Pain catastrophizing, beliefs and perception and their association with profiling characteristics in athletes

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ABSTRACT

Context: Variables associated with pain catastrophizing and pain beliefs in athletes presenting with musculoskeletal pain and/or sports related injuries are largely unexplored. We aimed to evaluate which anthropometric, sociodemographic, sporting, injury history and care seeking characteristics were associated with the Pain Catastrophizing Scale (PCS) and Pain Beliefs and Perceptions Inventory (PBAPI) scores in athletes.

Design: Cross-sectional

Methods: 312 athletes (40% females) from different sports and levels completed a questionnaire including demographic information, details regarding sports practice, injury history, healthcare use, PCS and PBAPI. Univariable associations between PCS and PBAPI scores and each variable were assessed using linear regression. Variables with univariable associations where $p < 0.05$ were entered into multivariable regression models

Results: The final multivariable model including gender, recurrent and persistent pain, a history of a severe atraumatic injury and a history of more than five atraumatic injuries explained 14.9 % of the variance in PBAPI scores. Performing a team sport and a history of more than five atraumatic injuries explained 5.1 % of the variance in PCS scores.

Conclusions: Gender, sporting and injury history characteristics explained only a small portion of the variance in PCS and PBAPI scores, whereas having received healthcare support and the number of appointments did not. Most of the variance was left unexplained.

Key words: sport, pain, cognition

1. Introduction

Injuries are an inherent risk of sports participation [1]. For example, in one single year (1992) approximately 3 million injuries related to organized sports were reported in the United States of which 770,000 required physician visits and 90,000 required hospitalization [2]. Epidemiological data from the UEFA injury study (2001-2008) revealed that a soccer player on average sustained two injuries per season, thus 50 injuries can be expected in a typical team of 25 players each season [3]. Sports injuries have not decreased during recent seasons, with data from men's professional soccer from 2014 to 2022 showing, for example, that hamstring injury rates have increased 3.9% annually, now constituting 24% of all injuries [4]. More severe injuries such as anterior cruciate ligament (ACL) rupture display a lower season prevalence (about 1.5%) in male elite level soccer [5]. However, although at one year following ACL reconstruction most players return to play (> 90%) [6, 7], only two thirds compete at the same pre-injury level three years after ACL rupture [5, 7, 8]. Performance indicators (i.e., number of passes, dribblings, scoring points and minutes played) and career survival are reduced in ACL reconstructed players in comparison with uninjured matched controls (median professional career length of 3.4 years following return to training), highlighting the need to further explore the underlying reasons [5, 6]. Similarly, shoulder dislocation is a common condition with a reported incidence ranging from 3 to 5% depending on age and sport [9-11]. Return to sport after primary shoulder stabilization surgery ranges between 84% and 97.5% [9, 12, 13], but the rates of returning to the pre-injury level of sports participation varies from 50% to 80% [13, 14]. Taken together, sporting injuries can have a detrimental impact on individual athletic performance [15].

The underlying mechanisms are not fully understood; however, Toale et al. [16] found that reasons for not returning to play following ACL reconstruction were mostly related to external life and psychological factors associated with their injury including fear of re-injury and lack of confidence in performance. Only a minority of athletes were unable to return due to ongoing pain or re-injury. To further support this, among psychological factors, recent reviews have found that pain catastrophizing, fear, anxiety and negative emotions (i.e., low optimism) were barriers to return to pre-injury sports activity level in athletes who have suffered a sport-related knee injury [17-21]. Instead, restoring self-confidence [22], while at the same time experiencing low levels of fear regarding re-injury and underperforming, were associated with successful rehabilitation of sports injuries in competitive athletes [19]. Therefore, a contemporary multidimensional approach to sports injury management, that considers biological, physical performance, psychological, social and contextual factors in sportspeople should be recommended to optimise recovery [23-25] and facilitate return to sports participation and sports performance. [26]. Such an approach would assess potentially important, modifiable factors such as pain-related beliefs or pain catastrophizing, and subsequently target these factors as part of a multidimensional intervention [27].

Overall, in sport, negative pain beliefs and perceptions have been scarcely investigated with a recent scoping review revealing that only 13% of studies examined cognitions as part of the pain assessment in people with upper / lower limb injuries [28]. Pain catastrophising did not significantly differ between healthy endurance, strength and non-athletes [29], although small differences (i.e. lower scores) were found in triathletes in comparison to amateur recreational people [30]. The available research on pain catastrophizing showed moderate negative correlations with mental toughness in recreational cyclists [31], and low (r = 0.27) associations with pain scores in collegiate athletes (i.e. those competing despite reporting pain) [32]. Moderate correlations (r = 0.35) between pain catastrophizing and perceived susceptibility to sports injury, and between pain catastrophizing and chronic psychological stress (r = 0.36) were also found [33]. The underlying reasons are not fully understood and thus it may be important to determine which broader factors can influence pain catastrophizing and beliefs in athletic cohorts as these may be potentially modifiable, and therefore could be targeted with appropriate interventions. Healthcare professional's interaction and beliefs are considered important in the formation and perpetuation of unhelpful beliefs in ordinary secondary care [34, 35]. However, care seeking characteristics (i.e., having received support for an injury and the number of appointments), injury type (i.e., traumatic vs atraumatic), number and severity of traumatic and atraumatic episodes, and pain status (i.e. solved, recurrent or persistent) have not been investigated in sportspeople. To our knowledge, it is currently unknown whether any other anthropometric, sociodemographic, sporting, injury history or care seeking characteristics (except for those aforementioned) are associated with pain catastrophizing or pain beliefs in athletes.

Therefore, this study aimed to examine associations between potentially-modifiable psychological factors - pain catastrophizing, pain beliefs and perception - and a broad range of anthropometric, sociodemographic, sporting level, injury history and care seeking characteristics in a sporting population, which have not yet been fully investigated.

METHODS

Study design and participants

Local sport clubs in Northern Italy (different sports, teams and levels) receiving medical support and/or consultancy from the study investigators were contacted and their members invited to participate in the study. This ensured that the study was given appropriate attention by the clubs managers, and athletes committed to answer the questionnaire. To be included in the current study, athletes had to meet the following inclusion criteria: 1) currently being athletes at recreational, semi-professional or professional levels participating in any kind of individual and/or team sport; 2) understand Italian language. All participants gave written consent. Regression modelling strategies suggest there should be at least 10 participants per variable entered into multivariable regression analysis [36]. Therefore, because data was collected on 22 variables, we aimed to recruit at least 220 athletes. All subjects were informed about the purpose of the study, and informed consent was obtained before the start of the experimental study according to the Declaration of Helsinki. Ethical approval was granted by London Sport Institute Ethic Committee (REC 25256).

Procedures

Questionnaire

The questionnaire for this study were submitted elettronically and completed in presence of one of the investigators, who was available for clarification of questions, if needed, between April and June 2023. All questionnaires were anonymous. The questionnaire collected the following profiling variables: demographics (i.e., gender, age, weight, height, BMI, level of education), details regarding sports practice (i.e., type of sport, level, hours per week), sleep (i.e. at least 8 hours per night [37, 38]), injury history and healthcare use seeking (including the total number of appointments with healthcare professionals), the Pain Catastrophizing Scale (PCS) [39] and the Pain Beliefs and Perceptions Inventory (PBAPI) [40].

Level of education

The level of scholastic education was defined as primary, secondary and tertiary education [41]

Sports practice

Details regarding the type of sport (contact vs non-contact [42] and team vs individual sport) and hours of sports practiced were collected

Sports level participation

Sports participation level of organised sport was defined according to Truong et al. [17] and Swann et al. [43] as follows: recreational (sport participation primarily for fun and entertainment); semi-professional (amateur sport participation at a high competitive level, which could be also paid); and professional (national and international elite sport participation at the highest level of a sport with monetary support).

Injury definition

Injuries were classified as traumatic and atraumatic according to their injury mechanism [44]. Their severity was defined according to days of absence from the sporting activity during the past 5 years as follows: minimal (1–3 days); mild (4–7 days); moderate (8–28 days); and severe (> 28 days) [45] . We also asked if participants considered their most severe injury as recovered, recurrent or persistent [46].

Participants were asked if they sought help from healthcare professionals and, if so, how many appointments they had attended.

Pain Catastrophizing

Pain catastrophizing was measured using the PCS [47], which is a valid and reliable questionnaire [39] examining a person's thoughts and feelings in terms of magnification, rumination, and helplessness about pain. On a 0 – 4 scale participants indicate the frequency at which they experience these different types of catastrophic thoughts described in 13 statements, giving a total score of 0 - 52 points, with higher scores reflecting greater pain catastrophising. The rumination subscale, magnification and helplessness comprise four, three and six statements respectively giving scores 0 - 16, 0 – 12 and 0 - 24 respectively.

Pain Beliefs and Perceptions

Pain beliefs and perceptions were measured using the PBAPI [48], which is a 16-item questionnaire with participants rating their beliefs using a 4-point Likert scale (response scale is recoded to ensure equal intervals as 1, 2, 3, 4 [48]). This explores a participant's personal beliefs on their subjective experience of pain [40]. The total score can range between 16 and 64 points, with higher scores reflecting greater belief endorsement (for example being in "total agreement" with statements such as "No one's been able to tell me exactly why I'm in pain" or "I am the cause of my pain" reflects greater belief endorsement). It also includes three subscales representing time (i.e., pain is an enduring part of life), mystery (i.e., pain is poorly understood) and self-blame (i.e., participants attribute the responsibility for their pain to themselves).

Statistical analysis

The distribution of the data was checked using the Kolmogorov–Smirnov normality test. Descriptive statistics (mean ± SD) for all variables were calculated. Categorical data were expressed as counts and percentages.

Pearson and Spearman's rank correlation coefficients (r) were used to determine whether variables had strong associations to each other, and thus may be reporting similar information ($r > 0.8$).

Univariable associations between the total PCS and PBAPI scores, and each profiling variable were assessed using linear regression. Variables with univariable associations ($p < 0.1$) were considered candidate variables and selected for multivariable regression models. Variables significant at $p < 0.05$ were included in the final multivariable models. Unstandardized coefficients and R^2 values were reported.

All data were computed through Microsoft Excel®2010. Data processing and descriptive statistics were processed using SPSS® (V.25. Chicago Illinois).

RESULTS

312 athletes from different sports, teams and levels volunteered to take part in this study. Descriptive statistics for each variable are given in Table 1. All athletes had at least one injury over the last 5 years.

All variables were retained for linear regression analysis since no significant associations between variables were present.

PCS

Team sport, semi-professional level and a history of more than five atraumatic injuries were associated with the total PCS score at a significance of $p < 0.1$ and were subsequently considered for inclusion in a multivariable model (n = 312). Team sport and a history of more than five atraumatic injuries were retained in the final multivariable model which explained 5.1% of the variance in PCS scores. The proportion of variance left unexplained was 94.9% (Table 2).

PBAPI

Gender, contact sports, higher education (i.e. secondary and tertiary), recurrent and persistent pain, a history of a severe atraumatic injury and a history of more than five atraumatic injuries were associated with the total PBAPI score at a significance of $p < 0.1$ and were subsequently considered for inclusion in a multivariable model.

The final multivariable model (n = 312) included being female, recurrent and persistent pain, a history of a severe atraumatic injury and a history of more than five atraumatic injuries, and explained 14.9% of the variance in PBAPI scores. The proportion of variance left unexplained was 85.1% (Table 3).

Of note 45 sportspeople (14%) had not sought care for their injuries. It was considered that those seeking care may have differed from those not seeking care in regards to their pain beliefs and levels of pain catastrophising, therefore multivariable regression modelling was repeated with those not seeking care excluded (n=267). Results for the two models were very similar. Indeed, only 13.6% of the variance in PBAPI scores was explained by recurrent and persistent pain, and a history of more than five atraumatic injuries, with 86,4% of variance left unexplained. Gender, team sport and a history of more than three atraumatic injuries explained 9.8% of the variance in PCS scores, leaving 90.2% of variance unexplained.

Table 1 Descriptive summary for the whole cohort characteristics shown as mean ± standard deviations (SD), 95% confidence intervals (CI) or number of participants (%)

Variable	**Decriptive statistic**
Gender	
Male	188 (60%)
Female	124 (40%)
Age	23.5 ± 7.1 [22.8, 24.3]
Weight (kg)	70.7 ± 14.2 [69.1, 72.3]
Height (cm)	175.3 ± 10.5 [174.6, 176.9]
BMI	22.7 ± 3.1 [22.4, 23.0]

Education	
Primary	32 (17%)
Secondary	106 (57%)
Tertiary	49 (26%)
Contact Sport	
Yes	219 (73%)
No	83 (27%)
Team Sport	
Yes	199 (64%)
No	113 (36%)
Hours per week	11.8 ± 7.6 [10.9, 12.6]
Hours of sleep	
At least 8	120 (38,5%)
Less than 8	192 (61,5%)
Level	
Amateur	100 (32%)
Semi-Professional	159 (51%)
Professional	53 (17%)
Traumatic injuries over last 5 years	
Yes	232 (74%)
No	80 (26%)
Number of episodes	
≥ 1	128 (41%)
≥ 3	82 (26%)
≥ 5	22 (7%)
Severity most important traumatic injury	
Minimal	21 (7%)
Mild	18 (6%)
Moderate	81 (26%)
Severe	113 (36%)
Atraumatic injuries over last 5 years	
Yes	232 (74%)
No	80 (26%)
Number of episodes	
≥ 1	71 (23%)
≥ 3	92 (30%)
≥ 5	80 (26%)

Severity most important atraumatic injury	
Minimal	89 (29%)
Mild	66 (21%)
Moderate	52 (17%)
Severe	36 (12%)
Current status most important injury	
Recovered	130 (42%)
Recurrent	136 (44%)
Persistent	38 (12%)
Healthcare help	
Yes	267 (86%)
No	45 (14%)
Number of appointments	
0	47 (15%)
0-5	62 (20%)
6-10	53 (17%)
11-20	63 (20%)
>20	87 (28%)
PCS total score	13.3 ± 8.9 [12.3, 14.3] (Median = 13.0, min = 0, max = 44)
Helplessness	4.4 ± 4.0 [4.0, 4.9]
Rumination	6.8 ± 4.5 [6.3, 7.3]
Magnification	2.1 ± 1.7 [1.9, 2.3]
PBAPI total score	29.2 ± 6.5 [28.4, 29.9] (Median = 28.0, min = 16, max = 57)
Time	16.9 ± 4.6 [16.4, 17.4]
Mystery	7.3 ± 2.6 [7.0, 7.6]
Self-Blame	5.0 ± 2.2 [4.7, 5.2]

Kg kilogram, *cm* centimetre, *BMI* body mass index, *PBAPI* Pain Beliefs and Perceptions Inventory, *PCS* Pain Catastrophizing Scale

Table 2 Final regression model for PCS (*n* = 312) (R^2= .051)

	Unstandardised Co-efficient (95% CI)	*p*-value	Beta Standardised Co-efficient
PCS			
Team Sport	-3.282 (-4.311 to -2.253)	.002	-.177
More than five atraumatic injuries	2.8 (1.667 to 3.933)	.014	.137

Table 3 Final multivariable regression model for PBAPI (*n* = 312) (R^2= .0149)

	Unstandardised Co-efficient (95% CI)	*p*-value	Beta Standardised Co-efficient
PBAPI			
Gender	1.670 (0.957 to 2.383)	.020	.126
Recurrent pain	2.277 (1.516 to 3.038)	.003	.174
Persistent pain	4.948 (3.831 to 6.065)	<.001	.249
Severe atraumatic injury	2.213 (1.121 to 3.305)	.044	.109
More than five atraumatic injuries	2.969 (2.164 to 3.774)	<.001	.199

DISCUSSION

This study examined potential associations between anthropometric, sociodemographic, sporting injury history, care seeking behaviour characteristics and PCS and PBAPI scores in athletes.

Females, athletes reporting recurrent and persistent pain, athletes with a history of a severe atraumatic injury and athletes with multiple atraumatic injuries (more than five) tended to report worse PBAPI scores (although explaining a small part of the variance). In our sample, practising a team sport and a history of more than five atraumatic injuries explained a small part of the variance in PCS scores. Interestingly, atraumatic injury history is a novel finding, which, to our knowledge, have not been investigated in the literature. Previous research [49] showed small statistically significant correlations between female gender (r = 0.16, p = 0.05), practising an individual sport (r = 0.17, p = 0.04) and worse pain catastrophizing scores. In accordance with our results, athletes participating in team sports may receive social support from their teammates, thus reducing the threat value of pain stimuli and feeling less helpless in the context of pain [50, 51]. Research has also shown that low level of education (i.e. having completed primary education only) is correlated with poorer self-reported mental health (B = -2.42, SE = 0.545, $p < 0.0001$) and poorer health literacy (B = –60.5, SE = 2.15, $p < 0.001$) [52], which may be therefore a barrier in accessing health information. However, in our sample, the level of education did not to appear to explain unhelpful cognitions.

Although the cross-sectional nature of this study does not allow inference of causation between worse pain catastrophising and PBAPI scores and their associated factors, negative pain-related cognitions may play a role in the development, transition and persistence of musculoskeletal pain [53] including increasing the risk of sports injuries and poorer injury recovery [54]. Atraumatic injuries were associated with both greater pain catastrophising and higher PBAPI scores. This appears a novel finding. We postulate that an injury where the sportsperson does not have an identifiable mechanism of injury (e.g. a tackle, twisting on a fixed foot) involves greater uncertainty regarding the "cause" of the problem, which may lead to more unhelpful cognitions while the person attempts to rationalise their condition [35]. Conversely, while some people suffering traumatic severe lower limb injuries (i.e. fractures) have presented with moderate to severe levels of pain catastrophizing [55], in our cohort the number and severity of traumatic injuries were not significant predictor variables for PCS and PBAPI scores. It can be hypothesized that being sporty may provide a protective effect towards catastrophic thinking and unhelpful cognitions following traumatic injuries, but this needs to be explored further.

PCS and PBAPI scores were not influenced by the number of interactions with healthcare professionals. Also, multivariable models were largely similar whether those not seeking care were, or were not, included. In secondary care there is substantial evidence that pain beliefs, perception and catastrophizing are associated with persistent low back pain severity and disability [56]. Clinical interaction, healthcare professionals' beliefs [34] and diagnostic labelling can play an important role in the formation and perpetuation of unhelpful pain beliefs [35, 57]. This study suggests that such influences may differ for sports injuries and sporting populations. In our cohort, gender, sporting and injury history characteristics explained a small portion of the variance in PCS and PBAPI.

It may be hypothesized that regular physical exercise can suppress pain catastrophizing, negative pain beliefs and perceptions [58-61]. Indeed, higher physical activity levels are also associated with higher pressure and thermal pain thresholds and lower unpleasantness ratings for noxious thermal stimuli [62-64]. In athletes this is associated with altered cortical function following noxious stimuli compared to non-athletes [63]. In practical terms, these findings may reflect a “protective” effect of exercise over pain (and its associated cognitions). This may also offer some explanation for the association between recurrent and persistent pain and higher PBAPI scores in this study. However, we acknowledge that we asked participants to report injuries, and measured pain-related cognitions; however, it should be noted that pain and injury are not synonymous [65].

Considering that treatment-related reductions in pain catastrophizing are prospectively associated with reductions in pain severity, depression, post-traumatic stress symptoms and disability [66], reframing pain experiences in a positive context such as the sporting environment may positively influence nociceptive processing, and thus offer potential therapeutic strategies that may modulate pain in clinical pain conditions [63]. In addition, our data suggest that negative pain-related pain cognitions should be explored in athletes in particular following multiple atraumatic injuries.

Overall, our multivariable regression models were able to explain only a small proportion of the variance in total PCS and PBAPI scores. However, from a pragmatic standpoint, we advise clinicians first to carefully explore beliefs and emotional responses of sportspeople who experience pain without an identifiable mechanism of injury (i.e. atraumatic injuries). Then, to help these in maintaining regular physical exercise while, at the same time, reconceptualise their pain by delivering a non-threatening person-centered explanation that considers multidimensional factors for their pain [67]. Further investigation into factors associated with pain catastrophising and pain beliefs in sporting populations is warranted as they can be transdiagnostic maladaptive processes that contribute to a wide range of health and mental health conditions [66, 68]. For example, cultural factors, not investigated in this study, have a relevant influence on health and illness experience and management (e.g. care seeking behaviour), including pain beliefs (e.g. causes of pain, consequences and controllability), perception and catastrophizing. These emerge early in life and are affected by family beliefs, religiosity, spirituality, race and ethnicity [35, 69].

Limitations

Our data were limited to relatively young northern Italian athletes. Therefore generalization of these results to older athletes and/or sporting populations from different countries and cultures requires caution. The broad inclusion of any sports injury, without a detailed description of injury site (i.e., spinal vs peripheral joints), may also limit the generalization of our results to specific injuries. The absence of a detailed medical registry for each individual athlete should be considered. We therefore recommend that future studies should explore whether cognitive and emotional responses differ in relation to specific injuries.

This study included athletes who had never sought help from healthcare professionals. To our knowledge, there is a paucity of literature investigating athletes with musculoskeletal pain and/or sports related injuries who do not seek healthcare. Further examination of this cohort may improve our understanding of specific traits (e.g. resilience, self-efficacy) that enable individuals to self-manage their conditions.

Finally, future research should investigate the influence of other broad multidimensional factors which were not considered in this study such as cultural and familial traits about pain, stress and depression on pain beliefs, perception and catastrophizing.

CONCLUSION

The findings of the current study indicate that practising a team sport and a history of more than five atraumatic injuries explained a small part of the variance in PCS scores, whereas a small part of the variance in PBAPI scores was explained by being female, recurrent and persistent pain, having a severe atraumatic injury and multiple (more than five) atraumatic injuries. PCS and PBAPI scores were not influenced by having sought care, the number of interactions with healthcare professionals, level of education, or the number and severity of traumatic injuries. Most of the variance in PCS and PBAPI scores was left unexplained.

Compliance with Ethical Standards

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Conflict of interest

Luca Maestroni, Martin Rabey, Camilla Mariani, Vittoria Villa, Laura Landi, Alessia Rodi, Fabio Civera, Francesco Bettariga and Anthony Turner declare that they have no conflict of interest relevant to the content of this review.

Authorship Contributions

LM, CM, VV, LL, AR and FC: concept, design and writing the first version of the manuscript. LM, MR, and AT: statistical analysis. FB: writing and editing of the manuscript.

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