. 2010, Stein et al. 2013). The five year pain/injury rate of 79% recorded by McGuinness and Doody, (2006) correspond well with the PID rate of 76.6% (Cahalan and O'Sullivan 2013a) and the one-year prospective pain and injury rate of 82.1% recorded in the elite adult cohort (Chapter 7). The slightly higher rate of injury in the prospective study may be accounted for by the omission of lesser injuries in the retrospective studies due to errors of recall. Rates of pain and injury recorded in other genres are by no means consistent. A 2008 systematic review of musculoskeletal pain and injury in dancers reported levels among various genres ranging from 3% to 95% (Hincapié et al. 2008). However several studies reporting levels of pain and injury similar to those found in ID are to be found. A rate of 74% has been reported in a cohort of university and professional ballet, contemporary and theatre dancers (Chmelar et al. 1987). A 2009 British survey of professional and student dancers reported an injury rate of 80% (Thomas and Tarr 2009) and injury in modern, theatrical, and classical dance has been found to range from 67% to 95% (Bronner et al. 2003b).

As stated, the lower limb, in particular the FA region, is often the most common site of pain and injury reported by dancers. 48.4% of subjects questioned during the establishment of baseline data in the elite adult ID cohort identified that they had suffered pain and injury to the FA region (Cahalan et al. 2014b). Prospectively, 46.2% of subjects reported pain and injury to the FA region over the course of the one-year study. Levels of FA pain and injury in elite ballet and modern dance have been found to range from 34% to 62% (Kadel 2006) with a recent study in ID reporting an incidence of FA pain and injury of 55.9% (Stein et al. 2013). Pain and injury to the lower back, which are sometimes cited as the most common musculoskeletal problem in ballet, are associated predominantly with those male dancers required to lift their partners (Alderson et al. 2009). Likewise, chorographical differences are likely to explain why the neck, shoulder and spine in DanceSport (McCabe et al. 2013) and knee and spine in breakdancing (Kauther et al. 2009), appear to be most often affected.

Much of the discrepancy in the levels of injury reported may be attributed to the lack of a uniform definition of injury in the literature. In this thesis, a time-loss definition of injury was used throughout and was based on elements of the following definition of injury: (Bronner et al. 2006)

> " a physical complaint sustained by a dancer resulting from performance, rehearsal, or technique… resulting in a physical complaint, medical injury, **time-loss** and/ or financial injury". (Bronner et al. 2006, p 69)

In a 2012 systematic review, it was stated that one of the most persistent problems in scientific dance research was the inconsistent, or indeed lack, of a definition of injury (Jacobs et al. 2012). Varied definitions of injury in the literature included the ability to perform only certain elements of a performance (Bronner and Brownstein 1997), the requirement for review or treatment by a health care professional (Byhring and Bø 2002), or a musculoskeletal complaint leading to financial costs incurred by the dance company (Bronner et al. 2003a). In 2012, the IADMS recommended that injury be defined as:

> “an anatomic tissue-level impairment as diagnosed by a licensed health care practitioner that results in full time loss of activity for one or more days beyond the day of onset” (Liederbach et al, 2006, pg 144)

It was further advised by the IADMS that any musculoskeletal complaints that do not meet these criteria do not form part of any injury surveillance system. Liederbach et al acknowledged however that use of this definition may just record the “tip of the iceberg” in terms of actual levels of dancer injury. Undoubtedly, the variety in how injury is defined will have an impact on reported rates of same incurred by dancers. In this thesis, it was decided to use a time-loss definition of injury as this definition has been identified as the most widely accepted and generally used definition in sports injury, including dance (Liederbach et al. 2012). As such, this allowed for some comparison of findings with existing reports of levels of pain and injury in dancers and other sporting populations. It is acknowledged that this definition is not without problems, including the under-reporting of non-time-loss injuries and the purported unreliability of time-loss injury definitions without diagnostic confirmation by an appropriate medical professional (Liederbach et al. 2012).

8.6 Perceived causes of pain and injury – the dancer perspective

A common thread running through many studies in dance empirically has been the perceived causes of pain and injury reported by dancers from many traditions. Consistently for several decades, overuse, fatigue and weakness, unsuitable floors/stages, and inadequate warm-up/stretching have been identified by dancers in studies as the main predisposing factors for pain and injury (Bowling 1989, Brinson and Dick 1996, Murgia 2013). These factors were also reported by the elite and PIDs involved in Chapters 3, 5 and 7 of this thesis (Cahalan and O'Sullivan 2013a, Cahalan et al. 2014b). Subjects also identified “accident” as a main cause of pain and injury in Chapters 3, 5 and 7. However, as the causes of accidents were not recorded, it is impossible to know if "accident" is a valid, stand-alone cause or a consequence of another factor such as fatigue or unsuitable flooring for instance.

Of late, the modulating impact of general health and psychosocial issues has been evermore associated with levels, and persistence, of pain and injury (Kamaleri et al. 2009, Tschudi-Madsen et al. 2011). A consistent finding in all the relevant studies in this thesis was that a higher number of subjective health complaints, higher levels of day to day pain and pain when dancing, and more bodily areas being affected by pain were associated with more absence from dance due to pain and injury. Sleep and mood have also emerged prospectively as importance factors in this regard. In their 2012 systematic review, Jacobs et al. reported preliminary findings that social and psychological issues may affect injury frequency and duration. The Irish dancers in Chapter 3 identified interpersonal stress as one of the main psychological problems encountered in their working lives (Cahalan and O'Sullivan 2013a). This echoed the findings in earlier cohorts of professional dancers in Britain (Brinson and Dick 1996) and Norway (Byhring and Bø 2002).

Interestingly however, dancers themselves rarely identify poor general health or negative psychosocial factors as contributing to pain and injury. Among the population of PIDs surveyed, psychological strain was highlighted as one of the main negative themes associated with the career of a PID (Cahalan and O'Sullivan 2013b). Subthemes included loneliness, homesickness, low self-esteem and low confidence, bullying, and an increased propensity for drug and alcohol abuse as well as eating disorders. However in this same population, only one subject identified psychosocial factors as being potentially associated with a higher risk of pain and injury (Cahalan and O'Sullivan 2013a). Similarly in the prospective study reported in Chapter 7, subjects perceived that stress played a causative role in only 2.5% of incidents of pain and injury reported (Cahalan et al. 2014a). This would suggest that even though Irish dancers are cognisant of the presence and negative impact of psychosocial factors, they are yet to draw a connection between the role of poor psychosocial health and higher frequency and duration of pain and injury. Likewise, mood, sleep or general health were not cited by any subjects in this cohort as potential risk factors for pain and injury. This is one of the key findings of this thesis and highlights the urgent need for dancer/teacher/parent education regarding the potential role of several diverse biopsychosocial elements as risk factors for pain and injury.

8.7 Pain versus injury and the biopsychosocial model of pain

As stated, a standard time-loss definition of injury was used consistently throughout this thesis. Pain however is a more elusive quality. The seminal 1960s work by Melzack and colleagues on pain gating is acknowledged as the first model to integrate biological and psychological mechanisms of pain (Melzack and Wall 1967, Melzack and Casey 1968). This model challenged the underlying tenets of the traditional biomedical model whereby pain was thought to result directly from actual physical damage to tissue (Mishler 1981). The subsequent biopsychosocial model of pain proposed that the experience of pain results from a combination of physical and/or general health and/or psychosocial factors, and that one's beliefs about pain can further serve to modulate both pain duration and intensity (Turk et al. 2011). The influence of psychosocial factors on the pain experience of individuals has been well established in several groups. These include patients suffering from chronic musculoskeletal (Pincus et al. 2013), rheumatologic (Nicassio et al. 2011), and neurological conditions (Michalski et al. 2011).

Research into the impact of psychosocial factors on pain and injury in dancers is limited and has been discussed in a number of the studies included in this thesis. Intrinsic factors including ambition, levels of catastrophising and social support have been shown to affect a dancer's pain experience (Hamilton et al. 1989, Noh et al. 2005). Dancers with musculoskeletal disorders presenting to health care professionals have also been found to display higher levels of psychological distress than non-dancing peers (Air 2013). It has been acknowledged in the literature that although pain is subjective, frequently dancers will ignore musculoskeletal pain until it becomes a severe injury (McCabe et al. 2013). Dancers have also been found to use the terms "pain" and "injury" interchangeably and sometimes incompatibly (Tarr and Thomas 2011). Additionally, dancers' beliefs regarding concerning "injury pain" and "performance pain" has been found to lead to different behaviours in dancers (Andersen 2005). Injury pain, which was perceived as potentially harmful, was found to lead to guarding, catastrophising and reduced self-confidence whereas performance pain was viewed more benignly as being under the voluntary control of the dancer and of brief duration. In Chapter 5, and 6, a greater number of psychological complaints were found to be associated with a higher level of pain and injury (Cahalan et al. 2014b). Subjects reporting more pain and injury also complained of a higher number of subjective general health complaints and lower mood. Prospectively, a higher number of psychological complaints approached statistical significance for membership of the "MTA" group. Likewise both cross-sectionally and prospectively, dancers who experienced more severe or more bothersome day to day pain, with more bodily sites affected, or who more frequently danced in pain, were more likely to suffer from more pain and injury. The co-existence of a "pain history" and other factors including poor subjective health, low mood and poor sleep may potentially implicate a physiologically sensitised state and impaired immune system function (Capuron and Miller 2011). Developments in neurophysiology have found that a compromised immune system may have an adverse impact upon pain sensitivity (Ren and Dubner 2010) and present as a range of unhealthy behaviours including anxiety, fatigue and poor sleep (Capuron and Miller 2011). An important finding of this thesis was that previous injury was not found to be associated with an increased level of pain and injury in any cohort. This is in contrast to a number of studies in other forms of dance. (Evans et al. 1996, Wiesler et al. 1996). However, the severity of previous pain in addition to previous time-loss defined injury was found to be significant in Chapter 7. This has important clinical implications and means that health professionals must not only inquire about previous absences from dance due to pain and injury, but also investigate the impact of that pain, and its chronicity.

8.8 Screening for pain and injury in ID

Given the universally high level of pain and injury in dance, there has been an acknowledgement of the need for appropriate screening programs to identify and address the needs of vulnerable dancers. It has been acknowledged in the literature that empirically, investigations into the underlying causes of dancer pain/injury have focussed largely on the physical attributes of both the dance and dancer (Liederbach et al. 2012). The evidence presented in this thesis would suggest that this focus may be to the detriment of other potentially important biopsychosocial factors. Physical factors both cross-sectionally and prospectively were not significantly associated with a risk of more full-body pain/injury, although the potential importance of physical factors in pain/injury affecting localised body parts is acknowledged. However, even in Chapter 6 where a number of physical factors were linked to more FA pain/injury, several non-physical factors were also strongly associated with pain/injury. A study of prospective factors affecting FA pain/injury will be conducted in due course to test the theory that physical factors are more important when examining specific bodily areas.

The success or otherwise of previous screening programs to identify and reduce risk factors for pain and injury in dancers has varied. A small prospective study of 39 pre-professional ballet dancers over a nine-month period which examined a range of intrinsic and extrinsic factors failed to establish significant associations between levels of reported injury and risk factors apart from male sex and older age (Luke et al. 2002). Interestingly, this program did not investigate levels and/or chronicity of pain, sleep or mood – all of which were found to be significant factors in our prospective research. An intervention program conducted in university-level modern dancers which limited testing and consequent recommendations to the physical attributes of the subjects failed to see a change in injury rates in the short term (Weigert and Erickson 2007). However a prospective three-year study in ballet dancers which used injury history and functional movement screening to develop personalised intervention programs reported significant reductions in injury levels to both male and female dancers (Allen et al. 2013). The "Hybrid Intervention Model" used in this study addressed physical deficits only through strength training and conditioning using a cross-training approach. Rates of injury reduced significantly from year one to year three from 4.76 injuries per 1000 hours danced (4.76/1000 h) to 2.22/1000 h and by 4.14/1000 h to 1.81/1000 h for male and female dancers respectively. In the absence of any control group however, it is impossible to establish the comparative success of this intervention program and to control for the non-specific effects of such an intervention such as the increased attention received.

Recommendations for multifaceted screening programs to include a range of biopsychosocial measures have been made by many researchers in the world of dance (Bronner et al. 2006, Russell 2013) and most notably with the recent IADMS white paper on injury surveillance and screening (Liederbach et al. 2012). Prior to this body of work, no recommendations for screening in an ID context had been made. This thesis confirms a significant level of pain and injury among this cohort and identifies several factors across a range of biopsychosocial domains which appear to render certain subjects more vulnerable to significant pain and injury. The requirement and utility of an appropriate pain and injury screening program for Irish dancers would appear to be obvious. This research has highlighted the importance of several domains including pain and injury, general medical and psychological health, lifestyle, social and physical domains which should be considered for any screening program for ID. Precise and potentially separate definitions of pain and injury should be developed as the foundation of any such screening program. A suggested definition of injury may require there to be a clear precipitating mechanism with demonstrable localised pathoanatomical findings, with clear aggravating and easing factors related to local movement, whereas a definition of pain may be developed based on existing pain mechanisms research (Smart et al. 2011).

Based on the evidence gathered in this thesis and evidence from other dance genres already discussed, a screening program embodying a biopsychosocial approach is supported. A proposed screening tool, with primary domains and associated subdomains, is presented exemplifying the evidence supporting, or not supporting, inclusion of various elements in ID. Table 8.1 shows the existing evidence for potential domains/subdomains of a proposed screening program in ID which are/are not supported by existing evidence. Results from the prospective study (Chapter 7) and two cross-sectional studies (Chapters 3 and 5) are shown in addition to research reporting associations between risk factors and FA pain/injury (Chapter 6). Additional elements endorsed by the IADMS but not yet investigated in ID are also shown.

Table 8.1: **Evidence in Irish dancing for potential screening protocol elements**

Domain	Subdomain	Evidence subdomain is a Factor*	Evidence subdomain is NOT a Factor*
Demographic	Age	1	2,3,4
	Sex	2,4	1,3
Dance history	Years dancing	1	2,3,4
	Level of skill	N/A	N/A
	Level of performance	N/A	N/A
Pain characteristics	Dance in pain	2,3	4
	Day to day pain	2,3,4	
	Bothersomeness of pain	2,4	3
Injury history	Previous pain/injury "Significant" previous injury		2,3,4
General medical and psychological health	Subjective health complaints	2,3,4	
	Psychological health complaints	2,4	1,3
	Menstrual history		2
	Bone density	N/A	N/A
	Mood	2,3	4
	Catastrophising	2	3,4
	Coping		2,3,4
	Energy		2,3,4
	Stress		2,3,4
Lifestyle/social	Sleep	3	4
	Nutrition		2,3,4
	Smoking		3,4
	Alcohol/drug use		2
	Warm-up	2,5	1,3,4
	Cool-down	5	1
	Cross-training		1,3,4
	Training load and monotony	N/A	N/A
Physical testing	Posture	N/A	N/A
	Flexibility	4♦	2,3
	Hypermobility		2,3,4
	Foot alignment		2,3,4
	Strength		2,3,4
	Balance	4♦	2,3
	Functional tests		2,3,4
	Fitness/endurance	4♦	2,3

	Pain pressure threshold		2,3,4
	Adiposity / Body fat composition		2,3,4
	Muscular reaction time	N/A	N/A
	Limb dominance	N/A	N/A
Environmental factors	Floor/stage construction	N/A	5
	Ambient factors – temperature, light, noise	N/A	N/A
	Costume/set design	N/A	N/A
	Employer policy regarding breaks	N/A	N/A
	Footwear	5♠	5♠

*Significance level of 0.05. N/A: Not assessed. 1: Professional cohort (Chapter 3), 2: Cross-sectional elite adult cohort (Chapter 5 , 3: Prospective elite adult cohort (Chapter 5), 4: Foot/ankle injury in elite adult cohort (Chapter 6), 5:Foot/ankle injury sub-elite cohort (McGuinness and Doody 2006).
♦ A better performance on these tests was significantly associated with more pain/injury. ♠ Split sole sneakers found to significantly reduce the risk of foot/ankle pain/injury. Shock absorbing heavy shoes and pomps did not.

It is the contention of this author that further study of a number of environmental factors here-in not investigated, and some improvements to the screening tool, may lead to improved prognostication of the model and therefore better outcomes for vulnerable dancers. A personalised intervention program based upon the outcome of such a screening program could then be developed. The precise nature of such an intervention, and the implementation and assessment of same, are beyond the scope of this thesis. However, it would appear that such a program should ideally also adopt a biopsychosocial approach to pain and injury.

8.9 Consistencies and inconsistencies

Many of the findings of this thesis are common to all ID cohorts examined. As mentioned, rates and locations of injury, and subjects' perceived risk factors for pain and injury were largely consistent between the professional cohort and the elite cohorts cross-sectionally and prospectively. In terms of risk factors associated with full body pain and injury (not confined to FA), several factors including a higher number of subjective general health complaints, low mood, more severe day to day pain and pain when dancing, and more bodily areas affected by pain were shown to be significant. The impact of a higher number of psychological complaints was identified in all three studies, being significantly associated in the two retrospective studies and closely approaching statistical significance prospectively.

Neither of the full body pain/injury studies showed any association between pain and injury and physical factors examined. As reported in Chapter 7, no physical factors were significantly associated with membership of the MTA group. This is an important finding particularly as many pre-existing screening programs rely heavily on physical testing (Liederbach et al. 2012). However, two factors that were close to statistical significance, namely greater hypermobility and better performance on the FMS, are worthy of future exploration. Generalised joint hypermobility in dancers has been found to correlate not only with a greater number of musculoskeletal complaints but also with a higher level of psychological distress (Scheper et al. 2013). Other studies allude to the link between the fragility of connective tissue in hypermobile persons in the general population, the resulting fatigue and ensuing injury and burnout (Day et al. 2011). This appears to be borne out by the fact that dancers with generalised joint hypermobility are underrepresented at elite levels in comparison to more junior or younger dance populations (McCormack et al. 2004). The functional tasks undertaken as part of the FMS were performed to evaluate motor control, general balance and range of movement (ROM) of various lower limb joints. The fact that those subjects who were more likely to be susceptible to pain/injury were those who performed better on this test is counterintuitive, yet not without precedent. In a study of elite collegiate athletes, there was also no association found between FMS movement pattern asymmetry and pain/injury (Warren et al. 2014). In a cohort of elite rowers, those who performed better on a similar functional movement tool (Movement Competency Screen) suffered from higher rates of lower back pain (Newlands 2013). Further research is required to confirm if the FMS, or another movement quality test, is predictive of pain/injury risk in ID. Other possibilities include the fact that these tests are slow and controlled and do not adequately simulate the explosive, dynamic nature of ID, and that dancers with excessive trunk rigidity or "core" stability may perform well on such tests and yet be incapable of moving fluidly during other dynamic tasks.

In Chapter 6, risk-factors for FA pain and injury again included a greater number of subjective health complaints, higher day to day pain and more bodily areas affected by pain. Physical factors including gastrocnemius flexibility, endurance and balance were also found to be related to more pain and injury. It is likely the importance of these physical factors is a direct result of limiting the FA investigation to a single bodily region, and that specific physical testing may be less significant when investigating pain and injury across the full body. This however remains an area for future investigation.

A number of inconsistencies exist in the research however. Sex was found to be strongly associated with pain and injury in the elite cross-sectional study (Chapter 5) and FA study (Chapter 6), but not in the prospective study (Chapter 7). The reasons for this anomaly are unclear but empirically, there is conflicting evidence to support if sex (Jacobs et al. 2012), and which sex (Nilsson et al. 2001, Allen et al. 2012) is more vulnerable to pain and injury. However as a non-modifiable characteristic, sex is potentially less important than the impact of some of the aforementioned risk factors. Mood was linked to greater pain and injury in the two full body studies (Chapters 5 & 7), but not in the FA study (Chapter 6). However, a trend for significance was recorded for the confusion-bewilderment mood subscale ($p=0.062$)

(Chapter 7). Anger/hostility was reported as significant prospectively (Chapter 7), and two subscales, namely tension-anxiety and confusion-bewilderment were found to be significantly associated with pain and injury in the cross-sectional study (Chapter 5). This would support the contention that mood is a significant factor for pain and injury. However, as mood is a transient state, differences in findings regarding mood subscales may be expected. Two factors, namely failure to always perform a warm-up and more catastrophising were only found to be significant in the cross-sectional full-body study (Chapter 5). The reasons underpinning this are again unclear. It has been established in the literature that catastrophising may be situational as well as dispositional (Thorn et al. 2004). Therefore as with mood, changes in a subject's circumstances may impact upon the level of catastrophising exhibited. A potential explanation for the variation with regards to the performance or otherwise of a warm-up may reflect the subject cohort composition. In Chapter 3, warm-up was almost uniformly practised by the professional cohort investigated, as reflects the common practice in professional dance populations. Approximately 27% of the cross-sectional population were student Irish dancers, many of whom had just begun their full time dance education. It is likely that over the course of the 12-month follow-up, these dancers may have begun to consistently perform a warm-up where previously they had not. Due to the relatively small size of the professional, student and competitive cohorts, individualised study of each group was not performed and may be an area for future study.

A critical area that emerged as significantly associated with greater pain and injury in the prospective study only was insufficient sleep. The effects of sleep deprivation are widespread and are influenced by several potential mechanisms including altered pain thresholds, increased cytokines, and the Hypothalamic-Pituitary-Adrenal (HPA) axis (Vgontzas et al. 2004, Buckley and Schatzberg 2005, Smart et al. 2011). Disturbed sleep is well established in sport and other dance genres as playing a role in pain, injury and performance (Adam et al.

2004, Hausswirth et al. 2013). The tool used to investigate sleep was relatively simple due to limitations of time (Auvinen et al. 2010) and potentially a more complex sleep tool such as the Pittsburgh Sleep Quality Index may be even more sensitive at identifying those with disordered sleep (Buysse et al. 1989). However given the existing literature and the strong association between insufficient sleep and pain and injury outlined in Chapter 7, the importance of sleep in the prevention of same may currently be underestimated.

8.10 Implications of findings for the ID community

It must be acknowledged that this thesis involves a relatively small number of subjects and the general applicability of the findings to Irish dancers in general may not be fully supported. However, a number of implications and recommendations for the ID community as a whole may be proposed. These include the following:

- It is desirable that those stakeholders involved in ID – dancers, teachers, parents, dance companies and health care professionals – would be made aware of the significant rate and risk of pain and injury to Irish dancers.
- Dance schools and companies should be encouraged and supported in collecting simple baseline data across all previously discussed domains and subdomains on their students/performers in order to develop a more complete profile of Irish dancers at various ages and levels. This is also one of the main recommendations of the aforementioned IAMDS white paper (Liederbach et al. 2012).
- Screening protocols should be employed where possible and involve a multifaceted biopsychosocial approach. Stakeholders should be educated as to the importance of non-physical factors as a risk factor for pain and injury. The importance of the

severity of previous pain and injury, sleep, mood, general health and psychological well-being should be highlighted to all relevant stakeholders.

- Pain and injury surveillance with clear definitions of what constitutes pain and injury should be conducted. This is particularly relevant for those dancers at elite or professional level, regardless of age. Further work to reach a consensus on appropriate definitions of pain and injury is required.
- Dance captains, company managers and senior dancers in touring productions should be educated in the identification of younger, at-risk dancers who may be suffering from some of the adverse sequelae of life on the road. This is particularly important as the findings of this thesis have consistently showed that poor psychological and subjective general health were consistently associated with increased levels of pain and injury.
- In a related issue, the management of professional touring companies may wish to examine the minimum age at which they will consider young dancers for employment.
- Programs supporting exit strategies for retiring professional dancers should be considered in line with what currently exists for other dance genres.
- Finally, the main governing bodies for Irish dance, professional touring companies and higher institutions for education where ID is taught should adopt a leading role in the education of their members, as well as supporting screening and injury surveillance in a consistent and integrated manner.

8.11 Limitations

A number of limitations have already been identified in each chapter. In summary, the principal limitations of this doctoral thesis are as follows:

- The relatively small number of subjects, particularly when assigned to professional, competitive and student groups, is the primary limitation of this study.
- Due to the method of recruitment it was impossible to calculate an accurate response rate, which may be indicative of volunteer bias, and a study cohort which is potentially non-representative of the wider elite ID population.
- Much of the research conducted was retrospective and vulnerable to errors of recall and omission.
- A time-loss definition of injury may under-report episodes of pain and musculoskeletal problems not leading to absence from dance. Furthermore it does not identify dancers who continue to perform despite being in pain.
- A limitation common to a number of the papers is the failure to define the term "accident" as it applies to perceived causes of injury. As such, any potential link between accident and other factors such as fatigue, poor ambient conditions or unsuitable stage etc. was not established.
- With regard to the examination of job satisfaction of PIDs, the main investigative tool used was an open ended question. This study may have benefitted from a more focussed questionnaire and several more focus group interviews.
- The administration of the questionnaire which formed the baseline assessment for the prospective study did not allow for subjects to maintain their anonymity. As such, the veracity of responses to potentially delicate topics including drug and alcohol consumption and eating patterns may have been tempered.

- The International Olympic Committee (IOC) recently replaced the term Female Athletic Triad with the term Relative Energy Deficiency in Sport (RED-S) (Mountjoy et al. 2014). This term describes a syndrome that affects many aspects of physiological function, health and athletic performance in both sexes and could have been used in preference to the previous term.
- In Chapter 6 involving the study of pain and injury to the FA region, a heterogeneous pool of FA conditions was examined. As such, no conclusions may be drawn about risk factors for specific FA disorders.
- Where diagnoses were reported, it was not recorded whether these diagnoses were made by healthcare professionals or by the subjects themselves. Therefore, inaccuracies regarding rates of reported pathologies are possible.
- In the prospective study, absence from dancing due to illness could not be included in the analysis as it was unclear if days lost to illness overlapped with any days lost to injury.
- Although the testing therapists practised the elements of the physical screening protocol prior to testing, no pilot reliability test was carried out prior to the study.
- There was no pre-determined warm-up protocol performed during the physical screening. Findings in the literature have shown that the nature of warm-up performed may impact upon performance in vertical leap, balance and joint range of movement. This should be factored into any future test protocols (Morrin and Redding 2013).
- In assessing cardiovascular fitness, percentage of maximal heart rate was reported in the cross-sectional full body and FA studies in Chapters 5 and 6. On further reading of the literature, this was modified to recovery heart rate for Chapter 7 as it may provide a better assessment of cardiovascular fitness.

- Some elements of the screening tool used may have been inappropriate to Irish dancers. Identification of more appropriate options may be an area for future study.
- The FMS tool was scored from one to three based on level of performance with a higher score indicating better performance. The recommended way to screen this tool is to rank from zero to three, with zero equating to pain on performance (Cook 2003). Given the importance of pain in the level of absence from dancing as evidenced in this thesis, usage of the FMS in the recommended manner is appropriate going forward.
- Detailed analysis of monthly training/dance intensities and volumes during the year – which have been collected but do not form part of this thesis – would be of potential value, and may add more to the predictive ability of a screening tool. In this study, undertaking this analysis was considerably complicated by the high rate of absence from dance reported. As previously stated, only 15 dancers reported missing no days dancing over the year, and the median absence from dance due to pain and injury over that period was 14 days. This added considerably to the difficulty of analysing this data, particularly when contrasted to studies where subjects have reported pain/discomfort but have been able to continue to perform or train despite pain (Newlands 2013, Gabbett et al. 2014). The author intends to investigate methods of analysing this longitudinal training load data in the future.

CHAPTER 9: CONCLUSIONS AND RECOMMENDATIONS

This thesis was conducted using well-established research paradigms for the prevention of injury in sport (Van Mechelen et al. 1992, Finch 2006). The goal of this body of work was to generate useful surveillance data on the epidemiology and aetiology of pain and injury in elite adult Irish dancers, and to suggest a framework for an evidence-based screening protocol for this population.

The findings of this doctoral thesis included the following:

- Based on the systematic review of the literature investigating musculoskeletal pain and injury in Irish dance, there is a lacuna of pre-existing research in this area. Most studies conducted prior to this doctoral thesis are retrospective in nature and focus on amateur, child and adolescent cohorts.
- Pain and injury in elite adult ID are commonplace and comparable to rates of pain and injury in elite ballet and contemporary dance.
- The foot and ankle region is by far the bodily area which sustains the most pain and injury in this population. Lower limb complaints account for the vast proportion of pain and injury experienced and dancing time lost by this population.
- The factors consistently identified by subjects as contributing to pain and injury in ID include accidents, fatigue and overuse, and inadequate warm-up and stretching. Of these factors, only fatigue - which may be related to insufficient sleep - was objectively found to be associated with higher levels of pain and injury. Dancers rarely identified any relationship between their own psychological and general health and their vulnerability or otherwise to pain and injury.

- A number of biopsychosocial factors appear to be associated with a higher risk of incurring future pain and injury including a history of higher levels of daily pain, dancing in pain, and more bodily sites affected by pain, higher number of subjective health complaints, insufficient sleep and lower mood,. A higher number of psychological complaints may also be considered a risk factor for more pain and injury.
- The lack of physical factors found by this thesis to contribute to pain and injury is an important conclusion, due to the primary reliance of many existing screening programs on physical assessment of dancers (Liederbach et al. 2012).
- Professional Irish dancers enjoy high levels of job satisfaction and would overwhelmingly recommend a career in Irish dance to young aspiring dancers.

Recommendations for future study may include the following:

- Prospective studies in larger populations of elite adult dancers are required to confirm the findings of this thesis.
- It would be useful to expand the current research parameters to include dancers under 18 years of age, and those child and adult dancers who participate at a sub-elite level. It is possible that these cohorts may be sufficiently different to the subjects in the current study to warrant individual investigation.
- Given the relatively high incidence of foot and ankle injury in this group, more detailed study of commonly occurring pathologies such as tendinopathies and stress fractures would be helpful. It is the intention of this author to examine the factors associated with foot and ankle pain/injury specifically using the data already collected from this cohort in the future.

- Research into any relationship between training load and pain/injury would add greatly to the knowledge in ID. This data has been collected by the author and will be the focus of a future study.
- A closer examination of illness (as distinct from musculoskeletal pain and injury) and any association it may have with pain and injury would be an important addition to the literature.
- Screening could be expanded to examine factors not investigated in this study such as muscular reaction time, ground reaction forces, bone density, and environmental factors such as footwear, floors/stage and costuming etc.
- The development of an accurate tool to functionally assess dance elements specific to ID would be a useful addition to any screening program.
- Continued efforts to expand the baseline biopsychosocial profile of the typical Irish dancer, whether elite or amateur, would also be welcomed.
- The development of personalised biopsychosocial intervention programs and the evaluation of same are required to complete all steps of the research paradigm for the prevention of pain and injury.
- This study did not examine the incidence of new injuries versus recurrent and multiple injuries. Existing research provides a useful framework for more detailed surveillance of Irish dancers going forward (Fuller et al. 2007, Clarsen et al. 2013, Finch and Cook 2013, Clarsen et al. 2014).

REFERENCES

Adam, M. U., Brassington, G. S., Steiner, H. and Matheson, G. O. (2004) 'Psychological factors associated with performance-limiting injuries in professional ballet dancers', *Journal of Dance Medicine & Science,* 8(2), 43-46.

Afari, N., Ahumada, S. M., Wright, L. J., Mostoufi, S., Golnari, G., Reis, V. and Cuneo, J. G. (2014) 'Psychological trauma and functional somatic syndromes: a systematic review and meta-analysis', *Psychosomatic Medicine,* 76(1), 2-11.

Ahmad, H., Ahmad, K. and Shah, I. A. (2010) 'Relationship between Job Satisfaction, Job Performance Attitude towards Work and Organizational Commitment', *European Journal of Social Sciences,* 18(2), 257-267.

Ahonen, J. (2007) 'Biomechanics of the foot in dance: a literature review', *Journal of Dance Medicine & Science: Official Publication of the International Association for Dance Medicine & Science,* 12(3), 99-108.

Air, M. E. (2013) 'Psychological Distress Among Dancers Seeking Outpatient Treatment for Musculoskeletal Injury', *Journal of Dance Medicine & Science,* 17(3), 115-125.

Alderson, J., Hopper, L., Elliott, B. and Ackland, T. (2009) 'Risk factors for lower back injury in male dancers performing ballet lifts', *Journal of Dance Medicine & Science,* 13(3), 83-89.

Alexandre, D., da Silva, C. D., Hill-Haas, S., Wong, D. P., Natali, A. J., De Lima, J. R., Bara Filho, M. G., Marins, J. J., Garcia, E. S. and Karim, C. (2012) 'Heart rate monitoring in soccer: interest and limits during competitive match play and training, practical application', *The Journal of Strength & Conditioning Research,* 26(10), 2890-2906.

Allen, N., Nevill, A., Brooks, J., Koutedakis, Y. and Wyon, M. (2012) 'Ballet injuries: injury incidence and severity over 1 year', *Journal of Orthopaedic and Sports Physical Therapy,* 42(9), 784-A1.

Allen, N., Nevill, A. M., Brooks, J. H., Koutedakis, Y. and Wyon, M. A. (2013) 'The effect of a comprehensive injury audit program on injury incidence in ballet: a 3-year prospective study', *Clinical Journal of Sport Medicine,* 23(5), 373-378.

Allmendinger, J., Hackman, J. R. and Lehman, E. V. (1996) 'Life and work in symphony orchestras', *The Musical Quarterly,* 80(2), 194-219.

Ambegaonkar, J. P., Caswell, S. V., Winchester, J. B., Shimokochi, Y., Cortes, N. and Caswell, A. M. (2013) 'Balance Comparisons Between Female Dancers and Active Nondancers', *Research Quarterly for Exercise and Sport,* 84(1), 24-29.

Andersen, J. (2005) 'Stretching before and after exercise: effect on muscle soreness and injury risk', *Journal of Athletic Training,* 40(3), 218.

Anderson, R. and Hanrahan, S. J. (2008) 'Dancing in pain: Pain appraisal and coping in dancers', *Journal of Dance Medicine & Science,* 12(1), 9-16.

Angioi, M., Metsios, G. S., Koutedakis, Y., Twitchett, E. and Wyon, M. (2009) 'Physical fitness and severity of injuries in contemporary dance', *Medical Problems of Performing Artists,* 24(1), 26-31.

Apfelstadt, H. (2011) 'The rewards and challenges of ensemble touring', *Canadian Music Educator,* Fall, 27-28.

Auvinen, J. P., Tammelin, T. H., Taimela, S. P., Zitting, P. J., Järvelin, M.-R., Taanila, A. M. and Karppinen, J. I. (2010) 'Is insufficient quantity and quality of sleep a risk factor for neck, shoulder and low back pain? A longitudinal study among adolescents', *European Spine Journal,* 19(4), 641-649.

Aziri, B. (2011) 'Job Satisfaction, A Literature Review', *Management Research and Practice,* 3(4), 77-86.

Baker, J., Scott, D., Watkins, K., Keegan-Turcotte, S. and Wyon, M. (2010) 'Self-reported and reported injury patterns in contemporary dance students', *Medical Problems of Performing Artists,* 25(1), 10-15.

Beighton, P. H., Grahame, R. and Bird, H. (2012) *Hypermobility of joints,* Capetown, South Africa: Springer.

Berlet, G. C., Kiebzak, G. M., Dandar, A., Wooten, C., Box, J. H., Anderson, R. B. and Davis, W. H. (2002) 'Prospective Analysis of Body Composition and SF36 Profiles in Professional Dancers over a 7-Month Season: Is There a Correlation to Injury?', *Journal of Dance Medicine & Science,* 6(2), 54-61.

Blackburn, J. T., Padua, D. A. and Guskiewicz, K. M. (2008) 'Muscle stiffness and spinal stretch reflex sensitivity in the triceps surae', *Journal of Athletic Training,* 43(1), 29-36.

Blyth, F. M., March, L. M., Brnabic, A. J., Jorm, L. R., Williamson, M. and Cousins, M. J. (2001) 'Chronic pain in Australia: a prevalence study', *Pain,* 89(2), 127-134.

Bowling, A. (1989) 'Injuries to dancers: prevalence, treatment, and perceptions of causes', *British Medical Journal,* 298(6675), 731-734.

Braun, V. and Clarke, V. (2006) 'Using thematic analysis in psychology', *Qualitative Research in Psychology,* 3(2), 77-101.

Breathnach, B. (1971) *Folk music and dances of Ireland,* Cork: Talbot Press.

Brennan, H. (2004) *The story of Irish dance: The First History of an International Cultural Phenomenon,* Dublin: Brandon.

Brinson, P. and Dick, F. (1996) *Fit to dance: The report of the national inquiry into dancers' health and injury,* London: Calouste Gulbenkian Foundation.

Bronner, S. and Brownstein, B. (1997) 'Profile of dance injuries in a Broadway show: a discussion of issues in dance medicine epidemiology', *The Journal of Orthopaedic and Sports Physical Therapy,* 26(2), 87-94.

Bronner, S., Ojofeitimi, S. and Mayers, L. (2006) 'Comprehensive Surveillance of Dance Injuries A Proposal for Uniform Reporting Guidelines for Professional Companies', *Journal of Dance Medicine & Science,* 3(4), 69-80.

Bronner, S., Ojofeitimi, S. and Rose, D. (2003a) 'Injuries in a modern dance company', *The American Journal of Sports Medicine,* 31(3), 365-373.

Bronner, S., Ojofeitimi, S. and Spriggs, J. (2003b) 'Occupational musculoskeletal disorders in dancers', *Physical Therapy Reviews,* 8(2), 57-68.

Buckley, T. M. and Schatzberg, A. F. (2005) 'On the interactions of the hypothalamic-pituitary-adrenal (HPA) axis and sleep: normal HPA axis activity and circadian rhythm, exemplary sleep disorders', *The Journal of Clinical Endocrinology & Metabolism,* 90(5), 3106-3114.

Buysse, D. J., Reynolds III, C. F., Monk, T. H., Berman, S. R. and Kupfer, D. J. (1989) 'The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research', *Psychiatry Research,* 28(2), 193-213.

Byhring, S. and Bø, K. (2002) 'Musculoskeletal injuries in the Norwegian National Ballet: a prospective cohort study', *Scandinavian Journal of Medicine & Science in Sports,* 12(6), 365-370.

Cahalan, R., O' Sullivan, P., Purtill, H., Bargary, N., Ni Bhriain, O. and O' Sullivan, K. (2014a) 'Inability to perform due to musculoskeletal pain and injury in elite adult Irish dancers: A prospective investigation of contributing factors ', *British Journal of Sports Medicine,* For submission October 2014.

Cahalan, R. and O'Sullivan, K. (2013a) 'Injury in Professional Irish Dancers', *Journal of Dance Medicine and Science,* 17(4), 150-158.

Cahalan, R. and O'Sullivan, K. (2013b) 'Job Satisfaction of Professional Irish Dancers: Implications for Performer Health and Well-being', *Journal of Dance Medicine & Science,* 17(4), 139-149.

Cahalan, R. and O'Sullivan, K. (2013c) 'Musculoskeletal pain and injury in Irish dancing: A systematic review', *Physiotherapy Practice and Research,* 34(2), 83-92.

Cahalan, R., O'Sullivan, K., Purtill, H. and O'Sullivan, P. (2014b) 'A cross-sectional study of elite adult Irish dancers: traits, pain & injury', *Journal of Dance Medicine & Science,* In print.

Cahalan, R., O'Sullivan, P., Purtill, H., Bargary, N. and O' Sullivan, K. (2014c) 'Foot and Ankle Pain and Injuries in Elite Adult Irish Dancers', *Medical Problem of Performing Artists,* Accepted for publication.

Capuron, L. and Miller, A. H. (2011) 'Immune system to brain signaling: neuropsychopharmacological implications', *Pharmacology & Therapeutics,* 130(2), 226-238.

Charlesworth, S. and Johansen, S. (2010) *Navicular drop test: User guide and manual* [online], available: http://kennisbank.hva.nl/document/225653 [accessed 20/09/2014].

Chmelar, R. D., Fitt, S. S., Schultz, B. B., Ruhling, R. O. and Zupan, M. F. (1987) 'A survey of health, training, and injuries in different levels and styles of dancers', *Medical Problems of Performing Artists,* 2(2), 61-66.

Cicchetti, D. V. (1994) 'Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology', *Psychological Assessment,* 6(4), 284-290.

Cimelli, S. N. and Curran, S. A. (2012) 'Influence of turnout on foot posture and its relationship to overuse musculoskeletal injury in professional contemporary dancers: a preliminary investigation', *Journal of the American Podiatric Medical Association,* 102(1), 25-33.

Clark, A. E. (2009) 'Job satisfaction in Britain', *British Journal of Industrial Relations,* 34(2), 189-217.

Clark, T., Williamon, A. and Redding, E. (2013) 'The value of health screening in music schools and conservatoires', *Clinical Rheumatology,* 32(4), 497-500.

Clarsen B, Myklebust G, Bahr R. (2013) 'Development and validation of a new method for the registration of overuse injuries in sports injury epidemiology: the Oslo Sports Trauma Research Centre (OSTRC) Overuse Injury Questionnaire', *British Journal of Sports Medicine,* 47(8):495-502

Clarsen B, Bahr R, Heymans M, et al. (2014) 'The prevalence and impact of overuse injuries in five Norwegian sports: Application of a new surveillance method', *Scandinavian Journal of Medicine and Science in Sports,* doi: 10.1111/sms.12223

Clement, D., Granquist, M. D. and Arvinen-Barrow, M. M. (2013) 'Psychosocial Aspects of Athletic Injuries as Perceived by Athletic Trainers', *Journal of Athletic Training,* 48(4), 512-521.

CLRG (2012) *History of An oi is i n e in ae a ha* [online], available: http://www.clrg.ie [accessed Accessed: 12/6/2012].

Cook, G. (2003) *Athletic body in balance,* IL, United States: Human Kinetics 1.

Crombez, G., Eccleston, C., Van Damme, S., Vlaeyen, J. W. and Karoly, P. (2012) 'Fear-avoidance model of chronic pain: the next generation', *The Clinical Journal of Pain,* 28(6), 475-483.

Cromie, S., Greenwood, J. G. and McCullagh, J. F. (2007) 'Does Irish-dance training influence lower-limb asymmetry?', *Laterality,* 12(6), 500-506.

Cullinane, J. P. (1987) *Aspects of the history of Irish dancing,* Cork: J. Cullinane.

Cumming, J. and Duda, J. L. (2012) 'Profiles of perfectionism, body-related concerns, and indicators of psychological health in vocational dance students: An investigation of the 2× 2 model of perfectionism', *Psychology of Sport and Exercise,* 13(6), 729-738.

Damush, T. M., Wu, J., Bair, M. J., Sutherland, J. M. and Kroenke, K. (2008) 'Self-management practices among primary care patients with musculoskeletal pain and depression', *Journal of Behavioral Medicine,* 31(4), 301-307.

Day, H., Koutedakis, Y. and Wyon, M. (2011) 'Hypermobility and dance: a review', *International Journal of Sports Medicine,* 32(7), 485-489.

Denegar, C. R. and Miller III, S. J. (2002) 'Can chronic ankle instability be prevented? Rethinking management of lateral ankle sprains', *Journal of Athletic Training,* 37(4), 430-435.

Dickinson, C., Campion, K., Foster, A., Newman, S., O'rourke, A. and Thomas, P. (1992) 'Questionnaire development: an examination of the Nordic Musculoskeletal Questionnaire', *Applied Ergonomics,* 23(3), 197-201.

DiGiovanni, C. W. and Justin Greisberg, M. (2007) *Foot and ankle: core knowledge in orthopaedics,* Pennsylvania, US: CV Mosby.

Dunn, K. M. and Croft, P. R. (2005) 'Classification of low back pain in primary care: using “bothersomeness” to identify the most severe cases', *Spine,* 30(16), 1887-1892.

Etherton, J., Lawson, M. and Graham, R. (2014) 'Individual and Gender Differences in Subjective and Objective Indices of Pain: Gender, Fear of Pain, Pain Catastrophizing and Cardiovascular Reactivity', *Applied Psychophysiology and Biofeedback,* 39(2), 89-97.

EuroFIA (2011) *Dancers' Career Transition: A EuroFIA Handbook*, Berlin, Germany: The International Federation of Actors.

Evans, R. W., Evans, R. I., Carvajal, S. and Perry, S. (1996) 'A survey of injuries among Broadway performers', *American Journal of Public Health,* 86(1), 77-80.

Fabunmi, A. A. and Akaraiwe, C. A. 'Hamstring Flexibility: Relationship between Straight Leg-Raise and Backsaver Sit and Reach Tests', in *Fourth International Council for Health, Physical Education, Recreation, Sport and Dance (ICHPER-SD)*, University of Botswana, Gaborne, Botswana, 14-17 October, 2008, Africa Regional Congress,

Faragher, E. B., Cass, M. and Cooper, C. L. (2005) 'The relationship between job satisfaction and health: a meta-analysis', *Occupational and Environmental Medicine,* 62(2), 105-112.

Finch, C. (2006) 'A new framework for research leading to sports injury prevention', *Journal of Science and Medicine in Sport,* 9(1), 3-9.

Finch CF, Cook J. (2013) 'Categorising sports injuries in epidemiological studies: the subsequent injury categorisation (SIC) model to address multiple, recurrent and exacerbation of injuries', *British Journal of Sports Medicine*, 48:1276-1280

Finch, C. F. and Owen, N. (2001) 'Injury prevention and the promotion of physical activity: What is the nexus?', *Journal of Science and Medicine in Sport,* 4(1), 77-87.

Fink, A. and Woschnjak, S. (2011) 'Creativity and personality in professional dancers', *Personality and Individual Differences,* 51(6), 754-758.

Franklin, Z., Smith, N. and Fowler, N. (2014) 'Defensive high-anxious individuals with chronic back pain demonstrate different treatment choices and patient persistence', *Personality and Individual Differences,* 64, 84-88.

Fredriksen, H. and Clarsen, B. (2014) 'High prevalence of injuries in the Norwegian National Ballet', *British Journal of Sports Medicine,* 48(7), 595-596.

Fuller CW, Bahr R, Dick RW, et al. (2007) 'A Framework for Recording Recurrences, Reinjuries, and Exacerbations in Injury Surveillance', *Clinical Journal of Sports Medicine,* 17(3):197-200

Gabbett, T. J., Whyte, D. G., Hartwig, T. B., Wescombe, H. and Naughton, G. A. (2014) 'The relationship between workloads, physical performance, injury and illness in adolescent male football players', *Sports Medicine*, 1-15.

Galambos, S. A., Terry, P. C. and Moyle, G. M. (2006) *Incidence of injury, psychological correlates, and injury prevention strategies for elite sport,* translated by Auckland (New Zealand): Australian Psychological Society, 125-129.

Galambos, S. A., Terry, P. C., Moyle, G. M. and Locke, S. A. (2005) 'Psychological predictors of injury among elite athletes', *British Journal of Sports Medicine,* 39(6), 351-354.

Gamboa, J. M., Roberts, L. A., Maring, J. and Fergus, A. (2008) 'Injury patterns in elite preprofessional ballet dancers and the utility of screening programs to identify risk characteristics', *The Journal of Orthopaedic and Sports Physical Therapy,* 38(3), 126-136.

Gannon, L. and Bird, H. (1999) 'The quantification of joint laxity in dancers and gymnasts', *Journal of Sports Sciences,* 17(9), 743-750.

Garcia, E., Godoy-Izquierdo, D., Godoy, J. F., Perez, M. and Lopez-Chicheri, I. (2007) 'Gender differences in pressure pain threshold in a repeated measures assessment', *Psychology, Health and Medicine,* 12(5), 567-579.

Garrick, J. G. and Requa, R. K. (1993) 'An analysis of epidemiology and financial outcome', *The American Journal of Sports Medicine,* 21(4), 586-590.

Glover, J. A. (2009) *The interpersonal lives of young adult women: A study of passionate friendship (dissertation)*, unpublished thesis Utah State University.

Gribble, P. A. and Hertel, J. (2003) 'Considerations for normalizing measures of the Star Excursion Balance Test', *Measures in Physical Education and Exercise Science,* 7(2), 89-100.

Grove, J. R., Main, L. C. and Sharp, L. (2012) 'Stressors, recovery processes, and manifestations of training distress in dance', *Journal of dance medicine & science: official publication of the International Association for Dance Medicine & Science,* 17(2), 70-78.

Gurdezi, S., Kohls-Gatzoulis, J. and Solan, M. (2013) 'Results of proximal medial gastrocnemius release in patients with Achilles tendinopathy', *Bone & Joint Journal Orthopaedic Proceedings Supplement,* 95, SUPP 1.

Hall, F. (1996) 'Posture in Irish dancing', *Visual Anthropology,* 8(2-4), 251-266.

Hamilton, L. H., Bristow, E. and Byars, M. J. (2002) 'College Programs for Professional Ballet Dancers: The Impact on Career Transition', *Journal of Dance Medicine & Science,* 6(1), 20-23.

Hamilton, L. H., Hamilton, W. G., Meltzer, J. D., Marshall, P. and Molnar, M. (1989) 'Personality, stress, and injuries in professional ballet dancers', *The American Journal of Sports Medicine,* 17(2), 263-267.

Hamilton, L. H., Solomon, R. and Solomon, J. (2006) 'A proposal for standardized psychological screening of dancers', *Journal of Dance Medicine & Science,* 10(1-2), 1-2.

Hamilton, W. G., Hamilton, L. H., Marshall, P. and Molnar, M. (1992) 'A profile of the musculoskeletal characteristics of elite professional ballet dancers', *The American Journal of Sports Medicine,* 20(3), 267-273.

Hausswirth, C., Louis, J., Aubry, A., Bonnet, G., Duffield, R. and Le, M. (2013) 'Evidence of disturbed sleep and increased illness in overreached endurance athletes', *Medicine in Science Sports and Exercise*, 1036-1045.

Hernandez, B. M. (2012) 'Addressing Occupational Stress in Dancers', *Journal of Physical Education, Recreation & Dance,* 83(6), 3-50.

Hertel, J., Braham, R. A., Hale, S. A. and Olmsted-Kramer, L. C. (2006) 'Simplifying the star excursion balance test: analyses of subjects with and without chronic ankle instability', *The Journal of Orthopaedic and Sports Physical Therapy,* 36(3), 131-137.

Hill, C. V. (2010) *Tap dancing America: a cultural history,* New York: Oxford University Press, USA.

Hincapié, C. A., Morton, E. J. and Cassidy, J. D. (2008) 'Musculoskeletal injuries and pain in dancers: a systematic review', *Archives of Physical Medicine and Rehabilitation,* 89(9), 1819-1829.

Hoch, A. Z., Papanek, P., Havlik, H. S., Raasch, W. G., Widlansky, M. E., Schimke, J. E. and Gutterman, D. D. (2009) 'Prevalence Of The Female Athlete Triad/Tetrad In Professional Ballet Dancers', *Medicine & Science in Sports & Exercise,* 41(5), 524-525.

Holst, G. J., Paarup, H. M. and Baelum, J. (2012) 'A cross-sectional study of psychosocial work environment and stress in the Danish symphony orchestras', *International Archives of Occupational and Environmental Health,* 85(6), 639-49.

Hoppock, R. (1935) *Job Satisfaction, by Robert Hoppock,* New York: Harper and brothers.

Howse, J. and McCormack, M. (2010) *Anatomy, dance technique & injury prevention,* London: Methuen Publishing.

Hruschka, D. J., Schwartz, D., St John, D. C., Picone-Decaro, E., Jenkins, R. A. and Carey, J. W. (2004) 'Reliability in coding open-ended data: Lessons learned from HIV behavioral research', *Field Methods,* 16(3), 307-331.

Hurley, N. and John, D. (2013) 'Low Back & Lower Extremity Injuries in Dance: Prevalence, Causes, Treatment & Prevention', *Journal of Kinesiology and Nutrition Student Research,* 1(1).

Jacobs, C. L., Hincapie, C. A. and Cassidy, J. D. (2012) 'Musculoskeletal Injuries and Pain in Dancers: A Systematic Review Update', *Journal of Dance Medicine & Science,* 16(2), 74-84.

Jeffri, J. (2005) 'After the ball is over', *International Journal of Cultural Policy,* 11(3), 341-355.

Judge, T. A., Piccolo, R. F., Podsakoff, N. P., Shaw, J. C. and Rich, B. L. (2010) 'The relationship between pay and job satisfaction: A meta-analysis of the literature', *Journal of Vocational Behavior,* 77(2), 157-167.

Kadel, N. J. (2006) 'Foot and ankle injuries in dance', *Physical and Medical Rehabilitation Clinics of North America,* 17(4), 813-826.

Kamaleri, Y., Natvig, B., Ihlebaek, C. M. and Bruusgaard, D. (2009) 'Does the number of musculoskeletal pain sites predict work disability? A 14-year prospective study', *European Journal of Pain,* 13(4), 426-430.

Karbo, K. (2006) 'Friendship: The Laws of Attraction.The formula for making and keeping a lasting friendship', *Psychology Today - New York,* 39(6), 90.

Kauther, M. D., Wedemeyer, C., Wegner, A., Kauther, K. M. and von Knoch, M. (2009) 'Breakdance injuries and overuse syndromes in amateurs and professionals', *The American Journal of Sports Medicine,* 37(4), 797-802.

Kennedy, J. G., Hodgkins, C. W., Colombier, J.-A., Guyette, S. and Hamilton, W. G. (2007) 'Foot and ankle injuries in dancers: review article', *International SportMed Journal: Foot and Ankle Injuries in Sport,* 8(3), 141-165.

Kerr, G., Krasnow, D. and Mainwaring, L. (1992) 'The nature of dance injuries', *Medical Problem of Performing Artists,* 7(1), 25-29.

Khan, K., Roberts, P., Nattrass, C., Bennell, K., Mayes, S., Way, S., Brown, J., McMeeken, J. and Wark, J. (1997) 'Hip and ankle range of motion in elite classical ballet dancers and controls', *Clinical Journal of Sport Medicine,* 7(3), 174-179.

Kitchen, C. (1994) 'Musical Theatre: a dance injury survey', *Dancing Times*, 611-613.

Kivel, C. G., d'Hemecourt, C. A. and Micheli, L. J. (2011) 'Treatment of Iliac Crest Apophysitis in the Young Athlete With Bone Stimulation: Report of 2 Cases', *Clinical Journal of Sport Medicine,* 21(2), 144-147.

Knapik, J., Bullock, S., Toney, E., Wells, J., Hoedebecke, E. and Jones, B. (2004) 'Influence of an injury reduction program on injury and fitness outcomes among soldiers', *Injury Prevention,* 10(1), 37-42.

Koutedakis, Y. (2000) '" Burnout" in Dance: The Physiological Viewpoint', *Journal of Dance Medicine and Science,* 4(4), 122-127.

Koutedakis, Y. and Jamurtas, A. (2004) 'The dancer as a performing athlete: physiological considerations', *Sports Medicine,* 34(10), 651-661.

Koutedakis, Y. and Sharp, N. (2004) 'Thigh-muscles strength training, dance exercise, dynamometry, and anthropometry in professional ballerinas', *The Journal of Strength & Conditioning Research,* 18(4), 714-718.

Koutedakis, Y., Stavropoulos-Kalinoglou, A. and Metsios, G. (2005) 'The significance of muscular strength in dance', *Journal of Dance Medicine & Science,* 9(1), 29-34.

Krasnow, D., Kerr, G. and Mainwaring, L. (1994) 'Psychology of dealing with the injured dancer', *Medical Problems of Performing Artists,* 9(1), 7-9.

Kreuger R.A. (1988) *Focus groups: a practical guide for applied research*. London: Sage.

Laird, M. (2003) 'The Transition of Dancers', in *Hawaii International Conference on Arts and Humanities*, Honolulu, USA., Jan 12-15,

Lavallée, L. and Flint, F. (1996) 'The relationship of stress, competitive anxiety, mood state, and social support to athletic injury', *Journal of Athletic Training,* 31(4), 296-299.

Leanderson, J., Eriksson, E., Nilsson, C. and Wykman, A. (1996) 'Proprioception in classical ballet dancers A prospective study of the influence of an ankle sprain on proprioception in the ankle joint', *The American Journal of Sports Medicine,* 24(3), 370-374.

Liederbach, M., Hagins, M., Gamboa, J. M. and Welsh, T. M. (2012) 'Assessing and Reporting Dancer Capacities, Risk Factors, and Injuries: Recommendations from the

IADMS Standard Measures Consensus Initiative', *Journal of Dance Medicine & Science,* 16(4), 139-153.

Liederbach, M. and Richardson, M. (2007) 'The importance of standardized injury reporting in dance', *Journal of Dance Medicine & Science,* 11(2), 45-48.

Lin, C.-F., Lee, I.-J., Liao, J.-H., Wu, H.-W. and Su, F.-C. (2011) 'Comparison of postural stability between injured and uninjured ballet dancers', *The American Journal of Sports Medicine,* 39(6), 1324-1331.

Ljung, T., Holm, G., Friberg, P., Andersson, B., Bengtsson, B. Å., Svensson, J., Dallman, M., McEwen, B. and Björntorp, P. (2012) 'The Activity of the Hypothalamic-Pituitary-Adrenal Axis and the Sympathetic Nervous System in Relation to Waist/Hip Circumference Ratio in Men', *Obesity Research,* 8(7), 487-495.

Loudon, J., Jenkins, W. and Loudon, K. (1996) 'The relationship between static posture and ACL injury in female athletes', *The Journal of Orthopaedic and Sports Physical Therapy,* 24(2), 91-97.

Lovibond, P. F. and Lovibond, S. H. (1995) 'The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories', *Behaviour Research and Therapy,* 33(3), 335-343.

Luke, A. C., Kinney, S. A., D Hemecourt, P. A., Baum, J., Owen, M. and Micheli, L. J. (2002) 'Determinants of injuries in young dancers', *Medical Problems of Performing Artists,* 17(3), 105-112.

Luszczynska, A., Gutiérrez-Doña, B. and Schwarzer, R. (2005) 'General self-efficacy in various domains of human functioning: Evidence from five countries', *International Journal of Psychology,* 40(2), 80-89.

Macintyre, J. and Joy, E. (2000) 'Foot and ankle injuries in dance', *Clinics in Sports Medicine,* 19(2), 351-368.

Mackinnon, D. W. (1965) 'Personality and the realization of creative potential', *American Psychologist,* 20(4), 273-281.

Magee, R. (1999) 'Irish dancing injuries ', in *International Association for Dance Medicine & Science*, Tring, United Kingdom, 2000, 140.

Mainwaring, L., Kerr, G. and Krasnow, D. (1993) 'Psychological correlates of dance injuries', *Medical Problems of Performing Artists,* 8(1), 3-6.

Malliaras, P., Cook, J. L. and Kent, P. (2006) 'Reduced ankle dorsiflexion range may increase the risk of patellar tendon injury among volleyball players', *Journal of Science and Medicine in Sport,* 9(4), 304-309.

Malliou, P., Rokka, S., Beneka, A., Mavridis, G. and Godolias, G. (2007) 'Reducing risk of injury due to warm up and cool down in dance aerobic instructors', *Journal of Back and Musculoskeletal Rehabilitation,* 20(1), 29-35.

Mayers, L., Judelson, D. and Bronner, S. (2003) 'The prevalence of injury among tap dancers', *Journal of Dance Medicine & Science,* 7(4), 121-125.

McCabe, T. R., Wyon, M., Ambegaonkar, J. P. and Redding, E. (2013) 'A bibliographic review of medicine and science research in dancesport', *Medical Problem of Performing Artists,* 28(2), 70-79.

McCormack, M., Briggs, J., Hakim, A. and Grahame, R. (2004) 'Joint laxity and the benign joint hypermobility syndrome in student and professional ballet dancers', *The Journal of Rheumatology,* 31(1), 173-178.

McEwen, K. and Young, K. (2011) 'Ballet and pain: reflections on a risk-dance culture', *Qualitative Research in Sport, Exercise and Health,* 3(2), 152-173.

McGuinness, D. and Doody, C. (2006) 'The injuries of competitive Irish dancers', *Journal of Dance Medicine & Science,* 1(2), 35-39.

McNair, D., Lorr, M. and Droppleman, L. (1971) *Profile of mood state manual,* San Diego (CA): Educational and Industrial Testing Service.

Melzack, R. and Casey, K. L. (1968) 'Sensory, motivational and central control determinants of pain: a new conceptual model', *The Skin Senses*, 423-443.

Melzack, R. and Wall, P. D. (1967) 'Pain mechanisms: a new theory', *Survey of Anesthesiology,* 11(2), 89-90.

Michalski, D., Liebig, S., Thomae, E., Hinz, A. and Bergh, F. T. (2011) 'Pain in patients with multiple sclerosis: a complex assessment including quantitative and qualitative measurements provides for a disease-related biopsychosocial pain model', *Journal of Pain Research,* 4, 219-225.

Miles, M. B. and Huberman, A. M. (1994) *Qualitative data analysis: An expanded sourcebook,* California: Sage Publications.

Mishler, E. G. (1981) 'Viewpoint: Critical perspectives on the biomedical model', *Social Contexts of Health, Illness, and Patient Care*, 1-23.

Mistiaen, W., Roussel, N. A., Vissers, D., Daenen, L., Truijen, S. and Nijs, J. (2012) 'Effects of Aerobic Endurance, Muscle Strength, and Motor Control Exercise on Physical Fitness and Musculoskeletal Injury Rate in Preprofessional Dancers: An Uncontrolled Trial', *Journal of Manipulative and Physiological Therapeutics,* 35(5), 381-389.

Mitchell, T., O'Sullivan, P., Smith, A., Burnett, A., Straker, L., Thornton, J. and Rudd, C. (2009) 'Biopsychosocial factors are associated with low back pain in female nursing students: a cross-sectional study', *International Journal of Nursing Studies,* 46(5), 678-688.

Moisa, C. O. (2010) 'Aspects of Youth Travel Demand', *Annales Universitatis Apulensis Series Oeconomica,* 12(2), 575-582.

Morgan, J. F., Reid, F. and Lacey, J. H. (1999) 'The SCOFF questionnaire: assessment of a new screening tool for eating disorders', *BMJ: British Medical Journal,* 319(7223), 1467.

Morrin, N. and Redding, E. (2013) 'Acute Effects of Warm-up Stretch Protocols on Balance, Vertical Jump Height, and Range of Motion in Dancers', *Journal of Dance Medicine & Science,* 17(1), 34-40.

Motta-Valencia, K. (2006) 'Dance-related injury', *Physical and Medical Rehabilitation Clinics of North America,* 17(3), 697-723.

Mountjoy M, Sundgot-Borgen, Burke L et al. (2014) 'The IOC consensus statement: beyond the Female Athlete Triad-Relative Energy Deficiency in Sport (RED-S)', *British Journal of Sports Med*icine, 48:491-497)

Mullen, R., Davis, J. A. and Polatajko, H. J. (2012) 'Passion in the performing arts: Clarifying active occupational participation', *Work: A Journal of Prevention, Assessment and Rehabilitation,* 41(1), 15-25.

Mundal, I., Gråwe, R. W., Bjørngaard, J. H., Linaker, O. M. and Fors, E. A. (2014) 'Psychosocial factors and risk of chronic widespread pain: An 11-year follow-up study—The HUNT study', *Pain,* 155(8), 1555-1561.

Murgia, C. (2013) 'Overuse, Tissue Fatigue, and Injuries', *Journal of Dance Medicine & Science,* 17(3), 92-100.

Newlands, C. M. (2013) *Low back pain incidence in New Zealand rowers and its relationship with functional movement patterns*, unpublished thesis (Doctoral Dissertation), Auckland University of Technology.

Nicassio, P. M., Kay, M. A., Custodio, M. K., Irwin, M. R., Olmstead, R. and Weisman, M. H. (2011) 'An evaluation of a biopsychosocial framework for health-related quality of life and disability in rheumatoid arthritis', *Journal of Psychosomatic Research,* 71(2), 79-85.

Nilsson, C., Leanderson, J., Wykman, A. and Strender, L. E. (2001) 'The injury panorama in a Swedish professional ballet company', *Knee Surgery, Sports Traumatology, Arthroscopy,* 9(4), 242-246.

Noh, Y.-E., Morris, T. and Andersen, M. B. (2007) 'Psychological intervention programs for reduction of injury in ballet dancers', *Research in Sports Medicine,* 15(1), 13-32.

Noh, Y. E., Morris, T. and Andersen, M. B. (2005) 'Psychosocial factors and ballet injuries', *International Journal of Sport and Exercise Psychology,* 3(1), 79-90.

Noon, M., Hoch, A. Z., McNamara, L. and Schimke, J. (2010) 'Injury Patterns in Female Irish Dancers', *Physical Medicine and Rehabilitation,* 2(11), 1030-1034.

Nowacki, R. M., Air, M. E. and Rietveld, A. (2012) 'Hyperpronation in Dancers Incidence and Relation to Calcaneal Angle', *Journal of Dance Medicine & Science,* 16(3), 126-132.

O'Halloran, E., Vioreanu, M. and Padinjarathala, B. (2011) '“Between the Jigs and the Reels”: Bilateral Metatarsal Phalangeal Stress Fractures in a Young Irish Dancer', *Clinical Journal of Sport Medicine,* 21(5), 454-455.

OCEBM (2011) *The Oxford 2011 levels of evidence* [online], available: http://www.cebm.net/mod_product/design/files/CEBM-Levels-of-Evidence-2.1.pdf [accessed 1/4/2013].

Ojofeitimi, S., Bronner, S. and Woo, H. (2012) 'Injury incidence in hip hop dance', *Scandinavian Journal of Medicine & Science in Sports,* 22(3), 347-355.

Okifuji, A. and Hare, B. D. (2011) 'Do sleep disorders contribute to pain sensitivity?', *Current Rheumatology Reports,* 13(6), 528-534.

Orlando, C., Levitan, E., Mittleman, M., Steele, R. and Shrier, I. (2011) 'The effect of rest days on injury rates', *Scandinavian Journal of Medicine & Science in Sports,* 21(6), 64-71.

Parker, R. (2011) *An exploration of the identity issues faced by retiring male ballet dancers (master's thesis)*, unpublished thesis University of Birmingham.

Patel, A. and DiGiovanni, B. (2011) 'Association between plantar fasciitis and isolated contracture of the gastrocnemius', *Foot & Ankle International,* 32(1), 5-8.

Patterson, E. L., Smith, R. E., Everett, J. J. and Ptacek, J. T. (1998) 'Psychosocial factors as predictors of ballet injuries: Interactive effects of life stress and social support', *Journal of Sport Behavior,* 21(1), 101-112.

Pedersen, M. E. and Wilmerding, V. (1998) 'Injury profiles of student and professional flamenco dancers', *Journal of Dance Medicine & Science,* 2(3), 108-114.

Pincus, T., Kent, P., Bronfort, G., Loisel, P., Pransky, G. and Hartvigsen, J. (2013) 'Twenty-Five Years With the Biopsychosocial Model of Low Back Pain—Is It Time to Celebrate? A Report From the Twelfth International Forum for Primary Care Research on Low Back Pain', *Spine,* 38(24), 2118-2123.

Pope, R., Herbert, R., Kirwan, J. and Graham, B. (2000) 'A randomized trial of preexercise stretching for prevention of lower-limb injury', *Medicine & Science in Sports & Exercise,* 32(2), 271-277.

Popescu, A., LeResche, L., Truelove, E. L. and Drangsholt, M. T. (2010) 'Gender differences in pain modulation by diffuse noxious inhibitory controls: a systematic review', *Pain,* 150(2), 309-318.

Potter, A. B., Lavery, E. S. and Bell, R. (1996) 'Body fat and body mass index measurements in preprofessional dance students: A comparison of formulas', *Medical Problems of Performing Artists,* 11, 43-46.

Quine, L. (1999) 'Workplace bullying in NHS community trust: staff questionnaire survey', *British Medical Journal,* 318(7178), 228-232.

Rafferty, S. (2010) 'Considerations for integrating fitness into dance training', *Journal of Dance Medicine & Science,* 14(2), 45-49.

Ren, K. and Dubner, R. (2010) 'Interactions between the immune and nervous systems in pain', *Nature Medicine,* 16(11), 1267-1276.

Richards, G. and Wilson, J. (2003) *New horizons in independent youth and student travel.A Report for the International Student Travel Confederation (ISTC) and the Association of Tourism and Leisure Education (ATLAS).* Amsterdam, Netherlands.

Ringham, R., Klump, K., Kaye, W., Stone, D., Libman, S., Stowe, S. and Marcus, M. (2006) 'Eating disorder symptomatology among ballet dancers', *International Journal of Eating Disorders,* 39(6), 503-508.

Rip, B., Fortin, S. and Vallerand, R. J. (2006) 'The relationship between passion and injury in dance students', *Journal of Dance Medicine & Science,* 10(1-2), 1-2.

Ritter, S. and Moore, M. (2008) 'The relationship between lateral ankle sprain and ankle tendinitis in ballet dancers', *Journal of Dance Medicine & Science,* 12(1), 23-31.

Rivera, D. C., Alexander, J. L., Nehrenz, G. M. and Fields, B. J. (2012) 'Dancers' perceptions of injuries', *Journal of Music and Dance* 2(1), 9-12.

Robson, B. E. (2010) 'Psychological Issues in the Clinical Approach to Dancers, Edition 3' in Robert T. Sataloff, A. G. B., and Richard J. Lederman, ed. *Performing Arts Medicine*, Narberth, PA: Science & Medicine, Inc.

Roncaglia, I. (2006) 'Retirement as a career transition in ballet dancers', *International Journal for Educational and Vocational Guidance,* 6(3), 181-193.

Rosenstiel, A. K. and Keefe, F. J. (1983) 'The use of coping strategies in chronic low back pain patients: relationship to patient characteristics and current adjustment', *Pain,* 17(1), 33-44.

Ruemper, A. and Watkins, K. (2012) 'Correlations Between General Joint Hypermobility and Joint Hypermobility Syndrome and Injury in Contemporary Dance Students', *Journal of Dance Medicine & Science,* 16(4), 161-166.

Russell, J. A. (2013) 'Preventing dance injuries: current perspectives', *Open Access Journal of Sports Medicine,* 4, 199-210.

Ryan, A. J. and Stephens, R. E. (1987) *The epidemiology of dance injuries, Dance Medicine: A Comprehensive Guide,* Chicago, IL,: Pluribus Press, Inc.

Salazar, A., Dueñas, M., Mico, J. A., Ojeda, B., Agüera-Ortiz, L., Cervilla, J. A. and Failde, I. (2013) 'Undiagnosed mood disorders and sleep disturbances in primary care patients with chronic musculoskeletal pain', *Pain Medicine,* 14(9), 1416-1425.

Scheper, M. C., de Vries, J. E., de Vos, R., Verbunt, J., Nollet, F. and Engelbert, R. H. (2013) 'Generalized joint hypermobility in professional dancers: a sign of talent or vulnerability?', *Rheumatology,* 52(651-658).

Scott, H. K. (2007) 'Music and Musicians: Practical Musician - Father Time', *Strings,* 22(1).

Sekulic, D., Peric, M. and Rodek, J. (2010) 'Substance use and misuse among professional ballet dancers', *Substance Use & Misuse,* 45(9), 1420-1430.

Shah, S., Weiss, D. S. and Burchette, R. J. (2012) 'Injuries in professional modern dancers: incidence, risk factors, and management', *Journal of Dance Medicine & Science,* 16(1), 17-25.

Shega, J. W., Ersek, M., Herr, K., Paice, J. A., Rockwood, K., Weiner, D. K. and Dale, W. (2010) 'The multidimensional experience of noncancer pain: Does cognitive status matter?', *Pain Medicine,* 11(11), 1680-1687.

Shippen, J. M. and May, B. (2010) 'Calculation of muscle loading and joint contact forces during the rock step in Irish dance', *Journal of Dance Medicine & Science,* 14(1), 11-18.

Shrier, I. (2001) 'Should people stretch before exercise?', *Western Journal of Medicine,* 174(4), 282-283.

Smart, K. M., Blake, C., Staines, A. and Doody, C. (2011) 'The Discriminative validity of "nociceptive,""peripheral neuropathic," and "central sensitization" as mechanisms-based classifications of musculoskeletal pain', *The Clinical Journal of Pain,* 27(8), 655-663.

Smith, R. E., Schutz, R. W., Smoll, F. L. and Ptacek, J. (1995) 'Development and validation of a multidimensional measure of sport-specific psychological skills: The Athletic Coping Skills Inventory-28', *Journal of Sport & Exercise Psychology*, 399-415.

SNAA, P. (2012) *A Diverse Palette: What Arts Graduates Say About Their Education and Careeres - annual report*, Bloomington, Indiana: Indiana University Centre for Postsecondary Research.

Solomon, R., Micheli, L. J., Solomon, J. and Kelley, T. (1995) 'The "cost" of injuries in a professional ballet company', *Medical Problems of Performing Artists,* 3, 3-10.

Solomon, R., Solomon, J., Micheli, L. J. and McGray, E. (1999) 'The" cost" of injuries in a professional ballet company: A five-year study', *Medical Problems of Performing Artists,* 14, 164-170.

Specht, J., Egloff, B. and Schmukle, S. C. (2011) 'Stability and change of personality across the life course: The impact of age and major life events on mean-level and rank-order stability of the Big Five', *Journal of Personality and Social Psychology,* 101(4), 862-882.

Stein, C. J., Tyson, K. D., Johnson, V. M., Popoli, D. M., d'Hemecourt, P. A. and Micheli, L. J. (2013) 'Injuries in Irish Dance', *Journal of Dance Medicine & Science,* 17(4), 159-164.

Sundgot-Borgen, J. and Torstveit, M. K. (2004) 'Prevalence of eating disorders in elite athletes is higher than in the general population', *Clinical Journal of Sport Medicine,* 14(1), 25-32.

Tabrizi, P., McIntyre, W., Quesnel, M. and Howard, A. (2000) 'Limited dorsiflexion predisposes to injuries of the ankle in children', *Journal of Bone & Joint Surgery, British Volume,* 82(8), 1103-1106.

Tanaka, H., Monahan, K. D. and Seals, D. R. (2001) 'Age-predicted maximal heart rate revisited', *Journal of the American College of Cardiology,* 37(1), 153-156.

Tarr, J. and Thomas, H. (2011) 'Mapping embodiment: methodologies for representing pain and injury', *Qualitative research,* 11(2), 141-157.

Thomas, H. and Tarr, J. (2009) 'Dancers' perceptions of pain and injury: Positive and negative effects', *Journal of Dance Medicine & Science,* 13(2), 51-59.

Thorn, B. E., Clements, K. L., Ward, L. C., Dixon, K. E., Kersh, B. C., Boothby, J. L. and Chaplin, W. F. (2004) 'Personality factors in the explanation of sex differences in pain catastrophizing and response to experimental pain', *The Clinical journal of pain,* 20(5), 275-282.

To, W., Wong, M. and Chan, K. (1995) 'The effect of dance training on menstrual function in collegiate dancing students', *Australian and New Zealand Journal of Obstetrics and Gynaecology,* 35(3), 304-309.

Tomlin, D. L. and Wenger, H. A. (2001) 'The relationship between aerobic fitness and recovery from high intensity intermittent exercise', *Sports Medicine,* 31(1), 1-11.

TopEndSports (2013) '30 Second Endurance Jump', available: http://www.topendsports.com/testing/tests/endurance-jump-30sec.htm [accessed 21/09/2014].

Tregouet, P. and Merland, F. (2013) 'The Effects of Different Shoes on Plantar Forces in Irish Dance', *Journal of Dance Medicine & Science,* 17(1), 41-46.

Tschudi-Madsen, H., Kjeldsberg, M., Natvig, B., Ihlebaek, C., Dalen, I., Kamaleri, Y., Straand, J. and Bruusgaard, D. (2011) 'A strong association between non-musculoskeletal symptoms and musculoskeletal pain symptoms: results from a population study', *BMC Musculoskeletal Disorders,* 12(1), 285-293.

Turk, D. C., Wilson, H. and Swanson, K. S. (2011) 'The biopsychosocial model of pain and pain management' in *Behavioral and Pharmacological Pain Management*, New York: Cambridge University Press, 16-43.

Turk, D. C. and Wilson, H. D. (2010) 'Fear of pain as a prognostic factor in chronic pain: conceptual models, assessment, and treatment implications', *Current Pain and Headache Reports,* 14(2), 88-95.

van Hecke, O., Torrance, N. and Smith, B. H. (2013) 'Chronic pain epidemiology–where do lifestyle factors fit in?', *British Journal of Pain,* 7(4), 209-217.

Van Mechelen, W., Hlobil, H. and Kemper, H. (1992) 'Incidence, severity, aetiology and prevention of sports injuries. A review of concepts', *Sports Medicine (Auckland, NZ),* 14(2), 82-99.

Van Staden, A., Myburgh, C. P. H. and Poggenpoel, M. (2009) 'A psycho-educational model to enhance the self-development and mental health of classical dancers', *Journal of Dance Medicine & Science,* 13(1), 20-28.

Vgontzas, A., Zoumakis, E., Bixler, E., Lin, H.-M., Follett, H., Kales, A. and Chrousos, G. (2004) 'Adverse effects of modest sleep restriction on sleepiness, performance, and inflammatory cytokines', *The Journal of Clinical Endocrinology & Metabolism,* 89(5), 2119-2126.

Wainwright, S. P. and Turner, B. S. (2006) '‘Just crumbling to bits’? An exploration of the body, ageing, injury and career in classical ballet dancers', *Sociology,* 40(2), 237-255.

Walker, I. J. and Nordin-Bates, S. M. (2010) 'Performance Anxiety Experiences of Professional Ballet Dancers The Importance of Control', *Journal of Dance Medicine & Science,* 14(4), 133-145.

Walker, I. J., Nordin-Bates, S. M. and Redding, E. (2011) 'Characteristics of talented dancers and age group differences: findings from the UK Centres for Advanced Training', *High Ability Studies,* 22(1), 43-60.

Walls, R., Brennan, S., Hodnett, P., O’Byrne, J., Eustace, S. and Stephens, M. (2010) 'Overuse ankle injuries in professional Irish dancers', *Foot and Ankle Surgery,* 16((1)), 45-49.

Wanke, E., Groneberg, D. and Quarcoo, D. (2011) 'Analysis and Evaluation of Occupational Accidents in Dancers of the Dance Theatre', *Sportverletzung Sportschaden: Organ der Gesellschaft fur Orthopadisch-Traumatologische Sportmedizin,* 25(1), 56-61.

Wanke, E. M., Arendt, M., Mill, H. and Groneberg, D. A. (2013) 'Occupational accidents in professional dance with focus on gender differences', *Journal of Occupational Medicine and Toxicology,* 8(1), 35-42.

Warren, M., Smith, C. and Chimera, N. (2014) 'Association of Functional Movement Screen™ With Injuries in Division I Athletes', *Journal of Sport Rehabilitation*, In press.

Watkins, A., Woodhull-McNeal, A., Clarkson, P. M. and Ebbeling, C. (1989) 'Lower extremity alignment and injury in young, preprofessional, college, and professional ballet dancers', *Medical Problems of Performing Artists,* 4, 148-53.

Weerapong, P., Hume, P. A. and Kolt, G. S. (2005) 'The mechanisms of massage and effects on performance, muscle recovery and injury prevention', *Sports Medicine,* 35(3), 235-256.

Weigert, B. J. and Erickson, M. (2007) 'Incidence of injuries in female university-level modern dancers and the effectiveness of a screening program in altering injury patterns', *Medical Problem of Performing Artists,* 22(2), 52-57.

Weiss, D. S., Shah, S. and Burchette, R. J. (2008) 'A profile of the demographics and training characteristics of professional modern dancers', *Journal of Dance Medicine & Science,* 12(2), 41-46.

WHO (2000) 'Obesity: preventing and managing the global epidemic', *World Health Organization Technical Report Series,* 894.

WHO (2010) 'International Classification of Disease, Version 10 (2010) [online], available: http://apps.who.int/classifications/icd10/browse/2010/en [accessed 03-10-2104].

Wiese-Bjornstal, D. M. (2010) 'Psychology and socioculture affect injury risk, response, and recovery in high-intensity athletes: a consensus statement', *Scandinavian Journal of Medicine & Science in Sports,* 20(s2), 103-111.

Wiesler, E. R., Hunter, D. M., Martin, 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.

Wikstrom, E. A., Tillman, M. D., Chmielewski, T. L., Cauraugh, J. H. and Borsa, P. A. (2007) 'Dynamic postural stability deficits in subjects with self-reported ankle instability', *Medicine and Science in Sports and Exercise,* 39(3), 397-402.

Wilmerding, M., McKinnon, M. M. and Mermier, C. (2005) 'Body Composition in Dancers A Review', *Journal of Dance Medicine & Science,* 9(1), 18-23.

Wulff, H. (1998) *Ballet across borders: Career and culture in the world of dancers,* Oxford: Berg Publishers.

Wyon, M., Allen, N., Angioi, M., Nevill, A. and Twitchett, E. (2006) 'Anthropometric factors affecting vertical jump height in ballet dancers', *Journal of Dance Medicine & Science,* 10(3-4), 3-4.

Wyon, M. A., Deighan, M. A., Nevill, A. M., Doherty, M. and Morrison, S. L. (2007) 'The cardiorespiratory, anthropometric, and performance characteristics of an international/national touring ballet company', *The Journal of Strength & Conditioning Research,* 21(2), 389-393.

Yan, A. F., Hiller, C., Smith, R. and Vanwanseele, B. (2011) 'Effect of Footwear on Dancers: A Systematic Review', *Journal of Dance Medicine & Science,* 15(2), 86-92.

Ylinen, J. (2007) 'Pressure algometry', *Australian Journal of Physiotherapy,* 53(3), 207.

Zimmerman, R. D. and Darnold, T. C. (2009) 'The impact of job performance on employee turnover intentions and the voluntary turnover process: A meta-analysis and path model', *Personnel Review,* 38(2), 142-158.

Appendix 1: Subject information sheets

UNIVERSITY of LIMERICK
O L L S C O I L L U I M N I G H

Injury in Professional Irish Dancers
Information Sheet

What is the study about?
This study is to find out about the types, amount and causes of injury in Irish dancers who have worked in shows/tours and also to find out about the physical health of Irish dancers who have retired.

Who can take part in this study?
To take part in the study, you must be 18 years of age or older. You must have worked as a professional Irish dancer for at least 8 months out of 1 year period. That means that your main income for that period came from working as an Irish dancer. It does not matter if you have retired from dancing or are still working as a dancer. It does not matter if you were on tour or stayed in the same location. You can participate in the study whether you were injured or not throughout your career.

What will I have to do?
If you wish to take part in the study, you must complete an online questionnaire that you will find at the following web address: http://www.surveymonkey.com/s/X9NC8QL. This survey will take about 10 minutes to complete and will ask for some details about you, any injuries you had while dancing and how you managed your injuries. It will also ask about the causes of your injuries in your opinion, and the role of support services like physiotherapy and massage. If you are retired from dancing professionally, there are a few questions about your physical health today.

Benefits
This study will help current dancers, teachers and those managing professional Irish dancers to anticipate possible causes of injury, and to prevent injury. Also, this is one of the first studies of its type, so injury in professional Irish dancing can be compared to injury in other types of dance.

Risks
There are no risks or dangers to you from taking part in this study.

What are the alternatives?
An alternative way of carrying out this study would be face to face interviews. But this would take much longer and be difficult as dancers live in many different places. Using the phone would also be more expensive and harder to record the answers given.

What if I do not want to take part?
Taking part in this study is purely voluntary. If you don't want to be in the study, you don't have to be. It won't affect your right to take part in other studies.

What happens to the information?
Your answers are anonymous so no-one will know who you are. You will be given a code for identification. Information will be stored securely on laptops. Only the people running the study will look at this information. After 7 years paper data will be shredded and electronic data will be electronically deleted from the laptops.

Who else is taking part?
Other people who are working at the moment as Irish dancers and dancers who have retired and no longer dance professionally.

What happens at the end of the study?
After all the information is collected, it will be analysed and a report of the main findings will be written up. It is hoped that this study will be published in journals about dancing and injury. It is also intended to give talks on the results in relevant conferences. All the data will be stored and destroyed as outlined above.

What if I have more questions or do not understand something?
If you have any questions, you can contact me at the details listed below at any time before, during or following the study.

Contact name and email details of Project Investigators
Kieran O'Sullivan kieran.osullivan@ul.ie 061 234119
Roisin Cahalan roisin.cahalan@ul.ie 061 229157

If you have concerns about this study and wish to contact someone independent, you may contact *The Chairman of the University of Limerick Research Ethics Committee*
c/o Anne O'Dwyer
Graduate School
University of Limerick
Limerick
Tel: (061) 202672

A Prospective Study of Injury and Pain in Elite Irish Dancers

Information Sheet

What is the study about?
This study is to investigate injury and pain in elite and professional Irish dancers. Dancers will be assessed and followed up over a year to see if the causes of injury can be identified. Hopefully, this will allow dancers identify when they are at risk for injury through the use of a new screening protocol which will be developed.

Who can take part in this study?
To take part in the study, you must be 18 years of age or older.
You must have worked as a professional Irish dancer for at least 8 months out of 1 year period. That means that your main income for that period came from working as an Irish dancer.
You can also take part in this study if you are not a professional Irish dancer, but if you have competed in solo competition at the World Championships or your local National Championships over the last 5 years.
You can also participate if you are in full time 3rd level education studying Irish dance.

What will I have to do?
If you wish to take part in the study, you will have to fill in the consent page attached to this document and return it to me.
Then you will fill in a questionnaire about your dancing and injury background, a brief medical history, some questions about your attitudes to pain and performing. There are also some questions about eating habits, sleep and job satisfaction. This should take between 20 and 30 minutes.
You will then participate in a brief physical screening which involves looking at basic levels of flexibility, balance and fitness. Your pain threshold will also be identified using a tool to measure pressure. There will be a test to see how high you can jump and a brief test of your leg endurance. Some functional tests like lunging and squatting are also included. This screening will also only take about 20 to 30 minutes.
Every month you will be sent and e-mail to see if you have become injured. If so, you will be asked a few questions about the severity and location of the injury, causes, and if anything significant has changed about you. This should take less than 5 minutes to fill in.

Benefits
This study will help current dancers, teachers and those managing professional Irish dancers to anticipate possible causes of injury, and to prevent injury. Also, this is one of the first studies of its type, so injury in professional and elite Irish dancing can be compared to injury in other types of dance. Also, this study hopes to develop a screening tool to be used to

identify future sources of injury. There will also be a raffle for a €100 voucher for an online retail company for all participants who complete all follow up questionnaires over the year.

Risks

You may become breathless in the fitness test. You may lose your balance standing on one leg in the balance test. You may experience a very brief sensation of discomfort when your pain threshold is being measures. Your muscles may be a little tired after the endurance test. No serious risks are involved.

What are the alternatives?

An alternative way of carrying out this study would be face to face interviews. But this would take much longer and be difficult as dancers live in many different places. Using the phone would also be more expensive and harder to record the answers given.

What if I do not want to take part?

Taking part in this study is purely voluntary. If you don't want to be in the study, you don't have to be. It won't affect you if you want to take part in other studies.

What happens to the information?

Your answers are anonymous so no-one will know who you are. You will be given a code for identification. Information will be stored securely on laptops. Only the people running the study will look at this information. After 7 years paper data will be shredded and electronic data will be electronically deleted from the laptops.

Who else is taking part?

Adult dancers who are working at the moment as professional Irish dancers, people studying Irish dance full time at 3rd level, and dancers who have competed in solo competition at World or National championship level at any time over the last 5 years.

What happens at the end of the study?

After all the information is collected, it will be analysed and a report of the main findings will be written up. It is hoped that this study will be published in journals about dancing and injury. It is also intended to give talks on the results in relevant conferences. All the data will be stored and destroyed as outlined above.

What if I have more questions or do not understand something?

If you have any questions, you can contact me at the details listed below at any time before, during or following the study. You can ask any questions you might have when you fill in the questionnaire, or during the physical screening.

Contact name and email details of Project Investigators

Kieran O'Sullivan kieran.osullivan@ul.ie 061 234119
Roisin Cahalan roisin.cahalan@ul.ie 061 229157
Peter O'Sullivan P.Osullivan@curtin.edu.au +61 8 9266 3629

If you have any concerns about this study and wish to contact someone independent you may contact: Chairman Education and Health Sciences Research Ethics Committee
EHS Faculty Office
University of Limerick
Tel (061) 234101

Email : ehsresearchethics@ul.ie

Appendix 2: Consent form: Professional Irish dancers

UNIVERSITY of LIMERICK
OLLSCOIL LUIMNIGH

A Prospective Study of Injury and Pain in Professional and Elite Irish Dancers

PARTICIPANT CONSENT FORM

Please read the following questions and tick the appropriate Yes or No box. Please sign the bottom of the page if you consent to participate in this study.

	YES	NO
I have read and understood the information sheet.		
I know that my participation is voluntary and that I can withdraw from the project at any stage without giving any reason.		
I agree to permit access to my medical record by the study Investigator if required.		
I agreement to notify the Investigator of any side effects arising during the study.		
I agree to participate in this study.		

SIGNATURE **BLOCK CAPITALS** **DATE**

Subject: ___________________ ___________________ ___/___/___

Investigator: ______________ ___________________ ___/___/___

Witness: ___________________ ___________________ ___/___/___

Thank you

Appendix 3: Subjective questionnaire: Prospective study

Subject No:	Date:	Time:

This questionnaire asks about a range of issues, including your dancing career, your general health and your history of pain or injury. It should take approximately 20 minutes to complete and is COMPLETELY CONFIDENTIAL. Please answer EVERY question. If you have any questions, the person who has given you this questionnaire will be happy to help you.

Age (years): ____ **Gender:** M/F **Nationality: ____________________**
email: ______________________ **Mobile Number: ________________**

<u>YOUR HEALTH</u>

Generally, how would you evaluate your own PHYSICAL and PSYCHOLOGICAL health during the *<u>past month?</u>*
Very good ( ) Good ( ) Neither good nor poor ( ) Poor ( ) Very poor ( )

During the *<u>past month</u>*, how much energy did you have?
Very much ( ) Quite a lot ( ) Some ( ) A little ( ) None ( )

The following are some common health problems and complaints. We want you to look at each and every one of them and report to what extent you have been affected *<u>during the last month</u>*.

	Not at all	A Little	Some	Severe
Palpitations/extra heartbeats	0	1	2	3
Chest pain	0	1	2	3
Breathing difficulties	0	1	2	3
Heartburn	0	1	2	3
Stomach discomfort	0	1	2	3
Diarrhoea	0	1	2	3
Constipation	0	1	2	3
Eczema	0	1	2	3
Tiredness	0	1	2	3
Dizziness	0	1	2	3
Anxiety	0	1	2	3
Sadness / depression	0	1	2	3
Sleep problems	0	1	2	3

Are you currently taking any medication? YES / NO.
If YES, please list: ____

How many <u>units of alcohol</u> do you drink per week approximately? (A unit of alcohol is a pub measure of spirits, a small glass of wine, a half pint of normal beer or an alcopop) ______________

Do you smoke?
Yes ( ) Previously, but not in the last month ( ) No ( )

Do you take recreational drugs?
Yes ( ) Previously, but not in the last month ( ) No ( )

Females only
What age was your first menstrual period? ____________________
How many menstrual cycles have you had in the last year? _______________
Have you been pregnant or given birth in the last year? YES /NO

IRISH DANCING DETAILS

Age you started Irish dancing? ________

Are you? (**Please select ONE which best describes you at present**)
A Professional Irish dancer ( ) 3rd level student of Irish dance ( ) Elite competitive dancer ( )

IF PROFESSIONAL Dancer: How long have you been working as a dancer (years)? ________

How long do you hope to **continue** as a professional Irish dancer (years)? ________________

How long have you been touring with this production (months/years)? __________________

IF STUDENT Dancer: Please give details of course and year. ________________________________
____

IF ELITE COMPETITIVE Dancer: Please give details of last National/World championship competed in and place achieved. ____

ALL DANCERS

On average, how many **hours a week** do you spend Irish dancing, including all rehearsals and performances? __________

What **type of shoes** do you use for dance **practice**?
Irish dance shoes ( ) Sneakers/runners ( ) Other dance shoes, eg. Capezio ( )
Other ( ) Please give details. ____

Do you dance on **sprung** floors? Please tick **one.**
Always ( ) Usually ( ) Often ( ) Sometimes ( ) Rarely ( ) Never ( )

Do you **warm-up** before rehearsal / performance. Please tick **one.**
Always ( ) Usually ( ) Often ( ) Sometimes ( ) Rarely ( ) Never ( )

Do you **cool-down** after rehearsal / performance? Please tick **one.**
Always ( ) Usually ( ) Often ( ) Sometimes ( ) Rarely ( ) Never ( )

On a scale from 1 – 10, (1 – min exertion, 10 – max exertion) how **intense** is your dance practise/rehearsal? 1 2 3 4 5 6 7 8 9 10

How do you deal **with warning signs of injury**? Tick as **many** as are applicable to you.
Tell someone else e.g. dance captain/teacher ( ) Take own preventative steps ( )
Seek professional treatment ( ) Soldier on ( )

Do you do any **other form of exercise** on a regular basis? YES / NO. **If yes**, describe that type of exercise (example, weight lifting, aerobics, Pilates, yoga, running, swimming, bicycling): ___________________
____

How many **hours per week** do you typically exercise apart from Irish dancing? ______________

On a scale from 1 – 10, (1 – min exertion, 10 – max exertion) how intense is your other exercise?
1 2 3 4 5 6 7 8 9 10

	NOT AT ALL SATISFIED				COMPLETELY SATISFIED
How satisfied are you with your current career/status as a dancer?	1	2	3	4	5

PAIN & INJURY

Have you at any time during the ***past 12 months*** had trouble (ache, pain, discomfort, numbness, tingling etc.) in any of the following body regions which affected your normal activity or changed your daily routine for more than one day? Please tick **all that apply**. If no trouble, tick none.

Head & Neck ( )
Upper back ( )
One or both elbows/wrists/hands ( )
One or both knees ( )
One or both calves ( )
None ( )
Lower back ( )
One or both shoulders ( )
One or both hips/thighs ( )
One or both shins ( )
One or both ankles/feet ( )

Which of these has been the single most troublesome body region, if any?

____

What was the diagnosis if you know it: eg. stress fracture, sprain, torn muscle etc. ___________

____

How much total performance/rehearsal time have you missed due to trouble in this body region in the last 5years?____

Has trouble in any other body regions over the last 5 years caused you to miss dancing for more than one week? YES / NO

If YES, please state for the 5 body regions most affected, how much total dance time have you missed in the last 5 years, and the diagnosis if you know it: eg. stress fracture, sprain, torn muscle etc.

Body Region	Time to get back to dancing	Diagnosis

1 ____
2 ____
3 ____
4 ____
5 ____

How often do you dance in pain? Please select one of the following
Never ( ) Rarely ( ) Sometimes ( ) Often ( ) Always ( )

Considering your **most serious injury** (i.e. the injury that led to your longest absence from Irish dancing), when did this injury occur?

Rehearsal period ( )
Early stage tour/season ( )
Middle stage tour/season ( )
Late stage tour/season ( )

Had you previously injured this body region? YES / NO

What treatment, if any, did you seek to manage this injury? _______________________________

____

What do you think was the main cause(s) of this injury: List as many causes as you think apply**.**

____

____

At the time of your **most severe pain or injury,** were you experiencing any of the following: T<u>ick as many as apply to you</u>. Leave blank if none apply to you.

General anxiety ( )
Performance anxiety ( )
Stress due to external factors e.g. bereavement or home-sickness( )
Eating problems ( )
Consistent difficulty concentrating in rehearsal/performance ( )
Tension with people ( )
Depression ( )
Over-use of alcohol/drugs ( )
Sudden drop in self-confidence ( )
General low self-confidence ( )
Other (please describe) ____

How often do you currently experience pain?
Always ( ) Day and night ( ) Several times per week ( ) Seldom ( ) Never ( )

If you have experienced pain in the last month, how bothersome has it been?
Not at all Bothersome ( ) Slightly Bothersome ( ) Moderately Bothersome ( )
Very Bothersome ( ) Extremely Bothersome ( )

Was your pain initiated by an incident at work or elsewhere? YES / NO.

Have you (currently/previously) been involved in litigation regarding the pain? YES / NO. If yes, explain if this is now completed. ____

Below is a list of things that people have reported doing when they feel pain. For each activity, please indicate, using the scale below, how much you engage in that activity when you feel pain

0________________________________3________________________________6
Never do that | Sometimes do that | Always do that

<u>WHEN I FEEL PAIN</u>…….	**0**	**1**	**2**	**3**	**4**	**5**	**6**
I worry all the time about whether the pain will end.							
I feel like I can’t go on.							
It’s terrible and I feel it’s never going to get any better							
It’s awful and I feel that it overwhelms me.							
I feel I can’t stand it anymore.							
I feel my life isn’t worth living							

<u>NUTRITION</u>
Do you make yourself sick because you feel uncomfortably full? YES / NO
Do you worry you have lost control over how much you eat? YES / NO
Have you recently lost more than one stone (14 lb or 7.7 kg) in a 3 month period? YES / NO
Do you believe yourself to be fat when others say you are thin? YES / NO
Would you say that food dominates your life? YES / NO

SLEEP

On average, how many hours per night do you sleep? __________

How well does each of the following statements apply ***over the past month***? (CIRCLE ONE)

I have nightmares :	Never	Sometimes	Often
I am too tired:	Never	Sometimes	Often
I have sleep problems:	Never	Sometimes	Often.

MOOD

Below is a list of words that describe feelings people have. Please read each one carefully and circle the answer which best describes how you feel ***over the past week***. Please answer all questions.

	Not at all	**A Little**	**Moderately**	**Quite a bit**	**Extremely**
Panicky	0	1	2	3	4
Confused	0	1	2	3	4
Annoyed	0	1	2	3	4
Mixed-up	0	1	2	3	4
Bitter	0	1	2	3	4
Anxious	0	1	2	3	4
Worried	0	1	2	3	4
Muddled	0	1	2	3	4
Nervous	0	1	2	3	4
Angry	0	1	2	3	4
Bad tempered	0	1	2	3	4
Uncertain	0	1	2	3	4

STRESS

Please read each statement and tick a number 0, 1, 2 or 3 which indicates how much the statement applied to you ***over the past week*.**

0 Did not apply to me at all.
1 Applied to me to some degree, or some of the time
2 Applied to me to a considerable degree, or a good part of time
3 Applied to me very much, or most of the time

Situation	**0**	**1**	**2**	**3**
I found it hard to wind down				
I tended to over-react to situations				
I felt that I was using a lot of nervous energy				
I found myself getting agitated				
I found it difficult to relax				
I was intolerant of anything that kept me from getting on with what I was doing				
I felt that I was rather touchy				

PERFORMANCE AND YOU

The following are statements that performers have used to describe their experiences. Please read each statement and circle how often you have these experiences when performing.

On a daily or weekly basis, I set very specific goals for myself that guide what I do.	Almost never	Sometimes	Often	Almost always
I get the most out of my talent and skill.	Almost never	Sometimes	Often	Almost always
When a coach or manager tells me how to correct a mistake I've made, I tend to take it personally and feel upset.	Almost never	Sometimes	Often	Almost always
When I'm performing, I can focus my attention and block out distractions.	Almost never	Sometimes	Often	Almost always
I remain positive and enthusiastic during competition, no matter how badly things are going.	Almost never	Sometimes	Often	Almost always
I tend to perform better under pressure because I think more clearly.	Almost never	Sometimes	Often	Almost always
I worry quite a bit about what others think of my performance.	Almost never	Sometimes	Often	Almost always
I tend to do lots of planning about how to reach my goals.	Almost never	Sometimes	Often	Almost always
I feel confident that I will play well.	Almost never	Sometimes	Often	Almost always
When a coach or manager criticizes me, I become upset rather than feel helped.	Almost never	Sometimes	Often	Almost always
It is easy for me to keep distracting thoughts from interfering with something I am watching or listening to.	Almost never	Sometimes	Often	Almost always
I put a lot of pressure on myself by worrying about how I will perform.	Almost never	Sometimes	Often	Almost always
I set my own performance goals for each practice.	Almost never	Sometimes	Often	Almost always
I don't have to be pushed to practice or play hard; I give 100%.	Almost never	Sometimes	Often	Almost always
If a coach criticizes or yells at me, I correct the mistake without getting upset about it.	Almost never	Sometimes	Often	Almost always
I handle unexpected situations in my performance very well.	Almost never	Sometimes	Often	Almost always
When things are going badly, I tell myself to keep calm, and this works for me.	Almost never	Sometimes	Often	Almost always
The more pressure there is during a performance, the more I enjoy it.	Almost never	Sometimes	Often	Almost always

While competing, I worry about making mistakes or failing to come through.	Almost never	Sometimes	Often	Almost always
I have my own performance plan worked out in my head long before the game begins.	Almost never	Sometimes	Often	Almost always
When I feel myself getting too tense, I can quickly relax my body and calm myself.	Almost never	Sometimes	Often	Almost always
To me, pressure situations are challenges that I welcome.	Almost never	Sometimes	Often	Almost always
I think about and imagine what will happen if I fail or screw up.	Almost never	Sometimes	Often	Almost always
I maintain emotional control regardless of how things are going for me.	Almost never	Sometimes	Often	Almost always
It is easy for me to direct my attention and focus on a single object or person.	Almost never	Sometimes	Often	Almost always
When I fail to reach my goals, it makes me try even harder.	Almost never	Sometimes	Often	Almost always
I improve my skills by listening carefully to advice and instruction from coaches and managers.	Almost never	Sometimes	Often	Almost always
I make fewer mistakes when the pressure is on because I concentrate better.	Almost never	Sometimes	Often	Almost always

Thank you for taking the time to complete this survey. Your input is greatly appreciated.

Appendix 4: Physical screen: Prospective study

Date:		**Time:**		**Location:**	

Subject No:	
Consent Form: Yes/ No	
Completed Questionnaire: Yes/No	
Consent Form Coded: Yes/ No	

Height (cm)		Weight (Kgs)	
Waist (cm)		Hip (cm)	
Arm reach (cm)		Leg length (cm)	R L
Resting HR (bpm)		Foot Length (cm)	
Tib Tub to floor (cm)		Start with right or left?	

PPT

Leg (right) 1 ________________ 2 ____________________ 3 _______________

Leg (left) 1 ________________ 2 ____________________ 3 _______________

Neck (right) 1 ________________ 2 ____________________ 3 _______________

Neck (left) 1 ________________ 2 ____________________ 3 _______________

Flexibility

Gastroc: Right 1 ________ Right 2 ________ Left 1 __________ Left 2 ____________

Hamstring: Right 1 ________ Right 2 ________ Left 1 __________ Left 2 ____________

TA - ultrasound: Right 1 ________ Right 2 ________ Left 1 __________ Left 2 ________

Navicular Drop

Right Foot __________ mm Left Foot __________ mm

Balance –Post Medial (1 demo, 1 practice)

Right

Measure 1: __________cm

Measure2: ___________cm

Measure 3: ___________cm

Left

Measure 1: __________cm

Measure 2: __________cm

Measure 3: __________cm

Beighton **1/0**

Passive dorsiflexion of **Right fifth finger** >90º	___
Passive dorsiflexion of **Left fifth finger** >90º	___
Passive apposition of **Right thumb** to the flexor surface of the forearm	___
Passive apposition of **Left thumb** to the flexor surface of the forearm	___
Hyperextension of **Right elbow** >10º	___
Hyperextension of **Left elbow** >10º	___
Hyperextension of **Right knee** >10º	___
Hyperextension of **Left knee** >10º	___
Palms on the floor with the knees fully extended	___
TOTAL	___

Fitness/Endurance Test (Few seconds practice)

Total number jumps: _____ Max HR: _____ Recovery HR:_____

Squat Test (1 Demo, 1 practice)

	Attempt 1	Attempt 2	Attempt 3
Heels stay down	Pass/Fail	Pass/Fail	Pass/Fail
Feet do not slide or rotate	Pass/Fail	Pass/Fail	Pass/Fail
Hips are below the knee	Pass/Fail	Pass/Fail	Pass/Fail
Knees aligned over feet	Pass/Fail	Pass/Fail	Pass/Fail
Dowel does not touch door	Pass/Fail	Pass/Fail	Pass/Fail

All elements met with good quality mvt: **3**

Participant required some type of compensation or was unable to complete the entire movement: **2**

Individual was unable to remain in the movement position throughout the movement, lost balance during the test, or did not meet the minimum criteria to score a 2: **1**

In Line Lunge (1 Demo, 1 practice)

	Right			Left		
Minimal to no upper body movement	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
Feet remain on the tape	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
Back knee touches tape behind heel front foot	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
Dowel does not touch door	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
Balance is maintained	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N

All elements met with good quality mvt: **3**

Participant required some type of compensation or was unable to complete the entire movement: **2**

Individual was unable to remain in the movement position throughout the movement, lost balance during the test, or did not meet the minimum criteria to score a 2: **1**

Vertical Jump

Jump 1 : ____cm Jump 2 : ____cm Jump 3 : ____cm

Appendix 5: Survey Monkey ™ Questionnaire: Study in professional Irish dancers

Injury in Professional Irish Dancers

A Study of Injury in Professional Irish Dancers

You are asked to participate in a research study conducted by Roisin Cahalan and Kieran O'Sullivan

This study will examine the rates and types of injuries sustained by current and former professional Irish dancers.

Please answer all questions.

The survey should take no more than 10 minutes to complete.

All information obtained from the questionnaire will be treated as confidential.

If you have any concerns about this study and wish to contact someone independent you may contact:

Chairman Education and Health Sciences Research Ethics Committee
EHS Faculty Office
University of Limerick
Tel (061) 234101
Email : ehsresearchethics@ul.ie

About You

1. Please indicate your gender

○ Male

○ Female

2. Please indicate your age

○ 18 - 20	○ 25 - 29	○ 35 - 39
○ 21 - 24	○ 30 - 34	○ 40 or older

3. To the nearest year, how long had you attended Irish Dancing lessons before becoming a professional Irish dancer?

4. At what age did you begin working as a professional Irish dancer?

5. To the nearest year, how long did you spend working as a professional Irish dancer?

Injury in Professional Irish Dancers

6. Which of the following shows did you perform with?
Tick as many as are applicable to you.

- [ ] Angelfire
- [ ] Celtic Tiger
- [ ] Dance of Desire
- [ ] Dancing on Dangerous Ground
- [ ] Dancing Through the Ages
- [ ] Essence of Ireland
- [ ] Feet of Flames
- [ ] GaelForce Dance
- [ ] Lord of the Dance
- [ ] Magic of the Dance
- [ ] Noctu
- [ ] Ragus
- [ ] Rhythm of the Dance
- [ ] Riverdance
- [ ] Spirit of the Dance
- [ ] The Pirate Queen
- [ ] To Dance on the Moon
- [ ] Trinity Irish Dance Company
- [ ] Other (please specify)

More About You

7. Please consider the following statements and select the answer that most applies to you
1 = Not at all true, 2 = Hardly true, 3 = Moderately true, 4 = Exactly true

	1	2	3	4
I can always manage to solve difficult problems if I try hard enough.	○	○	○	○
If someone opposes me, I can find the means and ways to get what I want.	○	○	○	○
It is easy for me to stick to my aims and accomplish my goals.	○	○	○	○
I am confident that I could deal efficiently with unexpected events.	○	○	○	○
Thanks to my resourcefulness, I know how to handle unforeseen situations.	○	○	○	○
I can solve most problems if I invest the necessary effort.	○	○	○	○
I can remain calm when facing difficulties because I can rely on my coping abilities.	○	○	○	○
When I am confronted with a problem, I can usually find several solutions.	○	○	○	○
If I am in trouble, I can usually think of a solution.	○	○	○	○
I can usually handle whatever comes my way.	○	○	○	○

Injury in Professional Irish Dancers

Injury Information

The following questions relate to any injury suffered throughout your whole professional career

8. How often did you/ do you dance in pain?

- ◯ Never
- ◯ Rarely
- ◯ Sometimes
- ◯ Often
- ◯ Always

9. During your career as a professional Irish dancer, did you ever miss one or more shows through injury?

- ◯ Yes
- ◯ No

Injury Location

10. Please select the body part(s) injured and level of injury sustained. Injury level is measured in terms of number of PERFORMANCE AND/OR REHEARSAL DAYS MISSED. Tick as many as are applicable to you.

	Minor Injury (1-7 days)	Moderate Injury (8 - 21 days)	Severe Injury (21 days or more)
Head/Face	☐	☐	☐
Neck	☐	☐	☐
Arms/hands	☐	☐	☐
Shoulders	☐	☐	☐
Elbow	☐	☐	☐
Upper back	☐	☐	☐
Lower back	☐	☐	☐
Pelvis	☐	☐	☐
Ribs	☐	☐	☐
Hip	☐	☐	☐
Groin	☐	☐	☐
Thigh	☐	☐	☐
Knee	☐	☐	☐
Calf	☐	☐	☐
Ankle	☐	☐	☐
Foot	☐	☐	☐
Toe	☐	☐	☐

Dealing With Injury

Injury in Professional Irish Dancers

11. In general, how did you react to the warning signs of an injury?

Tick as many as are applicable to you.

- ☐ Tell someone else eg. dance captain
- ☐ Take own preventative steps
- ☐ Seek professional treatment
- ☐ Soldier on

12. How did you try to pace your recovery after injury?

- ◯ Take it slowly/follow professional advice
- ◯ Return as quickly as possible
- ◯ Follow your own instinct

Your most serious injury

The next few questions relate to the MOST SERIOUS INJURY you suffered over the course of your professional career. To be more specific, the injury that caused you to miss the most shows and/or rehearsal time

13. What body part did you injure? Please select an answer from the menu below.

14. What structure(s) did you injure?

Tick as many as are applicable to you

- ☐ Bone
- ☐ Tendon
- ☐ Muscle
- ☐ Ligament
- ☐ Other (please specify)

15. How long did this injury prevent you from returning to dancing with the company?

- ◯ 1 - 7 days
- ◯ More than 21 days
- ◯ 8 - 21 days
- ◯ Career ending

16. At what stage of the production did you suffer this injury?

- ◯ Rehearsal prior to start of shows
- ◯ Midway through the production run.
- ◯ Early stages of the production run
- ◯ Towards the end of the production run.

Causes of Injury

17. Please rank what were, in your opinion, the MAIN factors leading to your injury? 1 = main factor causing injury, 2 = 2nd most relevant factor causing injury, etc. You need only tick boxes relevant to you.

	1	2	3	4	5	6	7	8	9	10	11
Fatigue/overwork	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Unsuitable Floor	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Cold environment	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Insufficient warm up	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Difficult choreography	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Repetitive Movement	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Poor diet	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Psychological distress	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Ignoring early warning signs	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Accident	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Other	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

Other (please specify)

18. When you got injured, were you experiencing any of the following problems? If no answer is applicable to you, you may leave the answer blank and move on. Tick as many as are applicable

- ☐ General anxiety
- ☐ Tension with people
- ☐ Performance anxiety
- ☐ Depression
- ☐ Stress due to external factors (eg. bereavement, home-sickness)
- ☐ Eating problems
- ☐ Over-use of alcohol/drugs
- ☐ General low self-confidence
- ☐ Sudden drop in self-confidence
- ☐ Consistent difficulty concentrating in rehearsal/performance
- ☐ Other (please specify)

19. Had you previously injured this body part?

- ◯ Yes
- ◯ No

Other Problems

Injury in Professional Irish Dancers

20. When working as a professional Irish dancer, did you ever suffer from any of the following?
Please tick as many as are applicable to you.
If none are applicable, please leave the answer blank and proceed to next question.

- ☐ General anxiety
- ☐ Tension with people
- ☐ Performance anxiety
- ☐ Depression
- ☐ Stress due to external factors (eg. bereavement, home-sickness)
- ☐ Eating problems
- ☐ Over-use of alcohol/drugs
- ☐ General low self-confidence
- ☐ Sudden drop in self-confidence
- ☐ Consistent difficulty concentrating in rehearsal/performance
- ☐ Other (please specify)

Where did you spend most of your career?

For the following questions, please answer only in relation to the show where you spent the greatest proportion of your professional career.

21. In which production did you spend most of your career as a professional Irish dancer.
Select one answer from the menu below.

22. In the dance company where you spent most of your professional career, how many shows on average did you perform in per week?

- ○ 1 - 3
- ○ 4 - 6
- ○ 7 or more

23. Was this company a touring production or a non-touring production?

- ○ Touring
- ○ Non-touring

24. To the nearest year, for how long did you perform with this dance company?

25. What type of warm-up if any did you perform?

- ○ Formal group warm-up
- ○ Individual warm-up
- ○ No warm-up
- ○ Other warm-up (please specify)

26. What type of cool-down if any did you perform?

- ◯ Formal group cool-down
- ◯ Individual cool down
- ◯ No cool-down
- ◯ Other cool-down (please specify)

27. Apart from Irish dancing, what other training did you do regularly (at least weekly) when working as a professional Irish dancer?
Tick as many as are applicable to you.
If not applicable to you, please leave this question blank and move on to next question.

- ☐ Aerobics
- ☐ Pilates
- ☐ Weight Training
- ☐ Biking
- ☐ Running
- ☐ Yoga
- ☐ Gym based aerobic activity
- ☐ Stretch classes
- ☐ Other forms of dance
- ☐ Swimming
- ☐ Other training (please specify)

28. What treatments did you find beneficial to managing your physical well-being when working as a professional dancer?
Tick as many as are applicable to you.
If not applicable to you, please leave this question blank and move on to next question.

- ☐ Anti-inflammatory medication
- ☐ Ice packs
- ☐ Physiotherapy
- ☐ Chiropractor
- ☐ Ice sprays
- ☐ Stretching
- ☐ Heat packs
- ☐ Massage
- ☐ Taping
- ☐ Heat rubs/sprays
- ☐ Painkillers
- ☐ Other treatment (please specify)

29. Which of the following support services were provided on a regular basis by the company?
Tick as many as are applicable to you.
If not applicable to you, please leave this question blank and move on to next question.

- ☐ Counsellor
- ☐ Nutritionist
- ☐ Sports Psychologist
- ☐ Massage Therapist
- ☐ Podiatrist (Foot specialist)
- ☐ Sports Therapist
- ☐ Medical Doctor
- ☐ Physiotherapist
- ☐ Other (please specify)

Injury in Professional Irish Dancers

Are you still dancing?

30. Are you still working as a professional Irish dancer?

- ◯ Yes
- ◯ No

Dancer Information

This section asks about your life at the present time

31. To the nearest year, how long has it been since you retired from professional Irish dancing?

[ ]

32. How often do you now Irish dance?

- ◯ Daily
- ◯ Weekly
- ◯ Monthly
- ◯ Every 3 or 4 months
- ◯ Never

33. How many times a week would you regularly do 30 minutes or more of moderate exercise?
Moderate exercise is any activity vigorous enough to increase your heart rate and cause you to be somewhat breathless.

- ◯ Never
- ◯ 1 - 2 times a week
- ◯ 3 - 4 times a week
- ◯ 5 - 6 times a week
- ◯ Every day

34. Do you ever suffer from any of the following:
If not applicable to you, you may leave the answer blank and move on.
Tick as many as are applicable to you.

- ☐ General anxiety
- ☐ Tension with people
- ☐ Performance anxiety at work
- ☐ Depression
- ☐ Stress due to external factors (eg. bereavement)
- ☐ Eating problems
- ☐ Over-use of alcohol/drugs
- ☐ General low self-confidence
- ☐ Sudden drop in self-confidence
- ☐ Consistent difficulty concentrating at work

- ☐ Other (please specify)

[ ]

Injury in Professional Irish Dancers

35. What effect has your career as a professional Irish dancer had on your PHYSICAL wellbeing today?

- ◯ Positive effect
- ◯ Negative effect
- ◯ No effect

Physical Benefits

36. What are the main PHYSICAL BENEFITS you feel are related to your career as a professional Irish dancer?
Tick as many as are applicable to you.

- ☐ Strong bones and muscles
- ☐ Greater flexibility
- ☐ High level of fitness
- ☐ Knowledge about managing injuries
- ☐ Other (please specify)

Physical Complaints

37. Have you had a pain, ache or tenderness at movement in one or more joints during THE LAST MONTH?
Please tick as many as are applicable to you.

- ☐ Any joint (excluding spine)
- ☐ Right foot
- ☐ Left foot
- ☐ Right ankle
- ☐ Left ankle
- ☐ Right knee
- ☐ Left knee
- ☐ Right hip
- ☐ Left hip
- ☐ Back
- ☐ Neck, shoulder
- ☐ Other

Current Well-being

Injury in Professional Irish Dancers

38. On a scale from 0-10, how would you describe your overall CURRENT QUALITY OF LIFE?
0 being worst possible quality of life, 10 being best possible quality of life

	0	1	2	3	4	5	6	7	8	9	10
Quality of Life	○	○	○	○	○	○	○	○	○	○	○

39. On a scale from 0-10, how would you describe your CURRENT OVERALL physical and mental health?
0 being worst possible health, 10 being best possible health

	0	1	2	3	4	5	6	7	8	9	10
Overall health	○	○	○	○	○	○	○	○	○	○	○

40. On a scale from 0-10, how would you describe any CURRENT PHYSICAL disability?
0 being no disability, 10 being totally unable to function physically

	0	1	2	3	4	5	6	7	8	9	10
Physical disability	○	○	○	○	○	○	○	○	○	○	○

41. Considering the impact on your physical and mental well-being of working as a professional Irish dancer, would you recommend this career to a young dancer?

- ○ Yes
- ○ No

42. What are the main reasons to recommend OR not to recommend this career to a young Irish dancer.
Please outline your reasons in the box below.

Thank you for your participation

Thank for your your time in completing this survey - it is greatly appreciated.

.

Then please press "Done" to submit your answers.

Appendix 6: Survey Monkey ™ Questionnaire: Monthly follow up

Irish Dancer Injury Monitoring

Injury in Elite Irish dancers: Follow Up Questionnaire

Thank you for your continued participation in this study. This questionnaire will take you less than 5 minutes to complete.

All information obtained from the questionnaire will be treated as confidential.

If you have any concerns about this study and wish to contact someone independent you may contact:

Chairman Education and Health Sciences Research Ethics Committee
EHS Faculty Office
University of Limerick
Tel (061) 234101
Email : ehsresearchethics@ul.ie

1. Please enter your participant code. If you have forgotten this, please enter your name.

2. Generally, how would you evaluate your own physical and psychological health during the past month?

○ Very good ○ Good ○ Neither good nor poor ○ Poor ○ Very poor

3. During the past month, how much energy did you have?

○ Very much ○ Quite a lot ○ Some ○ A little ○ None

Irish Dancer Injury Monitoring

4. The following are some common health problems and complaints. We want you to look at each and every one of them and report to what extent you have been affected during the last month.

	Not at all	A little	Some	Severe
Palpitations/extra heartbeats	○	○	○	○
Chest pain	○	○	○	○
Breathing difficulties	○	○	○	○
Heartburn	○	○	○	○
Stomach discomfort	○	○	○	○
Diarrhoea	○	○	○	○
Constipation	○	○	○	○
Eczema	○	○	○	○
Tiredness	○	○	○	○
Dizziness	○	○	○	○
Anxiety	○	○	○	○
Sadness / depression	○	○	○	○
Sleep problems	○	○	○	○

5. On average, how many hours a week have you spent Irish dancing, including all rehearsals and performances, over the last month?

Hours [ ]

6. On a scale from 1 – 10, (1 – min exertion, 10 – max exertion) how intense was your dance practise/rehearsal/performance over the last month?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10

Irish Dancer Injury Monitoring

7. On a scale from 0 – 10, please select the impact, if any, the following issues were having on your life over the last month. 0 = No impact, 10 = maximum impact.

	0	1	2	3	4	5	6	7	8	9	10
General Anxiety	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Tension with people	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Performance Anxiety	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Depression	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Stress due to external factors e.g. bereavement or home-sickness	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Over-use of alcohol /drugs	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Eating problems	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Sudden drop in self confidence	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Consistent difficulty concentrating in rehearsal/performance	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
General low self-confidence	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
Poor sleep quality	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

8. Has anything else significant changed in your life in the last month?

◯ Yes ◯ No

9. Please explain briefly what has changed in the last month?

Injury Information

10. Have you missed any dancing time due to illness in the last month?

◯ Yes ◯ No

11. If you have missed some dancing time due to illness, how many days were you affected for?

12. What was the nature of the illness?

Irish Dancer Injury Monitoring

13. Have you missed any rehearsal or performance time in the last month due to pain or injury?

- Yes
- No

Injury Location

14. What body part is involved? Please specify right/left if appropriate.

15. Had you previously experienced pain or injury in this body part?

- Yes
- No

16. How many days dancing (either rehearsal or performance) have you missed due to this injury in the last month?

Days

17. What, in your opinion, was the cause of this problem?

Thank you for your participation

Thank for your your time in completing this survey - it is greatly appreciated.

Then please press "Done" to submit your answers.