Dance medicine: risk factors for dancers' musculoskeletal injuries

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Chapter 6

Injury, Stress & Injury Prevention

Injury as a stressor in 67 first year contemporary dance students: A longitudinal cohort study

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Submitted

Abstract

In athletes, injuries lead to increased stress but athletes cope better with consecutive than with first-time-injury. In dancers such information is lacking. Thus we investigated whether injuries are associated with increased stress-levels, and if consecutive injuries are related to higher stress levels than first injury. Bachelor dance students were prospectively followed during five academic years (2016-2022). During the first month of the year, respectively, baseline characteristics were recorded using the "Performing artist and Athlete Health Monitor" (PAHM) including the VAS pain scale, the VAS stress scale, and the "Oslo Sport Trauma Research Center Questionnaire on Health Problems" (OSTRC). Throughout the year, stress, injuries and injury severity were reported monthly. The first-month assessment served as baseline in which dancers had to be injury free to be included in this analysis. Paired t-tests were conducted. 67 dancers (age 18.8 ±.8 years, 58.2% female) sustained at least one injury, of those 33 at least one consecutive injury. OSTRC severity scores ranged from a mean of 28.7 ±17.5 for first injuries to 31.4 ±17.1 for consecutive injuries. The mean baseline stress level for injuries was 24.3 ±17.2. Stress levels during first and consecutive injuries were elevated compared to the baseline stress levels, 34.8 ± 18.7 and 35.1 ±23.0, respectively. There were no differences between stress levels during first and consecutive injuries. Injuries are associated with increased stress levels in dancers, but stress levels were equally high after first and consecutive injury. We emphasize the importance of a holistic approach to injury rehabilitation, thus not only focusing on the physiological injury as such, but also include the dancers' psychological recovery and a focus on stress management for both enhanced recovery as well as prevention of future injuries.

1. Introduction

It is well known that mental stress has negative effects on health. For instance, chronic mental stress has been linked to several diseases, including mental disorders[1-5]. According to Andersen and Williams' stress-injury model, mental stress increases the risk of injury by inducing neurophysiological changes which can lead to a loss of neuromuscular control and flexibility, increased muscular tension, restriction of peripheral vision, or attentional deficits.[6]

In studies on ballet dancers the association between general as well as dance-related stress and injuries was confirmed.[7-9] Recently, research has demonstrated that this association could also be found in contemporary dancers.[10] Moreover, Noh and colleagues showed that being free from worry and being self-confident reduced the number of injuries, whilst dancers who had negative dance stress (i.e. presence of worries) had to face longer duration of injuries.[8]

Based on these studies[8-11], it can be concluded that stress increases the risk of injury. However, the injury as such might be regarded as a stressor as well. Several models attempted to describe stress responses to injury. Brewer's response model suggests that injury is first appraised cognitively, influenced by personal and situational factors, followed by an emotional and behavioral stress response.[12] Mainwaring's model highlights a more complex, multidimensional, person-to-situation interaction between factors related to the affected individual and their environment rather than a linear process of events.[11] Therein, the individual's psychological, physical, behavioral and social responses act as moderators, affecting and being affected by intrinsic determinants (e.g., demographics, traits, coping behavior, identity, nutritional aspects, knowledge, other stressors), as well

as extrinsic factors (e.g., dance environment, financial situation, social support, dance culture and identity, treatment).[13] As such, Mainwaring's model stresses the importance of a more holistic approach to the individual who sustained an injury. The latter is important since it will affect not only the physical rehabilitation of the injured but also address the individual athlete's psychological recovery which requires strong social support.[11, 14]

In sports science it has been described that athletes cope better with consecutive injuries than with a first-time-injury, having shown to be less anxious and more accepting with consecutive injury.[15] In dancers, however, such information is lacking. A very common approach in traditional dance settings is to perform and train despite the injury and in presence of pain.[16-18] The latter has also been described in other athletes[19]. Such an approach after a sustained injury may intensify dancers' fear of more severe and/or consecutive injuries [17, 20], which might increase stress levels after consecutive injuries. Therefore, we hypothesize that dancers' stress levels upon second- or further injuries are increased instead of decreased.

For that matter, the purpose of this study was to investigate whether 1) injuries are associated with increased stress levels, and 2) if consecutive injuries are associated with higher perceived stress levels than first injury in first-year contemporary dance students.

2. Methods

2.1 Participants

From the study year 2016-2017 until 2021-2022, five cohorts of first-year contemporary dance students (N=145) of Codarts University of the Arts, the Netherlands, were prospectively followed during one academic year (September to June). Results from the study year 2019-2020 were excluded from the analysis due to Covid-19 restrictions which prevented students from following regular classes.

The participants were enrolled in a four-year Bachelor Dance program, which focus on acquiring a wide range of modern dance techniques and competencies in various modern and contemporary styles as well as (modern) jazz, ballet, and 'floorwork'. Furthermore, the first-year of the Bachelor Dance's curriculum focuses on performance creative skills (i.e., improvisation, composition, and drama) as well as on basic knowledge on health (i.e., nutrition, anatomy, and (sport)psychology). First year dance students were included in this study if they were injury free in the first month of the academic year (to obtain a baseline stress level) and had sustained at least one injury in the rest of the academic year. An intake assessment as well as a baseline stress measurement had to be available.

2.2 Procedures

Data were collected at regular intervals for management and educational purposes and data collection was additionally embedded in the curriculum. In accordance with the Declaration of Helsinki, all students were informed prior to the procedure and provided written consent. The Medical Ethics Committee Erasmus MC of Rotterdam, the Netherlands, granted ethical approval for the study (MEC-2019-0163).

During the first month of each academic year, baseline characteristics were recorded, e.g., age (years), sex (male/female) and one-year history of injury (yes/no). Injuries in the past year before students entered the educational program at Codarts Rotterdam were registered. This one-year injury history was defined as “any physical complaint resulting in a fulltime loss of dance activities (e.g., participation in class, rehearsal, performance) for at least one week beyond the day of onset in the past year” [21]. Throughout the academic year, the students were asked to complete monthly questionnaires on their physical and mental health through the "Performing artist and Athlete Health Monitor" (PAHM). PAHM was developed by Codarts Rotterdam and is used to monitor physical and mental health in pre-professional and professional performing artists and athletes [22-24]. This online monitoring tool consists of several questionnaires and items, e.g., the visual analogue scale (VAS) pain scale, the VAS stress scale, the "Oslo Sport Trauma Research Center Questionnaire on Health Problems (OSTRC)", and items on injury characteristics, sleep quality, feelings, emotions, satisfaction with rehearsals and satisfaction with performances.

2.3 Assesment of Injury

The "Oslo Sport Trauma Research Center (OSTRC) Questionnaire on Health Problems" was assessed during the monthly questionnaire and consists of four key questions on the consequences of health problems on dance participation, training volume, performance and the degree to which students perceive any symptoms.[25] Possible answers ranged from 0 (no problem, no reduction, no effect, or no symptoms) to 25 (cannot participate at all or severe symptoms).[26] Questions 1 and 4 were scored on a four-point scale (0, 8, 17, and 25), while questions 2 and 3 were scored on a five-point scale (0, 6, 13, 19, and 25). The OSTRC Questionnaire has a high internal consistency, with a Cronbach’s alpha

of 0.96, good face validity [25, 26], and has previously been used within the performing arts.[10, 21, 22, 24, 27-31]

The severity of a health problem was calculated using the sum score of the four questions (scale 0-100) according to the method proposed by Clarsen et al., 2013.[26] If the severity score was higher than zero, a health problem was registered and the student was asked whether the health problem was an injury, mental complaint, or other problem. An all-complaint injury (i.e., substantial or non-substantial injury) was defined as "any physical complaint sustained by a dancer resulting in a severity score higher than zero (i.e., leading to consequences on participation, training volume, and/or performance), irrespective of the need for medical attention or time-loss from dance activities".[24] Substantial injuries were defined as problems leading to moderate or severe reductions in training volume (value ≥13 on question 2 of the OSTRC Questionnaire) or moderate, severe, or complete reductions in performance (value ≥13 on question 3 of the OSTRC Questionnaire).[25] Non-substantial injuries were defined as problems requiring no or little reduction in training volume (value <13 on question 2 of the OSTRC Questionnaire) or no or little reduction in performance (value <13 on question 3 of the OSTRC Questionnaire).[25] For the current study we selected the first and consecutive injury irrespective of their severity.

We categorized dancers as "dancers with substantial injuries" if they were injury-free in the month of baseline assessment (September) and sustained a substantial injury in the period between October and June. Dancers were categorized as "dancers with all-complaint injuries" if they were injury-free in the month of baseline assessment (September) and sustained a non-substantial or substantial injury in the period between October and June.

Consecutive injuries were considered consecutive if they were new injuries sustained after the first injury, or if they were sustained months apart from the first injury. For the latter, injury data had to be available prior to the injury and the dancers had to be injury-free before the month of the consecutive injury.

2.4 Assessment of Stress

On a monthly basis, students were asked to indicate their stress levels. Perceived general stress scores were measured using a visual analogue scale (VAS) ranging from 0 (no stress) to 100 (extreme amount of stress). The VAS is frequently used in stress assessment which also has been used to measure stress in dancers [10], and several validity studies have highlighted its psychometric properties. The VAS is at least as sensitive as other stress scales (i.e., 14-items Perceived Stress Scale) [32], is significantly correlated with objective stress measurements such as cardiovascular parameters (e.g., heart rate, blood pressure)[33], and shows satisfactory reliability[34] and inter-judge reliability [35]. No minimal clinically important difference has been determined.[36]

The stress level assessed in the first month of the academic year (September) was used as the baseline stress level. Stress levels measured within the month in which a first or consecutive injury occurred were used as accompanying injury stress levels. In addition, we subtracted the baseline stress levels from the stress levels that were reported during the month in which the first injury occurred as well as from the stress levels accompanying the consecutive injury to calculate changes in stress levels.

2.5 Statistical Analysis

SPSS Version 25 (IBM Corp., Armonk, USA) was used for all statistical analyses. Descriptive statistics were applied to describe baseline characteristics and stress scores using medians, interquartile ranges, frequencies and proportions (%). Normality was tested for parametric procedures using the Shapiro-Wilk test as well as explorative descriptive statistics, histograms, and Q-Q-plots. The analysis were conducted for the whole group, i.e., all-complaint injuries, as well as stratified for dancers with substantial injuries and dancers who sustained non-substantial injuries, respectively.

The differences between baseline stress levels and stress levels during injury were calculated with a paired students t-test. Additionally, we compared the changes in stress levels during the first and consecutive injury with a paired students t-test. For the t-tests we performed a complete case analysis (i.e. including those participants for which we have no missing data regarding stress scores).

To assess if there was a seasonal effect on stress levels we also calculated the monthly stress levels of the dancers who were injury free throughout the whole year. In addition we compared their baseline stress level to another month we randomly selected in such a way that the proportion of stress levels in a particular month was similar to that of the first all-complaint injuries.

3. Results

3.1 Participants

145 first-year students from 5 cohorts of first-year bachelor dance students participated in this study and gave their informed consent. In total, 67 students were injury-free at baseline assessment, sustained at least one injury during the academic year, and were therefore included in our analysis (*Figure 1*). The included dancers had a mean age of 18.8 ± 0.8 years, and 39 (58%) of the 67 dancers were female. The numbers of participants varied slightly between the different cohorts throughout the five years. Demographics can be found in *Table 1*.

3.2 Injuries

Throughout all cohorts, all dancers reported at least one all-complaint injury (substantial or non-substantial). Of these 67 dancers, 33 had at least one consecutive injury. OSTRC severity scores for first all-complaint injuries showed a mean of 28.7 ± 17.5 (minimum 6 to maximum 74). For consecutive all-complaint injuries OSTRC scores were 29.8 ± 16.3, with a minimum of 6 and a maximum of 67. The number of all-complaint injuries per dancer ranged from 1 to 7. In our population, 29 dancers (43%) sustained at least one substantial injury, of whom 8 also had a consecutive substantial injury. The number of substantial injuries per dancer ranged from 1 to 4 (*Table 1*). 38 dancers reported at least one non-substantial injury, of whom 14 had a consecutive non-substantial injury *(Figure 1)*.

3.3 Stress Levels

Mean baseline stress levels of the different groups are depicted in *Table 2 and Table 3*. The mean stress level for all included dancers was 26.9 ±19.8. In the whole group as well in the stratified analysis for substantial injuries and non-substantial injuries, we found that the stress levels during both the first injury and the consecutive injuries were significantly

elevated compared to the baseline stress levels (*Table 2*). The differences ranged from a 8 point increase in the non-substantial injury group during first injury to 27 points in the substantial injury group during both their first and consecutive injury. No differences were found between stress levels during first injuries and consecutive injuries. No statistically significant difference for a seasonal effect was found in the injury free dancers (mean difference -6.0 ±23.6; CI95% -14.6 to 2.3).

Table 1: Demographics: Dancers with at least one substantial or all-complaint injury
The values are given as the mean ±standard deviation, n (%) of the population

	N = 67
Age at baseline (years)	18.8 ± .80
Female	39 (58.2)
Cohort (year of study)	
2016-2017	12 (17.9)
2017-2018	14 (20.9)
2018-2019	13 (19.4)
2020-2021	14 (20.9)
2021-2022	14 (20.9)
Number of substantial injuries per dancer	N = 29
1 substantial injury	18 (62.1)
2 substantial injuries	8 (27.6)
3 substantial injuries	1 (3.5)
4 substantial injuries	2 (6.9)
Number of all-complaint injuries	N = 67
1 all-complaint injuries	21 (31.3)
2 all-complaint injuries	20 (29.9)
3 all-complaint injuries	13 (19.4)
4 all-complaint injuries	5 (7.5)
5 all-complaint injuries	6 (9.0)
6 all-complaint injuries	1 (1.5)
7 all-complaint injuries	1 (1.5)

4. Discussion

In first year contemporary dance students, we prospectively investigated whether injuries are associated with increased stress levels, and if consecutive injury periods are associated to higher perceived stress levels than first injury periods. Our results showed that stress levels increased during a period when an injury was sustained. However, the stress levels during consecutive injury periods and the stress levels perceived during the period of the first injury seemed similar.

Research has shown that the perception of stress is subjective, depending on factors such as the personality and coping behavior of the injured person, the motivational climate or perceived social support.[9, 13, 29, 37] As previously shown, stress responses as well as a history of stressors such as previous injury were strongly associated with injury rates in dancers [10] and other athletes [6, 38]. We, however, showed the reverse association and that the injury as such should be regarded as a stressor for the dancer since the aftermath of an injury results in heightened stress levels and thus can lead to less optimal or reduced ability to perform or, in a worst case scenario, the need to quit training and performing until fully recovered. For that matter, injuries come with emotional, physiological, cognitive, and social ramifications, which potentially increase stress reactions in the injured.[7, 12, 39-41] Injuries leave a person with pain as well as a variety of interchanging emotions. These emotions range from shock to anxiety, confusion, worry, frustration up to optimism and are depending on the severity of the injury and external influences[11] as well as prospect and success of rehabilitation.[13] Our results showed that our dancers can be compared to other athletes, because both target groups show increases of stress during injury periods.[42]

However, differences between dancers and other athletes seem apparent. Research in sports medicine has shown that first time injured athletes experienced the rehabilitation period as more stressful, they were less self-confident and exhibited a lower overall mood compared to consecutively injured athletes.[15] In contrast, consecutively injured athletes, however, coped better with second or third injury than with first time injuries. They were more accepting of consecutive injuries, were more socially secure and less anxious and thus likely less stressed.[15] This is not in agreement with our findings in dancers. We found that stress levels after consecutive injuries did not differ from stress levels after first injuries. Two aspects, namely the handling of injury in traditional dance settings as well as the resulting negative outcomes and thus negative experience of first injury might explain this difference and are discussed in the following.

Sports science has documented the so-called athletic identity which describes the tendency in athletes to continue training despite injury and pain, specifically in those athletes whose identification with their sport and dedicated discipline, i.e., athletic identity, was very high.[19] In dance, the same tendency was found which can be detrimental to dancers' health.[17, 43, 44] Comparable to other sports[11], injury is regarded as a threat to dancers' and institutions' existence, and dancers live in fear of injury and pain.[17] Simultaneously, however, they also have to learn to accept injuries as a part of their dance careers and work through them to avoid sanctions or missing out on opportunities.[17, 23, 29]. While many dancers perceive the confusion resulting from this counter-intuitive approach[17], they try to accept it as part of their identity and attempt to regard injury as a positive sign of vocation, dedication and discipline in order to cope.[17, 45] However, there is a fine line between working through and accepting injury[18, 42] versus failing to show self-responsible health seeking behavior which includes seeking assistance, getting

diagnosis and treatment and rehabilitating injury to avoid further consequences such as overuse or consecutive injury.[46] This ill-advised hardiness as coping strategy after an injury could contribute to the increased stress response our dancers also and especially perceived after consecutive injury. Furthermore, and comparable to other sports professionals[47], dancers exhibited higher pain and pain tolerance thresholds[20] than non-athletic controls. A variety of biological as well as psychological factors introduced through rigorous professional athletic training are considered to be responsible.[47] However, in contrast to other athletes, dancers were also found to be more acutely sensitive to pain.[20] Although this appears to be a paradox on first thought, the study tried to explain it through dancers' high experience of pain and injury as well as their fear of it.[20] Those results and our results underscore the importance of adequate handling of the first injury, since inadequate handling could result in problematic stress responses as well as negative outcomes of injury which both can negatively affect healing and prolong recovery.[8, 40, 41, 48, 49] As such, dancers' specifically high stress levels after consecutive injury might result from such acute sensitivity as a consequence of their fear of negative experiences after their first injury.

4.1 Practical implementations & future research

Our results showed that dancers perceive elevated stress levels during first and consecutive injury periods. Above all, implementing primary injury prevention measures in order to spare dancers such stress experiences cannot be overstressed. Furthermore, adequate handling of pain and injury in dance settings have been stressed in literature before.[16, 18, 20] The importance of such an approach is substantiated by our results, which show the need to help dancers to cope with their stress during injury periods, but also actively reduce stress levels in the first place. Various reasons might contribute to the

elevated stress response levels which need to be investigated in order to be able to assist dancers in finding ways of reducing and handling those stress responses. Among them are adequate coping skills of the dancer [31], but also active compliance to primary injury prevention as well as health seeking behavior in case of injury. The latter includes reporting injuries[23] which needs to be fostered through empowering motivational climates[29], emotional and social support[37] as well as the importance of and compliance to holistic injury rehabilitation taking not only the injury but also psychosocial aspects into account [11].

Diagnosis, treatment and rehabilitation of injuries implies coming to terms with the injury and its sequelae, including the application of coping skills and thus building resilience. While moving through multidimensional phases of injury appraisal through targeted rehabilitation[11], emotions in athletes have shown to be changing from predominantly negative at first to becoming more positive, particularly after diagnosis.[50] Reasons are that the knowledge somebody gains through diagnosis will decrease injury-related stress levels and thus coping behavior.[7] Going through rehabilitation allows to reflect on the lessons learned through injury occurrence.[50] As such, they increase resilience and are essential for future coping behavior but also secondary injury prevention. If dancers, for whatever reason, deny and continue training at the pre-injury level they might remain engulfed in negative emotions by missing out on those beneficial effects of diagnosis and rehabilitation. Further research is needed to investigate whether this might increase stress levels and make them prone to a consecutive injury.

4.2 Strengths, limitations & recommendations

To our knowledge this is the first study to investigate injury as a stressor in dancers. A major strength of this study is the longitudinal prospective design. Nonetheless, some

limitations have to be addressed. The self-reported injuries and stress scores led to limited diagnostic details available for analysis. Future research could combine objective with subjective documentation of injuries and stress perception, including medical diagnosis of injuries as well as stress measurement based on physical parameters such as amylase and cortisol sampling.[51, 52] Furthermore, we assessed stress on a monthly basis, and therefore, short periods of stress peaks [53] as well as likely daily fluctuations [54] might be overlooked. Moreover, part of the effect we found could be due to seasonal fluctuations of stress levels, for instance due to exams. Using higher sampling frequencies, for instance weekly, will provide more accurate data, although compliance might be lower.[55] Future studies should prospectively assess injury as a stressor in various dance populations as well as in bigger sample sizes, since we ended up with small sample sizes due to stratification, in order to be able to conclude for different age groups, dance styles, dance levels and years of dance experience.

4.4 Conclusion

Our results indicate that injury in itself can be regarded as a stressor in dancers. Hence, our results suggest that injury rehabilitation and prevention programs as well as the education of dancers should include coping skills and the handling of stress in dancers' lives in order to facilitate dancers' handling of stress following an injury .

Figure 1: Flowchart documentation of the inclusion criteria for analysis

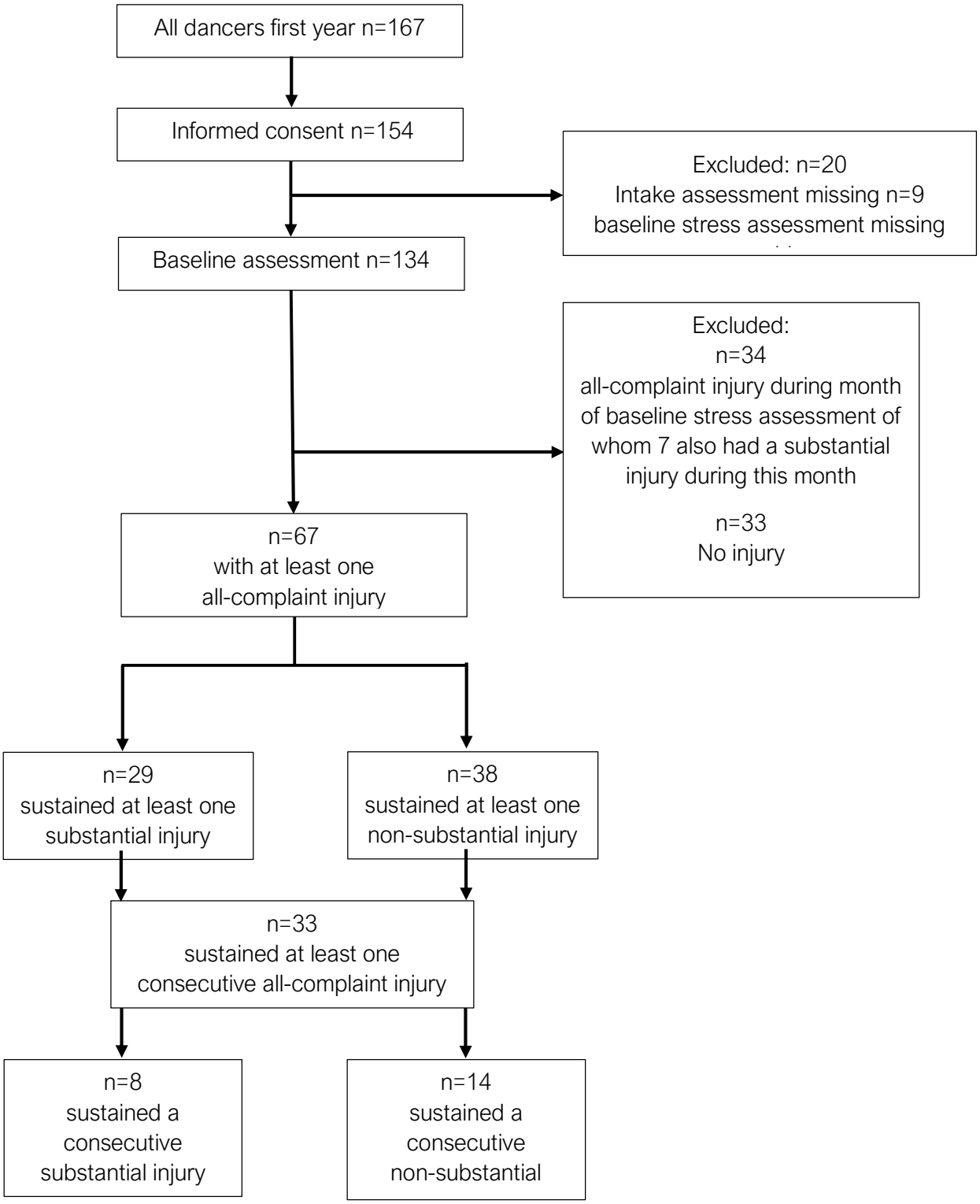

Table 2: Comparison stress levels at baseline to stress levels in the month of an injury occurence (paired t-tests)
The values are given as the mean ±standard deviation (SD), n (%) of the population; CI: Confidence interval, 95%

	Baseline Stress levels	First injury Stress levels	Mean difference between baseline & first injury	Consecutive Injury Stress levels	Mean difference between baseline & consecutive injury	Mean change difference between first & consecutive injury
	Mean (SD)	Mean (SD)	Mean (SD) (95%CI)	Mean (SD)	Mean (SD) (95%CI)	Mean (SD) (95%CI)
All-complaint Injuries N=67	26.9 ±19.8	35.5 ±19.7	-8.6 ±23.4 (-14.3 to -2.9)	NA	NA	NA
All-complaint Injuries N=33	24.3 ±17.2	34.8 ± 18.7	NA	35.1 ±23.0	-10.8 ±26.4 (-20.1 to -1.4)	-3.3 ±18.3 (-9.8 to 3.2)
Substantial injuries N=29	28.7 ±21.4	39.4 ±22.1	-10.7 ±23.9 (-19.8 to -1.6)	NA	NA	NA
Substantial Injuries N=8	28.0 ±16.5	49.8±13.1	NA	54.8 ±25.1	-26.8 ±24.5 (-47.2 to -6.3)	-5.0 ±26.0 (-26.8 to 16.8)
Non-substantial Injuries N=38	25.5 ±18.7	33.7 ±21.0	-8.2 ± 23.6 (-15.9 to -0.4)	NA	NA	NA
Non-substantial Injuries N=14	22.1 ±13.7	28.1 ±18.5	NA	29.8 ±17.2	-7.7 ±22.1 (-20.5 to 5.1)	-1.61 ±19.9 (-13.1 to 9.9)

Table 3: Stress levels of injury-free and injured dancers, including injury frequencies per month
Values are given as N of the injury-free and all-injury population, mean ±standard deviation (SD)

	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
N injury-free	33	31	29	28	23	24	23	22	24
Stress level Mean ±SD	26.9 ±20.7	34.7 ±24.3	33.1 ±20.3	27.8 ±20.5	30.7 ±24.0	23.1 ±22.8	30.0 ±21.1	39.8 ±26.4	42.5 ±26.4
N injured	67	63	61	53	57	56	56	53	50
Stress level Mean ±SD	26.9 ±19.8	28.8 ±18.2	32.7 ±18.5	30.3 ±20.6	31.4 ±19.2	33.7 ±21.5	38.6 ±22.5	41.8 ±24.6	47.3 ±23.8
Injuries n (%)									
First all-complaint injury	NA	16 (23.9)	21 (31.3)	4 (6.0)	8 (11.9)	7 (10.4)	7 (10.4)	4 (6.0)	-
Consecutive all-complaint injury	NA	-	7 (10.4)	11 (16.4)	8 (11.9)	6 (9.0)	7 (10.4)	4 (6.0)	3 (4.5)

References Chapter 6

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