Received: 20 September 2021 | Revised: 5 November 2021 | Accepted: 1 December 2021

DOI: 10.1111/sms.14110

ORIGINAL ARTICLE

WILEY

Profiles of psychosocial factors: Can they be used to predict injury risk?

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Funding information
None.

The creation of risk profiles using the model of stress and athletic injury (J Appl Sport Psychol. 1998;10(1):5) represents a proposed shift from the reductionism paradigm to the complex sport approach in an attempt to formulate prevention strategies to combat the increasing number of injuries being reported in sporting populations. As a result, the primary purpose of this study was to: (a) identify different risk profiles based on psychosocial factors associated with the Williams and Andersen's model of stress and athletic injury model; and (b) examine potential differences in the frequency of injuries across these risk profiles. A prospective research design was utilized with a sample of 117 competitive soccer players (81 males and 36 females) from Sweden and the United States of America. Data was collected at two time points over the course of three months. At time 1 (beginning of the season) - a demographic information sheet, the Life Event Survey for Collegiate Athletes (LESCA), Sport Competitive Anxiety Test (SCAT), and Brief Cope were administered. At time two (T2), three months after the initial data collection, participants' traumatic injuries were recorded. Latent profile analysis (LPA) showed that 3 profiles solution showed best fit to data. Players in profile 1 and 2 reported fewer injuries compared to players in profile 3. However, whereas individuals in profile 1 had a lower predictive risk of sustaining an injury when compared to those in profile 3, both profiles had similar anxiety levels and use of coping strategies with differing stress levels. These findings suggest that the interaction between different proposed risk factors might influence injury risk.

KEYWORDS
athletes, injury prevention, profiling, sport injury

1 | INTRODUCTION

Globally, it can be argued that we are amid increased sport participation rates[2] and a corresponding increase in and injury rates.[3] Accordingly, in response, sports medicine researchers and practitioners have attempted to address the increased injury rates by predominately focusing on injury prevention strategies that are primarily physical, physiological, and biomechanical in nature.[4-6] To inform the development of interventions aimed to reduce the risk of injuries a number of studies have been conducted. Most of these studies have, however, adapted a reductionistic approach where the potential risk factors have been investigated in isolation.[7,9-13] This approach appears to

ignore the notion that a combination of factors, and not any single one, makes an individual more susceptible to sustaining an injury.[14] Thus, Bittencourt et al.[15] proposed a shift from the reductionism paradigm to the complex sport approach. Within the complex sport approach, researchers and practitioners, attempt to determine the nature of relationships between factors.[15] Additionally, this approach also places heavy emphasis on the identification of patterns of interaction, thus leading to the formation of risk profiles.[15,16]

Because sport injury is a complex phenomenon[17] the Williams and Andersen's model of stress and athletic injury[1] is an appropriate theoretical framework to demonstrate the applicability of the complex sport approach to sport injury. This model purports that injury occurs due to a combination of psychosocial factors and an individual's cognitive appraisal of a stressful situation.[18] More specifically, individuals with high competitive anxiety, a history of experiencing stressful events, and poor coping resources will experience increased physiological arousal and attentional disruption when placed in a stressful situation. Consequently, such an individual is at an increased risk for injury when compared to others. Given the significance of the Williams and Andersen's model of stress and athletic injury,[1] within the psychology of sport injury literature, it is reasonable to assume that the basic tenets associated with the model can be used to create risk profiles. These risk profiles, ideally, should consist of a combination of history of stressors, coping resources, and a personality trait.[1] According to Bittencourt et al.[15] these types of risk profiles can then be used to "inform the probability of injury occurrence."[p.1311].

Risk profiles have successfully been utilized in the sports medicine literature with regards to predicting the risk of anterior cruciate ligament[19] injuries. For example, studies have found that athletes who were deemed to be at high risk for ACL injuries have showed better treatment effect for targeted neuromuscular training[20,21] when compared to those with lower risk profiles. The utilization of risk profiles, however, within the psychology of sport injury literature is in its infancy. Maddison and Prapavessis[8] were able to identify athletes at high risk for injuries (based on their psychological profile) and subsequently assessed the effectiveness of a cognitive behavioral intervention in reducing their vulnerability to injuries. Results supported the use of the intervention in reducing the injuries reported to those deemed to be high risk. Thus, there appears to be some utility in investigating the use of risk profiles in the injury prevention realm.

Although the use of risk profiles is currently limited in the psychology of sport injury literature, we believe increased utilization is warranted. Moreover, because sport injuries primarily occur due to a combination of factors, it is logical to utilize a complex sport approach. Furthermore, the fact that the creation of risk profiles "considers the interconnected and multidirectional interaction between all factors"[15(p. 1311)] provides additional support for the movement away from the investigation of isolated risk factors. We believe that the Williams and Andersen's model of stress and athletic injury,[1] provides an ideal theoretical framework from which risk profiles can developed. As a result, the primary purpose of this study was to: (a) identify risk profiles based on psychosocial factors associated with the Williams and Andersen's model of stress and athletic injury model[1]; and (b) examine differences in the frequency of injuries across these risk profiles.

2 | METHOD

2.1 | Participants

The sample used in the current study consisted of competitive soccer players ($N = 121$) from Sweden and the United States of America. Four players did not report complete data on the independent variables and were, therefore, excluded from the sample. The Swedish participants ($n = 67$) included males ($n = 53$) and females ($n = 14$) ranging in age from 15 and 31 years ($M = 17.87$, $SD = 3.78$). On average, these individuals participated in soccer related activities 7.88 h/week ($SD = 2.65$). In the American sample ($n = 50$), there were males ($n = 28$) and females ($n = 22$) whose ages ranged from 17 to 22 years ($M = 19.38$, $SD = 1.28$). These individuals participated in soccer related activities on average 16.80 h/week ($SD = 1.28$).

2.2 | Instruments

A demographic information sheet, the Sport Competitive Anxiety Test (SCAT),[22] the Life Event Survey for Collegiate Athletes (LESCA),[23] and the Brief COPE[24] were the primary instruments utilized to gather information in the current study. The demographic information sheet included questions related to participants' age, the number of hours spent in sport-related activity per week, and the number of previous injuries sustained.

The SCAT[22] was used to assess participants' competitive trait anxiety, specifically if they perceive competitive situations as threatening and respond with elevated state anxiety. The SCAT[22] consists of 15 items and respondents are asked to indicate how they generally feel when competing in their sport using a 3-point Likert scale: 1 (hardly ever); 2 (sometimes); and 3 (often). Ten of the items on the SCAT[25] assess competitive anxiety while the remaining

five items are considered neutral and not scored. Total scores on the SCAT[22] is achieved by summing the responses of the ten items, used to assess competitive anxiety. The SCAT[22] has in previous studies shown convergent and discriminant validity[25] and Martens et al.[22] reported internal consistency coefficients ranging from 0.95–0.97. The Cronbach's alpha in the current sample was 0.83.

The LESCA[23] is a 69-item life event survey which was used to assess participants' life stress. The LESCA[23] is a checklist which asks participants to indicate if they have experienced a series of life events during the previous 12 months. If an individual has experienced an event, they then need to rate the impact of the event at the time it occurred using an 8-point Likert scale ranging from −4 (extremely negative) to +4 (extremely positive). The LESCA[23] produces three life event scores: negative (sum of all the negative scores), positive (sum of all the positive scores) and total (sum of the absolute values of positive and negative scores). Test re-test reliability coefficient scores ranged from 0.76 to 0.84 and 0.48 to 0.72 over the course of 1 week and 8 weeks respectively.[23]

The Brief COPE[24] is a 28-item questionnaire used to assess participants' use of a variety of coping strategies. The Brief COPE[24] an abbreviated version of the COPE[26] consists of 28 items distributed between 14 different coping strategies. These strategies are: active coping, planning, positive reframing, acceptance, humor, religion, use of emotional support, use of instrumental support, self-distraction, denial, venting, substance use, behavioral disengagement, and self-blame. In the current study we followed the recommendation from Doron et al.[27] and divided these strategies into five categories (ie, avoidance, cognitive restructuring, problem solving, distraction, support). Respondents are asked to indicate "how often" they use any of the 14 coping strategies using a 5-point Likert scale ranging from 1 (I haven't been doing this at all) to 5 (I have been doing this a lot). The Brief COPE[24] has been shown to have good internal consistency and reliability in addition to concurrent validity.[28] The Cronbach's alpha for the different subscales in the current study ranged from 0.64 to 0.80 with seven of the subscales having an alpha lower than 0.70.

2.3 | Procedure

Permission was received from the lead and second authors' Institutional/Regional Ethics Committee for Human Investigation before data collection began. Once permission was received the lead and second author used convenience sampling to identify prospective participants for the study. Once prospective participants were identified, coaches were contacted to gauge their interest in allowing their athletes to participate in the study. If a favorable response was received from a coach, a formal meeting was set up to provide them with all the necessary details associated with the study. After a coach consented to allowing their team to participate, a team meeting was set up to explain the following to participants: 1) to participate, one had to be free of injury at the start of the study; 2) the nature of the study and what their participation would entail; 3) the voluntary nature of their participation in the study; 4) all responses to the instruments used in the study would be confidential; 5) they can withdraw from the study at any time; and 6) team standing would not be affected by their decision to participate or not in the study. If all prospective participants agreed to be in the study, an informed consent document was signed, and they were asked to provide their names to ensure that individual injury data would be matched up correctly at the three-month data collection time point.

In the current study, we used Fuller et al's[29] definition of injury. According Fuller et al.[29] an injury is anything occurring during a scheduled training or game resulting in a player having to miss the next training or game. The actual data collection for the current study occurred in two stages. First at time one (T1), all participants completed the demographic information sheet, the LESCA,[23] SCAT,[22] and Brief COPE.[24] At time two (T2), three months after the initial data collection, all participants' traumatic injuries were recorded by participating teams' sports medicine professionals. Only traumatic injuries were included in the data collection procedures since the Williams and Andersen's model of stress and athletic injury[1] was specifically developed for those types of injuries.

2.4 | Data analysis

Descriptive analyses were conducted using SPSS version 24. In addition, as a step in the descriptive analyses we performed a logistic regression analysis using Mplus 8.0 and the robust maximum likelihood estimator (MLR). The reason for this was to illustrate potential differences between a variable-centered and person-centered approach.

A latent profile analyses (LPA), using Mplus 8.0 was performed to identify subgroups (ie, profiles) using the basic tenets of the Williams and Andersen's model of stress and athletic injury model[1]: personality, stress, and coping variables. In addition, because the amount of sport participation is closely related to injury risk we also decided to include this variable into the list of potential risk factors. The posterior profile probabilities, in the LPA, were estimated to define each participant's most likely profile belonging.[30] We estimated a sequence of nested models, starting with a one profile model, to examine if

more complex models (ie, models containing more profiles) showed better fit to the data than more parsimonious ones. A combination of statistical criteria in combination with interpretation of the substantive meaning of the different profiles was used to determine the model that best explained the data.

We used several different statistical model fit indices to determine the model with the best fit to data.[30] First, lower Bayesian Information Criterion (BIC)[31] and sample-size adjusted BIC (SSA-BIC)[32] indicated better fit to data. Second, statistically significant ($p < 0.05$) results on the Lo-Mendell-Rubin test (LMR)[33] and the bootstrap likelihood ratio test, (BLRT)[29] indicated that the more complex model had a better fit to the data in comparison to the more parsimonious one. Third, the entropy values were inspected to determinate how accurate the respondents fit their respective profiles. A higher entropy value was associated with better profile separation. Last, we also relied on theory and substantive meaning to select the most meaningful solution. Models where one or several profiles contained too few participants (ie, when a profile contained less than 10% of the sample) were rejected. The reason for this decision was that these profiles are, in most cases, spurious.[34]

To test if there were any differences in injury risk between the identified profiles, we followed the recommendation of Nielsen et al.[35] and calculated Risk Difference (RD) effect sizes with accompanied 95% confidence intervals (CI). The data that support the findings of this study are available from the corresponding author upon reasonable request.

3 | RESULTS

During the study a total of 29 injuries ($M = 0.25$, $SD = 0.47$) were reported by participants. Thus, 90 participants did not sustain an injury during the three months study period. The results from the logistic regression analysis showed that only avoidance coping strategies had a statistically significant association with the risk of sustaining an injury (for odds ratios with 95% CI, see Table 1).

The model fit indices of the LPA showed that the smallest SSA-BIC value was generated for the four-profile solution, while the BIC favored the 2-profile solution. Neither the adjusted LMR nor the BLRT showed consistent results regarding the number of profiles to retain. More specifically, the BLRT was statistically significant for all solutions, also indicating the best solution to contain more than four profiles. The entropy was similar for all solutions. Nevertheless, solutions with more than three profiles contained one or more subgroups with less than six participants and did not change the interpretation of the results so therefore we accepted the three-profile solution as the final model (see Table 2 for model fit indices of the LPA).

TABLE 1 Odds ratios and 95% confidence intervals for the logistic regression result

Predictor	Odds ratio	95% CI
Negative life event stress	1.03	0.99–1.07
Positive life event stress	1.00	0.96–1.04
Anxiety	0.35	0.09–1.31
Support	0.90	0.43–1.88
Problem solving	0.98	0.42–2.30
Avoidance	0.19	0.04–0.85
Distraction	1.83	0.65–5.21
Cognitive restructuring	1.13	0.49–2.60

The three profiles contained 78 (profile 1), 26 (profile 2), and 13 (profile 3) participants, respectively. The participants in profile 1 showed low levels of both positive and negative life event stress. They also had moderate to high levels of coping strategies for on all five coping dimensions. Last, they had similar levels of anxiety as the participants in the two other profiles. The participants in profile 2 had the highest levels of negative life event stress, low levels of anxiety as well as low levels of coping strategies, especially on the avoidance category. In comparison, the participants in profile 3 showed similar levels of coping strategies and anxiety levels as the participants in profile 1, but in comparison to the participants in profile 1 and 2, higher levels of positive life event stress. For more information see Table 3.

The results showed that the injury prevalence was, for the different profiles, 17.9% (profile 1), 26.9% (profile 2), and 46.1% (profile 3). The results from the calculation of risk differences showed that the players in profile 1 had, in comparison to the players in profile 3, 28.2.% lower injury risk (95% CI = [0.20, 56.61]). Also, the players in profile 1 had an 9.7% lower injury risk (95% CI = [−10.98, 28.03]) than the players in profile 2. The risk difference between profile 2 and profile 3 was 19.2% (95% CI = [−12.79, 52.25]), indicating lower injury risk for the players in profile 2.

4 | DISCUSSION

Given the lack of success in the utilization of the reductionism paradigm to reduce the number of injuries sustained at all levels of sport participation, it is worth considering alternative approaches. One such approach, according to Bittencourt et al.[15] is to shift from the utilization of prevention strategies based upon

TABLE 2 Model fit indices, and entropy for the estimated models

Model	BIC	SA-BIC	Entropy	LMR	BLRT
2 Profiles	2994.71	2915.68	0.89	<0.001	<0.001
3 Profiles	2997.96	2890.48	0.89	0.60	<0.001
4 Profiles	3005.40	2869.47	0.82	0.45	<0.001

TABLE 3 Means and standard deviations for the three latent profiles

Variable	Profile 1 ($n = 78$)	Profile 2 ($n = 26$)	Profile 3 ($n = 13$)
Negative life event stress	9.85 (10.06)	16.58 (18.32)	14.54 (11.93)
Positive life event stress	10.67 (7.94)	11.04 (7.12)	35.08 (14.60)
Anxiety	1.73 (0.39)	1.75 (0.39)	1.69 (0.40)
Support	2.62 (0.69)	1.65 (0.56)	2.29 (0.76)
Problem solving	3.06(0.47)	1.89 (0.49)	3.15 (0.70)
Avoidance	1.78 (0.35)	1.14 (0.18)	1.34 (0.23)
Distraction	2.51 (0.51)	1.46 (0.37)	1.87 (0.30)
Cognitive restructuring	2.69 (0.55)	1.77 (0.63)	2.60 (0.80)

the reductionism paradigm to those which utilize the complex sport approach. The complex sport approach acknowledges the notion that a combination of factors makes an individual more susceptible to injury. Along those lines, the Williams and Andersen's model of stress and athletic injury[1] is an ideal model, which allows researchers to utilize its numerous factors to potentially create risk profiles, which according to Bittencourt et al.[15] can then be used to "inform the probability of injury occurrence." Results from the current study showed that a person-centered approach can be more informative in comparison to the variable-centered approach. More specifically, the results from the LPA showed that different patterns of risk factors were associated with different risk for injuries. More specifically, players in profile 1 and 2 sustained fewer injuries compared to players in profile 3. However, while players in profile 1 had a lower risk of sustaining an injury compared to those in profile 3, those in both profiles had similar anxiety levels and use of coping strategies with differing stress levels.

As stated above, the combination of factors in profile 1 appear to be the least conducive to experiencing an injury in the current study. While direct support in the psychology of sport injury literature for this finding may be lacking, there is support for the individual factors. That is, researchers have found that the presence of high levels of life event stress is associated with increased risk for injuries.[36] The presence and use of coping strategies, more specifically the adaptive and functional aspects, have been found to be related to decreased injury frequency.[37] Last, anxiety have been found to increase the likelihood of an individual being injured.[38] Taken as a whole, it is possible that the presence of moderate to high coping strategies, acted as a buffer[37] to offset the relatively low levels of stress. Furthermore, coping resources, according to Soares,[39] aids with the decision-making process, and this ability, according to Gabbett[40] is related to decreased injury occurrence. As such, it may be that the presence of these coping resources coupled with the low levels of anxiety and life event stress resulted in athletes in profile 1 being at lower risk to sustain an injury in the current sample.

Interestingly, profiles 1 and 3 had similar levels on most factors except their stress levels. Based on this finding it could be assumed that the differences in stress levels (ie, low levels of life event stress vs. higher levels of positive and negative life stress) could have been a mechanism explaining differences in injury susceptibility. Research findings have traditionally supported the presence of high levels of negative life stress and injury occurrence[36] and there has also been some support for high levels of positive life stress and injury occurrence.[41] The combined presence of both positive and negative life events within the same dataset potentially represents a new addition to the psychology of sport injury literature. Moreover, because negative life stress has been associated with increased emotional reactivity in the part of the brain where attention is processed[42] positive life stress potentially has an emotional reactivity component though not to the magnitude of negative life stress. It is therefore possible that a combination of both positive and negative life stress could have influenced individuals' emotional capacity[37] perhaps leading to increased injury rate reported for those individuals in profile 3 when compared to those in profiles 1 and 2. It is also worth mentioning that profile 2 had the highest overall negative life stress but those individuals were deemed to have the lowest injury risk.

The results of the current study must be interpreted in light of the study's limitations. First, the study utilized a series of self-report instruments as part of its data collection procedures. As such it is possible that participants could have completed these instruments in a biased or socially desirable manner. Second, convenience sampling was used to recruit participants into the study which limits the generalizability of the findings to other populations and samples. Third, the small sample size, both in relation to the full sample and the number of participants in profile 2 and 3, is considered as a limitation. The result should, therefore, be interpreted with caution. Fourth, half of the Brief COPE[24] subscales had reliability estimates lower than the recommended value of 0.70 which could have influenced the data collected. Finally, the cross-cultural composition of the sample coupled with the differing amount of time each sample engaged in training on a weekly basis could have influenced the number of injuries reported by participants. Moreover, any number of cultural factors, not accounted or controlled for, could have influenced participants' responses to the self-reported instruments and the number and types of injuries sustained and reported.

4.1 | Perspectives

The current study not only represents an attempt to shift the narrative from a reductionism paradigm to a complex sport approach but more importantly it reflects the utilization of a theoretical model (ie, the Williams and Andersen's model of stress and athletic injury[1]) to create a useful practical concept (ie, risk profiles) that can subsequently be utilized as a means of injury prevention. Based on the results we suggest that it is important to consider the total amount of stress (instead of just focusing on negative life events) when monitoring the risk of injury. While the sports medicine literature has traditionally focused on mitigating the effects of stress as it pertains to injury occurrence, perhaps a more holistic approach is needed. Moreover, both the positive and negative life stress should be considered along with other relevant factors as they relate to injury occurrence, thereby moving away from the reductionism paradigm.

DATA AVAILABILITY STATEMENT

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

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How to cite this article: Clement D, Tranaeus U, Johnson U, Stenling A, Ivarsson A. Profiles of psychosocial factors: Can they be used to predict injury risk? *Scand J Med Sci Sports*. 2022;32:782–788. doi:10.1111/sms.14110