scientific reports

Check for updates

OPEN

Basic psychological needs satisfaction, coping functions, and emotional experiences in competitive athletes: a multi-states theory perspective

Claudio Robazza[1]✉, Francesca Vitali[2], Laura Bortoli[3] & Montse C. Ruiz[4]

The aim of the study was to investigate the relationship between basic psychological needs satisfaction, coping functions, cognitive appraisals, emotions, and psychobiosocial experiences in competitive athletes. Multi-states (MuSt) theory was used as the theoretical framework. The study involved a convenience sample of 183 Italian athletes (102 men), aged 16 to 48 years (*M* = 24.86, *SD* = 7.42), who were engaged in individual or team sports. The results showed that basic psychological needs satisfaction was positively related to problem-focused and emotion-focused coping, challenge appraisal, pleasant emotions, and functional psychobiosocial experiences, while negatively linked to threat appraisal and unpleasant emotions. Furthermore, problem-focused and emotion-focused coping were positively related to challenge appraisal, pleasant emotions, and functional psychobiosocial experiences, while negatively related to threat appraisal and unpleasant emotions. Path analysis findings showed positive indirect effects via problem-focused coping and challenge appraisal from both competence and relatedness to excitement, happiness, and functional psychobiosocial experiences. The results highlight the impact of basic psychological needs satisfaction, coping functions, and cognitive appraisals on athletes' emotional experiences. Overall findings support MuSt theoretical underpinnings and suggest that athletes who experience competence, autonomy, and relatedness are likely to adopt adaptive coping, view challenges as growth opportunities, experience pleasant emotions, and undergo functional psychobiosocial experiences. From an applied perspective, practitioners should prioritize basic psychological needs satisfaction in athlete development programs to foster functional coping, challenge appraisal, optimal emotional experiences, and performance.

Keywords Self-determination theory, Need-supportive environment, Challenge & threat, Functional emotions

Emotional experiences play a crucial role in human adaptation, significantly influencing effort, focus, decision-making, memory, behavioral responses, and social interactions of individuals[1]. In the sport context, athletes routinely face high-pressure situations where their performance achievements have a relevant impact on their social status, psychological health, and self-esteem. As a consequence, the competitive environment tends to elicit a broad spectrum of emotions in the athletes which may either impair or enhance their ability to interpret situational cues, process information, and perform. Not surprisingly, the ability to manage emotions under stress is an essential skill for both athletic performance and well-being, making it a central focus in sport psychology research[2,3].

Multi-states (MuSt) theory, developed by Ruiz and colleagues[4], offers a comprehensive framework to the study of individual experiences as related to their athletic performance. In particular, MuSt theory aims to describe, understand, explain, and predict the various performance related experiences that athletes undergo during

[1]Department of Medicine and Aging Sciences, BIND-Behavioral Imaging and Neural Dynamics Center, "G. d'Annunzio" University of Chieti-Pescara, Via dei Vestini, 31, 66100 Chieti, Italy. [2]Department of Neurosciences, Biomedicine and Movement Sciences, University of Verona, Verona, Italy. [3]"G. d'Annunzio" University of Chieti-Pescara, Chieti, Italy. [4]Faculty of Sport and Health Sciences, University of Jyväskylä, Jyväskylä, Finland. ✉email: c.robazza@unich.it

training and competition. It also seeks to predict athletes' performance outcomes, while serving as a framework for the identification of strategies for effective regulation of emotions and actions, which has been tested in the context of team sports[5]. According to MuSt theory, performance is viewed as a dynamic and multifaceted process that emerges from the interactions between the individual, the task, and the environment, which act as antecedents of athletes' subjective experiences. This process involves athletes' cognitive appraisals, that is the assessment of their perceived ability to meet the demands of a performance situation. An athlete interprets a situation as a challenge when they believe they possess the necessary skills, resources, and support to deal with a performance situation, seeing it as an opportunity for growth and success[6,7]. In contrast, a threat appraisal is an athlete's assessment of a situation as overly demanding and beyond their ability to manage the task at hand, leading to fear of negative outcomes[8,9]. In MuSt theory, competitive appraisals are considered mediators of the emotion-performance relationship. The emotions and associated psychobiosocial experiences that result from these appraisals significantly shape performance outcomes. Psychobiosocial experiences encompass various emotional and non-emotional aspects of subjective feelings related to performances from the past, present, and anticipated future[10]. These experiences include psychological (e.g., cognitive, confidence, motivational), biological (bodily, motor-behavioral), and social (e.g., communicative, social support) components. A central concept of psychobiosocial experiences is their functionality, which depends on an individual's perception of whether the experiences are functional (i.e., facilitative) or dysfunctional (i.e., debilitative) for performance, the availability of resources to manage situational demands, and self-regulation skills[11,12]. Research has shown that athletes tend to report psychobiosocial feelings that are predominantly functional for performance when assessing their competitive experiences[11,13,14].

Previous research examining other important constructs as determinants of cognitive appraisals and athletes' psychobiosocial experiences focused on basic psychological needs[15]. The basic psychological needs theory, which is a central mini-theory within self-determination theory (SDT[16]) highlights the crucial role of fulfilling three fundamental needs—competence, autonomy, and relatedness—in promoting individual motivation and well-being[16–18]. SDT posits that for an activity to be intrinsically motivating, individuals must experience a sense of competence, autonomy, and relatedness, and when these needs are satisfied, individuals are more likely to be intrinsically motivated, that is, engage in an activity driven by inherent satisfaction[19]. Competence, which involves feeling effective and capable in one's activities, in control of the own actions, and believing to successfully perform a task, is nurtured in environments that provide optimal challenges, positive feedback, and opportunities for skill development. Conversely, when competence needs are frustrated, individuals may experience feelings of inadequacy and helplessness, particularly when facing difficulties in mastering tasks. Autonomy, which pertains to the perception of having control over one's actions and decisions, is enhanced when individuals perceive their activities as self-endorsed and aligned with their values and interests. An individual's autonomy is undermined by experiences of external pressure and lack of choice, leading to feelings of being controlled or coerced. Relatedness, which encompasses the need to feel valued and connected to others, being part of a caring and supportive community, is fulfilled through respectful and considerate social interactions. The frustration of this need can result in feelings of isolation, exclusion, and loneliness[20,21].

In the context of sport, a growing body of research demonstrates that satisfying these basic psychological needs is linked to positive outcomes, such as intrinsic motivation, enjoyment, well-being, physical health, engagement, and enhanced performance. Conversely, negative outcomes, including, burnout, exhaustion, disengagement, and negative emotions, are likely to occur when these needs are frustrated[22,23]. In a large sample of athletes, Robazza et al.[15] found that competence need satisfaction was positively related to pleasant emotions and functional psychobiosocial experiences, while it was negatively associated with maladaptive emotion regulation strategies (i.e., expressive suppression), and unpleasant emotions. Furthermore, relatedness satisfaction was associated with adaptive emotion regulation strategies (i.e., cognitive reappraisal), pleasant emotions, and functional psychobiosocial experiences, and inversely related to expressive suppression and unpleasant emotions. Mediation analysis suggested that satisfying the needs for autonomy and relatedness fosters pleasant emotions and functional psychobiosocial experiences through the use of adaptive emotion regulation strategies. These findings underscore the importance of satisfying athletes' basic psychological needs and employing adaptive emotion regulation to promote pleasant emotions and functional psychobiosocial experiences.

Lazarus and Folkman[24,25] provided an influential perspective on emotion regulation. In their seminal work on stress and coping they introduced two primary types of coping functions: problem-focused and emotion-focused coping. This approach offers distinct although interactive pathways for addressing the stressors faced by individuals, including athletes dealing with the pressure and demand of their sport[26]. Problem-focused coping is characterized by efforts directed at tackling the root cause of stress. This approach involves cognitive and behavioral actions aimed at altering or managing the stress-inducing situation, such as planning, problem-solving, seeking information, and taking direct action to reduce or eliminate the stressor. The essence of problem-focused coping lies in its objective to change the environmental conditions or the athlete's actions to diminish the pressure or demands they face. On the other hand, emotion-focused coping encompasses strategies aimed at managing the emotional response to stress rather than changing the stressor itself. These strategies include seeking emotional support, engaging in relaxation techniques, or cognitive reframing, which involves changing the way one thinks about the stressful situation to reduce its emotional impact. The goal of emotion-focused coping is to alleviate the emotional distress associated with the stressor, thereby making it more bearable even if the actual circumstances remain unchanged (for reviews, see[27–29]). In addition to these primary coping functions, Kowalski and Crocker[30] included avoidance coping in a questionnaire assessing coping functions in sport. Avoidance coping involves behaviors (e.g., escaping from the situation) and thoughts (e.g., cognitive distancing) aimed at avoiding the stressor by disengaging from the situation and avoiding the underlying issue[31].

Study purpose

In a study testing the tenets of MuSt theory, Morrone et al.[13] investigated how some individual, trait-like factors influence precompetitive experiences and their impact on athletic performance. Path analysis results supported MuSt theory, showing self-confidence to positively influence self-evaluated performance through challenge appraisal and functional psychobiosocial experiences. Conversely, worry and concentration disruption were found to negatively impact performance through threat appraisal. However, this study did not consider the role of other relevant factors as antecedents of cognitive appraisals, such as environmental conditions that support intrinsic motivation. The current study was aimed to fill this gap by incorporating athletes' perceived satisfaction of basic psychological needs as an antecedent factor. Specifically, using MuSt theory[4] as a theoretical framework, we aimed to examine whether basic psychological needs would contribute to the experience of pleasant emotions and functional psychobiosocial feelings via the mediation of effective coping and challenge appraisals. Building upon MuSt theory and SDT underpinnings, as well as existing empirical evidence[13,15], we formulated two hypotheses.

Hypothesis 1 Based on SDT, fulfilling basic psychological needs for competence, autonomy, and relatedness has been shown to promote intrinsic motivation, adaptive functioning[16], and adaptive emotion regulation strategies[15]. Therefore, we hypothesized that basic psychological needs satisfaction would be positively related to both problem- and emotion-focused coping. According to MuSt theory, which highlights the role of cognitive appraisals and psychobiosocial experiences in shaping performance outcomes[4], we anticipated that both forms of coping would lead to pleasant emotions (e.g., excitement, happiness) and functional psychobiosocial experiences. Furthermore, we hypothesized that challenge appraisals—reflecting an athlete's perception of having adequate resources to meet situational demands[6]—would positively correlate with both forms of coping, pleasant emotions, and functional psychobiosocial experiences. Conversely, we expected basic psychological needs satisfaction to be negatively associated with threat appraisals and unpleasant emotions (e.g., anxiety, dejection, and anger). Threat appraisals, which arise when demands are perceived to exceed resources[8], were hypothesized to correlate negatively with pleasant emotions and functional psychobiosocial experiences and positively with unpleasant emotions.

Hypothesis 2 Drawing on SDT[16] and MuSt theory[4], we hypothesized positive indirect effects of basic psychological needs (predicting variables) on pleasant emotions and functional psychobiosocial experiences (outcome variables) through problem- and emotion-focused coping and challenge appraisals (mediating variables; see Fig. 1). Previous research has suggested that coping strategies mediate the relationship between psychological needs satisfaction and emotional experiences[15]. Problem- and emotion-focused coping, conceptualized in the current study as relatively stable individual tendencies to manage stressors, were posited to influence athletes' cognitive appraisals of an upcoming important competition. These appraisals, in turn, were expected to influence the emotional and psychobiosocial experiences associated with competition.

Method

Participants

Based on a priori power analysis conducted with G*Power 3.1.9.7[32] for linear multiple regression, entering an effect size of $f^2 = 0.15$ (medium effect), an alpha level of 0.05, and a desired power ($1 - \beta$) of 0.80, with 7 predictors, the minimum sample size estimated was 103. A convenience sample of 186 Italian athletes (81 women and 105 men), aged 18 to 48 years ($M = 24.86$, $SD = 7.42$), practicing individual sports ($n = 117$; e.g., fencing, gymnastics, martial arts, swimming, tennis, and track & field) or team sports ($n = 69$; e.g., basketball, futsal, rugby, soccer, and volleyball) was recruited from main sport clubs in central Italy. The athletes had between 5 and 25 years of competitive experience ($M = 11.50$, $SD = 6.44$) at local (16.9%), regional (33.9), national (37.2%), or international level (12.0%). The participants practiced their sport an average of about four times a week ($SD = 1.49$).

Measures

To minimize both the time required and the psychological burden of data collection, and therefore to ensure accurate and reliable individual responses, we carefully selected key items from basic psychological need satisfaction, coping functions, and cognitive appraisals measures. This selection was grounded in a consensus reached through triangulation approach among the study authors. In particular, three authors independently reviewed the entire measures and selected three items from each measure that were deemed most representative,

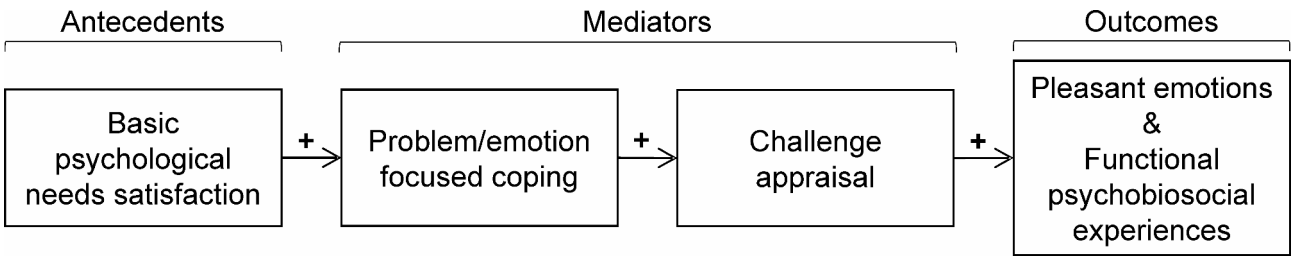

Fig. 1. Hypothesized relationships among variables.

relevant, and critical for the construct being assessed. They then discussed their chosen items to identify overlaps and differences, ultimately reaching a consensus on a set of three most suitable items. The collaborative effort in cross-checking and item selection was conducted to ensure that the items chosen were representative of the core constructs under investigation. Furthermore, we consolidated items representing five different emotions into single, composite items, each representing a distinct emotional state. This single-item approach aligns with recommendations and practices observed in the literature (e.g.[33]), demonstrating the practical advantages of the single-item approach for data collection purposes.

Basic needs satisfaction

Three scales from the Basic Needs Satisfaction in Sport Scale (BNSSS[34]) were used to assess key constructs: Competence, the feeling of being effective, capable, and skilled (e.g., "I feel I am good at my sport"); Autonomy-choice, the sense of volition and ownership of one's actions and decisions (e.g., "In my sport, I can take part in the decision-making process"); and Relatedness, the feeling of being connected, cared for, and accepted by others (e.g., "There are people in my sport who care about me"). Three items were selected for each scale. Participants provided responses on a 7-point Likert scale, ranging from 1 (*not true at all*) to 7 (*very true*), based on their level of agreement with the situation described. Previous research has confirmed the reliability of the Italian version of the BNSSS[35], with acceptable internal consistency (omega coefficients) for Competence (0.835), Autonomy-choice (0.831), and Relatedness (0.805).

Coping functions

Coping was assessed using the Coping Function Questionnaire (CFQ[30]). The CFQ assesses three coping functions: Problem-focused coping, viewed as the effort to actively confronting and attempting to alter the stressful situation (e.g., "I do my best to change the situation"); Emotion-focused coping, or the effort to manage thoughts and emotions while staying in the stressful situation (e.g., "I stay in the situation and try to control my emotions to better deal with the situation"); and Avoidance coping, referred to the attempt to escape or avoid the stressful situation altogether (e.g., "I try to get out of the situation as soon as I can to reduce the stress"). The CFQ was adapted to the Italian language using a back-translation procedure[36]. Specifically, the three Italian authors, fluent in English, were involved in this procedure. Two of them independently translated the CFQ from English to Italian, ensuring that the content was culturally appropriate, and that the original meaning of the items was preserved. The two translated versions were then compared to resolve any differences and inconsistencies, until consensus was reached. The third author translated this version back into English. Finally, the three authors compared the original, the back-translated, and the Italian versions to check for possible discrepancies and to ensure accuracy, leading to the final Italian version of the scale. Three items were then selected for each subscale. Athletes were asked to indicate the extent to which they used a described behavior to cope with stressful situations in competition. Items were rated on a 5-point Likert scale, ranging from 1 (*not at all*) to 5 (*very much*).

Cognitive appraisals

Athletes' cognitive appraisals of an upcoming important competition were evaluated using the Challenge and Threat in Sport (CAT-Sport) scale[37]). Participants rated the degree to which they viewed the competition as a challenge (e.g., "I anticipate achieving success rather than experiencing failure") and as a threat (e.g., "I feel this task is a threat"). Three items were used for each scale. Responses were scored on a 6-point Likert scale, ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). Following a similar back-translation procedure, the CAT-Sport was translated and adapted into Italian.

Emotions

Competitive emotions were evaluated using the items of the Sport Emotion Questionnaire (SEQ[38]). The SEQ items of each scale were combined into single items to assess five distinct emotional states: Excitement ("exhilarated, excited, enthusiastic, energetic"), Happiness ("pleased, joyful, happy, cheerful"), Anxiety ("uneasy, tense, nervous, apprehensive, anxious"), Dejection ("upset, sad, unhappy, disappointed, dejected"), and Anger ("irritated, furious, annoyed, angry"). Participants were instructed to reflect on the intensity of each emotion they expected to experience before an upcoming important competition and rate it on a 5-point scale, ranging from 0 (*not at all*) to 4 (*extremely*). The factor structure and reliability of the SEQ was previously supported for the Italian version of the scale[39], with Cronbach's alpha values ranging from 0.741 to 0.863 and composite reliability values ranging from 0.742 to 0.864.

Psychobiosocial experiences

To assess emotion-related (psychobiosocial) experiences, we used 12 items from Ruiz et al.'s stimulus list[4] for individualized profiling. These items were presented in a semantic differential format, similar to the Psychobiosocial Experience Semantic Differential scale in sport (PESD-Sport) developed by Robazza et al.[11]. Each bipolar item represented 12 modalities with 3 to 5 adjectives each: (a) psychological modalities—emotion, confidence, anxiety, assertiveness, cognitive, motivational, and volitional; (b) bodily modalities—bodily-somatic and motor-behavioral; and (c) social modalities—operational, communicative, and social support. Each item consisted of bipolar adjective pairs, with dysfunctional descriptors on the left side and their functional antonyms on the right side of a Likert-type scale (e.g., "Dejected, unhappy, sad, distressed" vs. "Enthusiastic, happy, joyful, cheerful"; "Unconfident, incapable, insecure, uncertain" vs. Confident, capable, secure, certain"). Participants were asked to reflect on their expected emotional experiences before an upcoming important competition and rate each bipolar descriptor based on its potential impact on their performance. They could assign a score from 4 (*very much*) to 1 (*a little*) on the dysfunctional side, or from 1 (*a little*) to 4 (*very much*) on the functional side. If a descriptor was not deemed representative of one's experience, a score of 0 (*neither. nor*) was assigned. Ratings

on the dysfunctional side were then converted to negative scores, resulting in a range of −4 to 4 for each item, with 0 indicating no effect. The total score was calculated by summing the individual item scores. The validity of the PESD-Sport, including its factorial, construct, convergent, discriminant, and nomological aspects, was established among Italian athletes[11].

Procedure

This study adhered to the ethical guidelines set forth in the Declaration of Helsinki and approval was gained from ethics committee of the provinces of Chieti and Pescara (n. 19, 09/09/2021). Sport managers and coaches involved with sport federations and clubs in central Italy were contacted either in person or by phone, with the aim to provide a detailed explanation of the purpose of the study to obtain permission to contact their athletes. The eligibility criteria required participants to practice at least twice a week, participate in regular competitions at a local level or higher during the season, and be 18 years of age or older. After establishing contact and obtaining their permission, managers and coaches were requested to share the invitation with other potential participants within their networks. Athletes were briefed on overall objective of the study and assured anonymity of their responses and voluntary participation. Athletes who were interested in taking part were sent a link to an online questionnaire containing informed consent details, demographic inquiries, and all measures. Informed consent was obtained from all the participants involved in the study. The link was made available to the participants following initial contact via email or phone, and it was promoted by the Italian Olympic Committee of Abruzzo Region. Athletes could complete the web-based survey at their convenience. Survey completion took roughly 20 min. Designed to require a single answer for each question, the online platform ensured all items were answered and prevented missing data. All participants who agreed to participate completed the survey in the middle of the competitive season, within a period of two weeks to one month before a major event.

Data analysis

Before conducting the main analysis, the dataset was screened for potential univariate and multivariate outliers on the mean total scores of the variables (i.e., Competence, Autonomy, Relatedness, Problem-focused coping, Emotion-focused coping, Avoidance coping, Challenge appraisal, Threat appraisal, and Psychobiosocial experiences), and the single-item mean scores of Excitement, Happiness, Anxiety, Dejection, and Anger. Assumptions of normality and multicollinearity were also checked[40]. Descriptive statistics and McDonald's ω reliability values were computed for all measures.

Pearson product-moment correlation coefficients between variables were computed to test Hypothesis 1. To assess the strength of relationships between variables, correlation coefficients were interpreted based on Zhu's guidelines[41]: 0–0.19 = no correlation, 0.20–0.39 = low correlation, 0.40–0.59 = moderate correlation, 0.60–0.79 = moderately high correlation, and > 0.80 = high correlation. A multivariate analysis of variance (MANOVA) was conducted to investigate potential differences in the scores of dependent variables based on gender. To account for multiple comparisons and prevent type I error inflation, significant differences for univariate follow-up were set at $p = .004$ (i.e., adjusted alpha level of 0.05).

Path analysis was performed in M*plus*[42] (v. 8.5) to test Hypothesis 2 (Fig. 1). A good-fitting model is indicated by several criteria[43]: a normed chi-square (χ^2/df) less than 5, a comparative fit index (CFI) and Tucker-Lewis index (TLI) both close to 0.95, and a root mean square error of approximation (RMSEA) and standardized root mean square residual (SRMR) both lower than 0.06. Indirect effects were assessed using a bias-corrected bootstrap method with 5000 resamples and 95% confidence intervals (CIs) constructed around the standardized estimate (β). An indirect effect is considered significant if its CI excludes zero[44].

Results

Three multivariate outliers were identified and excluded from further analysis. Assumptions of normality and multicollinearity were substantially met, and reliability values were acceptable for all measures (see Table 1). MANOVA revealed significant differences by gender, Wilks' $\lambda = 0.853$, $F(14, 168) = 2.063$, $p = .016$, $\eta_p^2 = 0.147$. However, univariate follow-up did not yield significant differences. In the whole sample, the mean scores of Problem-focused and Emotion-focused coping were higher than Avoidance coping. Moreover, mean scores of Challenge appraisal were higher than Threat appraisal, and mean scores of pleasant emotions (Excitement and Happiness) were higher than unpleasant emotions (Anxiety, Dejection, and Anger). All differences were significant at $p < .001$. These findings, alongside the high scores on the basic psychological needs satisfaction components and the positive mean scores of Psychobiosocial experiences, suggest that the athletes in the current sample perceived the coaching environment as satisfying their basic psychological needs, and experienced upcoming competitions as more challenging, pleasant, and functional, rather than threatening, unpleasant, and dysfunctional.

The patterns of correlations between study variables were in the expected direction, providing support for Hypothesis 1 (Table 1). Specifically, we found that: (a) Competence and Relatedness were positively associated with Problem-focused coping, Challenge appraisal, Excitement, Happiness, and Psychobiosocial experiences, and negatively associated with Threat appraisal, Anxiety, Dejection, and Anger; (b) Autonomy and Relatedness were positively linked to both Problem- and Emotion-focused coping; (c) Problem-focused and Emotion-focused coping were positively related to Challenge appraisal, Excitement, Happiness, and Psychobiosocial experiences, and negatively related to Anxiety and Anger; (d) Avoidance coping did not significantly correlate with any other variables, except for a small correlation with Emotion-focused coping; (e) Challenge appraisal was positively linked to Happiness and Functional experiences, and negatively linked to Anxiety and Anger; and (f) Threat appraisal was negatively related to Excitement, Happiness, and Functional experiences, and positively related to Anxiety, Dejection, and Anger.

	M	SD	Skewness	Kurtosis	1	2	3	4	5	6	7	8	9	10	11	12	13	ω
1. Autonomy	4.73	1.47	−0.48	−0.51	–													0.78
2. Competence	4.96	1.23	−0.22	−0.71	0.12	–												0.69
3. Relatedness	5.81	1.04	−0.84	1.03	0.18	0.12	–											0.87
4. Problem-focused coping	3.64	0.67	0.14	−0.60	0.27*	0.27*	0.25*	–										0.74
5. Emotion-focused coping	3.46	0.66	0.24	0.13	0.31*	0.07	0.25*	0.60†	–									0.67
6. Avoidance coping	2.99	0.89	0.05	−0.40	0.19	−0.09	0.10	0.05	0.30*	–								0.77
7. Challenge appraisal	5.06	0.85	−1.10	1.38	0.16	0.32*	0.27*	0.39*	0.28*	0.10	–							0.79
8. Threat appraisal	1.64	0.86	1.46	1.47	−0.14	−0.35*	−0.27*	−0.30*	−0.23*	0.06	−0.51§	–						0.86
9. Excitement	2.61	0.91	−0.47	−0.01	0.07	0.20*	0.21*	0.28*	0.17	−0.09	0.36*	−0.21*	–					–
10. Happiness	2.66	0.98	−0.30	−0.72	0.17	0.23*	0.40§	0.29*	0.20*	0.02	0.44§	−0.34*	0.61†	–				–
11. Anxiety	1.46	1.04	0.57	−0.17	−0.11	−0.21*	−0.10	−0.22*	−0.20*	−0.03	−0.39*	0.39*	−0.06	−0.23*	–			–
12. Dejection	0.52	0.84	1.99	4.34	−0.06	−0.29*	−0.26*	−0.15	−0.11	0.07	−0.45§	0.49§	−0.17	−0.22*	0.47§	–		–
13. Anger	0.50	0.89	2.11	4.50	−0.02	−0.03	−0.25*	−0.19	−0.22*	0.08	−0.19	0.34*	−0.14	−0.19	0.38*	0.62†	–	–
14. Psychobiosocial experiences	1.90	0.98	−0.61	0.14	0.30*	0.50§	0.25*	0.45§	0.34*	0.09	0.54§	−0.47§	0.51§	0.53§	−0.33*	−0.45§	−0.28*	0.88

Table 1. Descriptive statistics, Pearson product-moment correlation coefficients, and Mcdonald's omega (ω) values ($N = 183$). Correlation *low, §moderate, †moderately high (Zhu, 2012). Excitement, Happiness, Anxiety, Dejection, and Anger were single-item measures.

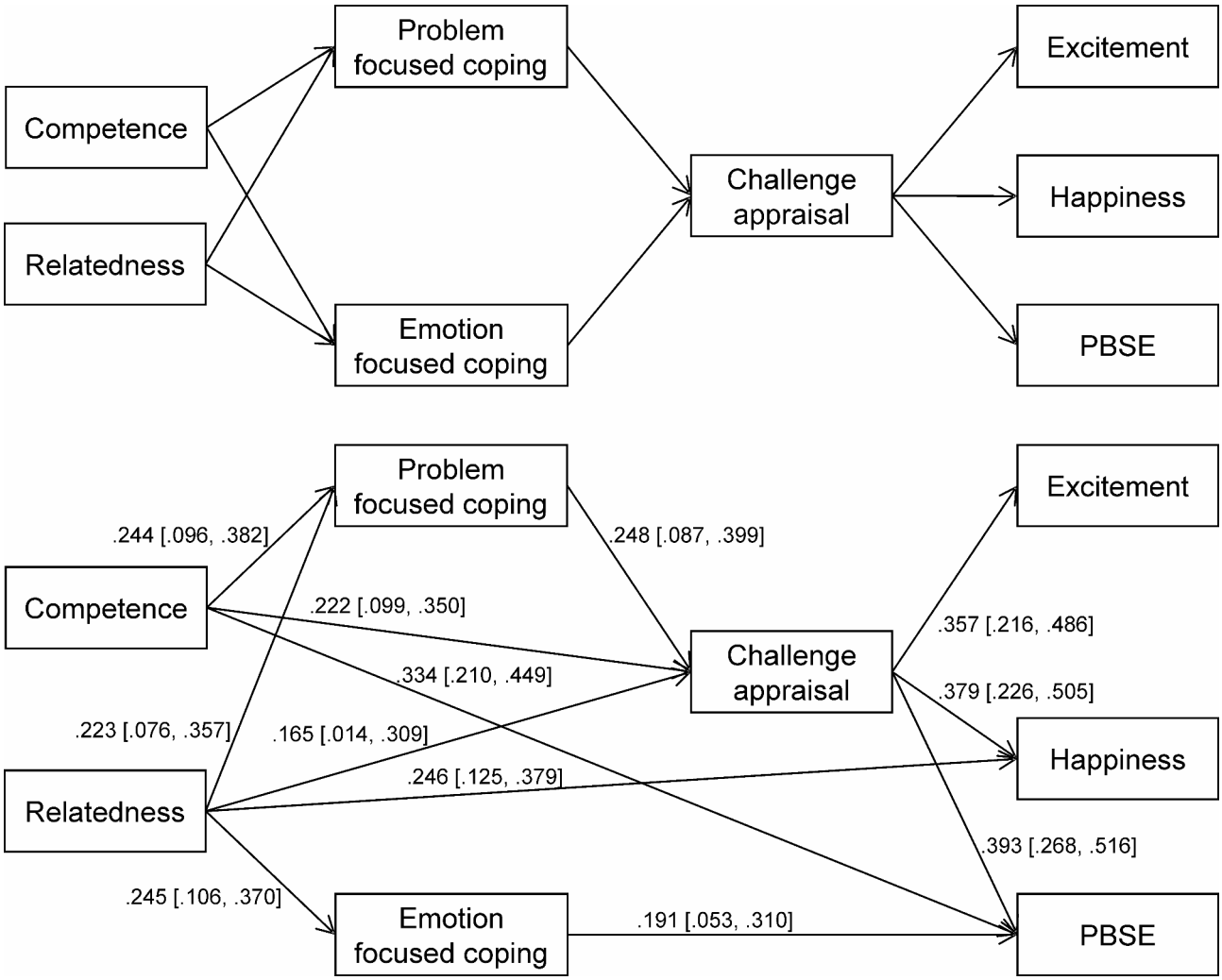

Fig. 2. Hypothesized model (upper part) and results from final path analysis (lower part) of the relationships between basic psychological needs (competence and relatedness), coping strategies (problem-focused and emotion-focused), and cognitive appraisals (challenge) on excitement, happiness, and psychobiosocial experiences (PBSE). Note: Only significant paths are presented. All standardized values (β) are significant at $p < .05$ (95% CI are in square brackets).

According to MuSt theory tenets[4] (Fig. 1), and based on correlation results, path analysis was conducted on the relationship between basic psychological needs of Competence and Relatedness (antecedents), Problem-focused and Emotion-focused coping (mediators), and Challenge appraisal (mediator) on Excitement, Happiness, and functional psychobiosocial experiences (Fig. 2, upper part). Autonomy was not included in the path analysis because it was not significantly related to cognitive appraisals or emotions. The hypothesized model on the relationships between the study variables provided poor fit to the data, $\chi^2/df = 5.476$, CFI = 0.819, TLI = 0.650, RMSEA = 0.156 (90% CI = 0.123–0.192), SRMR = 0.123. Inspection of modification indices suggested fit improvement after adding five paths in the model from Competence and Emotion-focused coping to Psychobiosocial experiences, from Competence and Relatedness to Challenge appraisal, and from Relatedness to Happiness. These additions are in line with theoretical assumptions; thus, a revised model was estimated. The revised model (Fig. 2, lower part) yielded good fit, $\chi^2/df = 1.145$, CFI = 0.997, TLI = 0.991, RMSEA = 0.028 (90% CI = 0.000–0.091), SRMR = 0.043.

As predicted in Hypothesis 2, bootstrap analysis resulted in significant indirect effects from Competence to Excitement, Happiness, and Psychobiosocial experience, and from Relatedness to the same outcomes. The basic needs satisfaction-emotion relationship was mediated by Problem-focused coping and Challenge appraisal (Fig. 2, lower part). Specifically, Competence had positive indirect effects on Excitement ($\beta = 0.022$, 95% CI = 0.006, 0.051), Happiness ($\beta = 0.023$, 95% CI = 0.006, 0.051), and Psychobiosocial experience ($\beta = 0.024$, 95% CI = 0.007, 0.054). Relatedness had similar positive indirect effects on Excitement ($\beta = 0.020$, 95% CI = 0.005, 0.049), Happiness ($\beta = 0.021$, 95% CI = 0.006, 0.050), and Psychobiosocial experience ($\beta = 0.022$, 95% CI = 0.005, 0.053). Indirect effects via Emotion-focused coping and Challenge appraisal were not statistically significant.

Discussion

Using MuSt theory[4] as a theoretical framework, this study examined the interplay between athletes' basic psychological needs satisfaction, coping functions, and cognitive appraisals in influencing emotions and psychobiosocial experiences related to performance. Findings provide support for MuSt theory underpinnings and offer novel insights into the role of basic psychological needs satisfaction in potentially influencing coping functions, challenge appraisal, and emotional experiences.

Psychological needs satisfaction

The results align with the core principles of self-determination theory[16,18], which posits that the satisfaction of basic psychological needs is essential for fostering intrinsic motivation and overall well-being. According to our first hypothesis, positive correlations were observed between competence and relatedness with problem-focused coping, challenge appraisal, pleasant emotions (excitement and happiness), and functional psychobiosocial experiences, along with the negative correlations with threat appraisal and unpleasant emotions (anxiety, dejection, and anger). This finding supports the notion that the satisfaction of athletes' basic psychological needs is related to adaptive coping responses to stress, pleasant emotional states, and functional psychobiosocial experiences.

Our results are consistent with previous research linking pleasant emotions and functional psychobiosocial experiences to the satisfaction of basic psychological needs[15] and a mastery climate[14]. According to achievement goal theory[45,46], a mastery climate is characterized by a coach who values and praises individual efforts, task commitment, and improvements. These aspects are also emphasized in self-determination theory, which highlights the importance of creating a supportive environment that fulfills athletes' psychological needs and promotes intrinsic motivation and pleasant emotional states[22,23].

Coping and challenge appraisal

Correlation results showed both problem- and emotion-focused coping to be positively associated with beneficial outcomes, such as perceiving stressful situations as challenges rather than threats. Furthermore, challenge appraisals, which occur when athletes view demanding situations as opportunities for growth and success[6,8,9], were positively associated with pleasant emotions and functional psychobiosocial experiences. On the other hand, threat appraisals, where athletes perceive situations as overwhelming and beyond their capacity to manage the situation, were linked to anxiety, dejection, and anger. This suggests that coping helps athletes view competitions as positive challenges and opportunities to experience pleasant and functional emotions, which are crucial for enhancing focus, motivation, and performance[47]. Coping also helps reducing the likelihood of feeling unpleasant emotions like anxiety and anger, which can impair performance.

As Lazarus[25] underscored, problem- and emotion-focused coping are not mutually exclusive, but rather two interconnected aspects of the coping process. Both are essential components of the total coping effort, and ideally, they work together for the same purpose. It is the balance between these two functions—how one thinks about the problem (problem-focused coping) and how one manages their emotional response to it (emotion-focused coping)—that determines the effectiveness of coping efforts. Rather than viewing coping functions and strategies as separate or competing, they should be viewed as complementary aspects of a holistic coping process aimed at improving the individual relationship with the environment. For example, a gymnast who experiences a slip on the beam during a warm-up before a crucial competition might cope with rising anxiety by tightening her core during turns or focusing on maintaining her balance by using self-talk cues, such as "strong core" and "steady gaze" (problem-focused coping). At the same time, she may take slow, deep breaths, relax her muscles, and focus on the present moment to maintain composure (emotion-focused coping).

Interestingly, avoidance coping, which involves trying to escape or ignore stressors, did not show significant correlations with other studied variables. This suggests that athletes in this study did not perceive avoidance coping to be as effective as problem- and emotion-focused coping, through which stressors are addressed or managed directly without avoiding or disregarding it.

The mediating role of coping and cognitive appraisals

Path analysis provided evidence for the mediating role of problem-focused coping and challenge appraisal in the relationship between basic psychological needs and pleasant emotions/functional experiences. This finding is consistent with previous research[15] highlighting the importance of adaptive emotion regulation strategies, such as cognitive reappraisal, in promoting pleasant emotions and functional experiences. The current study extends these findings by suggesting a crucial role of basic psychological needs satisfaction as environmental conditions in facilitating the adoption of adaptive coping for optimal performance and well-being.

In particular, the observed link between basic psychological needs satisfaction and problem-focused coping suggests that athletes who feel competent and connected to others are more likely to engage in active strategies to manage stressful situations. In the context of sport, where athletes frequently encounter demanding challenges and pressure-inducing situations, problem-focused coping can help athletes maintain a sense of control and mastery over their environment by actively addressing the causes of stress, thereby fostering pleasant emotional states and functional experiences[47].

Consistent with MuSt theory[4], the results underscore the pivotal role of cognitive appraisals in shaping athletes' emotional and psychobiosocial experiences. It is worth noting that the mean scores for challenge appraisal and pleasant emotions were significantly higher than those for threat appraisal and unpleasant emotions, respectively. This suggests that athletes in our sample tended to view competition as a less threatening and more exciting opportunity to express their skills and achieve success, and likely believed they had the necessary resources and support to meet the competitive demands of their sport.

In summary, the results support Hypothesis 2, which aligns with MuSt theory underpinnings[4] by suggesting the satisfaction of psychological needs to be an antecedent of adaptive coping and challenge appraisals, thereby leading to pleasant emotions and functional experiences. When athletes perceive their basic psychological needs are met, they are more likely to adopt functional coping. In a need-supportive environment that fulfills their psychological needs, athletes feel confident in their abilities, capable of addressing challenges autonomously, and socially supported. This further reinforces the importance of creating "empowering" environments to satisfy athletes' psychological needs[48]. Such environments are expected to facilitate the development of effective, self-directed coping mechanisms, and result in more optimal experiences for the athletes.

Limitations and future research directions

This study has some limitations that need to be considered. Firstly, the cross-sectional design prevents establishing firm causal relationships between psychological needs, coping functions, appraisals, and emotional outcomes. Longitudinal or experimental studies are more suited to provide a comprehensive understanding of the temporal and causal dynamics of these relationships. Secondly, the reliance on self-report and single-item measures, along with the use of convenience sampling, introduces potential biases such as social desirability and recall errors. Such approach may overlook important nuances that multi-item scales could capture, especially in easily accessible samples of participants. To mitigate these limitations, future research should consider triangulating data with additional measures, such as physiological assessments or behavioral observations. Using multi-item measures would also help minimize the risk of oversimplification. Furthermore, employing random sampling techniques could enhance generalizability and representativeness of findings. Thirdly, considering that MuSt theory posits performance and well-being as outcomes, an important step for future research would include the investigation of the direct and indirect effects of basic psychological needs satisfaction, coping, and appraisals on actual performance (e.g., competition results, training progress) as well as indices of well-being, personal growth, and self-improvement. Fourthly, along with emotional responses MuSt theory considers core components of action in the process leading to performance and well-being. Both emotions and action components should be incorporated in future research[5]. This would increase our understanding of the emotion-performance relationships and would contribute to further testing the feasibility of MuSt theory. Finally, the current study and previous investigations focused on a limited number of antecedents, including perfectionism[49,50], self-confidence, emotional arousal control, worry, and concentration disruption[13]. Additional individual and environmental antecedents of psychobiosocial states should be considered, such mental toughness[51], passion[52], and social support[53].

Practical implications

The study findings hold relevant implications for coaches, sport psychology consultants, and athletes alike. Creating a sport environment that meets athletes' basic psychological needs can enhance their stress management ability, emotional regulation, and interpretation of environmental cues. For example, implementing a structured training program that includes regular team meetings and team-building activities[54] can foster a sense of belonging by stimulating constructive interactions between athletes. This, in turn, can result in improved performance, increased enjoyment and engagement in sport, and better overall well-being. For instance, need-supportive behaviors are those in which coaches provide constructive feedback, encourage autonomy by involving athletes in decision-making processes and nurturing a sense of belonging within the team or training group. Both coaches and sport psychology consultants can assist athletes in adopting a challenge-oriented mindset though workshops that help athletes view competitions as opportunities for growth and success rather than threats to their well-being. Athletes could also be trained to manage challenging situations more effectively. For example, they could use video analysis of competitive events to identify and manage stressors, practice under pressure[55] to develop effective problem-solving skills, and learn to regulate their behaviors and emotional reactions by focusing on the relevant task and embracing the competitive pressure. Sport psychology consultants could adopt cognitive-behavioral techniques or mindfulness-based interventions[56–58] to help athletes view stressors as challenges instead of threats, develop a positive mindset, and adopt more adaptive coping strategies.

Conclusion

This study provides insights into the relationships between athletes' satisfaction of basic psychological needs, coping functions, cognitive appraisals, and emotional experiences. The results advance our understanding of the psychological dynamics that influence athletic performance, providing empirical support to the tenets of MuSt theory and expanding the currently limited body of work on MuSt theory. This theory emphasizes the importance of understanding the complex psychological experiences and challenges faced by athletes, offering meaningful insights into how these factors influence their performance. From an applied perspective, findings underscore the importance of fostering environments that fulfill basic needs, promote adaptive coping, and encourage positive appraisals, which are deemed to enhance athletes' emotional performance and well-being. The results support the notion that when athletes feel competent, autonomous, and connected, they are able to cope better with stress and maintain a positive mindset, which lead to better experiences and optimal conditions for performance. Overall findings support MuSt theory propositions and offer practical guidance for coaches, sport psychologists, and athletes aiming to optimize performance and well-being in competitive settings.

Data availability

The data generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Received: 20 July 2024; Accepted: 8 January 2025
Published online: 13 January 2025

References

1. Coppin, G. & Sander, D. Theoretical approaches to emotion and its measurement. In *Emotion Measurement* (ed Meiselman, H. L.) 3–37 (Woodhead Publishing, 2021).
2. Beatty, G. F. & Janelle, C. M. Emotion regulation and motor performance: an integrated review and proposal of the temporal influence model of emotion regulation (TIMER). *Int. Rev. Sport Exerc. Psychol.* **13**, 266–296 (2019).
3. Ruiz, M. C., Raglin, J. S. & Hanin, Y. L. The individual zones of optimal functioning (IZOF) model (1978–2014): historical overview of its development and use. *Int. J. Sport Exerc. Psychol.* **15**, 41–63 (2017).
4. Ruiz, M. C., Bortoli, L. & Robazza, C. The multi-states (MuSt) theory for emotion- and action-regulation in sports. In *Feelings in Sport: Theory, Research, and Practical Implications for Performance and well-being* (eds Ruiz, M. C. & Robazza, C.) 3–17 (Routledge, 2021).
5. Ruiz, M. C., Luojumaki, R., Karvinen, S., Bortoli, L. & Robazza, C. Self-regulation in high-level ice hockey players: an application of the MuSt theory. *Int. J. Environ. Res. Public. Health*. **18**, 13317 (2021).
6. Blascovich, J. Challenge and threat. In *Handbook of Approach and Avoidance Motivation* (ed Elliot, A. J.) 431–445 (Psychology Press, 2008).
7. Hase, A., O'Brien, J., Moore, L. J. & Freeman, P. The relationship between challenge and threat states and performance: a systematic review. *Sport Exerc. Perform. Psychol.* **8**, 123–144 (2019).
8. Meijen, C., Turner, M., Jones, M. V., Sheffield, D. & McCarthy, P. A theory of challenge and threat states in athletes: a revised conceptualization. *Front. Psychol.* **11**, 126 (2020).
9. Sammy, N., Harris, D. & Vine, S. Challenge and threat states, and emotions. In *Feelings in Sport: Theory, Research, and Practical Implications for Performance and Well-being* (eds Ruiz, M. C. & Robazza, C.) 18–26 (Routledge, 2021).
10. Hanin, Y. L. Emotions in sport: current issues and perspectives. In *Handbook of Sport Psychology* (eds Tenenbaum, G. & Eklund, R.) 31–58 (Wiley, 2007).
11. Robazza, C., Ruiz, M. C. & Bortoli, L. Psychobiosocial experiences in sport: development and initial validation of a semantic differential scale. *Psychol. Sport Exerc.* **55**, 101963 (2021).
12. Ruiz, M. C. & Robazza, C. Emotion regulation. In *The Routledge International Encyclopedia of Sport and Exercise Psychology. Applied and Practical Measures* (eds Hackfort, D. & Schinke, R. J.) Vol. 2, 263–280 (Routledge, 2020).
13. Morrone, M. et al. Predicting performance of elite kickboxers using the multi-states theory framework. *Eur. J. Sport Sci.* **24**, 405–414 (2024).
14. Robazza, C., Morano, M., Bortoli, L. & Ruiz, M. C. Perceived motivational climate influences athletes' emotion regulation strategies, emotions, and psychobiosocial experiences. *Psychol. Sport Exerc.* **59**, 102110 (2022).
15. Robazza, C., Morano, M., Bortoli, L. & Ruiz, M. C. Athletes' basic psychological needs and emotions: the role of cognitive reappraisal. *Front. Psychol.* **14**, 1205102 (2023).
16. Ryan, R. M. & Deci, E. L. *Self-determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness* (The Guilford Press, 2017).
17. Ryan, R. M. & Reeve, J. Intrinsic motivation, psychological needs, and competition: A self-determination theory analysis. In *The Oxford Handbook of the Psychology of Competition* (eds Garcia, S. M., Tor, A. & Elliot, A. J.) 240–264 (Oxford University Press, 2024).
18. Vansteenkiste, M., Soenens, B. & Ryan, R. M. Basic psychological needs theory: a conceptual and empirical review of key criteria. In *The Oxford handbook of Self-determination Theory* (ed Ryan, R. M.) 84–123 (Oxford University Press, 2023).
19. Ryan, R. M. & Vansteenkiste, M. Self-determination theory: Metatheory, methods, and meaning. In *The Oxford Handbook of Self-determination Theory* (ed Ryan, R. M.) 3–30 (Oxford University Press, 2023).
20. Vansteenkiste, M., Ryan, R. M. & Soenens, B. Basic psychological need theory: advancements, critical themes, and future directions. *Motiv Emot.* **44**, 1–31 (2020).
21. Vansteenkiste, M. & Soenens, B. How to foster motivation? The need-based motivating compass as a source of inspiration. In *Motivation Science: Controversies and Insights* (eds Bong, M., Reeve, J. & Kim, S.) 335–340 (Oxford University Press, 2023).
22. Schüler, J., Wolff, W. & Duda, J. L. Intrinsic motivation in the context of sports. In *Sport and Exercise Psychology: Theory and Application* (eds Schüler, J., Wegner, M., Plessner, H. & Eklund, R. C.) 171–192 (Springer, 2023).
23. Standage, M. Self-determination theory applied to sport. In *The Oxford Handbook of Self-determination Theory* (ed Ryan, R. M.) 701–723 (Oxford University Press, 2023).
24. Lazarus, R. S. & Folkman, S. *Stress, Appraisal, and Coping* (Springer, 1984).
25. Lazarus, R. S. *Stress and Emotion: A new Synthesis* (Springer, 1999).
26. Nicholls, A. R. & Thelwell, R. C. Coping conceptualized and unraveled. In *Coping in Sport: Theory, Methods, and Related Constructs* (ed Nicholls, A. R.) 3–14 (Nova Science, 2010).
27. Hoar, S. D., Kowalski, K. C., Gaudreau, P. & Crocker, P. R. E. A review of coping in sport. In *Literature Reviews in Sport Psychology* (eds Hanton, S. & Mellalieu, S. D.) 47–90 (Nova Science, 2006).
28. Nicholls, A. R. & Polman, R. C. J. Coping in sport: a systematic review. *J. Sports Sci.* **25**, 11–31 (2007).
29. Nuetzel, B. Coping strategies for handling stress and providing mental health in elite athletes: a systematic review. *Front. Sports Act. Living*. **5**, 1265783 (2023).
30. Kowalski, K. C. & Crocker, P. R. E. Development and validation of the coping function questionnaire for adolescents in Sport. *J. Sport Exerc. Psychol.* **23**, 136–155 (2001).
31. Endler, N. S. & Parker, J. D. A. Assessment of multidimensional coping: Task, emotion, and avoidance strategies. *Psychol. Assess.* **6**, 50–60 (1994).
32. Faul, F., Erdfelder, E., Lang, A. G. & Buchner, A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav. Res. Methods*. **39**, 175–191 (2007).
33. Cece, V., Guillet-Descas, E., Juhel, K. & Martinent, G. Emotional determinants and consequences of flow experience of young elite athletes involved in intensive training centers across the competitive season. *Int. J. Sport Exerc. Psychol.* **20**, 896–914 (2022).
34. Ng, J. Y. Y., Lonsdale, C. & Hodge, K. The Basic needs satisfaction in Sport Scale (BNSSS): instrument development and initial validity evidence. *Psychol. Sport Exerc.* **12**, 257–264 (2011).
35. Morano, M., Bortoli, L., Ruiz, M. C. & Robazza, C. Psychobiosocial states as mediators of the effects of basic psychological need satisfaction on burnout symptoms in youth sport. *Int. J. Environ. Res. Public. Health*. **17**, 4447 (2020).
36. Tran, T. V., Nguyen, T. H. & Chan, K. T. *Developing cross-cultural Measurement in Social work Research and Evaluation* 2nd edn (Oxford University Press, 2017).
37. Rossato, C. J. L., Uphill, M. A., Swain, J. & Coleman, D. A. The development and preliminary validation of the challenge and threat in Sport (CAT-Sport) Scale. *Int. J. Sport Exerc. Psychol.* **16**, 164–177 (2018).
38. Jones, M. V., Lane, A. M., Bray, S. R., Uphill, M. & Catlin, J. Development and validation of the Sport emotion questionnaire. *J. Sport Exerc. Psychol.* **27**, 407–431 (2005).
39. Robazza, C., Bertollo, M., Ruiz, M. C. & Bortoli, L. Measuring psychobiosocial states in sport: initial validation of a trait measure. *PLoS One*. **11**, e0167448 (2016).

40. Hair Jr., J. F., Black, W. C., Babin, B. J. & Anderson, R. E. *Multivariate Data Analysis* (Cengage, 2019).
41. Zhu, W. Sadly, the earth is still round ($p < 0.05$). *J. Sport Health Sci.* **1**, 9–11 (2012).
42. Muthén, L. K. & Muthén, B. O. *Mplus user's Guide* (Muthén & Muthén, 2017).
43. Hu, L. & Bentler, P. M. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct. Equ Model.* **6**, 1–55 (1999).
44. Hayes, A. F. *Introduction to Mediation, Moderation, and Conditional Process Analysis: A regression-based Approach* (The Guilford Press, 2022).
45. Ames, C. Achievement goals, motivational climate, and motivational processes. In *Motivation in Sports and Exercise* (ed Roberts, G. C.) 161–176 (Human Kinetics, 1992).
46. Nicholls, J. G. Achievement motivation: conceptions of ability, subjective experience, task choice, and performance. *Psychol. Rev.* **91**, 328–346 (1984).
47. Jones, M. & Uphill, M. Emotion in sport: Antecedents and performance consequences. In *Coping and Emotion in Sport* (eds Thatcher, J., Jones, M. & Lavallee, D.) 33–61 (Routledge, 2012).
48. Appleton, P. R. & Duda, J. L. Examining the interactive effects of coach-created empowering and disempowering climate dimensions on athletes' health and functioning. *Psychol. Sport Exerc.* **26**, 61–70 (2016).
49. Robazza, C., Sivilli, P., Bortoli, L. & Ruiz, M. C. Perfection behind the whistle: perfectionism and perceived performance in soccer referees. *Heliyon* **9**, e22856 (2023).
50. Ruiz, M. C., Appleton, P. R., Duda, J. L., Bortoli, L. & Robazza, C. Perfectionism and performance-related psychobiosocial states: the mediating role of competition appraisals. *Eur. J. Sport Sci.* **23**, 797–808 (2023).
51. Gucciardi, D. F. Mental toughness: Progress and prospects. *Curr. Opin. Psychol.* **16**, 17–23 (2017).
52. Schellenberg, B. J. I., Verner-Filion, J. & Vallerand, R. J. The role of passion in the experience of emotions in sport. In *Feelings in Sport: Theory, Research, and Practical Implications for Performance and well-being* (eds Ruiz, M. C. & Robazza C.) 37–46 (Routledge, 2021).
53. Freeman, P. Social support in sport. In *Handbook of Sport Psychology* (eds Tenenbaum, G. & Eklund, R. C.) 447–463 (Wiley, 2020).
54. Beauchamp, M. R., McEwan, D. & Waldhauser, K. J. Team building: conceptual, methodological, and applied considerations. *Curr. Opin. Psychol.* **16**, 114–117 (2017).
55. Low, W. R., Stoker, M., Butt, J. & Maynard, I. Pressure training: from research to applied practice. *J. Sport Psychol. Action.* **15**, 3–18 (2024).
56. Britton, D., Wood, A. G. & Pitt, T. Having impact and doing it quickly: the place for brief and single-session cognitive-behavioral therapies in sport psychology practice. *Sport Psychol.* **38**, 137–146 (2024).
57. Fink, C. & Ruiz, M. C. Mindfulness and emotions in sport. In *Feelings in Sport: Theory, Research, and Practical Implications for Performance and Well-being* (eds Ruiz, M. C. & Robazza, C.) 143–154 (Routledge, 2021).
58. Murdoch, E. M. et al. The effectiveness of stress regulation interventions with athletes: a systematic review and multilevel meta-analysis of randomised controlled trials. *Int. Rev. Sport Exerc. Psychol.* **17**, 145–181 (2024).

Acknowledgements

This research was funded by a grant from the Abruzzo Region and carried out in collaboration with the Italian Olympic Committee of Abruzzo Region (CONI, Comitato Regionale Abruzzo) https://abruzzo.coni.it/, and the "G. d'Annunzio" University of Chieti-Pescara.

Author contributions

C.R, L.B., and M.C.R. conceived the study, C.R and L.B. conducted the study, C.R. analyzed the data. All authors prepared the original draft and reviewed the manuscript.

Declarations

Competing interests

The authors declare no competing interests.

Additional information

Correspondence and requests for materials should be addressed to C.R.

Reprints and permissions information is available at www.nature.com/reprints.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.