

**Injury, illness and physical demands of
professional contemporary dancers:
Health outcomes and methodological
issues**

by Annie Caroline Jeffries

Thesis submitted in fulfilment of the requirements for
the degree of

Doctor of Philosophy

Under the supervision of
Professor Franco Impellizzeri
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Certificate of Authorship and Originality of Thesis

I, Annie Jeffries declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the school of Sport, Exercise & Rehabilitation, Faculty of Health at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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Annie Jeffries

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Preface

This thesis for the degree of Doctor of Philosophy is in the format of published or submitted manuscripts and abides by the ‘Procedures for Presentation and Submission of Theses for Higher Degrees – University of Technology Sydney; Policies and Directions of the University’.

Based on the research design and data collected by the candidate two manuscripts have been published and two manuscripts are currently under review in peer reviewed journals. These papers are firstly brought together by an *Introduction*, which provides background information, an explanation of the research problem and the aims of the series of studies. A *Literature Review* then follows with an overview of health-related issues and measures in professional dance including injury, illness and training load, highlighting the gaps within the literature. The body of the research in this thesis is then presented in manuscript form, in a sequence following the development of research ideas in this investigation. As such, each manuscript outlines and discusses the individual methodology and the findings of each study separately. These chapters are formatted according to the specific journal requirements and therefore may slightly vary from each other. The *General Discussion* chapter provides an interpretation of the collective findings and practical applications from the series of investigations conducted. The *Summary* chapter incorporates the flow of research ideas and conclusions from each project and outlines directions for future research.

List of manuscripts submitted for publication

Jeffries, A.C., Wallace, L., Coutts, A.J., Cohen, A.M., McCall, A., Impellizzeri, F.M. (2020). Injury, Illness, and Training Load in a Professional Contemporary Dance Company: A Prospective Study. *Journal of Athletic Training*. 55(9), 967–976.

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Statement of candidate contribution

Table 1. 1: Percentage contribution of authors to peer-reviewed manuscripts of thesis

Author	Study One (Chapter Three)					
	Annie Jeffries	Lee Wallace	Aaron Coutts	Ashlea Cohen	Alan McCall	Franco Impellizzeri
Research design	60%					40%
Ethics application	90%		10%			
Subject recruitment	80%			20%		
Data collection	70%			30%		
Data cleaning	100%					
Statistical analysis	70%					30%
Manuscript preparation	100%					
Manuscript revision	40%	5%	10%		10%	35%

Author	Study Two (Chapter Four)					
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Research design	60%					40%
Ethics application						
Subject recruitment						
Data collection	70%	20%				10%
Data cleaning	80%					20%
Statistical analysis	90%					10%
Manuscript preparation	100%					
Manuscript revision	40%	5%	10%	15%	10%	20%

Author	Study Three (Chapter Five)					
	Annie Jeffries	Samuele Marcora	Aaron Coutts	Lee Wallace	Alan McCall	Franco Impellizzeri
Research design	40%	20%				40%
Ethics application						
Subject recruitment						
Data collection	60%					40%
Data cleaning						
Statistical analysis						
Manuscript preparation	100%					
Manuscript revision	20%	25%	10%	5%	10%	30%

Author	Study Four (Chapter Six)					
	Annie Jeffries	Andrew Novak	Aaron Coutts	Alan McCall	Shaun McLaren	Franco Impellizzeri
Research design	60%					40%
Ethics application	90%					10%
Subject recruitment	90%					10%
Data collection	100%					
Data cleaning	100%					
Statistical analysis	50%	20%				30%
Manuscript preparation	100%					
Manuscript revision	30%	10%	10%	10%	10%	30%

Abstract

Introduction: Professional dance is a highly demanding physical activity, with both high injury rates and training load and no research examining illness occurrence. Additionally, few studies have investigated these relationships concurrently. In order to investigate relationships conceptual models and valid measurement tools are required. Despite the widespread use of these measurement tools few have been validated. Therefore, this thesis sought to investigate training load, injury and illness in dance and also develop an appropriate conceptual framework for monitoring and also validating measurement tools in dance. In *Study One*, medical attention and time loss injury, illness and training load data were recorded across one year in a cohort of professional contemporary dancers (n=16). The results show that professional dancers experienced high training loads relative to other athletes and concomitantly high injury and illness incidences and risks. In addition, dancers continued training and performing, even when affected by medical attention injury or illness. *Study Two* was a two-part systematic review. Part one identified the most commonly used athlete reported outcome measures (AROMs) in sport for monitoring training responses; part two assessed the risk of bias, measurement properties, and level of evidence, based on international clinimetric guidelines. Results demonstrated that whilst the measurement properties of multiple-item AROMs derived from psychometrics were acceptable (with the exclusion of content validity and measurement error) the single-item AROMs most frequently used in sport science have not been validated. Until proper validation studies are completed, all conclusions based on these AROMs are questionable. *Study Three* was the development of an updated conceptual framework providing an overarching model that may help understand and guide the development, validation, implementation, and interpretation of measures used for athlete monitoring. Using the conceptual framework (*Study Three*) as a foundation, *Study Four*

examined the construct validity and reliability of the single items fatigue and recovery for measuring the training effects in dancers. Results provide preliminary evidence confirming the construct validity, reliability and agreement for the single item of fatigue. The recovery item, despite acceptable reliability and agreement, was only partially confirmed in terms of construct validity, when using the SRSS recovery items as reference. *Conclusion:* Collectively, this thesis provides novel information regarding factors affecting dancer's health and the development of a conceptual framework for monitoring and also validating measurement tools in dance.

Keywords

Rating of perceived exertion

Upper respiratory tract infection

Injury surveillance

Measurement properties

Training effects

Performance

Subjective measures

Athlete monitoring

Fatigue

Recovery

Table of Contents

.....	1
Certificate of Authorship and Originality of Thesis	i
Acknowledgements	ii
Preface	iii
List of manuscripts submitted for publication	iv
Conference proceedings	iv
Statement of candidate contribution	v
Abstract	vii
Keywords	ix
List of Figures	xiv
List of Tables	xvi
List of Abbreviations	xvii
Chapter One	1
General Introduction	1
Background	2
<i>Dance overview</i>	2
<i>Injury in dance</i>	4
<i>Injury risk factors</i>	6
<i>Training load as a risk factor for injury</i>	7
<i>Illness in dance</i>	8
<i>Dancer and athlete monitoring</i>	9
Statement of the Problem	11
Research Objectives	12
Purpose of Studies	13
Research progress linking the manuscripts	15
Chapter Two	17
Literature Review	17
Introduction	19
<i>Injury in dance</i>	19
<i>Injury definition</i>	20
<i>Risk factors of injury in dance</i>	21
<i>Training load in dance</i>	23
<i>Training load and injury</i>	24

<i>Illness</i>	27
<i>Illness and training load</i>	28
<i>Illness in dance</i>	29
<i>Monitoring athletes with subjective measures</i>	30
<i>Physical training frameworks or models</i>	32
Summary	40
Chapter Three	42
A prospective study on injury, illness and training load in a professional contemporary dance company	42
Preface	43
Abstract	44
Introduction	46
Methods	48
Results	51
Discussion	60
Recommendations for future research	68
Conclusion	69
Chapter Four	70
Athlete Reported Outcome Measures for monitoring training responses: a systematic review of risk of bias and measurement property quality according to the COSMIN guidelines	70
Preface	71
Abstract	72
Introduction	74
Methods	76
Results	81
Discussion	92
Critical issues and limitations	99
Conclusion and practical recommendations	101
Chapter Five	103
Development of a revised conceptual framework of physical training for measurement validation and other applications	103
Preface	104
Abstract	105
Aims of the conceptual framework	107
<i>What is a conceptual framework?</i>	107

<i>Why develop a conceptual framework of physical training?</i>	108
Development process of the conceptual framework	109
<i>The previous version of the physical training framework</i>	110
<i>Identification of other frameworks</i>	111
<i>Integration with other frameworks</i>	112
<i>New and expanded concepts</i>	114
Conceptual Framework	116
<i>Training effects</i>	119
<i>Measures of training effects</i>	121
<i>Functional measures</i>	121
<i>Physiological measures</i>	122
<i>Subjective measures</i>	123
<i>Other measures</i>	124
<i>Sport performance outcomes</i>	125
<i>Individual and contextual factors</i>	126
Examples of practical and theoretical applications of the conceptual framework	127
<i>Training monitoring</i>	127
<i>Training tolerance</i>	129
<i>Performance readiness</i>	129
Limitations	134
Summary and conclusion	134
Chapter Six	136
Development and validation of single items for fatigue and recovery in dancers	136
Preface	137
Abstract	138
Introduction	139
Methods	141
Results	147
Discussion	160
Limitations	164
Conclusion	165
Chapter Seven	167
General Discussion	167
<i>Main findings</i>	168
<i>Injury, illness, and training load in a professional contemporary dancers</i>	169

<i>Athlete-Reported Outcome Measures for monitoring training responses</i>	174
<i>Development of a revised conceptual framework of physical training</i>	176
<i>Development and validation of single items for fatigue and recovery: preliminary results in dancers</i>	178
<i>Limitations</i>	181
<i>Practical implications</i>	182
Chapter Eight	184
Summary and Future Directions	184
<i>Summary</i>	185
<i>Future directions</i>	187
Chapter Nine	189
References	189
Chapter Ten	216
Appendices	216
Appendix A: Mean session RPE and duration.....	217
Appendix B: Mean daily group session RPE.....	218
Appendix C: Mean weekly group sRPE based training load.....	219
Appendix D: Quality of the evidence for measurement properties of AROMs.....	222
Appendix E: Results of the Athlete Reported Outcome Measures.....	223
Appendix F: Quality of studies on measurement properties.....	233
Appendix G: Measurement properties according to COSMIN	236
Appendix H: Discussion Athlete Reported Outcome Measures.....	240
Appendix I: Correlation matrix (Spearman's rho) SRSS and single items	249
Appendix J: Correlation matrix (Spearman's rho) BRUMS with single items.....	250
Appendix K: Correlation matrix (Spearman's rho) SRSS and BRUMS.....	251
Appendix L: Combined correlogram.....	252
Appendix Ma: Concept elicitation saturation grid for fatigue.....	253
Appendix Mb: Concept elicitation saturation grid for recovery.....	253
Appendix N: University ethics approval dance study.....	254
Appendix O: University ethics approval questionnaire study	256
Appendix P: Informed consent form dance study	258
Appendix Q: Informed consent form questionnaire study.....	259

List of Figures

Figure 1. 1: Contemporary dance.....	3
Figure 1. 2: Classical ballet.....	3
Figure 1. 3: Ballroom dance.....	3
Figure 1. 4: Jazz dance	3
Figure 1. 5: General outline of the research progress	16
Figure 2. 1: The relationship between internal and external training load	33
Figure 2. 2: Theoretical framework of the training process.....	35
Figure 2. 3: Banister Impulse-Response (IR) model.....	36
Figure 2. 4: Basic antagonistic structure of the Performance Potential metamodel.	37
Figure 2. 5: European College of Sport Science and the American College of Sports Medicine joint consensus statement.....	39
Figure 3. 1: Flow diagram of study design.	52
Figure 3. 2: The distribution of injury severity by injury location.	56
Figure 3. 3: Kaplan-Meier curve.....	57
Figure 3. 4: Injury incidence rate per 1000 exposure hours.....	59
Figure 4. 1: Preferred reporting for systematic reviews (PRISMA) flow diagram part one	82
Figure 4. 2: Preferred reporting for systematic reviews (PRISMA) flow diagram part two.....	87
Figure 5. 1: Conceptual framework of physical training	117
Figure 5. 2: Hypothetical examples.	133
Figure 6. 1: Unipolar and bipolar scale for fatigue	144
Figure 6. 2: Unipolar and bipolar scale for recovery	144
Figure 6. 3: Flow chart showing participant eligibility and available sample sizes	148
Figure 6. 4: Correlogram matrix of the single items, Short Recovery and Stress Scale and the Brunel Mood Scale for the whole sample	155

Figure 6. 5: Correlogram matrix of the single items, Short Recovery and Stress Scale and the Brunel Mood Scale for the concept elicitation sample.....	156
Figure 6. 6: Combined correlogram for single item (SI) fatigue absolute and realtive and Brunel Mood Scale (B).	157
Figure 6. 7: Participant response for reference concept identification of fatigue and recovery.....	159

List of Tables

Table 1. 1: Percentage contribution of authors to peer-reviewed manuscripts of thesis..	v
Table 3. 1: Participant baseline characteristics surveillance period.....	53
Table 3. 2: Injury distribution characteristics, participants injured, and incidence rates	54
Table 3. 3: Body region and tissue classification of new injuries.....	55
Table 3. 4: Individual Daily and Weekly injury and illness rate for load percentiles (mean imputation).	59
Table 4. 1: Instruments used more than twice (% of the total amount of AROMs).	84
Table 4. 2: Single items (% of the total amount of AROMS).....	85
Table 4. 3: Quality of the evidence for measurement properties of the AROMs	88
Table 4. 4: Quality of the AROM development.....	90
Table 5. 1: Operational definitions.....	118
Table 6. 1: Participant characteristics for construct validity and reliability samples...	149
Table 6. 2: Hypotheses and criteria.....	150
Table 6. 3: Distribution of the scores	154
Table 6. 4: Agreement and reliability.....	158

List of Abbreviations

Absolute	unipolar scale
ABQ	athlete burnout questionnaire
ACSM	American college of sports medicine
ARSS	acute recovery stress scale
AROM	athlete reported outcome measure
AU	arbitrary units
BRUMS	Brunel Mood Scale
CK	creatine kinase
CI	confidence interval
CMJ	countermovement jump
COSMIN	COnsensus-based Standards for the selection of health Measurement Instruments
COVID-19	corona virus disease of 2019
CR-10	category ratio
DALDA	daily analysis of life demands for athletes
DOMS	delayed-onset muscle soreness
ECSS	European college of sport science
Fatigue ABS	fatigue absolute
Fatigue REL	fatigue relative
GPS	global positioning system
HREC	human research ethics committee
H	hours
HRV	heart rate variability
IQR	inter quartile range
IR	impulse-response
LW	linearly weighted
Med-Inj	medical attention injury
Neg.emo.state	negative emotional state
Mental perf	mental performance
MTDS	multi-component training distress scale
NIH	national institute of health

No	number
OFSM	overtraining questionnaire of the societe francaise de medecine du sport
Overall recov	overall recovery
PerPot	Performance potential metamodel
Physical perf	physical performance
POMS	Profile of mood state
PRISMA	Preferred Reporting Items for Systematic Review and Meta-Analysis
PROMIS	Patient-Reported Outcomes Measurement Information System
PRSS	Perceived recovery stress scale
PSS	perceived stress scale
REDCap	research electronic data capture
Recov ABS	recovery absolute
Recov REL	recovery relative
Relative	bipolar scale
RESTQ-Sport	Recovery-stress questionnaire athletes
SI	single item
SRSS	Short recovery and stress scale
SRSS Recov	Short recovery and stress scale recovery
SD	standard deviation
sRPE	session rating of perceived exertion
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
Tim-Inj	time loss injury
TQR	Total quality recovery scale
TL	training load
URTI	upper respiratory tract infection
y	years