Dance medicine: risk factors for dancers' musculoskeletal injuries

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Chapter 3

Motivational Climate & Teacher/Master

Perceptions of motivational climate and musculoskeletal injuries in ballet dancers

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Abstract

Sports science identified the trainer-athlete-relationship in the etiology of injuries. We aimed to investigate 1. the association between empowering (EMC) and disempowering (DMC) motivational-climate and musculoskeletal injuries in ballet, 2. if EMC moderates the association between DMC and injuries.

A cross-sectional cohort survey-study was conducted among ballet dancers (>18 years) reporting acute and overuse injuries of the previous two years. Motivational climate was assessed with the Empowering-and-Disempowering-Motivational-Climate-Questionnaire (1-5-Likert). The Oslo-Sports-Trauma-Research-Centre-Overuse-Injury-Questionnaire assessed severity of overuse injuries. Linear regression was performed adjusted for the confounders age, sex, expertise, experience, and initiation-age with an interaction term between EMC and DMC to assess effect modification.

189 dancers (26.7±7.9 years; 130 professionals, 27 nations) reported 197 acute and 465 overuse injuries (previous two years). Mean EMC was 3.1±1.07, DMC 3.3±1.08. EMC was associated with less acute (β=-0.22; 95%CI -0.40 to -0.04) and overuse injuries (β=-0.74; 95%CI -0.99 to -0.50), while DMC was associated with more injuries (acute: β=0.30; 95%CI 0.13 to 0.47; overuse: β=0.74; 95%CI 0.50 to 0.98). When tested together and adjusted for confounders, EMC lost its protective effect (acute: β=-0.15; 95%CI -0.19 to 0.49; overuse: β=-0.34; 95%CI -0.81 to 0.13). DMC was positively associated with injuries throughout all settings (acute: β=0.43; 95%CI 0.10 to 0.76; overuse: β=0.46; 95%CI 0.00 to 0.91). EMC showed no moderating effects on DMC in the adjusted models.

To avoid injuries, it is not enough to create an EMC, because any disempowering nuances may negatively affect empowering climates. Teachers should avoid DMC altogether to prevent injuries in dancers.

3.1 Introduction

As in many high performance sports, vocational, professional, but also amateur ballet dancers experience musculoskeletal injuries, which have been reported to range from 0.6 to 5.6 injuries per 1000 hours of dance (1, 2) The majority of ballet dancers' injuries are overuse injuries and sustained to the lower extremities and spine (3), with a number of different risk factors involved in their development.

Comparable to any other athlete or performer, the psychological environment surrounding the ballet dancer could account for such a risk factor. Among other influences, the behavior of the ballet teacher or ballet master creates a certain motivational climate. The motivational climate has been identified as a predictor for health and wellbeing of athletes, influencing their performance, engagement, and adherence (4-10). Fusing the concepts from self-determination-theory (11) and achievement-goal-theory (12), Duda (2013) described the resulting motivational climate to be more or less empowering or disempowering (13, 14). Based on the tenets of self-determination-theory, achievement-goal-theory and previous research, empowering motivational climates are characterized as task-involving as well autonomy- and socially-supportive, while disempowering climates as more ego-involving, controlling, and relatedness-thwarting. Moreover, in Duda's approach, empowering and disempowering climates are not fundamentally two ends on a continuum, but instead are conceptualized as coexisting (6, 15).

In an empowering motivational climate (EMC), individuality, the dancer's perspectives and self-referenced development are supported. The dancer's reflection on the presence and handling of physical complaints through an empowering atmosphere could contribute to reduce the number of injuries by fighting the idea that pain and injuries are an integrating part of the dance world. (16, 17) An acceptance of individual anatomical limitations instead of a focus on the need to employ compensatory strategies to fulfil ideal dance technical demands could further contribute to avoid many injuries.(18) The focus on social interaction and task-orientation satisfies basic psychological needs for autonomy, competence, as well as relatedness and facilitates co-operative learning. The resulting focus on teamwork could reduce injuries, because there is less need to compete with peers or live up to teachers' expectations, while dancing through pain and injury. In such a climate, mistakes are seen as a chance to learn, while physical complaints and their need to heal is acknowledged. In task-involving climates, trying hard in skill development is appreciated and dancers' are offered meaningful choices and opportunities to input. Hence, empowering climates can foster self-efficacy (19), perceived ability and enjoyment (20, 21) as well as self-worth (22). Studies have found performance- and personality enhancing effects of empowering teacher behavior, which provides rationale, supports meaningful choice and fosters self-referenced perception of competence (23). This nurtures psychological health mirrored in positive affective states or self-esteem, and enhances performance in athletes (9, 13) and dancers (7, 8, 10), while harm or illness can be prevented (24).

A disempowering motivational climate (DMC), in the contrary, stresses an ego-involving view of competence, in which high levels of intra-competition between dancers (performance orientation) and punishment of mistakes are perceived. Disappointment in the dancer expressed by the teacher as well as unequal recognition are examples of controlling teacher behavior, which can result in feelings of humiliation, pressure, intimidation, and control in the dependent person, e.g., the dancer (25). Such a climate does not offer an environment in which dancers can acknowledge or report physical complaints, accept their anatomical individuality or are encouraged to speak out in case of pain or shortcomings. Thus, such an atmosphere is disempowering, fostering maladaptive behavior such as perfectionistic concerns or anxiety (26, 27), forcing the dancer to suppress physical or psychological discomfort, which could support development of stress, illness, or injury.

In a study involving 406 English athletes from various team and individual sports, EMC could be linked to more positive outcomes, such as enjoyment in sports participation, while DMC was associated with reduced accomplishment as well as physical symptoms.(6) In 112 female and male adolescents football players, perceived coach-created empowering motivational climate positively was associated with the children's autonomous motivation. (28) It was positively related to their enjoyment of daily physical activity and negatively related to their percentage of body fat. In female elite football as well as female youth football, empowering features of the climate (e.g., task-involving, autonomy- and social support) and the relationship with or behavior of the coach were negatively related to injuries. Disempowering aspects (e.g., ego-orientations, perceived performance climates, the coach as a source of distress) have shown to be positively associated with overuse or previous injuries. (29, 30)

To our knowledge, no study has investigated the relationship between the motivational climate and musculoskeletal injuries in ballet dancers. Hence, the primary aim of this study was to investigate ballet dancers' perceptions of teacher created empowering and disempowering motivational climates and their association with musculoskeletal injuries. It is hypothesized that an EMC can be positively related to the prevention of musculoskeletal injuries and that DMC can be associated with injuries and ill-health. Second, given EMC and DMC coexist, this study aimed to test whether the EMC moderated the effects of DMC and its association with injuries, i.e., if EMC has a buffering effect on the hypothesized debilitating effects of DMC (6).

3.2 Methods

3.2.1 Study design

A cross-sectional cohort study was performed, using a survey based on 90 questions. The METC-LDD (Medical-Ethic Committee Leiden│Den Haag│Delft) waived METC approval as it did not subject to the WMO (Medical Research Involving Human Subjects act) (N19.082/RM/fIT1). Informed consent was obtained electronically.

3.2.2 Participants

3.2.2.1 Inclusion & exclusion criteria

Participants were professional, pre-professional/vocational, and amateur ballet dancers over 18 years of age, with regular classical ballet training and experience for at least 3 years. Insufficient data (i.e., <75% of the questionnaire answered) were regarded as exclusion criteria. Since the survey was composed in English to serve international purpose, sufficient English language skills were an inclusion criteria for participation.

3.2.2.2 Recruitment method

The link to the survey was presented via social media (Facebook, Instagram), embedded in a short explanation, in which the dancers were asked to further distribute and share the information through their personal contacts, within theatres, ensembles, dance panels, blogs, and other contact options. The survey was executed anonymously and no personal data, through which dancers could be identified, was recorded. 188 ballet ensembles and

51 dance organizations from around the world were informed via email and through contact forms on their website.

3.2.3 Assessments

3.2.3.1 Demographics

General questions assessed baseline demographics such as sex, nationality, age at starting to dance ballet and workload of the previous two years. Workload was assessed as dancer exposure (DE), which equals a dancer's event (irrespective of duration of exposure), i.e., participation in a class, rehearsal, or performance as recommended in dance science literature (31), as well as per athlete exposure hour (AE), i.e., 60 minutes. Level of expertise, i.e., pre-/professional or amateur dancer, was derived from the reported AE: professionals included professional and pre-professional dancers in vocational institutions and were defined as dancers with 16+ hours exposure per week, whereas amateurs had a maximum of 15 hours of dancing per week.(32-35)

3.2.3.2 Injuries

Primary outcome measures were the number of acute and overuse musculoskeletal injuries of the previous two years (36). Overuse injury (37) was defined as any ongoing or recurrent musculoskeletal pain, ache, stiffness, instability, giving away, swelling, locking etc., sustained within the previous two years from dance related activities (i.e., performance, rehearsal, or technique class), which could not be linked to a clearly identifiable event but which affects the dancer's ability to dance, forces to perform and train with pain or functional disability, modify technique, reduce workload, or stop dancing altogether. Acute Injury (37) referred to any acute injury, whose onset could be linked to a specific injury event, in the course of dance related activities (i.e., performance, rehearsal, or technique class) within the previous two years, which affects the dancer's ability to dance, forces to perform and train with pain or functional disability, modify technique, reduce workload, or stop dancing altogether.

Self-reported acute injuries within the previous two years were recorded through 17 items representing 16 body parts and an additional item as possibility to report other injuries than those associated to the given locations. Within each item the following was asked: diagnosis, time loss, pain, the necessity to modify training or technique, and instability to assess the severity of the injury.

Overuse injuries and their severity were assessed based on three sets of questions from the *Oslo Sports Trauma Research Centre (OSTRC) Overuse Injury Questionnaire* (37) adapted for dancers. The items recorded participation in training, rehearsals, or performance by 4 options (i.e., '*full participation without pain'*, '*full participation but with pain during dancing*', '*reduced participation*', and '*I could not participate at all'*), reduction of dancing volume/load through 5 options (i.e., '*No reduction*', '*to a minor extent*', '*to a moderate extent*', '*to a major extent*', and '*I could not dance at all*'), as well as how the overuse injury affected the dancer's performance through 5 items (i.e., '*no effect*', '*to a minor extent*', '*to a moderate extent*', '*to a major extent*', and '*I could not perform at all*').

Moreover, the mode of diagnosis was recorded for both injury mechanisms, i.e., whether the diagnosis was done by a medical professional, the teacher, or the dancers themselves.

3.2.3.3 Motivational Climate

The two high-order dimensions of motivational climate mirroring teacher's behavior, namely empowering and disempowering climate, were assessed through the *(Empowering and Disempowering Motivation Climate Questionnaire)* (38), which was adapted for dancers for the purpose of this study. The dancers were asked to think of their primary ballet teacher of the previous two years, whom they had spent most of their training time with. 33 items were based on a 1-5-Likert-Scale, ranging from 'Strongly disagree" (1) to 'Strongly agree' (5) resulting in mean scores for each subscale, i.e., EMC and DMC. 17 items represented dimensions of EMC, defined by its three lower-order domains, namely task-involving (e.g., '*My Ballet Master/Teacher/Pedagogue/Trainer makes sure dancers feel/felt good when they improve/improved*'), autonomy-supporting (e.g., '*My Ballet Master/Teacher/Pedagogue/Trainer gives dancers choices and options*'), and social-supporting behavior (e.g., '*My Ballet Master/Teacher/Pedagogue/Trainer really cares for me no matter what happens*') with 9, 5, and 3 items, respectively. 16 items assessed DMC, with 7 items for lower-order ego-involving climate (e.g., '*My Ballet Master/Teacher/Pedagogue/Trainer gives most attention to the best dancers*') and 9 items for controlling behavior (e.g., '*My Ballet Master/Teacher/Pedagogue/Trainer shouts at dancers in front of others to make them do certain things*').

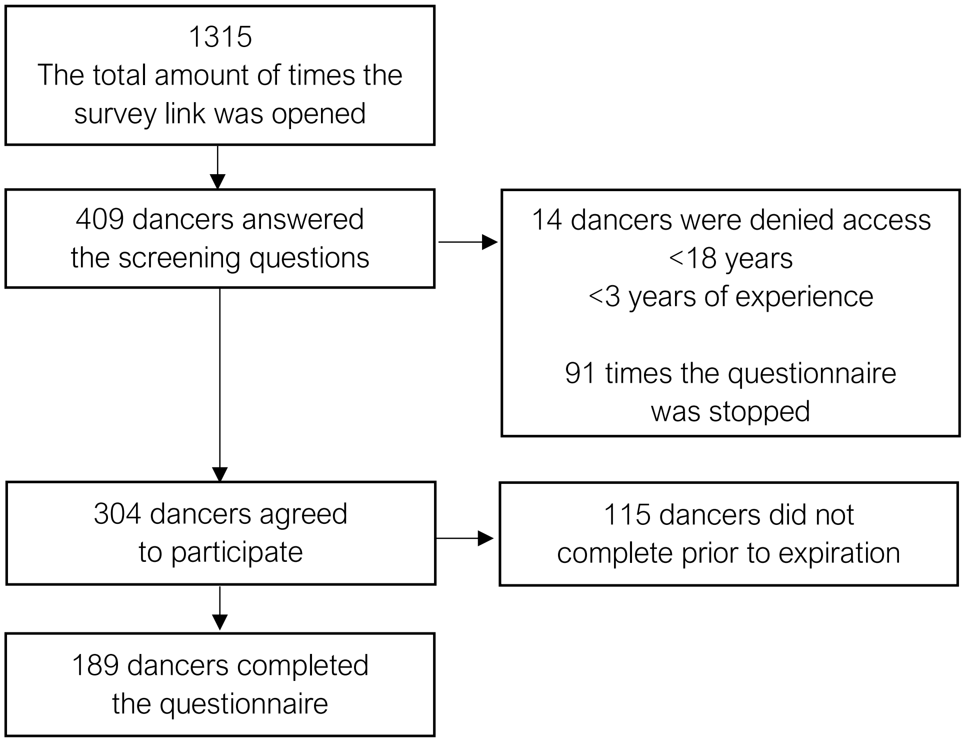
3.2.3 Statistical analysis

SPSS 25 for windows was used for statistical analysis. Normality assumptions were neglectable due to sufficient sample size (39). Multicollinearity was assessed between all *Empowering and Disempowering Motivation Climate Questionnaire*-items (cutoff VIF

<5.0, tolerance >0.2) (40). Cronbach's α was applied to test internal reliability of the *Empowering and Disempowering Motivation Climate Questionnaire*-subscales, and explorative factor analysis (EFA) was used to identify the underlying structure of the scale (Extraction method: Maximum Likelihood; Rotation method: Equamax with Kaiser Normalization; Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett Test).

Uni- and multivariate linear regression served to determine the extent of the relationship between the perceived teacher created higher-order climates and acute or overuse injuries, respectively. The association was assessed in 8 models. In model 1, a univariate regression, we assessed the effect of EMC on acute and overuse injuries, respectively. Model 2 was model 1 with adjustment for the confounders age, sex, years of ballet training, age at ballet initiation, and level of expertise (i.e., professional or amateur dancer). Model 3 evaluated the effect of DMC on both injury mechanisms, in model 4, model 3 was adjusted for confounders. Model 5, a multivariate regression, tested the effect of both, EMC and DMC on acute as well as overuse injuries, and the equivalent model 6 again adjusted for confounding variables. Model 7 evaluated the moderating effect of EMC on DMC (EMC x DMC), for both injury mechanisms with adjustment for confounders in model 8. For this interaction, Hayes' PROCESS v3.5 for SPSS (41) was applied. PROCESS offers the adoption of the Johnson-Neyman-technique, which identifies points in the range of the moderator (EMC) in which the interaction effect of X (DMC) on Y (injuries) becomes statistically significant. When no Johnson-Neyman-Score is reported the output indicates that the effect of DMC on the outcome is significant throughout the whole range of DMC (1-5 Likert Scale) with no buffering effect of EMC.

Figure 1: Flowchart participant documentation



3.3 Results

3.3.1 Population

189 ballet dancers, 156 females and 33 males with a mean age of 26.7 ±7.9 years were included *(Figure 1)*, representing 27 nations (Appendix 1). Most dancers were professional dancers (70%). 5 dancers could not be identified according to level of expertise because their athlete exposure hours were identified as outliers (i.e. > 100 up to 4000 athlete exposure hours). For details see table 1.

Table 1: Demographics: the values are given as the mean ±standard deviation, N (%) of the population
DE: Dancer exposure (= per event, irrelevant of duration of exposure)
AE: Athlete exposure (= per hour, i.e., 60 minutes)

	All N=189	Females N=156	Males N=33
Age at participation (years)	26.7 ±7.86	26.6 ±7,96	27.2 ±7.47
Ballet experience (years)	14.5 ±6.97	14.6 ±7.25	14.0 ±5.51
Age at ballet initiation (years)	8.0 ±5.78	7.4 ±4.61	11.0 ±9.06
Athlete exposure AE (N) (hours/week)	185 26.8 ±15.24	152 25.1 ±15.45	33 34.2 ±11.73
Dancer exposure DE (N) (events/week)	184 12.3 ±9.60	151 11.5 ±9.52	33 16.2 ±9.09
Dancing level Professional AE N(%) (hours/week) Amateur AE N(%) (hours/week)	 130 (70.3) 35.5 ±8.19 55 (29.7) 6.2 ±3.94	 100 (65.8) 34.9 ±8.53 52 (34.2) 6.3 ±3.99	 30 (90.9) 37.3 ±6.73 3 (9.1) 3.7 ±1.52
Empowering climate Professional Amateur	3.1 ±1.07 2.8 ±.1.03 3.8 ±0.75	3.2 ±1.04 2.8 ±1.02 3.8 ±0.76	2.7 ±1.11 2.5 ±1.05 4.1 ±0.65
Disempowering climate Professional Amateur	3.3 ±1.08 3.6 ±.1.03 2.7 ±0.89	3.3 ±1.06 3.6 ±1.01 2.7 ±0.86	3.5 ±1.19 3.7 ±1.10 2.1 ±1.37

3.3.2 Injuries

A total of 197 acute injuries (table 2) were reported by 116 dancers, resulting in 1.0 ±1.16 acute injuries per dancer, of which 161 (81.7%) were diagnosed by a medical professional. The ankle was the body part that was most often affected. 20% of all dancers had an acute ankle injury. When looking at severity acute injuries often resulted into *'timeloss'* and *'pain'* (table 3a and 3b), suggesting that these injuries were substantial. Acutely pulled muscles and acute bone blockage in foot, wrist, shoulder, and hamstrings were reported as 'other acute injuries'.

A total of 465 overuse injuries were reported by 162 dancers (85.7%), 2.5 ±1.9 per dancer and 317 (68%) diagnosed by a medical professional, (table 2). Again the ankle was most often affected by overuse injuries (table 4a and 4b). Muscle soreness until numbness and pain, chronic respiratory diseases, and anorexia were reported as 'other injuries'. Appendix 2 provides an overview of the reported acute and overuse injuries.

For severity, most injuries resulted in *'Full participation but with pain during dancing'* . In combination with *'no reduction of dancing load'* and *'moderate'* to *'major effect on performance'*, substantial burden for the dancers can be noted. Timeloss could not be assessed conclusively for overuse injuries.

3.3.3 Empowering and disempowering motivational climate

Multicollinearity analysis showed acceptable levels of correlation between all items of EMC and DMC. Cronbach's α suggested good internal reliability between items of the *Empowering and Disempowering Motivation Climate Questionnaire* (EMC α = 0.946; DMC α = 0.96). Explorative factor analysis (KMO = 0.97; Bartlett Test p = 0.00) showed clear loading onto 2 factors, which was additionally verified in a Scree Plot. As intended, items of the EMC loaded most strongly onto one factor (range of factor loading: 809 – 515), whilst variables of the DMC loaded onto the second factor (range of factor loading: 853 – 251). The DMC (3.3 ±1.08) and the EMC (3.1 ±1.07) mean scores were moderate.

3.3.4 Motivational climate and injuries

Higher EMC scores were associated with less injuries (acute: β -0.25, 95%CI -0.40 to -0.10; overuse: β -0.92, 95%CI -1.13 to -0.71). After adjustment for confounders in Model 2, these associations remained similar (acute: β -0.22, 95%CI -0.40 to -0.04; overuse: β -0.74, 95%CI -0.99 to -0.50). Higher DMC scores were associated with more acute injuries in model 3 (unadjusted: β 0.31, 95%CI 0.16 to 0.46; adjusted: β 0.30, 95%CI 0.13 to 0.47) and more overuse injuries (unadjusted: β 0.90, 95%CI 0.68 to 1.11; adjusted: β 0.74, 95%CI 0.50 to 0.98) in models 3 and 4. When including both EMC and DMC in one regression model (models 5 and 6), EMC lost its protective effects for both acute (unadjusted: β 0.10, 95%CI -0.22 to 0.41; adjusted: β -0.15, 95%CI -0.19 to 0.49) and overuse injuries (unadjusted: β -0.53, 95%CI -0.97 to -0.09; adjusted: β -0.34, 95%CI -0.81 to 0.13), while the negative effects of DMC remained for acute injuries (unadjusted: β 0.39, 95%CI 0.08 to 0.70; adjusted: β 0.43, 95%CI 0.10 to 0.76) as well as overuse injuries (unadjusted: β 0.44. 95%CI 0.00 to 0.87; adjusted: β 0.46, 95%CI 0.00 to 0.91).

3.3.5 Effect modification of EMC on DMC and injuries

In model 7 and 8 we assessed whether EMC had a moderating effect on DMC and its association with injuries (table 5). EMC only moderated the relationship between the DMC and acute injuries in the unadjusted model (DMC x EMC **β** 0.15, 95%CI 0.01 to 0.28). The Johnson-Neyman score indicated that only when the EMC score was higher than 3.28, did it buffer the debilitating effects of DMC on acute injuries. However, when adjusting for confounders in Model 8, the moderating role of EMC disappeared (acute: **β** 0.14, 95%CI -.01 to 0.29; overuse: **β** -0.15, 95%CI -0.35 to 0.06).

Table 2: Prevalence, frequency, diagnosis of injuries as mean ±standard deviation and N (%) of the population
acute injuries: sudden onset caused by high-intensity forces, i.e., accidents resulting in sprains, strains, contusions, fractures etc.
overuse injuries: result from repetitive micro-traumata of submaximal mechanical loading, also called "chronic injuries".

	Acute injuries	Overuse injuries
Total sum of injuries in 189 dancers	197	465
Injuries per dancer	1.0 ±1.16	2.5 ±1.86
Injuries per female dancer	1.0 ±1.17	2.3 ±1.78
Injuries per male dancer	1.1 ±1.13	3.3 ±2.05
Injuries per professional dancer	1.2 ±1.25	2.9 ±1.94
Injuries per amateur	0.7 ±0.89	1.5 ±1.20
Injuries per dancer		
0	73 (38.6)	27 (14.3)
1	65 (34.4)	42 (22.2)
2	33 (17.5)	31 (16.4)
3	12 (6.3)	44 (23.3)
4	1 (0.5)	18 (9.5)
5	4 (2.1)	14 (7.4)
6	1 (0.5)	8 (4.2)
7		3 (1.6)
8		0 (0)
9		2 (1.1)
Injuries diagnosed by medical professional	161 (81.7)	317 (68.0)
Injuries diagnosed by the ballet teacher/master	8 (4.1)	24 (5.2)
Injuries diagnosed by the dancers themselves	28 (14.2)	124 (26.7)

Table 3a: Locations and severity of acute injuries: Dancers who experienced acute injuries to the upper extremities and torso
Injury locations are calculated as N(%) of the whole study population; severity is calculated as n(%) of the number of dancers affected.
Legend:
acute injuries: sudden onset caused by high-intensity forces, i.e., accidents resulting in sprains, strains, contusions, fractures etc.

	Head	Shoulder	Arm	Thorax	Cervical	Thoracic	Lumbar	Sacroiliac
Total N (%)	11 (5.8)	9 (4.8)	6 (3.2)	3 (1.6)	5 (2,7)	0 (0)	8 (4,2)	5 (2,7)
Timeloss n(%)	9 (81.8)	8 (88.9)	4 (66.7)	2 (66.7)	2 (40.0)	0 (0)	6 (75.0)	5 (100.0)
Modifying technique n(%)	2 (18.2)	5 (55.5)	2 (33.4)	1 (33.3)	3 (60.0)	0 (0)	3 (37.5)	3 (60.0)
Dancing with pain n(%)	3 (27.3)	7 (77.8)	3 (50.0)	1 (33.3)	3 (60.0)	0 (0)	7 (87.5)	3 (60.0)
Dancing with instability n(%)	1 (9.1)	6 (66.7)	2 (33.3)	0 (0)	1 (20.0)	0 (0)	2 (25.0)	1 (20.0)

Table 3b : Locations and severity of acute injuries: Dancers who experienced acute injuries to the lower extremities and 'other injuries'.
Injury locations are calculated as N(%) of the whole study population; severity is calculated as n(%) of the number of dancers affected.
Legend:
acute injuries: sudden onset caused by high-intensity forces, i.e., accidents resulting in sprains, strains, contusions, fractures etc.

	Hip	Thigh	Knee	Shin	Calf	Ankle	Foot	Toes	Other Injuries
Total N (%)	15 (7,9)	17 (9,0)	33 (17,5)	4 (2,1)	4 (2,1)	37 (19,6)	20 (10,6)	10 (5,3)	10 (5,3)
Timeloss n(%)	8 (53.3)	11 (64.7)	26 (78.8)	2 (50.0)	3 (75.0)	28 (75.7)	17 (85.0)	4 (40.0)	8 (80.0)
Modifying technique n(%)	6 (40.0)	8 (47.1)	17 (51.5)	1 (25.0)	3 (75.0)	16 (43.2)	7 (35.0)	5 (50.0)	5 (50.0)
Dancing with pain n(%)	9 (60.0)	13 (76.5)	21 (63.6)	1 (25.0)	4 (100.0)	21 (56.8)	6 (30.0)	7 (70.0)	4 (40.0)
Dancing with instability n(%)	5 (33.3)	3 (17.6)	15 (45.5)	2 (50.0)	0 (0)	20 (54.1)	6 (30.0)	1 (10.0)	2 (20.0)

Table 4a: Locations and severity of overuse injuries: Dancers who experienced overuse injuries to the upper extremities and torso
Injury locations are calculated as N(%) of the whole study population; severity is calculated as n(%) of the number of dancers affected.
Legend:
overuse injuries: result from repetitive micro-traumata of submaximal mechanical loading, also called "chronic injuries".

	Head	Shoulder	Arm	Thorax	Cervical	Thoracic	Lumbar	Sacroiliac
Total N (%)	10 (5.3)	28 (14.8)	5 (2.6)	5 (2.6)	9 (4.8)	10 (5.3)	57 (30.2)	20 (10.6)
Participation in training, rehearsals, performance n(%)								
Full participation without pain	-	2 (7.1)	-	1 (20.0)	-	1 (10.0)	2 (3.5)	-
Full participation but with pain during dancing	6 (60.0)	22 (78.6)	3 (60.0)	3 (60.0)	8 (88.9)	7 (70.0)	49 (86.0)	19 (95.5)
Reduced participation	2 (20.0)	4 (14.3)	-	1 (20.0)	-	1 (10.0)	4 (7.0)	1 (5.0)
I could not participate	2 (20.0)	-	2 (40.0)	-	1 (11.1)	1 (10.0)	2 (3.5)	-
Reduction of dancing volume/load n(%)								
No reduction	4 (40.0)	17 (60.7)	2 (40.0)	4 (80.0)	6 (66.7)	4 (40.0)	44 (77.2)	11 (55.5)
To a minor extent	3 (30.0)	10 (35.7)	-	-	2 (22.2)	2 (20.0)	6 (10.5)	6 (30.0)
To a moderate extent	-	-	1 (20.0)	1 (20.0)	-	1 (10.0)	5 (8.8)	2 (10.0)
To a major extent	-	1 (3.6)	-	-	-	2 (20.0)	-	1 (5.0)
I could not dance at all	3 (30.0)	-	2 (40.0)	-	1 (11.1)	1 (10.0)	2 (3.5)	-
Affect performance n(%)								
No effect	1 (10.0)	7 (25.0)	2 (40.0)	1 (20.0)	-	2 (20.0)	6 (10.5)	2 (10.0)
To a minor extent	3 (30.0)	11 (39.3)	-	2 (40.0)	3 (33.3)	3 (30.0)	14 (24.6)	3 (15.0)
To a moderate extent	4 (40.0)	6 (21.4)	-	1 (20.0)	4 (244.4	3 (30.0)	23 (40.4)	10 (50.0)
To a major extent	1 (10.0)	3 (10.7)	1 (20.0)	1 (20.0)	1 (11.1)	1 (10.0)	12 (21.1)	4 (20.0)
I could not perform at all	1 (10.0)	1 (3.6)	2 (40.0)	-	1 (11.1)	1 (10.0)	2 (3.5)	1 (5.0)

Table 4b b: Locations and severity of overuse injuries: Dancers who experienced overuse injuries to the lower extremities and 'other injuries'. Injury locations are calculated as N(%) of the whole study population; severity is calculated as n(%) of the number of dancers affected.
Legend:
overuse injuries: result from repetitive micro-traumata of submaximal mechanical loading, also called "chronic injuries".

	Hip	Thigh	Knee	Shin	Calf	Ankle	Foot	Toes	Other injuries
Total N (%)	40 (21.2)	14 (7.4)	68 (36.0)	28 (14.8)	7 (3.7)	73 (38.6)	44 (23.3)	26 (13.8)	21 (11.1)
Participation in training, rehearsals, performance n(%)									
Full participation without pain	3 (7.5)	1 (7.1)	3 (4.4)	-	-	4 (5.5)	4 (9.1)	-	1 (4.8)
Full participation but with pain during dancing	20 (50.0)	7 (50.0)	46 (67.6)	16 (57.1)	5 (71.4)	46 (63.0)	33 (75.0)	19 (73.1)	17 (81.0)
Reduced participation	14 (35.0)	5 (35.7)	13 (19.1)	10 (35.7)	2 (28.6)	11 (15.1)	5 (11.4)	3 (11.5)	2 (9.5)
I could not participate	3 (7.5)	1 (7.1)	6 (8.8)	2 (7.1)	-	12 (16.4)	2 (4.5)	4 (15.4)	1 (4.8)
Reduction of dancing volume or load n(%)									
No reduction	15 (37.5)	8 (57.1)	32 (47.1)	15 (53.6)	2 (28.6)	36 (49.3)	22 (50.0)	16 (61.5)	17 (81.0)
To a minor extent	11 (27.5)	4 (28.6)	12 (17.6)	4 (14.3)	3 (42.9)	12 (16.4)	12 (27.3)	3 (11.5)	2 (9.5)
To a moderate extent	7 (17.5)	1 (7.1)	14 (20.6)	4 (14.3)	1 (14.3)	8 (11.0)	6 (13.6)	1 (3.8)	1 (4.8)
To a major extent	4 (10.0)	1 (7.1)	5 (7.4)	3 (10.7)	-	5 (6.8)	2 (4.5)	2 (7.7)	-
I could not dance at all	3 (7.5)	-	5 (7.4)	2 (7.1)	1 (14.3)	12 (16.4)	2 (4.5)	4 (15.4)	1 (4.8)
Affect performance n(%)									
No effect	6 (15.0)	2 (14.3)	4 (5.9)	-	-	3 (4.1)	5 (11.4)	4 (15.4)	2 (9.5)
To a minor extent	12 (30.0)	5 (35.7)	14 (20.6)	8 (28.6)	3 (42.9)	12 (16.4)	15 (34.1)	2 (7.7)	1 (4.8)
To a moderate extent	15 (37.5)	1 (7.1)	19 (27.9)	7 (25.0)	3 (42.9)	30 (41.1)	10 (22.7)	4 (15.4)	11 (52.4)
To a major extent	3 (7.5)	6 (42.9)	27 (39.7)	12 (42.9)	-	18 (24.7)	12 (27.3)	12 (46.2)	6 (28.6)
I could not perform at all	4 (10.0)	-	4 (5.9)	1 (3.6)	1 (14.3)	10 (13.7)	2 (4.5)	4 (15.4)	1 (4.8)

Table 5: The association between empowering and disempowering climates and acute as well as overuse injuries
Legend:
Models 2, 4, 6, and 8 were adjusted for the confounders age, sex, level of expertise, years of ballet, and age at ballet initiation.
Models 7 and 8 show the interaction between EMC and DMC (DMC x EMC)

Parameters acute injuries	β	95% CI for β		Parameters overuse injuries	β	95% CI for β	
		Lower	Upper			Lower	Upper
Model 1: EMC	-0.250	-0.402	-0.099	Model 1: EMC	-0.919	-1.132	-0.705
Model 2: EMC adjusted	-0.220	-0.400	-0.041	Model 2: EMC adjusted	-0.741	-0.986	-0.496
Model 3: DMC	0.307	0.160	0.455	Model 3: DMC	0.896	0.684	1.108
Model 4: DMC adjusted	0.300	0.127	0.472	Model 4: DMC adjusted	0.741	0.503	0.979
Model 5: EMC	0.095	-0.215	0.405	Model 5: EMC	-0.531	-0.970	-0.092
DMC	0.389	0.083	0.695	DMC	0.437	0.004	0.870
Model 6: EMC adjusted	0.154	-0.185	0.493	Model 6: EMC adjusted	-0.342	-0.809	0.125
DMC adjusted	0.428	0.097	0.758	DMC adjusted	0.456	0.001	0.912
Model 7: EMC	0.027	-0.313	0.367	Model 7: EMC	-0.449	-0.982	0.085
DMC	0.293	-0.040	0.626	DMC	0.554	0.027	1.081
Interaction (DMC x EMC)	0.145	0.007	0.283	Interaction (DMC x EMC)	-0.176	-0.375	0.023
Model 8: EMC	0.096	-0.264	0.456	Model 8: EMC	-0.282	-0.814	0.250
DMC	0.336	-0.018	0.690	DMC	0.551	0.030	1.073
Interaction adjusted	0.140	-0.007	0.287	Interaction adjusted	-0.145	-0.345	0.055

3.4 Discussion

This study evaluated the association between ballet dancers' perceptions of teacher created motivational climate and musculoskeletal injuries. In a cross-sectional study including 189 professional and amateur dancers we found that motivational climate was perceived as moderate to low as well as more disempowering than empowering. In our population, DMC was associated with acute and overuse injuries. While EMC had potential to prevent injuries, it lost its effect when DMC was included in the analysis. The stronger association between EMC and DMC, respectively, and overuse injuries is probably related to the fact that acute injuries occur un-anticipated, as sudden macro trauma, while overuse injuries result from more subtle submaximal overload leading to micro-traumata over a longer period of time. Thus, overuse injuries are more strongly depending on the psychological environment surrounding the dancer.

3.4.1 Injuries

The dancers sustained approximately 2.5 times more overuse than acute injuries in the previous two years. This was the case in our whole population as well as in the two levels of expertise, i.e., amateurs and professionals. The prevalence and anatomical locations of injuries found in our dancers are consistent with recent studies (1, 42-44). The lower extremities were the body parts most affected. The highest numbers of acute as well as overuse injuries were sustained to the ankle and the knee, followed by overuse injuries to the lumbar spine.

In order to show the burden of injuries we displayed the items reporting severity for each anatomical injury location instead of aggregating mean scores for overall severity assessment. Overuse injuries result from repetitive micro-traumata instead of one acute macro-trauma (45, 46). Working through those traumata instead of curing complaints renders the athlete at a high risk to sustain further harm. This was documented in sports science and mirrors the difficulty of managing overuse injuries (37). Our tables on the anatomical locations of overuse injuries display patterns, which confirm these tendencies in dancers, who tend to work with pain and/or instability but without reduction of training load. After (or when dancing through micro-) trauma, neuromuscular control might be impaired through alterations in injured tissues responsible for proprioception, sensorimotor control, and strength (47), increasing the risk of overuse and re-injury. Moreover, the stress related to an injury, levels of pain, and perceived lack of recovery has been shown to be associated with an increased risk for repetitive injuries (48).

3.4.2 Motivational climate and injuries

In the current study we focused on the role of the ballet teacher or ballet master in the motivational climate. While they are not the only factors, which determine a motivational climate, they are significant others with a big influence on dancers.(49) Especially in the lives of professional dancers, they are the persons dancers spend most of their time with. Focusing on this important influence of the teacher the motivational climate has been identified as a key predictor for health, wellbeing as well as the athlete's or artist's performance, engagement, and adherence in sports- as well as in dance science (4-10). Self-efficacy (19) as well as self-worth (22, 50), enjoyment and perceived ability (20, 21, 28) can be fostered through EMC. Moreover, EMC can provide an environment for dancers in which they are allowed or even encouraged to report and cure their injuries and complaints without fear of sanctions or other ramifications.

In the contrary, teachers, who encourage ego-orientation or who exhibit controlling behavior create a DMC. In a previous study, female football coaches/trainers were shown to become a source of distress for the athletes through their choices and behaviors, which could be linked to overuse injuries (29). In another study on female youth football, the association between previous injuries and features of a DMC (i.e., ego-orientation as well as performance climates) was demonstrated (30).

Our study is the first to report that DMC can be positively related to musculoskeletal injuries in dancers, confirming Duda's model with respect to physiological correlates. The Empowering and Disempowering Motivational Climate-Questionnaire, which we adapted for dancers, investigates the behavior and motivational strategies of the ballet teacher or ballet master, which create a certain motivational climate. As our results indicate, already nuances of DMC can threaten the dancer's wellbeing by heightening the occurrence of injury. According to Duda's model, the DMC most likely impacts on injury occurrence by thwarting dancers' feelings of task-focused competence, autonomy- and relatedness, and making it more likely that the dancer has an ego-involvement and controlled motivation. Our results are consistent with previous studies, which have considered alternative psychological outcomes such as burnout, need dissatisfaction, reduced accomplishment, and overall ill-health in child, adolescent, and adult athletes of various team and individual sports (6, 25, 28, 51-53).

The relationship with overuse injuries, which constitute the majority of dancers' injuries, is of particular interest in our findings. Unfortunate handling of pain as well as injury has recurrently been described as a factor in the high number of overuse injuries in dancers (3, 16, 17), in which disempowering environments could play a role. The creation of a

DMC could lead to the perceived need in dancers to work through pain and injury in order to please teachers or avoid sanctions,(54-56). Moreover, a competitive atmosphere, as an integrating aspect of a disempowering environment, might force dancers to push themselves through pain, risk acute as well as overuse injuries in their goal to outperform others or keep contracts. The fear of mistakes, as another aspect of DMC, could lead to the need to overcome individual anatomical limitations in the search of dance technical excellency, which might contribute to injury risk by employing the need for compensatory strategies, ignoring the need to reduce workload or modify exercises to allow complaints and injuries to heal.(18)

Our findings show that DMC can be linked to injuries, while an EMC can positively support injury prevention and may thus support wellbeing, consistent with previous research on dancers (7, 8). However, a growing number of researchers stress the importance of considering the interaction between EMC and DMC rather than regarding EMC and DMC as mutually exclusive concepts (38, 57, 58). Lower-order empowering (i.e., autonomy- and social support as well as task-involving) and disempowering (i.e., ego-involving and controlling behavior) dimensions interact with each other (6). This suggests that in reality, the overall motivational climate for most dancers is not only positive or negative, i.e., the behavior of the ballet teacher or ballet mater towards the dancer is most likely empowering and disempowering. Our findings emphasize the importance of this interaction with respect to dancers' injuries. When both climate scores were taken into account in the regression analysis, the preventive effects of the EMC disappeared. Moreover, when the confounders were included, EMC did not moderate DMC on injuries. These findings build upon Appleton and Duda's, 2016, who showed that even strong perceptions of EMC (mean scores between 4 and 4.5) might not be enough to prevent ill-health and suboptimal functioning (6). However, different aspects have to be discussed with regard to these findings: Dancers might perceive basically positive, task-involving approaches such as allowing and working on mistakes as troublesome and pressuring, thus as disempowering. On the contrary, a pushing or even pressuring behavior in a ballet teacher or ballet master could be interpreted as disciplined and thus regarded as task-involving aspect, although the questionnaire applied to investigate the motivational climate would regard such tendencies as disempowering. This would result in a different understanding and interpretation of questionnaire items in dancers and researchers. Such tendencies were also found in other studies investigating motivational climate in dancers. (27, 58) The EMC and DMC scores of our total sample were quite close, albeit more disempowering than empowering. Explorative factor analysis showed that dancers had a tendency to perceive disempowering features such as ego-involving and competitive environment in the questionnaire as more positive than expected, probably as accepted aspect of their lives.

Another aspect is that Appleton and Duda's findings might be especially relevant in dance with respect to the difference we found between amateur and professional dancers. The ballet dancers in our study perceived lower levels of EMC than DMC. Professional dancers in particular reported lower scores for EMC (2.8 ±1.02) and higher scores for DMC (3.6 ±1.03) than amateurs (EMC 3.8 ±.75; DMC 2.7 ±.89). Several factors could be responsible for these results: On the one hand, life, goals, environment as well as workload and consequently quality of motivation are different between professional and amateur ballet dancers. On the other hand, pressures and expectations from audience and organizations, such as schools, theatres etc., on teachers to produce excellent dancers, together with a lack of knowledge in those teachers, who have transitioned from their own career into teaching/training dancers without any further special education, could result in them creating more of a DMC than EMC. However, since injury numbers in professional dancers are high (1), our findings have to be regarded as specifically important in the field of professional dance. Those teaching and training dancers have to be aware of their essential role in creating an empowering, (i.e., injury-preventive) climate but equally, refrain from creating or allowing any disempowering nuances in teaching and training environments in order to protect their dancers from injuries and ill-health. Moreover, stressing EMC and avoiding DMC altogether would make teachers more susceptive to the feedback and individual goals and needs of the dancer. The latter will also have a performance enhancing effect, as cited in the above, and additionally might reduce the high costs of absence, sick leave and related expenses such as re-casting, re-rehearsing etc. in companies (59, 60) because it has the potential to reduce injury numbers.

3.4.3 Strengths and limitations

This study is the first to investigate the association between the motivational climate created by ballet teachers or master and the presence of musculoskeletal injuries in ballet dancers. While our main findings are comparable to previous literature, some limitations exist in this cross-sectional and retrospective study. Recall bias has to be taken into consideration regarding our instructions that dancers may think of their primary teacher, the motivational climates created by them, and injuries of the previous two years. Also, we instructed the study participants to think of the teacher they spend most of their time with since dancers very often have more than one ballet teacher or ballet master. The current design was chosen because a prospective research design with a subset of dancers was considered not feasible since professional dancers declared their fear of sanctions when speaking their minds freely. For that matter, the survey was executed completely anonymously. Moreover, this initial reaction of dancers supports our results reflected in the high DMC scores, especially in professional dancers. However, although the professional dancers of our sample reported lower mean scores for EMC and higher for DMC than the amateurs, our number of amateurs was too low to stratify our data. We grouped dancers into professional and pre-professional as opposed to amateurs by weekly hourly workload. As such we did not make a distinction between professional and pre-professional/vocational dancers. Finally, we do not know whether our study population is representable for the main stream dance population. However, our very large international study with a wide distribution as far as across 27 nations is the first to evaluate the association between motivational climates and musculoskeletal injuries as well as the interaction between EMC and DMC with regard to injuries.

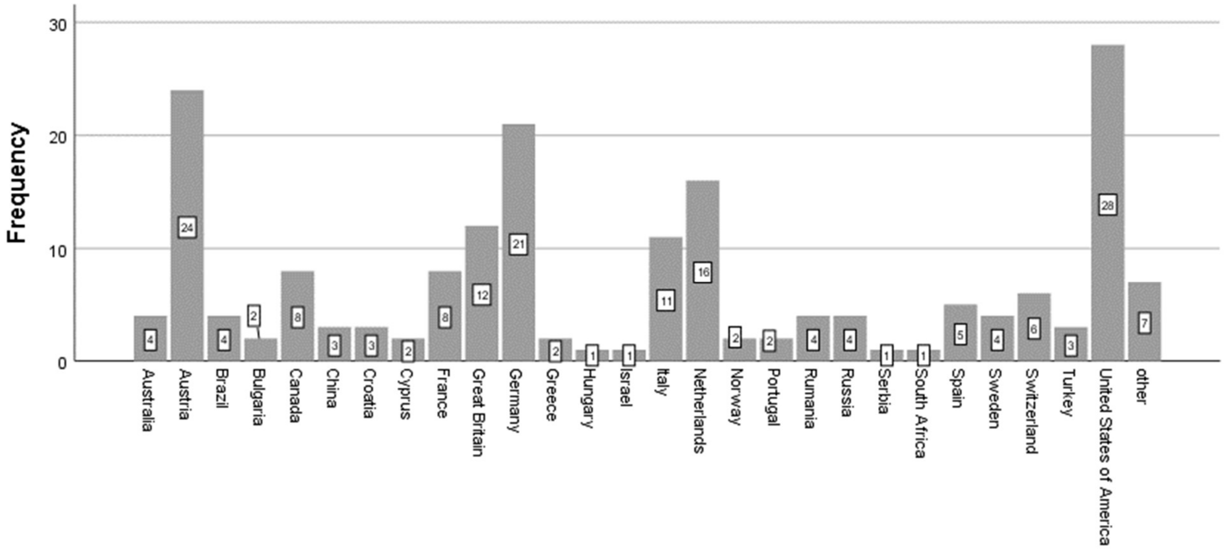
3.4.4 Practical implications

Our findings provide important practical implications for professional and amateur dancers, ballet teachers as well as health and administrative personnel working with dancers. As shown in various team and individual sports as well as in educational settings, the behavior of the teacher or coach, which creates a certain motivational climate, plays an essential role for the wellbeing of the performing artist, athlete or student (6, 7, 30, 61). EMC may not only prevent injuries, as we could confirm in our sample, but fosters intrinsic motivation by supporting commitment through enjoyment, task-focused goal orientation, and perceived competence, leading to performance enhancement (62). However, our results stress that it may be even more important to strive to avoid any disempowering nuances emerging in training and work environment of ballet dancers, if injuries are to be prevented.

3.5 Conclusion

In order to avoid injuries in ballet dancers it is not enough to create an EMC in ballet education, training, and work environment, because the potentially preventive EMC seems to be diminished in the presence of a DMC. Ballet teachers or ballet masters should try to avoid DMC altogether to prevent injuries and ill-health in dancers and foster positive outcomes such as injury reduction, overall health, and performance enhancement.

Appendix 1: Number of dancers per nationality



Appendix 2: Overview of reported acute and overuse injuries
Legend:
FHL: Flexor hallucis longus muscle

Reported injuries	Reported injuries	Reported injuries
Lower back issues and pain	Ruptured ACL	Dancer's Tendonitis (FHL and tibialis)
Inflammation, bruises, burns	Ruptured hamstring	Sore muscles with (severe) pain
Concussion	Ruptured ligament	Osteoarthritis
Dislocated bones, (sub-)luxations	Ruptured muscle (not specified)	Overtraining, Stress
Fractured 2nd metatarsal	Ruptured rotator cuff	Tibial Stress Syndrome
Fractured 5th metatarsal	Ruptured tendon	Trigger toe (with FHL tendonitis)
Fractured tibia	Sprained ligament	Pain (unspecified)
Fractured rib, bruised rib	Sprained/twisted ankle	Breathing problems
Fractured toes	Sprained/twisted knee	Ankle pain/overuse (unspecified)
Fractured wrist	Sprained/twisted wrist	Calf pain/overuse (unspecified)
Fracture (not specified)	Muscle and other (repetitive) injury	Foot pain/overuse (unspecified)
Impingement ankle/foot	Supination trauma	Hip pain/overuse (unspecified)
Impingement femoroacetabular	Tendinopathy (Achilles)	Knee pain/overuse (unspecified)
Intervertebral disc issues/prolaps	Toenail and Skin lesions	Neck pain/overuse (unspecified)
Luxated/-ing patella	Chronic Respiratory Diseases	Shin pain/overuse (unspecified)
Luxated shoulder	Eating Disorders, Dehydration	Toe pain/overuse (unspecified)
Meniscus lesion	Dehydration	

References Chapter 3

1. Allen N, Nevill A, Brooks J, Koutedakis Y, Wyon M. Ballet injuries: injury incidence and severity over 1 year. J Orthop Sports Phys Ther. 2012;42(9):781-90. Epub 2012/07/21. doi: 10.2519/jospt.2012.3893. PubMed PMID: 22814244.
2. Smith PJ, Gerrie BJ, Varner KE, McCulloch PC, Lintner DM, Harris JD. Incidence and Prevalence of Musculoskeletal Injury in Ballet: A Systematic Review. Orthop J Sports Med. 2015;3(7):2325967115592621. Epub 2015/12/18. doi: 10.1177/2325967115592621. PubMed PMID: 26673541; PubMed Central PMCID: PMCPMC4622328.
3. Jacobs CL, Cassidy JD, Cote P, Boyle E, Ramel E, Ammendolia C, et al. Musculoskeletal Injury in Professional Dancers: Prevalence and Associated Factors: An International Cross-Sectional Study. Clin J Sport Med. 2017;27(2):153-60. Epub 2016/02/19. doi: 10.1097/JSM.0000000000000314. PubMed PMID: 26889817.
4. Smith RE, Smoll FL, Cumming SP. Effects of a motivational climate inntervention for coaches on young athletes' sport performance anxiety. J Sport Exerc Psychol. 2007;29(1):39-59. Epub 2007/06/09. doi: 10.1123/jsep.29.1.39. PubMed PMID: 17556775.
5. Smoll FL, Smith RE, Cumming SP. Effects of a Motivational Climate Intervention for Coaches on Changes in Young Athletes' Achievement Goal Orientations. J Clin Sport Psychol. 2007;1(1):23-46. doi: 10.1123/jcsp.1.1.23. PubMed PMID: WOS:000214816600004.
6. Appleton PR, Duda JL. Examining the interactive effects of coach-created empowering and disempowering climate dimensions on athletes' health and functioning. Psychology of Sport and Exercise. 2016;26:61-70. doi: 10.1016/j.psychsport.2016.06.007. PubMed PMID: WOS:000382598800009.
7. Hancox JE, Quested E, Ntoumanis N, Duda JL. Teacher-created social environment, basic psychological needs, and dancers' affective states during class: A diary study. Pers Indiv Differ. 2017;115:137-43. doi: 10.1016/j.paid.2016.03.033. PubMed PMID: WOS:000403134900024.
8. Quested E, Duda JL. Exploring the social-environmental determinants of well- and ill-being in dancers: a test of basic needs theory. J Sport Exerc Psychol. 2010;32(1):39-60. Epub 2010/02/20. PubMed PMID: 20167951.
9. Quested E, Duda JL. Setting the Stage: Social-environmental and motivational predictors of optimal training engagement. Perform Res. 2009;14(2):36-45. doi: Pii 916491123 10.1080/13528160903319265. PubMed PMID: WOS:000272085100005.
10. Quested E, Duda JL. Perceptions of the motivational climate, need satisfaction, and indices of well- and ill-being among hip hop dancers. J Dance Med Sci. 2009;13(1):10-9. Epub 2009/05/07. PubMed PMID: 19416610.
11. Deci EL, Ryan RM. The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. Psychol Inq. 2000;11(4):227-68. doi: Doi 10.1207/S15327965pli1104_01. PubMed PMID: WOS:000166046400001.
12. Ames C. Achievement Goals, Motivational Climate, and Motivational Processes. In: Roberts G, editor. Motivation in Sport and Exercise. Champaign, IL: Human Kinetics Publishers; 1992. p. 161-76.
13. Duda JL. The conceptual and empirical foundations of Empowering Coaching (TM): Setting the stage for the PAPA project. Int J Sport Exerc Ps. 2013;11(4):311-8. doi: 10.1080/1612197x.2013.839414. PubMed PMID: WOS:000436534100002.

14. Duda JL. Achievement Goal Research in Sport: Pushing the Boundaries and Clarifying Some Misunderstandings. In: Roberts GC, editor. Advances in Motivation in Sport and Exercise. Leeds: Human Kinetics; 2011. p. 129-82.
15. Smith N, Tessier D, Tzioumakis Y, Fabra P, Quested E, Appleton P, et al. The relationship between observed and perceived assessments of the coach-created motivational environment and links to athlete motivation. Psychology of Sport and Exercise. 2016;23:51-63. doi: 10.1016/j.psychsport.2015.11.001. PubMed PMID: WOS:000371842800006.
16. Vassallo AJ, Pappas E, Stamatakis E, Hiller CE. Injury Fear, Stigma, and Reporting in Professional Dancers. Saf Health Work. 2019;10(3):260-4. Epub 2019/09/10. doi: 10.1016/j.shaw.2019.03.001. PubMed PMID: 31497323; PubMed Central PMCID: PMCPMC6717803.
17. Thomas H, Tarr J. Dancers' perceptions of pain and injury: positive and negative effects. J Dance Med Sci. 2009;13(2):51-9. Epub 2009/06/11. PubMed PMID: 19508809.
18. Kaufmann JE, Nelissen R, Exner-Grave E, Gademan MGJ. Does forced or compensated turnout lead to musculoskeletal injuries in dancers? A systematic review on the complexity of causes. J Biomech. 2021;114:110084. Epub 2020/12/19. doi: 10.1016/j.jbiomech.2020.110084. PubMed PMID: 33338756.
19. Zourbanos N, Haznadar A, Papaioannou A, Tzioumakis Y, Krommidas C, Hatzigeorgiadis A. The Relationships Between Athletes’ Perceptions of Coach-Created Motivational Climate, Self-Talk, and Self-Efficacy in Youth Soccer. Journal of Applied Sport Psychology. 2016;28(1):97-112. doi: 10.1080/10413200.2015.1074630.
20. Jaakkola T, Ntoumanis N, Liukkonen J. Motivational climate, goal orientation, perceived sport ability, and enjoyment within Finnish junior ice hockey players. Scand J Med Sci Sports. 2016;26(1):109-15. Epub 2015/02/05. doi: 10.1111/sms.12410. PubMed PMID: 25648198.
21. Cheon SH, Reeve J, Lee J, Lee Y. Giving and receiving autonomy support in a high-stakes sport context: A field-based experiment during the 2012 London Paralympic Games. Psychology of Sport and Exercise. 2015;19:59-69. doi: 10.1016/j.psychsport.2015.02.007. PubMed PMID: WOS:000355062400008.
22. Quested E, Duda JL. Perceived autonomy support, motivation regulations and the self-evaluative tendencies of student dancers. J Dance Med Sci. 2011;15(1):3-14. Epub 2011/06/28. PubMed PMID: 21703088.
23. Mageau GA, Vallerand RJ. The coach-athlete relationship: a motivational model. J Sports Sci. 2003;21(11):883-904. Epub 2003/11/25. doi: 10.1080/0264041031000140374. PubMed PMID: 14626368.
24. Quested E, Duda, J. L., Ntoumanis, N., & Maxwell, J. P. . Daily fluctuations in the affective states of dancers: A cross-situational test of Basic Needs Theory. Psychology of Sport and Exercise. 2013;14:586-95.
25. Bartholomew KJ, Ntoumanis N, Ryan RM, Bosch JA, Thogersen-Ntoumani C. Self-determination theory and diminished functioning: the role of interpersonal control and psychological need thwarting. Pers Soc Psychol Bull. 2011;37(11):1459-73. Epub 2011/06/28. doi: 10.1177/0146167211413125. PubMed PMID: 21700794.
26. Nordin-Bates SM, Quested E, Walker IJ, Redding E. Climate Change in the Dance Studio: Findings From the UK Centres for Advanced Training. Sport Exerc Perform. 2012;1(1):3-16. doi: 10.1037/a0025316. PubMed PMID: WOS:000209410500002.
27. Carr S, Wyon M. The impact of motivational climate on dance students’ achievement goals, trait anxiety and perfectionism. Journal of Dance Medicine & Science. 2003; 7(4):105-14.
28. Fenton SAM, Duda JL, Appleton PR, Barrett TG. Empowering youth sport environments: Implications for daily moderate-to-vigorous physical activity and adiposity. J Sport Health

Sci. 2017;6(4):423-33. Epub 2018/10/26. doi: 10.1016/j.jshs.2016.03.006. PubMed PMID: 30356602; PubMed Central PMCID: PMCPMC6189245.
29. Pensgaard AM, Ivarsson, A., Nilstad, A., Solstad, B. E., Steffen, K. . Psychological stress factors, including the relationship with the coach, and their influence on acute and overuse injury risk in elite female football players. BMJ Open Sport & Exercise Medicine. 2018;4(e000317). doi: 10.1136/bmjsem-2017-000317.
30. Steffen K, Pensgaard AM, Bahr R. Self-reported psychological characteristics as risk factors for injuries in female youth football. Scand J Med Sci Sports. 2009;19(3):442-51. Epub 2008/04/26. doi: 10.1111/j.1600-0838.2008.00797.x. PubMed PMID: 18435692.
31. Liederbach M, Hagins, M., Gamboa, J.M., Welsh, T.M. . Technical report of the Standard Measures Consensus Initiative of the International Association for Dance Medicine and Science. Recommendations and implementation strategies for the assessment of reporting of dancer capacities, risk factors and injuries: steps toward consensus. Journal of Dance Medicine & Science. 2012;16(4):139-53.
32. Winston P, Awan R, Cassidy JD, Bleakney RK. Clinical examination and ultrasound of self-reported snapping hip syndrome in elite ballet dancers. Am J Sports Med. 2007;35(1):118-26. Epub 2006/10/06. doi: 10.1177/0363546506293703. PubMed PMID: 17021311.
33. Steinberg N, Siev-Ner I, Peleg S, Dar G, Masharawi Y, Zeev A, et al. Injury patterns in young, non-professional dancers. J Sports Sci. 2011;29(1):47-54. Epub 2010/11/19. doi: 10.1080/02640414.2010.521167. PubMed PMID: 21086212.
34. Twitchett E, Angioi M, Koutedakis Y, Wyon M. The demands of a working day among female professional ballet dancers. J Dance Med Sci. 2010;14(4):127-32. Epub 2010/01/01. PubMed PMID: 21703083.
35. Lampe J, Groneberg DA, Ohlendorf D, Wanke EM. Pain in female dancers and dance teachers: Perception, assessment, and related behavior. Scand J Med Sci Spor. 2019;29(4):623-32. doi: 10.1111/sms.13387. PubMed PMID: WOS:000460975000014.
36. Negus V, Hopper D, Briffa NK. Associations between turnout and lower extremity injuries in classical ballet dancers. J Orthop Sport Phys. 2005;35(5):307-18. doi: DOI 10.2519/jospt.2005.35.5.307. PubMed PMID: WOS:000229224000005.
37. Clarsen B, Myklebust G, Bahr R. 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. Br J Sports Med. 2013;47(8):495-502. Epub 2012/10/06. doi: 10.1136/bjsports-2012-091524. PubMed PMID: 23038786.
38. Appleton PR, Ntoumanis N, Quested E, Viladrich C, Duda JL. Initial validation of the coach-created Empowering and Disempowering Motivational Climate Questionnaire (EDMCQ-C). Psychology of Sport and Exercise. 2016;22:53-65. doi: 10.1016/j.psychsport.2015.05.008. PubMed PMID: WOS:000367116400007.
39. Lumley T, Diehr P, Emerson S, Chen L. The importance of the normality assumption in large public health data sets. Annu Rev Public Health. 2002;23:151-69. Epub 2002/03/23. doi: 10.1146/annurev.publhealth.23.100901.140546. PubMed PMID: 11910059.
40. Rogerson PA. Statistical methods for geography. London: Sage; 2001.
41. Hayes AF. Introduction to Mediation, Moderation, and Conditional Process Analysis, Second Edition A Regression-Based Approach. Little TD, editor. New York: Guilford Press; 2017.
42. Sobrino FJ, de la Cuadra C, Guillen P. Overuse Injuries in Professional Ballet Injury-Based Differences Among Ballet Disciplines. Orthop J Sports Med. 2015;3(6). doi: Artn 2325967115590114 10.1177/2325967115590114. PubMed PMID: WOS:000370382100009.

43. Smith TO, Davies L, de Medici A, Hakim A, Haddad F, Macgregor A. Prevalence and profile of musculoskeletal injuries in ballet dancers: A systematic review and meta-analysis. Phys Ther Sport. 2016;19:50-6. Epub 2016/04/16. doi: 10.1016/j.ptsp.2015.12.007. PubMed PMID: 27080110.
44. Lampe J, Groneberg DA, Borgetto B, Ohlendorf D, Wanke EM. Assessment of musculoskeletal pain in dance focusing on dance-style related differences. Phys Sportsmed. 2019;47(4):433-40. Epub 2019/05/18. doi: 10.1080/00913847.2019.1613120. PubMed PMID: 31099296.
45. Bronner S, Ojofeitimi, S., Mayers, L. Comprehensive surveillance of dance injuries: a proposal for uniform reporting guidelines for professional companies. Journal of Dance Medicine & Science. 2006;10(3):69-80.
46. Murgia C. Overuse, fatigue, and injury: neurological, psychological, physiological, and clinical aspects. J Dance Med Sci. 2013;17(2):51-2. Epub 2013/06/14. doi: 10.12678/1089-313x.17.2.51. PubMed PMID: 23759478.
47. Fulton J, Wright K, Kelly M, Zebrosky B, Zanis M, Drvol C, et al. Injury risk is altered by previous injury: a systematic review of the literature and presentation of causative neuromuscular factors. Int J Sports Phys Ther. 2014;9(5):583-95. Epub 2014/10/21. PubMed PMID: 25328821; PubMed Central PMCID: PMCPMC4196323.
48. van der Does HT, Brink MS, Otter RT, Visscher C, Lemmink KA. Injury Risk Is Increased by Changes in Perceived Recovery of Team Sport Players. Clin J Sport Med. 2017;27(1):46-51. Epub 2016/03/06. doi: 10.1097/JSM.0000000000000306. PubMed PMID: 26945309.
49. Araújo L, Cruz J, Almeida L. Inspirational teachers : their role in the development of excellence in professional dancers. International Symposium on Performance Science August 24-27 2011; Toronto, Canada2011.
50. O'Rourke DJ, Smith RE, Smoll FL, Cumming SP. Relations of Parent- and Coach-Initiated Motivational Climates to Young Athletes' Self-Esteem, Performance Anxiety, and Autonomous Motivation: Who Is More Influential? Journal of Applied Sport Psychology. 2014;26(4):395-408. doi: 10.1080/10413200.2014.907838.
51. Isoard-Gautheur S, Guillet-Descas E, Duda JL. How to achieve in elite training centers without burning out? An achievement goal theory perspective. Psychology of Sport and Exercise. 2013;14(1):72-83. doi: https://doi.org/10.1016/j.psychsport.2012.08.001.
52. Balaguer I, González L, Fabra P, Castillo I, Mercé J, Duda JL. Coaches' interpersonal style, basic psychological needs and the well- and ill-being of young soccer players: a longitudinal analysis. J Sports Sci. 2012;30(15):1619-29. Epub 2012/10/16. doi: 10.1080/02640414.2012.731517. PubMed PMID: 23062028.
53. Reinboth M, Duda JL, Ntoumanis N. Dimensions of coaching behavior, need satisfaction, and the psychological and physical welfare of young athletes. Motiv Emotion. 2004;28(3):297-313. doi: DOI 10.1023/B:MOEM.0000040156.81924.b8. PubMed PMID: WOS:000223659900004.
54. Mainwaring L, Krasnow D. Psychological response to hip injuries in the young elite dancer. International Association for Dance Medicine and Science Conference, 9th Annual Meeting, October 1999; Tring, England 1999.
55. Mainwaring LM, Finney C. Psychological Risk Factors and Outcomes of Dance Injury: A Systematic Review. J Dance Med Sci. 2017;21(3):87-96. Epub 2017/09/06. doi: 10.12678/1089-313X.21.3.87. PubMed PMID: 28871899.
56. Jenkins JB, Wyon, M., & Nevill, A. Can turnout measurements be used to predict physiotherapist-reported injury rates in dancers? . Medical Problems of Performing Artists,. 2013;28(4):230-5.
57. Tessier D, Smith N, Tzioumakis Y, Quested E, Sarrazin P, Papaioannou A, et al. Comparing the objective motivational climate created by grassroots soccer coaches in

England, Greece and France. Int J Sport Exerc Ps. 2013;11(4):365-83. doi: 10.1080/1612197x.2013.831259. PubMed PMID: WOS:000436534100007.
58. Nordin-Bates SM, Schwarz JFA, Quested E, Cumming J, Aujla IJ, Redding E. Within- and between-person predictors of disordered eating attitudes among male and female dancers: Findings from the UK Centres for Advanced Training. Psychology of Sport and Exercise. 2016;27:101-11. doi: 10.1016/j.psychsport.2016.07.004. PubMed PMID: WOS:000385472800012.
59. Solomon R, Solomon J, Micheli LJ, McGray E. The 'cost' of injuries in a professional ballet company: A five-year study (Dancers, medical problems). Med Probl Perform Ar. 1999;14(4):164-9. PubMed PMID: WOS:000083944100002.
60. Garrick JG, Requa RK. Ballet injuries – an analysis of epidemiology and financial outcome. Am J Sports Med. 1993;21(4):586-90.
61. Amorose AJ, Horn TS. Intrinsic motivation: Relationships with collegiate athletes' gender, scholarship status, and perceptions of their coaches' behavior. J Sport Exercise Psy. 2000;22(1):63-84. doi: DOI 10.1123/jsep.22.1.63. PubMed PMID: WOS:000085972800004.
62. Duda J, Balaguer I. The coach created motivational climate. 2007. p. 117-30.