

The Impact of Coping Strategies and Trait Anxiety on Self-Reported Injuries Among Pre-professional Contemporary and Ballet Dancers: A Prospective Study

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Abstract

Introduction: Injuries are prevalent in dance, affecting performance. Understanding injury risk factors is essential for prevention. Coping strategies and anxiety influence injury risk, yet their influence among pre-professional ballet and contemporary dancers aged 15+ remains underexplored. This transitional stage is marked by increased training intensity, heightened psychological demands, and performance pressure, increasing the risk of injury. This study examined the association between coping strategies, trait anxiety, and injury risk among contemporary and ballet pre-professional dancers aged 15+. **Methods:** In October 2022, participants from a French dance school completed an intake questionnaire assessing demographics (age, sex, injury history), dispositional coping strategies (Brief COPE), and trait anxiety (STAI-Y trait). From November 2022 to February 2023, participants completed monthly questionnaires assessing injuries, using the Oslo Sports Trauma Research Center questionnaire on Health Problems (OSTRC-H) during a prospective follow-up. Injuries were defined as “all-complaints injuries” (any physical complaint irrespective of the need for medical attention and/or time loss) and/or “substantial injuries” (leading to moderate/severe/complete reduction in training volume or performance). Binomial logistic regression examined associations between demographics, coping strategies, trait anxiety, and injury risk. **Results:** Eighty-two dancers consented to participate. The final analysis included 31 (37.8%) participants (mean age: 17.4 ± 1.36 years) excluding those with pre-existing injuries reported in the intake ($n=8$) or a completion rate $< 30\%$ ($n=43$). Included participants had higher active coping scores than excluded students ($U=418.5$, $P=.006$). The completion rate among included participants was 80.64%. Nineteen students (61.29%) reported at least 1 all-complaints injury. “Humor” as a coping strategy was associated with reduced risk of substantial injury (OR: 0.55, 95% CI: 0.27–1.14, $P=.02$). No associations were found between demographics, training volume, trait anxiety, and injury outcomes. **Conclusion:** Humor may be a coping strategy that reduces self-reported substantial injuries among pre-professional ballet and contemporary dancers. Encouraging humor may support emotional resilience in injury prevention. **Level of Evidence:** 3

Keywords

dance, injury, coping, risk factors, adolescent/children/pediatrics

Key Points

- A majority of pre-professional dancers in the sample experienced injuries, with over a third facing moderate to severe impairments in their practice.
- Participants that completed the study had higher active coping scores than participants that dropped the study.
- Humor as a coping strategy may reduce the risk of substantial injury among contemporary and ballet pre-professional dancers.

Introduction

The prevalence of injuries in pre-professional ballet, modern, and contemporary dancers ranges from 47% to 100%, with injury incidence rates ranging from 0.77 to 4.71 injuries per 1000 hours of dance, according to a review by Kenny et al.¹ The importance of understanding injury risk factors and prevention strategies in dance has been emphasized in International Association for Dance Medicine & Science (IADMS) consensus statements,^{2,3} which provide key recommendations for injury surveillance and management in dancers, further highlighting the need for research in this area. Recent years have seen growing attention on the influence of psychological factors on injury risk. Review studies^{1,4} have identified several psychological factors influencing the risk of dance-related injuries, including stress, eating disorders, and coping strategies. These factors may also affect the decision to seek healthcare, the course and success of rehabilitation, and the healing process.^{4,5} Therefore, studying psychological factors associated with injury risk is essential for better understanding injury prevention.

Among the psychological factors related to injury risk, limited coping skills have been linked to an increased risk of injury^{6,7} in pre-professional contemporary and ballet dancers. Coping strategies enable individuals to regulate their stress responses through various mechanisms, such as avoiding stressors, planning, or seeking social support.^{8,9} Employing appropriate coping strategies is essential for dancers who encounter substantial stressors, such as pressure related to physical appearance, the need to push through personal limitations, challenges in managing fatigue, pain, and injury, or the emotional strain of living away from family at a young age.¹⁰ Some evidence suggests that the use of effective coping strategies can reduce perceived stress^{11,12} and/or the duration of injury¹³ among dancers.

Studies exploring the relationship between injuries and coping strategies among ballet and/or contemporary dancers^{6,7,14} have employed the Athletic Coping Skills Inventory (ACSI-28),¹⁵ a coping questionnaire tailored to sports and competitive environments. This tool assesses psychological skills relevant to sports and performance contexts, including dimensions such as “concentration,” “coachability,” and “peak under pressure.” However, pre-professional dancers may also encounter stressors beyond

athletic contexts, such as academic pressure or interactions with healthcare professionals, which are not specifically addressed by the ACSI-28. A more general coping questionnaire like the Brief COPE may be more suitable for assessing a broader spectrum of coping strategies beyond athletic contexts.

Developed by Carver,¹⁶ the Brief COPE is a widely used self-report measure based on Lazarus and Folkman’s transactional model of stress¹⁷ and Carver and Scheier’s behavioral self-regulation model.⁹ The dispositional version assesses relatively stable, trait-like coping strategies that individuals employ to manage stress and challenging situations over time. It assesses 14 distinct coping strategies, such as “denial,” “avoidance,” or “active coping.” These strategies, which individuals may use in various stressful situations, are well-defined and can be targeted in future research, making the Brief COPE¹⁶ particularly relevant for understanding how pre-professional dancers manage stress beyond the performance context.

However, coping strategies are not the sole psychological factors influencing injury risk. Among these factors, trait anxiety has been identified as a moderator of the relationship between stress exposure and subsequent time-loss injuries among ballet dancers.¹⁸ Trait anxiety, defined as a stable predisposition to experience anxiety across various situations,¹⁹ has consistently been associated with increased physiological arousal and diminished concentration under stress.^{18,20} An 8-month prospective study involving 46 professional ballet dancers¹⁸ identified trait anxiety as a moderating factor in the positive association between recent life stress and time-loss musculoskeletal injuries. Given its stability and potential to influence how dancers perceive and respond to stressors, trait anxiety represents a critical psychological variable that warrants further investigation in the context of injury risk.

Similar to research on coping and injury risk, studies investigating the relationship between trait anxiety and injury risk among dancers have relied on sport-specific anxiety questionnaires.^{6,18} These tools, designed to capture anxiety responses in competitive athletic contexts, may not adequately reflect dispositional anxiety that extends beyond sport-specific situations for dancers. To address this limitation, a more general instrument, such as the trait version of the State-Trait Anxiety Inventory (STAI-Y trait),¹⁹ may be more appropriate. The STAI-Y trait is a widely validated

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tool, that measures dispositional anxiety independently of specific contexts. Unlike sport-specific measures, the STAI-Y trait provides a general assessment applicable across various populations and settings, thereby offering broader insights into the psychological profiles of pre-professional dancers.

Since both coping strategies and trait anxiety shape individuals' responses to stressors^{6,11,12,18,20} and are associated with injury risk,^{13,18} it is essential to examine these factors together. Apart from Noh et al,⁶ few studies have explored the association between coping strategies, trait anxiety, and injury risk among pre-professional contemporary and ballet dancers. However, this population is particularly vulnerable to injury due to the combined challenges of ongoing physical maturation²¹ and increasing technical demands, which may not yet be fully supported by their current physical capacities. Supporting this, prior research has shown that less experienced female ballet dancers were more likely to miss dance sessions due to injury compared to their more experienced counterparts.²² These overlapping biological and experiential vulnerabilities highlight the importance of investigating psychological factors in this population to better understand injury risk.

While sport and dance injuries arise from a complex, recursive interplay of physical, psychological, and environmental factors,²³ the present study focuses specifically on stable psychological characteristics, namely trait anxiety and coping strategies, as key contributors to injury risk among pre-professional ballet and contemporary dancers. By isolating these variables, we aim to examine their specific roles in shaping dancers' responses to stressors and their subsequent impact on injury risk. Such focused investigations are essential to develop more comprehensive models of injury prevention in dance. Therefore, this study employed a prospective design to examine the association between coping strategies, trait anxiety, and injury risk among contemporary and ballet pre-professional dancers aged 15 and older.

Materials and Methods

Study Design and Ethics

This prospective cohort study was conducted and reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.²⁴ Ethical approval was obtained from the Research Ethics Committee (CER) of the University Côte d'Azur on July 7, 2022 (registration number: 2022-056).

The study was conducted at the Rosella Hightower Dance School in Cannes, France, which offers a pre-professional dance training program from high school through a 2-year bachelor's degree. This program enables dancers to obtain both a Professional Dancer's Diploma and a bachelor's degree in Performing Arts. In addition to academic

subjects (for students prior to the high school diploma) and university courses (for students after high school), the program offers a hybrid curriculum that integrates ballet and contemporary dance training. A specialized on-campus dance healthcare center provides students with access to a variety of healthcare professionals, including osteopaths and physiotherapists, ensuring coordinated care in case of injury. Health-related courses, including anatomy, nutrition, and psychological well-being, are also integrated into the program.

Participants

Potential participants were recruited from pre-professional dancers enrolled in the school's pre-professional contemporary and ballet dance program. Due to the nature of the questionnaire items, participants were required to be at least 15 years old. To reduce biases in the psychological constructs assessed, only individuals who reported being injury-free in the intake questionnaire were included in the final analysis. Participants were prospectively followed over 1 semester, from November 2022 to February 2023.

All participants were informed of the study procedures during a class session and provided written consent. An *a priori* power analysis was not conducted, since a pre-existing single cohort was available.

Procedure

The study was introduced during a health class at the dance school. Participant consent, or assent with parental consent for those under 18 years of age, was distributed at the end of this presentation and collected before the second session from pre-professional dancers who agreed to participate.

Questionnaires were completed by the participants using the Performing Artist Health Monitor (PAHM), a web-based system developed by Codarts Rotterdam.^{25,26} Each month, participants received an email with a link to their personal portal on the platform to complete the questionnaires. A reminder was sent to those who had not responded within 5 days.

The intake questionnaires were completed during a class in October 2022, with the researcher present to address any questions. The order of administration was: baseline characteristics and 1-year injury history, Brief COPE dispositional version, then STAI-Y trait. Completion of the intake questionnaires took between 20 and 30 minutes.

Monthly questionnaires were completed using the PAHM from November 2022 to February 2023 to record injuries. The questionnaire included the OSTRC-H, injury characteristics (location, history, and acute or overuse onset²⁷) and took 2 to 10 minutes depending on whether an injury was reported. It was autonomously completed by the participants during a class each month.

Intake questionnaires. Baseline characteristics were recorded, including age (years), sex (male/female) and 1-year injury history (yes/no) defined as “any physical complaint resulting in a full-time loss of dance activities (e.g., participation in class, rehearsal, or performance) for at least 1 week beyond the day of onset in the past year.”²⁸(p. 2)

Brief COPE. A French translated version of the Brief COPE¹⁶ by Muller and Spitz²⁹ was used. Despite the low number of questions per dimension, the tool maintains good psychometric properties in terms of external validity and correlation with instruments measuring psychological balance, distinguishing a wide range of behavioral styles used by individuals to cope with problems.²⁹ The French translation, validated among 934 undergraduate students, showed adequate structural validity for the 14-factor solution; $\chi^2=606$, $P<.05$, root mean squared error of approximation (RMSEA)=0.04, Goodness-of-Fit Index (GFI)>0.95, adjusted Goodness-of-Fit Index (AGFI)>0.92, (RMR)<0.03. However, neither Cronbach’s alpha reliability nor the test–retest reliability were reported by the authors.²⁹

The Brief COPE assesses 14 classes of coping strategies: (1) active coping, (2) planning, (3) instrumental support, (4) emotional support, (5) venting, (6) behavioral disengagement, (7) self-distraction, (8) self-blame, (9) positive reinterpretation, (10) humor, (11) denial, (12) acceptance, (13) religion, and (14) substance use. It can be administered as dispositional/trait coping (habitual coping style) and/or situational/state coping (coping with a specific stressor). Responses use a 4-point Likert scale (1-4), with each evaluated strategy scored from 2 to 8. A higher score indicates a more frequent use of the strategy. Given the study’s focus on identifying stable psychological contributors to injury risk, we employed the dispositional version to assess habitual coping strategies. The situational version was omitted, as it reflects variable, context-dependent responses, which are less appropriate for explaining injury risk variation.

STAI-Y trait. The French version of the STAI-Y trait³⁰ was used to assess participants’ general tendency to experience anxiety as a stable personality trait, to perceive stressful situations as threatening or dangerous.¹⁹ The STAI-Y trait is a 20-item self-report questionnaire in which participants indicate how they “generally feel” on a 4-point Likert scale ranging from “almost never” to “almost always.” For 11 items, a higher score indicates a higher level of anxiety, while for the remaining items, the scoring weights are reversed. The total score ranges from 20 to 80 points, with higher scorer indicating higher anxiety.¹⁹ This French translation of the STAI-Y³⁰ has demonstrated strong psychometric properties among 1,080 first-year university students, with Cronbach’s alpha coefficients of .91 for the trait anxiety scale, indicating high internal consistency. Additionally,

the test-retest reliability over a 2-week period demonstrated a correlation of .94 ($P<.001$) for the trait anxiety scale, confirming its temporal stability.

Monthly questionnaires. The OSTRC-H (Oslo Sports Trauma Research Center questionnaire on Health Problems) includes 4 questions assessing the consequences of health issues on training volume, performance, participation, and the perceived severity of symptoms by the participants. Responses are scored from 0 (no health issues, full participation, no symptoms, or impact on practice) to 25 (unable to participate in activities or severe symptoms).³¹ Questions 1 and 4 are scored on a 4-point scale (0-8-17-25), while questions 2 and 3 are scored on a 5-point scale (0-6-13-19-25). The severity of health issues is measured by summing the scores of the 4 questions (0-100) according to the method proposed by Clarsen et al.³¹ If the total score exceeds 0, a health issue was recorded, and the participant was asked to specify the nature of the problem using a modified version of the original classification³²: injury, mental complaint, or other problem.

For injuries, the participant was directed to a physical injury information form to gather additional details on the location, history, and the nature of the injury (traumatic or overuse).²⁷ This form was tailored for dancers by Stubbe et al.²⁵ The questionnaire has previously been used in studies involving contemporary dancers.^{7,26} Monthly evaluations were chosen for practical considerations as they have been shown to represent a reliable method for estimating injury prevalence and severity scores among elite adolescent ballet dancers.³³

Definition of injury. Injuries were defined as *all-complaints injuries*, according to the following definition: “any physical complaint sustained by a dancer resulting in a severity score higher than zero (i.e., leading to consequences for participation, training volume, and/or performance), irrespective of the need for medical attention or time loss from dance activities.”²⁶(p. 2) Consistent with the study by Stubbe et al.,²⁵ a *substantial injury* was defined as a health issue that leads to a moderate or severe reduction (value ≥ 13 on questions 2 and 3 of the OSTRC-H) in training volume, a moderate or severe reduction in performance, or a complete inability to participate in dance.³¹ When the same injury was reported in 2 or more consecutive questionnaires, it was recorded as a single injury.²⁷ If an injury reported in consecutive questionnaires met the criteria for being classified as substantial in any of these reports, it was categorized as a single substantial injury.

Average severity score. The severity score for all-complaints injuries and substantial injuries was estimated by dividing the sum of the scores of the participants who reported an injury or a substantial injury by the number of participants

who reported an injury or a substantial injury. Since an injury may affect a participant's training over several months, with an OSTRC-H score greater than 0, the OSTRC-H severity score may include values corresponding to the same injury reported across several monthly questionnaires.

Dance exposure time. *Dance exposure time* was defined as “Any participation in a class, rehearsal, or performance in which the dancer was exposed to the possibility of a dance injury weighted for time doing activity.”² and measured as unit of time (hour) spent on physical dance activities.²⁶ Total dance exposure time, expressed in hours, was estimated using the school's official weekly schedules. For each academic year level, the weekly duration of all scheduled dance activities (technique classes, rehearsals, performances) was summed to approximate weekly dance exposure time. Although individual attendance was not recorded, these schedules provided a standardized estimate of weekly dance exposure time. This variable was included in the analysis to account for differences in training volume between participants, as the number of physical activities varied by academic year level.

Statistical Analyses

Statistical analyses were conducted using JASP software (Version 0.19.1)³⁴ with a significance level alpha of .05. Descriptive statistics (mean, standard deviation, and proportion) were used to describe baseline characteristics. The Shapiro-Wilk test was used to assess the normality of continuous variables. Variables that violated the assumption of normality ($P < .05$) were analyzed using non-parametric methods (Mann-Whitney U tests).

Missing data in the Brief COPE or STAI-Y trait were analyzed using Little's test on R (package: Naniar). If the proportion of missing values was less than 5% and the data were found to be missing completely at random (MCAR) according to Little's test, scores were estimated by excluding these missing values to minimize potential bias. In cases of missing data regarding the monthly injury assessment using the OSTRC-H, students were assumed to be injury-free for the corresponding month.

Following the study conducted by van Winden et al,²⁶ only the participants who responded to more than 30% of the monthly assessments were included in the analyses. As each participant received 4 monthly questionnaires, the inclusion threshold was set at a minimum of 2 completed questionnaires. This cut-off was the closest approximation to the intended 30% response rate while ensuring sufficient data for analysis. Participants included and excluded from the analyses were compared with respect to age, sex, STAI-Y trait scores, and Brief COPE scores using Mann-Whitney U tests.

The *Injury Incidence Proportion* (IP) for all-complaints injuries and substantial injuries was estimated over the data collection period by dividing the number of participants reporting at least 1 all-complaints/substantial injury during the data collection period (total IP) or the month (monthly IP) by the number of respondents during the same period.³⁵

The *Injury Incidence Rate* (IR; with a 95% confidence interval) was estimated for all-complaints and substantial injuries as the number of injuries per 1000 hours of dance time exposure.³⁵ The IR *estimated standard error* (SE) and 95% CI for IR per 1000 hours of dance time exposure, as estimated following the formulas of Knowles et al, were reported.³⁵

Exposure variables. Logistic regressions were performed to determine which variables were associated with injury, as this is an appropriate statistical test for dependent dichotomous variables, such as injured versus not-injured.^{36,37} Discrete variables for substantial and all injuries were transformed into dichotomous variables: *not injured* (0) or *injured* (1), with the reference group in the models being “not injured.” In addition to psychological constructs, age (years), sex (male), 1-year injury history (yes/no) and dance exposure (hours per week) were included in the analysis.

Following a procedure of Luiggi and Griffet³⁸ and Jacobs et al,³⁹ a preliminary univariate analysis was performed to select candidate variables for the multivariable analysis. Any variable with a P -value $\leq .15$ was included in the multivariable regression.³⁸ Stepwise regressions were then applied with the Aikake Information Criterion (AIC) as elimination criterion to limit the number of exposure variables.⁴⁰ The results of the regression analyses for each potential risk factor were expressed in odds ratios (ORs), and the Nagelkerke R^2 value was used to report the proportion of variance explained by the model,³⁶ as this analog R^2 is closely related to the R^2 estimate from ordinary least-squares.⁴¹

Results

Eighty-two contemporary and ballet pre-professional dancers (Male=29) aged 15 to 23 years ($M=17.43$, $SD=1.72$) provided informed consent and completed the intake questionnaire in October 2022. Four monthly follow-up questionnaires were sent between November 2022 and February 2023.

Eight participants (9.75%) were excluded prior to final analysis due to an ongoing injury reported in the intake questionnaire. An additional 43 participants (52.43%) were excluded as they completed fewer than 2 out of 4 questionnaires sent. The final sample included 31 participants (Male=10), aged 15 to 20 years ($M=17.4$, $SD=1.36$), who together completed 100 out of the 124 monthly questionnaires sent, resulting in a completion rate of 80.64% (Table 1) [AQ: 6].

Table 1. Participants Characteristics as Mean (SD) or Count (Proportion).

Characteristics	All participants (n = 31)	Sophomore (n = 1)	Junior (n = 5)	Senior (n = 9)	Bachelor 1st (n = 5)	Bachelor 2nd (n = 6)	Trainee (n = 5)
Age (years)	17.4 (1.4)	15 (0)	15.8 (0.4)	17 (1)	17.6 (0.89)	18.6 (0.82)	18.6 (0.8)
Sex (male)	10 (32.3%)	1 (100%)	0 (0%)	2 (22.2%)	2 (40%)	3 (50%)	2 (40%)
Weekly dance exposure time (hours)	28.6 (7.8h)	17.5	21	21	34.5	38	35
Average dance exposure time per student from November 2022 to February 2023	463.4 (130.6h)	280	336	336	552	608	595

Trainee: Students in second year of bachelor's program that divide their time equally between campus-based activities and professional company engagements.

Table 2. Median scores and interquartile ranges for the Brief COPE subscales and STAI-Y Trait.

	Median	25th percentile	75th percentile	Shapiro-Wilk	P-value of Shapiro-Wilk
Brief COPE dimensions					
Active coping	6	4	7	0.89	.005**
Planning	6	4	7.5	0.90	.009**
Instrumental support	4	4	6	0.91	.015*
Emotional support	6	4.5	6.5	0.95	.21
Venting	4	4	5.5	0.93	.06
Positive reinterpretation	5	4	7	0.93	.04*
Acceptance	6	4	6.5	0.92	.02*
Denial	3	2	4.5	0.81	<.001***
Self-blame	5	4	6	0.94	.07
Humor	4	3	5	0.92	.02*
Religion	3	2	5	0.83	<.001***
Distraction	5	4	5.5	0.92	.02*
Substance use	2	2	4	0.71	<.001***
Behavioral disengagement	2	2	4	0.81	<.001***
Trait anxiety					
STAI-Y trait	47	41.5	56	0.98	.83

* $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

Psychological Questionnaires

Among the 868 data points collected from the Brief COPE questionnaire, 3 values (0.3%) were missing for the 31 participants included in the analyses. The results of Little's test indicated that the data were missing completely at random (MCAR), $\chi^2(81) = 88.5$, $P = .265$. No data were missing for the STAI-Y trait. Since several subscales of the Brief COPE showed significant deviations from normality according to the Shapiro-Wilk test, we chose to report all scores, including STAI-Y Trait, as medians with first and third quartiles (Table 2).

Comparison of Participants Based on Inclusion Status

Included participants ($n = 31$) were compared to those excluded due to an insufficient number of responses ($n = 43$)

in terms of age, sex, STAI-Y trait scores, and Brief COPE scores. Mann-Whitney U tests were conducted to compare these 2 groups, as Shapiro-Wilk tests indicated a significant deviation from normality on all variables except for the STAI-Y trait score. A significant difference was observed in the active coping dimension of the Brief COPE between the 2 groups ($U = 418.5$, $P = .006$). Participants included in the final analysis had a higher score in active coping ($M = 5.774$, $SD = 1.543$, $M = 4.674$, $SD = 1.476$) than the excluded participants.

Injury Incidence Proportion

In total, 31 all-complaints injuries were reported by 19 participants during the data collection period. Of these 31 all-complaints injuries, 11 were substantial injuries. The *injury incidence proportion* (IP) for the whole study period was 61.29% (19 out of 31 total participants) for all-complaints

injuries and 35.48% (11 out of 31 total participants) for substantial injuries. The monthly IP, defined as the proportion of injured participants relative to the total respondents each month, varied across the follow-up period (November to February). For all-complaints injuries, the proportion of participants reporting at least 1 injury ranged from 11.11% (3 injured participants out of 27 respondents in January) to 43.33% (13 injured participants out of 30 respondents in November). For substantial injuries, the proportion ranged from 7.41% (2 injured participants out of 27 respondents in December) and 21.05% (4 injured participants out of 19 respondents in February). The average severity score on the OSTRC-H was 31.89 (SD=14.23) for all-complaints injuries, and 44.75 (SD=13.67) for substantial injuries.

The 19 injured participants reported an average of 1.63 injuries between November 2022 and February 2023. Twelve participants (38.71%) reported no injuries, 8 participants (25.81%) reported 1 injury, 10 participants (32.26%) reported 2 injuries, and 1 participant (3.26%) reported 3 injuries.

Injury Incidence Rate

A total of 14 367 hours of dance exposure was recorded during the academic year based on the school's weekly schedules for each group, resulting in an IR of 2.16 (95% CI, 1.40–2.92) for all-complaints injuries, and a substantial injury IR of 0.77 per 1000 hours of dance exposure (95% CI, 0.31–1.22). The total number of days missed entirely or partially due to injury was 70 days ($M=5.00$, $SD=3.58$), involving 14 students.

Independent Risk Factors Associated with Self-Reported Injury

Univariate logistic regressions were conducted for both outcomes (all-complaints injuries and substantial injuries) using the 14 dimensions of the Brief COPE, the total STAI-Y trait score, sex, age, 1-year injury history, and weekly dance exposure time to select candidate variables. Variables with a P -value $<.15$ in univariate analyses were considered for inclusion in the multivariable models. For all-complaints injuries, the selected variables were humor ($P=.12$), religion ($P=.13$), and behavioral disengagement ($P=.13$). For substantial injuries, the selected variables were active coping ($P=.07$), planning ($P=.13$), positive reinterpretation ($P=.05$), acceptance ($P=.06$), humor ($P=.02$), denial ($P=.13$) and 1-year injury history ($P=.14$). These variables were then entered into a multivariable logistic regression model using a stepwise procedure, retaining only those with a P -value $\leq .05$ in the final model (Tables 3 and 4) [AQ: 8].

Multivariable Logistic Regression

For all-complaints injuries, after a stepwise logistic regression on the selected variables, the model included humor and behavioral disengagement as predictors (Nagelkerke $R^2=0.26$, $\chi^2(3)=6.47$, $P=.04$). The OR [95% CI] for sustaining an injury was 0.61 [0.35–1.05] among participants with a high sense of humor ($P=.07$) and 0.60 [0.35–1.04] among participants with a high behavioral disengagement ($P=.07$).

For substantial injuries, after a stepwise logistic regression on the selected variables, the model retained humor and positive reinterpretation (Nagelkerke $R^2=0.40$, $\chi^2(3)=10.64$, $P=.005$). The OR [95% CI] for sustaining a substantial injury was 0.485 [0.25–0.96] among participants with a high sense of humor ($P=.037$), and 0.64 [0.36–1.15] among participants with a higher positive reinterpretation score ($P=.14$).

Discussion

This prospective study examined the association between coping strategies, trait anxiety, and injury risk among contemporary and ballet pre-professional dancers aged 15 and older. Over 1 semester, participants were monitored and injuries categorized as all-complaints and/or substantial injuries. Logistic regression analyses showed that humor as a coping strategy significantly reduces the risk of substantial self-reported injury. Dancers with higher humor scores had approximately 51% lower odds of sustaining a substantial injury compared to those with lower humor scores.

The median coping scores in our sample were similar to mean scores reported by Muller and Spitz²⁹ in a sample of 934 undergraduate students. However, direct comparison is limited due to differences in statistical measures (median vs mean) and demographic characteristics (eg, age). Future research comparing larger samples of pre-professional dancers and other student populations could provide valuable insights into the coping strategies used across these groups.

Our sample's median trait anxiety score on the STAI-Y was 47, notably higher than the mean score of 39.5 reported by Lopes et al⁴² among 22 professional contemporary dancers. In their sample, 2 dancers (9.1%) exhibited high levels of trait anxiety (score ≥ 56), compared to 8 dancers (25.8%) in our cohort. Differences in sample characteristics, such as professional versus pre-professional status or age, limit direct comparisons. One possible, though not yet empirically supported, explanation is that the demands of the professional dance environment may favor individuals with lower trait anxiety. Dancers experiencing higher anxiety might be more likely to alter their career trajectory in response to the cumulative stressors associated with

Table 3. [AQ: 9] Result of All-complaints Injuries Univariate Logistic Regression for All Parameters.

	Non injured (N=12)	Injured (N=19)	OR (95% CI)	Nagelkerke R ²	P
Participants characteristics					
Age	17 (1.54)	17.68 (1.2)	1.49 (0.84-2.66)	0.08	.16
Sex (male)	5 (41.67)	5 (26.32)	2 (0.43-9.29)	0.03	.38
1-y injury history (Yes)	3 (25)	5 (26.32)	1.07 (0.2-5.63)	<0.001	.93
Dance exposure (h/week)	27.58 (7.93)	28.44 (11.04)	1.1 (0.94-1.09)	0.002	.81
Trait anxiety					
STAI-Y trait	49.5 (10.96)	46.95 (8.9)	0.97 (0.9-1.05)	0.02	.47
Brief COPE dimensions					
Active coping	6.08 (1.44)	5.58 (1.61)	0.8 (0.49-1.31)	0.04	.37
Planning	6.08 (1.44)	5.53 (1.54)	0.8 (0.53-1.21)	0.05	.30
Instrumental support	4.92 (2.02)	4.58 (1.61)	0.89 (0.59-1.36)	0.01	.6
Emotional support	5.83 (1.7)	5.26 (1.41)	0.77 (0.46-1.28)	0.05	.31
Venting	4.67 (2.23)	4.53 (1.31)	0.95 (0.62-1.47)	0.002	.82
Positive reinterpretation	5.67 (1.67)	5 (1.86)	0.8 (0.53-1.23)	0.05	.31
Acceptance	5.67 (1.56)	5.32 (1.86)	0.89 (0.58-1.36)	0.01	.58
Denial	3.75 (1.91)	3.37 (1.74)	0.89 (0.59-1.33)	0.01	.56
Self-blame	5.42 (1.24)	5.21 (1.36)	0.88 (0.5-1.56)	0.008	.66
Humor	4.83 (1.59)	3.84 (1.64)	0.68 (0.42-1.1)	0.11	.10
Religion	3 (1.48)	4.05 (1.96)	1.45 (0.9-2.36)	0.11	.13
Distraction	4.92 (1.56)	4.79 (1.23)	0.93 (0.54-1.6)	0.002	.79
Substance use	3.08 (1.78)	2.95 (1.27)	0.94 (0.57-1.54)	0.002	.8
Behavioral disengagement	3.67 (2.02)	2.74 (1.15)	0.67 (0.4-1.12)	0.11	.10

Data are presented as mean ($\pm$ SD) or count (%). Significant at $P < .15$.

Abbreviations: OR, odds ratio; CI, confidence interval.

Table 4. [AQ: 10] Result of Substantial Injuries Univariate Logistic Regression for All Parameters.

	Non injured (N=20)	Injured (N=11)	OR (95% CI)	Nagelkerke R ²	P
Participants characteristics					
Age	17.5 (1.5)	17.27(1.1)	0.88 (0.51-1.53)	0.009	.65
Sex (male)	8 (40)	2(18.18)	3 (0.51-17.69)	0.07	.22
1-y injury history (yes)	7 (35)	1 (9.09)	0.19 (0.02-1.76)	0.12	.14
Dance exposure (h/week)	29.75 (9.86)	25.12 (9.43)	0.95 (0.86-1.03)	0.08	.19
Trait anxiety					
STAI-Y trait	47.5 (9.71)	48.73 (9.96)	1.01 (0.94-1.1)	0.005	.73
Brief COPE dimensions					
Active coping	6.15 (1.35)	5.09 (1.7)	0.61 (0.36-1.05)	0.15	.06
Planning	6.05 (1.32)	5.18 (1.72)	0.74 (0.48-1.13)	0.09	.14
Instrumental support	4.75 (1.8)	4.64 (1.75)	0.96 (0.63-1.48)	0.001	.86
Emotional support	5.65 (1.5)	5.18 (1.6)	0.81 (0.49-1.34)	0.03	.40
Venting	4.75 (1.89)	4.27 (1.27)	0.84 (0.53-1.33)	0.03	.44
Positive reinterpretation	5.75 (1.62)	4.36 (1.8)	0.6 (0.37-0.99)	0.19	.03
Acceptance	5.9 (1.62)	4.64 (1.69)	0.61 (0.37-1.02)	0.17	.04
Denial	3.85 (1.84)	2.91 (1.58)	0.69 (0.4-1.18)	0.1	.13
Self-blame	5.3 (1.08)	5.27 (1.68)	0.98 (0.55-1.75)	0.0001	.95
Humor	4.8 (1.67)	3.18 (1.08)	0.43 (0.22-0.86)	0.32	.004
Religion	3.4 (1.5)	4.09 (2.34)	1.23 (0.82-1.85)	0.04	.31
Distraction	5.05 (1.47)	4.45 (1.04)	0.69 (0.37-1.29)	0.07	.22
Substance use	3.1 (1.55)	2.82 (1.33)	0.86 (0.5-1.5)	0.01	.59
Behavioral disengagement	3.25 (1.71)	2.82 (1.33)	0.82 (0.49-1.39)	0.03	.45

Data are presented as mean ($\pm$ SD) or count (%). Significant at $P < .15$.

Abbreviations: OR, odds ratio; CI, confidence interval.

professional performance. Further research comparing pre-professional and professional dancers is warranted to examine this hypothesis.

The IR of all-complaints injuries in our study (2.16 per 1000 hours) aligns with previous prospective studies using similar all-complaints injuries definitions: Lee et al²¹ (2.27 per 1000 hours) among 66 pre-professional dancers, van Winden et al²⁶ (1.9 per 1000 hours) among 134 contemporary dance students, and Novosel et al²² (1.4 per 1000 hours) in a cohort of 99 professional ballet dancers. Ekegren et al⁴³ using a time-loss injury definition, reported an IR of 1.38 per 1000 hours among 266 pre-professional dancers aged 15 to 19 years.

By contrast, Gamboa et al⁴⁴ reported a lower IR (0.77 per 1000 hours) in elite pre-professional ballet students aged from 9 to 20 years likely due to a narrower injury definition, (only cases needing at least 1 physical therapy) and retrospective design prone to recall bias. Our IR was lower than the 4.4 per 1000 hours reported by Allen et al⁴⁵ in a prospective study of 52 professional ballet dancers using a time-loss injury definition. The higher rate in their study may be partly attributed to the high number of performances during the study period ($n=145$), which likely increased physical demands and injury risk. In comparison, our cohort experienced substantially fewer performances during the follow-up period.

Humor may reduce substantial injury risk by allowing psychological distancing from stressors, as reflected by the statements evaluating this strategy: *"I've been making fun of the situation"* and *"I've been making jokes about it."* Though unconfirmed in the literature, humor users might better adjust their practice in response to painful experiences, potentially preventing an injury from escalating to a point where it substantially impacts their dance practice. Alternatively, they may downplay injury severity since injury categorization as substantial relies on self-assessment. Future research should include third-party evaluations (by healthcare practitioners) injury assessments to clarify this.

Our study did not find an association between trait anxiety and injury risk, possibly due to the small size of our sample. Similarly, a study with a small sample of 41 female gymnasts,⁴⁶ reported no association between the STAI-Y trait anxiety score and sports injury risk. In contrast, Lysens et al⁴⁷ who studied a larger sample of 185 freshman physical education students, identified a curvilinear association, where both low and high levels of trait anxiety increased injury risk, while moderate levels appeared to be more protective. However, such findings should be interpreted cautiously due to differences in physical activity types and study designs.

Our findings align with previous dance research. Smith et al¹⁸ reported that certain dimensions of trait anxiety measured using the Sport Anxiety Scale (SAS)¹⁵ moderated the

relationship between minor daily stressors and subsequent injury-related time loss but did not directly predict injury risk. Similarly, Noh et al⁶ found no significant association between trait anxiety and either the occurrence or the duration of injuries among ballet dancers, also using the SAS.¹⁵ However, similar to our study, Noh et al.⁶ identified a significant association between certain coping strategies, assessed using the ACSI-28, and injury risk. These findings suggest that dancers' stress management may be more critical in understanding injury vulnerability than their general predisposition to experience anxiety. Nonetheless, addressing trait anxiety remains valuable, given its potential moderating effects on the relationship between stress and injury outcomes.

Limitations and Future Perspectives

Our study suffered from progressive attrition throughout the year, limiting data analysis to a semester from November to February. Several reasons may explain this dropout. To encourage completion of the questionnaires, data collection was embedded within the curriculum. However, to avoid intrusive supervision by the person in charge, participants self-reported when they had completed the questionnaire so that the teacher could start the class. Since the use of a phone or other digital device was necessary to complete the questionnaires, it was not possible for the person in charge to determine whether participants were filling out the questionnaire or engaging in other activities on their devices. To avoid this uncertainty, a control method implemented within the application might be necessary to monitor the number of completed questionnaires while preserving the anonymity of responses. Furthermore, the daily volume of training (dance training and regular schooling) could explain the high dropout rate. Given that participants had limited breaks between academic subjects and dance classes, they may have taken the opportunity to use their phones for a break rather than completing the questionnaires. Incorporating a reward to enhance motivation could be relevant to reduce attrition in future protocols. Moreover, our samples differ in several aspects compared to previous studies. While van Winden et al⁷ included only university-level contemporary dance students, our sample included both high school and university contemporary and ballet students. As a result, our sample is, on average, younger ($M=17.4$ years (± 1.36)) compared to the sample of Van Winden et al.⁷ ($M=19.2$ years (± 1.5)). This age difference could explain the attrition, as younger age has been identified as a risk factor for discontinuation attrition.⁴⁸

The French versions of the STAI-Y³⁰ and Brief COPE²⁹ questionnaires, while psychometrically validated in large samples of university students, were not specifically validated in a population of dancers. Although these instruments are widely used in sport and clinical research, their

applicability to the specific psychological and contextual characteristics of dancers may be limited. Future studies should consider validating these tools directly in dance populations to ensure their relevance and sensitivity.

Given the low proportion of missing data in the Brief COPE (0.17%), the exclusion of missing items was deemed an appropriate method to minimize bias and ensure the robustness of the results. Comparison between included and excluded participants from the analyses based on response rate showed no differences in terms of age, sex, STAI-Y trait scores. Differences were observed for the “active coping,” “humor,” and “planning” strategies of the Brief COPE. These results are consistent considering the evaluated dimensions of active coping and planification. Active coping involves actively seeking solutions when a problem arises, whereas planning involves anticipating necessary steps and time required for resolution. Students who relied less on active problem-solving strategies or planning may have faced greater difficulty in consistently completing the monthly questionnaires independently. It could be valuable to study the direct link between adherence to a longitudinal research protocol and the coping abilities of student dancers. Therefore, to improve adherence, dedicated slots for research participation should be scheduled for participants.

The small sample size ($N = 31$) of our study increases the risk of Type II errors, meaning that true associations between psychological variables and injury risk may have gone undetected due to insufficient statistical power. As such, non-significant findings should be interpreted with caution. Due to the small sample size relative to the number of potential exposure variables initially considered ($n = 24$), there is an inherent risk of overfitting in our regression models. Although we implemented a two-step approach, first selecting candidate variables based on univariate analyses ($P < .15$), and then applying stepwise regression using the Akaike Information Criterion (AIC), these methods may not fully eliminate overfitting when the ratio of predictors to cases is low. Therefore, the associations identified in this study should be interpreted with caution and regarded as exploratory. Future studies with larger samples are necessary to validate these findings and confirm the stability of the identified predictors.

While this study focused exclusively on trait anxiety and coping strategies as potential injury risk factors, it did not account for the broader, recursive, and dynamic interactions among physical, environmental, and other psychological variables that contribute to dance injuries. Future research should aim to integrate these additional factors into more comprehensive models to capture the full complexity of injury etiology in dance. It would be interesting, with a larger participant group, to study comprehensively the association that may exist between coping strategies, the risk of injury, and various parameters such as eating disorders, depressive symptoms, or motivational disorders as those

factors have been independently related to the risk of injury.⁴ This future research could provide a deeper understanding of the possible associations between psychological states and coping strategies in pre-professional dancers. Additionally, as certain coping strategies differ between groups of participants who completed the majority of questionnaires and those who completed fewer, it would be interesting to specifically test the effect of the coping strategies used by individuals and their adherence to a longitudinal research protocol.

Practical Implications

Although coping strategies have been explored from the perspective of performance, humor as a dispositional strategy (used by an individual in various situations) appears to reduce the risk of injury. Promoting adaptive coping strategies among pre-professional dancers, such as using humor to gain perspective on stressors, or strengthening interpersonal skills, may contribute to injury prevention. However, encouraging the use of humor should not entail minimizing or invalidating students' emotional experiences, but rather supporting their ability to approach challenges with a perspective. Overall, such strategies should aim to enhance emotional resilience, rather than foster avoidance or emotional suppression. Particular attention should be given to the completion of questionnaires in longitudinal studies with this population to prevent participant attrition during the study.

Conclusions

This study identified a significant association between humor as a dispositional coping strategy and injuries encountered by pre-professional ballet and contemporary dancers, suggesting that humor may be a protective factor that reduces injury risk. However, additional research is needed to confirm these results with a larger group of participants. A high attrition rate was observed within our sample of pre-professional dancers aged 15 and older. Participants included in the final analysis exhibited a greater use of active coping strategies compared to those excluded due to insufficient response rates. To enhance adherence to a longitudinal research program, it may be beneficial to implement methods for monitoring assessment completion or providing incentives to participants.

Acknowledgments

The authors would like to thank the PNSD Rosella Hightower and all the students for their participation in this study.

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Ethical Considerations

This study received approval from the Research Ethics Committee (CER) of the University Côte d'Azur on July 7, 2022 (registration number: 2022-056).

Consent to Participate

All students were informed of the study procedures and provided written consent.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the Université Côte d'Azur under grant number 17146. The founder was not involved in study design, collection, analysis, and interpretation of data, writing of the report and decision to submit the article for publication.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author, Chatar, I., upon reasonable request.

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