

Worry as a bridge between self-compassion and competition anxiety in athletes: evidence from mediation and network analyses

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Abstract

Background

Competition anxiety is a pervasive concern in sport, yet the mechanisms linking self-compassion to its cognitive and somatic dimensions remain incompletely understood. This study extended prior work by examining whether worry and rumination mediate the self-compassion-anxiety relationship in athletes, testing measurement invariance across subgroups, and mapping the network architecture connecting self-compassion facets, repetitive negative thinking, and anxiety dimensions.

Methods

This study analysed openly available cross-sectional data from 263 competitive athletes (141 males, 122 females; mean age = 23.72 years) practising six sports. Measures included the Self-Compassion Scale, Penn State Worry Questionnaire, Ruminative Responses Scale, and Trait Competition Anxiety Inventory. Analyses proceeded in three phases: moderated mediation regression with 10,000 bias-corrected bootstrap samples, multi-group confirmatory factor analysis for measurement invariance across gender and sport type, and Gaussian graphical model network analysis with bridge centrality estimation.

Results

Worry significantly mediated the association between self-compassion and both somatic anxiety and concern, whereas the brooding pathway was non-significant. All moderation effects involving gender and sport type were non-significant. Metric invariance held across gender and sport type, though scalar invariance was not achieved. Network analysis identified worry as the node with the highest bridge strength (0.659) linking cognitive vulnerability to competition anxiety, while isolation was the self-compassion facet with the strongest bridge expected influence connecting to the cognitive vulnerability domain. The network was stable, with a correlation-stability coefficient of 0.593.

Conclusions

The protective effect of self-compassion on competition anxiety operates primarily through the reduction of worry, a mechanism that is consistent across gender and sport type. Worry and isolation represent promising intervention targets for sport psychologists seeking to reduce competition anxiety through self-compassion-based and cognitive strategies.

Trial registration

not applicable

Background

Competition anxiety is one of the most extensively studied psychological phenomena in sport science [1, 2]. Multidimensional theories conceptualise it as comprising at least two distinct components: cognitive anxiety, characterised by negative expectations and worry about performance outcomes, and somatic anxiety, reflecting the physiological-affective dimension of the anxiety response [3, 4]. Smith, Smoll, and Schutz [5] further identified concentration disruption as a third cognitive facet, capturing intrusive thoughts that interfere with attentional focus during competition. When left unaddressed, elevated trait competition anxiety has been linked to impaired performance, increased injury risk, and compromised athlete well-being [1, 6, 7]. Understanding the individual-level factors that predict competition anxiety is therefore critical for designing evidence-based preventive interventions.

Self-compassion, defined as an orientation of kindness and non-judgement towards oneself during times of suffering or perceived inadequacy [8], has emerged as a promising psychological resource in sport and exercise contexts [9]. Neff's [8] model proposes three bipolar components self-kindness versus self-judgement, common humanity versus isolation, and mindfulness versus over-identification measured by the 26-item Self-Compassion Scale (SCS). A growing body of evidence indicates that higher self-compassion is associated with lower competitive anxiety, reduced shame, greater emotional regulation, and more adaptive coping among athletes [9–11]. In collegiate athletes, Huysmans and Clement [10] found inverse associations between self-compassion and both worry and somatic anxiety. Moreover, brief self-compassion interventions have demonstrated reductions in state self-criticism and rumination in female athletes [12, 13], suggesting that self-compassion may be amenable to targeted training.

Repetitive negative thinking (RNT) is an umbrella term for perseverative cognitive processes, including worry and rumination that are transdiagnostically associated with anxiety and depressive disorders [14, 15]. Worry is typically future-oriented, involving anticipatory apprehension about potential threats [11, 16, 17], whereas rumination is past-oriented, involving passive and repetitive dwelling on distress and its consequences [18]. Factor-analytic work by Treynor, Gonzalez, and Nolen-Hoeksema [19] further distinguished two rumination subtypes: brooding (a maladaptive, passive comparison of one's current situation with unachieved standards) and reflection (a more adaptive, purposeful cognitive problem-solving process). In the general population, self-compassion has been shown to relate inversely to both worry and rumination, which in turn mediate its negative association with trait anxiety [20, 21]. However, the joint roles of these RNT components in shaping competition anxiety have received limited attention in athletic samples.

Casali, Ghisi, and Jansen [22] offered the first investigation integrating self-compassion, worry, rumination, and trait competition anxiety in a multi-sport sample of 263 Italian athletes. Their regression and mediation analyses demonstrated that worry, but not rumination, mediated the association between self-compassion and the somatic and cognitive (concern) dimensions of competition anxiety. These findings provided valuable initial evidence; however, several questions remain. First, Casali et al. [22] did not test whether the mediation pathway was moderated by demographic or sport-related variables such

as gender or sport type, leaving open the question of boundary conditions. Second, the measurement invariance of the underlying constructs across subgroups was not examined, limiting confidence in between-group comparisons. Third, the analytic framework relied on latent-variable and regression-based approaches, which estimate net effects of constructs on one another but do not reveal the fine-grained, pairwise interactions among individual facets of self-compassion, cognitive vulnerability, and anxiety dimensions.

Network analysis offers a complementary lens for understanding psychological phenomena by modelling variables as interconnected nodes rather than indicators of a latent construct [23, 24]. In a psychological network, edges represent partial correlations that persist after controlling for all other variables, thereby revealing unique conditional associations. Bridge centrality metrics further identify which nodes most strongly connect otherwise distinct conceptual communities for example, which self-compassion facet is most tightly linked to cognitive vulnerability or anxiety [25]. Although network approaches have begun to appear in sport psychology for modelling competitive state anxiety [26] and athlete mental health [27], no study to date has applied a network framework to the interplay among self-compassion, repetitive negative thinking, and trait competition anxiety.

The present study is an analysis of the openly available Casali et al. [22] dataset, designed to extend the original findings through three complementary analytic phases. Phase 1 tests a moderated mediation model in which self-compassion predicts competition anxiety (somatic and concern) both directly and indirectly through worry and brooding, with gender and sport type (individual vs. team) examined as potential moderators. Phase 2 evaluates multi-group measurement invariance of the key constructs across gender and sport type using structural equation modelling. Phase 3 estimates a Gaussian graphical model (GGM) network to map the conditional association structure among six self-compassion facets, worry, brooding, reflection, and two anxiety dimensions, computing bridge centrality to identify the nodes that most strongly link the self-compassion, cognitive vulnerability, and anxiety communities. By combining variable-centred, person-centred, and network-based methods within a single dataset, this study aims to provide a more comprehensive understanding of how self-compassion, repetitive negative thinking, and competition anxiety interconnect in athletes, with implications for targeted intervention design.

Methods

Study design and data source

This study is an analysis of openly available cross-sectional data collected by Casali, Ghisi, and Jansen [22]. The original dataset was deposited on Figshare under a CC BY 4.0 licence (DOI: [28]) and accompanies the article published in *Psychological Reports* [22]. Because the data are fully anonymised and publicly accessible, no additional ethical approval was required; the original study was approved by the University of Padova's Ethics Committee for Research in Psychology (protocol no. 3405) [22]. The

reuse of this dataset is consistent with current recommendations for open science and reproducibility in sport psychology [29, 30].

Participants

The sample comprised 263 competitive athletes (141 males, 122 females; $M_{\text{age}} = 23.72$, $SD = 6.97$). Participants were recruited from sports clubs across several Italian regions and practised six sports: volleyball ($n = 102$), track and field ($n = 38$), archery ($n = 37$), swimming ($n = 29$), rugby ($n = 29$), and martial arts ($n = 28$). Of these, 132 competed in individual sports and 131 in team sports. Competitive levels ranged from regional to national, and participants varied in years of practice, weekly training sessions, and annual number of competitions [22].

Measures

Self-Compassion Scale (SCS). Self-compassion was measured using the 26-item SCS [8], Italian validation by Veneziani et al. [31]. Items are rated on a 5-point Likert scale (1 = *almost never* to 5 = *almost always*). The scale yields six subscale scores self-kindness, self-judgement, common humanity, isolation, mindfulness, and over-identification which can be combined into an overall self-compassion score after reverse-coding the three negative facets [8]. In the original sample, internal consistency was high ($\alpha = .88$) [22].

Penn State Worry Questionnaire (PSWQ). Dispositional worry was assessed with the 16-item PSWQ [4], Italian validation by Meyer et al. [32]. Items are rated on a 5-point scale (1 = *totally disagree* to 5 = *totally agree*); five items are reverse-scored, producing a total score of 16–80 with higher values indicating greater pathological worry [32]. Internal consistency in the present dataset was $\alpha = .90$ [22].

Ruminative Responses Scale (RRS). Rumination was measured with the 22-item RRS [18], Italian validation. Items are rated on a 4-point scale (1 = *never* to 4 = *always*); summed scores range from 22 to 88 [18]. In addition to the total score, two empirically derived subscales were examined: brooding (passive comparison of one's situation with unachieved standards) and reflection (purposeful cognitive problem-solving), following the factor-analytic work of Treynor, Gonzalez, and Nolen-Hoeksema [19]. Internal consistency for the total scale was $\alpha = .89$ in this sample [22].

Trait Competition Anxiety Inventory (WAIT). Trait competition anxiety was assessed with a 12-item inventory adapted from the Sport Anxiety Scale [5] by Hanton et al. [33], translated into Italian for this study as no validated Italian version was available at the time of data collection [22]. Items are rated on a 4-point Likert scale (1 = *almost never* to 4 = *almost always*). The WAIT yields three 4-item subscales: somatic anxiety ($\alpha = .71$), concern ($\alpha = .81$), and concentration disturbances ($\alpha = .56$). Because the concentration disturbances subscale did not reach acceptable internal consistency, it was excluded from the primary analyses, consistent with the original authors' decision [22]. Only the somatic anxiety and concern subscales were retained as outcome variables.

The original dataset also included the Rumination-Reflection Questionnaire (RRQ; Trapnell & Campbell [34]); however, 63% of values on this measure were missing, and it was therefore excluded from all analyses.

Analytic strategy

All analyses were conducted in R version 4.5.2 [35] and are organised into three complementary phases.

Phase 1: Moderated mediation. Building on the mediation model of Casali et al. [22], we fitted a series of moderated mediation regression models to test whether self-compassion (SCS total) predicts trait competition anxiety (WAIT somatic; WAIT concern) both directly and indirectly through worry (PSWQ) and brooding (RRS brooding), and whether these indirect paths are moderated by gender or sport type (individual vs. team). Model variables were mean-centred prior to creating interaction terms. Significance of indirect effects was evaluated with 5,000 bias-corrected bootstrap confidence intervals [8]. Multicollinearity was monitored using the variance inflation factor (VIF < 5 threshold).

Phase 2: Multi-group structural equation modelling. To examine measurement invariance across gender and sport type (individual vs. team), we fitted multi-group confirmatory factor analysis models using the *lavaan* package [36]. Invariance was tested sequentially: configural, metric (equal factor loadings), and scalar (equal intercepts). Model comparison used the $\Delta\text{CFI} \leq .010$ criterion [37] supplemented by the χ^2 difference test. Establishing at least metric invariance is a prerequisite for meaningful between-group comparisons of structural paths [37].

Phase 3: Network analysis. To move beyond latent-variable models and examine the fine-grained interplay among self-compassion facets, worry, rumination components, and anxiety dimensions, we estimated a Gaussian graphical model (GGM) using the *bootnet* and *qgraph* packages [23]. Partial correlations were regularised with the graphical LASSO and model selection was performed via the Extended Bayesian Information Criterion (EBIC, $\gamma = 0.5$) [23]. Because the variables span three conceptual domains self-compassion, cognitive vulnerability, and competitive anxiety we computed bridge centrality metrics (bridge strength, bridge expected influence) to identify nodes that most strongly connect domains [25]. Network accuracy and stability were evaluated with 1,000 non-parametric bootstrap samples, and the correlation-stability coefficient (CS-coefficient) was required to exceed 0.25 for interpretable centrality estimates [23].

Software and reproducibility

Key R packages included *lavaan* [36] for SEM, *bootnet* and *qgraph* [23] for network estimation and visualisation, and base R functions for regression and bootstrapping. Fully annotated analysis scripts, the raw dataset, and all output files are available in the project's Open Science Framework repository [56] to ensure full reproducibility.

Results

Preliminary analyses

The sample comprised 263 Italian athletes (141 males, 122 females; $M_{age} = 23.72$, $SD = 6.97$, range 17–49) drawn from data reported by Casali, Ghisi, and Jansen [22]. Participants represented six sports: volleyball ($n = 102$), track and field ($n = 38$), archery ($n = 37$), swimming ($n = 29$), rugby ($n = 29$), and martial arts ($n = 28$). When classified by sport type, 132 athletes competed in individual sports and 131 in team sports.

Several preliminary data-quality decisions were made. First, the Rumination-Reflection Questionnaire (RRQ) was excluded because of 63% missing data. Second, the RRS Reflection subscale exhibited an anomalous distribution (skewness = 1.65, $SD = 15.34$ compared with 7.40 for Brooding); consequently, RRS Brooding was retained as the sole rumination indicator [18, 19]. Shapiro-Wilk tests indicated that SCS total ($W = .996$, $p = .681$) and PSWQ ($W = .994$, $p = .422$) were normally distributed, whereas the WAIT subscales and RRS Brooding deviated from normality. To accommodate non-normality, the robust maximum-likelihood estimator (MLR) was used throughout [36]. Subscale-level internal consistency for the SCS was acceptable ($\alpha = .75$); original item-level reliabilities reported by Casali et al. [22] were excellent (SCS $\alpha = .89$, PSWQ $\alpha = .93$, WAIT $\alpha = .82$, RRS $\alpha = .92$).

Table 1
Descriptive statistics by gender and sport type

Variable	Gender		Sport Type						
	Overall M (SD)	Female M (SD)	Male M (SD)	d	p	Individual M (SD)	Team M (SD)	d	p
SCS total	3.03 (0.58)	2.91 (0.57)	3.13 (0.57)	-0.39	.002	3.06 (0.60)	3.00 (0.55)	0.10	.437
SCS mind.	3.24 (0.87)	3.03 (0.83)	3.42 (0.87)	-0.46	< .001	3.27 (0.88)	3.21 (0.87)	0.07	.592
PSWQ	45.27 (12.45)	48.03 (12.38)	42.89 (12.01)	0.42	< .001	46.61 (12.88)	43.93 (11.90)	0.22	.083
RRS Brood.	21.80 (7.40)	22.54 (7.34)	21.16 (7.42)	0.19	.144	23.58 (7.59)	20.01 (6.80)	0.50	< .001
WAIT som.	9.06 (2.61)	9.67 (2.53)	8.54 (2.57)	0.44	< .001	9.61 (2.66)	8.51 (2.44)	0.43	< .001
WAIT conc.	9.22 (3.01)	9.89 (2.93)	8.63 (2.97)	0.43	< .001	9.54 (3.09)	8.89 (2.91)	0.22	.087
WAIT conc. discr.	7.08 (2.34)	7.33 (2.40)	6.87 (2.28)	0.20	.121	7.32 (2.43)	6.84 (2.23)	0.21	.102
Note. SCS = Self-Compassion Scale; mind. = mindfulness; PSWQ = Penn State Worry Questionnaire; RRS Brood. = Ruminative Response Scale, Brooding subscale; WAIT som. = somatic anxiety; WAIT conc. = performance concern; WAIT conc. discr. = concentration disruption. d = Cohen's d. ***p < .001, **p < .01.									

Table 1 presents descriptive statistics overall and by gender and sport type. Female athletes reported significantly lower self-compassion (SCS total: $d = -0.39$, $p = .002$) and mindfulness ($d = -0.46$, $p < .001$) alongside higher worry (PSWQ: $d = 0.42$, $p < .001$), somatic anxiety ($d = 0.44$, $p < .001$), and worry about performance ($d = 0.43$, $p < .001$) compared with male athletes [12, 38, 39]. Individual-sport athletes reported significantly higher rumination (RRS Brooding: $d = 0.50$, $p < .001$) and somatic anxiety (WAIT somatic: $d = 0.43$, $p < .001$) than team-sport athletes.

Bivariate correlations

Table 2
Bivariate correlations among study variables

Variable	1	2	3	4	5	6
1. SCS	—					
2. PSWQ	– .49***	—				
3. RRS Brood.	– .48***	.45***	—			
4. WAIT som.	– .25***	.31***	.24***	—		
5. WAIT conc.	– .38***	.39***	.26***	.52***	—	
6. WAIT conc. distr.	– .19**	.24***	.18**	.47***	.44***	—
Note. ** $p < .01$, *** $p < .001$.						

Table 2 displays zero-order correlations. Self-compassion was moderately and negatively associated with worry ($r = -.49, p < .001$), brooding ($r = -.48, p < .001$), and performance concern ($r = -.38, p < .001$) [8, 12]. Worry was positively related to all three WAIT dimensions, with the strongest link to performance concern ($r = .39, p < .001$) [32, 40]. Brooding likewise correlated with somatic anxiety ($r = .24$) and performance concern ($r = .26$; both $ps < .001$) [18, 19].

Phase 1: moderated mediation analysis

A moderated mediation model was estimated via structural equation modelling with MLR estimation and 10,000 bootstrap iterations [36, 41]. Self-compassion served as the predictor, PSWQ and RRS Brooding as parallel mediators, the three WAIT subscales as outcomes, and gender and sport type as moderators, with age controlled.

Regarding a-paths, self-compassion significantly predicted lower worry ($\beta = -.47, p < .001$) and lower brooding ($\beta = -.49, p < .001$). Gender was a significant predictor of worry ($\beta = .12, p = .041$), indicating that female athletes reported higher PSWQ scores after controlling for self-compassion. Sport type predicted brooding ($\beta = -.30, p < .001$), with team-sport athletes reporting lower scores [5, 40].

For b-paths, worry significantly predicted all three sport-anxiety dimensions: somatic ($\beta = .22, p = .009$), concern ($\beta = .24, p = .001$), and concentration disruption ($\beta = .17, p = .026$) [4]. By contrast, RRS Brooding did not significantly predict any WAIT subscale (all $ps > .39$). The only significant direct effect was from self-compassion to WAIT concern ($\beta = -.22, p = .004$), indicating a residual protective role of self-compassion beyond the mediating pathway [8, 12].

Table 3
Bootstrap indirect effects (10,000 iterations)

Pathway	Estimate	95% Boot CI	p
SCS → PSWQ → WAIT somatic	-0.454	[-0.922, -0.088]	.034
SCS → PSWQ → WAIT concern	-0.575	[-1.066, -0.211]	.009
SCS → PSWQ → WAIT concentration	-0.313	[-0.651, -0.021]	.050
SCS → Brooding → WAIT somatic	-0.064	[-0.380, 0.247]	.684
SCS → Brooding → WAIT concern	-0.070	[-0.449, 0.303]	.712
SCS → Brooding → WAIT concentration	-0.119	[-0.424, 0.160]	.420
Total indirect → somatic	-0.518	[-1.017, -0.112]	.024
Total indirect → concern	-0.645	[-1.159, -0.205]	.008
Total indirect → concentration	-0.432	[-0.842, -0.073]	.028
<i>Note.</i> CI = confidence interval. Significant indirect effects are those with 95% CIs excluding zero.			

As shown in Table 3, the indirect effects of self-compassion on all three sport-anxiety outcomes through PSWQ were significant, whereas none of the pathways through RRS Brooding reached significance. Total indirect effects were significant for somatic anxiety (estimate = - 0.518, 95% CI [- 1.017, - 0.112], $p = .024$), performance concern (estimate = - 0.645, 95% CI [- 1.159, - 0.205], $p = .008$), and concentration disruption (estimate = - 0.432, 95% CI [- 0.842, - 0.073], $p = .028$). The model accounted for 25% of PSWQ variance, 32% of RRS Brooding variance, 17% of WAIT somatic, 21% of WAIT concern, and 9% of WAIT concentration variance. All moderation interactions (SCS $\times$ gender, SCS $\times$ sport type) and all indices of moderated mediation were non-significant (all $ps > .35$, all CIs included zero) [41].

Phase 2: multi-group invariance testing

Table 4
Multi-group invariance fit indices

Grouping	Level	CFI	RMSEA	SRMR	$\Delta\chi^2$ p
Gender	Configural	.892	.126	.063	—
Gender	Metric	.882	.112	.065	.298
Gender	Scalar	.847	.113	.079	.016
Sport type	Configural	.912	.135	.055	—
Sport type	Metric	.886	.120	.066	.050
Sport type	Scalar	.752	.157	.101	< .001
<i>Note.</i> CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual; $\Delta\chi^2$ = scaled chi-square difference test.					

Table 4 summarises fit indices across invariance levels [37]. For gender, the configural-to-metric comparison was non-significant ($\Delta\chi^2$ p = .298), supporting metric invariance; however, the metric-to-scalar step was significant (p = .016), indicating that scalar invariance did not hold. Group-specific estimates revealed that male athletes showed stronger worry–anxiety paths (PSWQ → WAIT somatic β = .24, p = .012; PSWQ → WAIT concern β = .40, p < .001; PSWQ → WAIT concentration β = .29, p = .010), whereas female athletes displayed a stronger direct self-compassion–concern path (β = −.35, p < .001) [12, 38, 39].

For sport type, metric invariance held at the borderline ($\Delta\chi^2$ p = .050), whereas scalar invariance failed (p < .001). Among individual-sport athletes, worry predicted somatic anxiety (β = .36, p < .001) and performance concern (β = .32, p = .001). In contrast, team-sport athletes demonstrated significant direct effects of self-compassion on both performance concern (β = −.39, p < .001) and somatic anxiety (β = −.25, p = .018), bypassing the mediating pathway [5, 40].

Phase 3: network analysis

An 11-node Gaussian Graphical Model was estimated using the EBICglasso algorithm with the cor_auto correlation method [23, 25]. Centrality stability was adequate for strength (CS coefficient = .593) and closeness (.517) but insufficient for betweenness (.049), which was therefore excluded from interpretation.

The strongest edges within the network connected self-compassion subfacets: SCS minus-isolation with SCS minus-overidentification (.428), SCS self-kindness with SCS minus-judgement (.350), and SCS self-kindness with SCS mindfulness (.347). These densely interconnected self-compassion nodes formed a tightly knit cluster, consistent with the theoretical structure of self-compassion [8].

Standardised strength centrality was highest for SCS minus-overidentification (1.01), SCS minus-isolation (0.94), and SCS self-kindness (0.80), indicating that these nodes had the strongest overall

connections in the network. Bridge centrality analysis [25] identified the key nodes linking the self-compassion cluster to the worry-anxiety cluster. By bridge strength, the most prominent bridges were PSWQ (0.659), WAIT concern (0.572), RRS Brooding (0.472), SCS minus-isolation (0.423), and SCS minus-overidentification (0.416). Bridge expected influence was most negative for SCS minus-isolation (– 0.423) and SCS minus-overidentification (– 0.416), followed by RRS Brooding (– 0.307), confirming that these self-compassion facets exert dampening effects across communities [23, 25].

Discussion

This study extended the original work of Casali et al. [22] by applying three complementary analytic frameworks moderated mediation, multi-group structural equation modelling, and network analysis to the interplay among self-compassion, repetitive negative thinking, and trait competition anxiety in a multi-sport sample of 263 Italian athletes. The findings both replicate and expand upon previous evidence, and carry practical implications for sport psychology intervention.

Worry as the dominant cognitive mediator

Consistent with Casali et al. [22] and Raes [20], the moderated mediation models confirmed that worry (PSWQ) is the primary pathway through which self-compassion relates to both somatic anxiety and concern. The indirect effect through worry was significant for all three WAIT outcomes, whereas the brooding pathway was non-significant. This pattern mirrors the differentiated mediational structure reported in non-clinical populations, where worry preferentially mediates the self-compassion anxiety link and brooding mediates the self-compassion-depression link [20]. From a theoretical standpoint, the result is coherent with the temporal orientation of these processes: worry is future-directed and maps onto the anticipatory nature of competition anxiety, whereas brooding is retrospectively focused and may be more relevant to post-event affective disturbances [14, 32, 42, 43]. Importantly, none of the interaction terms involving gender or sport type reached significance, suggesting that the mediational mechanism operates comparably across male and female athletes and across individual and team sport contexts within this sample.

Measurement invariance across subgroups

Multi-group confirmatory factor analyses revealed that metric invariance held for both gender ($\Delta\chi^2 p = .298$) and sport type ($p = .050$), indicating that the factor loadings of the measured constructs are equivalent across these groups [37, 44]. This is a prerequisite for meaningful comparison of structural paths and latent means [37, 45]. However, scalar invariance was not supported in either grouping, meaning that observed score differences may partly reflect systematic response-style variations rather than true latent-mean differences [45–47]. These findings align with prior work noting that while the factor structure of sport anxiety measures is robust across gender, item intercepts can differ [48]. Researchers conducting between-group comparisons in similar samples should therefore exercise caution when interpreting raw mean differences and consider partial invariance models or item-level adjustments.

Network architecture and bridge nodes

The Gaussian graphical model provided a granular view of the conditional associations among self-compassion facets, cognitive vulnerability components, and anxiety dimensions. Worry (PSWQ) emerged as the node with the highest bridge strength (0.659), confirming its role as the primary conduit linking the cognitive vulnerability and anxiety communities. This converges with the mediation results and strengthens the inference that worry occupies a structurally pivotal position in this psychological system [23, 25, 49]. Among the self-compassion facets, isolation (reverse-scored as “minus isolation”) displayed the highest bridge expected influence (-0.423), suggesting that athletes who feel disconnected from others during difficulty are most strongly linked to elevated cognitive vulnerability. This is theoretically consistent with Neff’s [8] characterisation of isolation as the facet most antithetical to adaptive coping, as it reflects a sense that personal suffering is unique and shameful rather than a shared human experience.

The network was acceptably stable, with the correlation-stability coefficient for bridge strength reaching 0.593 well above the recommended 0.25 threshold [23]. This indicates that the centrality ordering is robust to case-dropping and can be interpreted with reasonable confidence. Notably, the network approach complements the mediation analysis by revealing that the worry-anxiety bridge operates alongside more nuanced connections (e.g., self-kindness to mindfulness, brooding to reflection) that are invisible in aggregate regression models [23, 50].

Practical implications

Taken together, the results point to two complementary intervention targets. First, because worry is the dominant bridge between self-compassion and competition anxiety, sport psychologists may benefit from incorporating evidence-based worry-reduction techniques such as cognitive restructuring, attentional training, or stimulus control strategies into pre-competition psychological preparation [32, 41, 51]. Second, the prominence of isolation as a bridge node within the self-compassion community suggests that interventions fostering a sense of common humanity may be especially effective. Self-compassion programmes that include psychoeducation and writing exercises have already shown promise in reducing somatic anxiety in climbers [52] and state rumination in female athletes [12]. Our network findings further specify that such programmes might yield the greatest cross-domain benefits if they explicitly target the isolation-common humanity dimension alongside worry management. Importantly, the absence of moderation by gender or sport type implies that these strategies need not be differentially tailored to male versus female athletes or to individual versus team sport settings, at least within the demographic range represented here.

Limitations

Several limitations should be acknowledged. First, the cross-sectional design precludes causal inference; the directional pathways estimated in the mediation and network models represent statistical, not causal, relationships [53, 54]. Longitudinal or experience-sampling designs are needed to test the

temporal dynamics implied by the present models. Second, the sample comprised Italian athletes from six sports, and generalisation to other nationalities, competitive levels, or sport cultures should be approached cautiously. Third, the concentration disturbances subscale of the WAIT was excluded due to low internal consistency ($\alpha = .56$), limiting the scope of conclusions regarding this dimension of competition anxiety [22]. Fourth, the dataset did not include measures of state anxiety, actual performance outcomes, or injury data, preventing examination of downstream consequences. Finally, as a secondary analysis of an existing dataset, the study was constrained to the variables collected by the original investigators, and the sample size of 263 may limit the precision of network edge estimates, particularly for smaller partial correlations [23, 55].

Conclusion

This study demonstrates that the protective association between self-compassion and trait competition anxiety in athletes is primarily channelled through worry, a finding that is robust across gender and sport type and that converges across mediation and network analytic approaches. Worry occupies the most structurally central bridge position linking cognitive vulnerability to competition anxiety, while isolation is the self-compassion facet most strongly connected to the cognitive vulnerability domain. Multi-group analyses confirm that the factor structure of the key measures is metrically invariant across gender and sport type, although scalar invariance is not fully achieved. These findings underscore the value of multi-method secondary analyses of open datasets for advancing both theory and practice in sport psychology. Future research should adopt longitudinal designs to test the causal mechanisms implied here and evaluate whether interventions targeting worry reduction and the isolation-common humanity dimension of self-compassion produce measurable reductions in competition anxiety and improvements in athletic well-being.

Abbreviations

Abbreviation	Definition
SCS	Self-Compassion Scale
PSWQ	Penn State Worry Questionnaire
RRS	Ruminative Responses Scale
WAIT	Trait Competition Anxiety Inventory
GGM	Gaussian graphical model
SEM	Structural equation modelling
CFA	Confirmatory factor analysis
EBIC	Extended Bayesian Information Criterion
VIF	Variance inflation factor
CS-coefficient	Correlation-stability coefficient
CFI	Comparative fit index
OSF	Open Science Framework

Declarations

Ethics approval and consent to participate

This study is a secondary analysis of openly available, fully anonymised data originally collected by Casali, Ghisi, and Jansen and deposited on Figshare under a CC BY 4.0 licence. The original study was approved by the University of Padova's Ethics Committee for Research in Psychology (protocol no. 3405) and was conducted in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. Because the data are fully de-identified and publicly accessible, no additional ethical approval was required for the present secondary analysis.

Consent for publication

Not applicable.

Availability of data and materials

The dataset analysed during the current study is publicly available in the Figshare repository (DOI: <https://doi.org/10.6084/m9.figshare.13580624.v1>). Fully annotated R analysis scripts, the raw dataset, and all output files are available in the project's Open Science Framework repository (<https://osf.io/n5ae7>).

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

KNA conceptualised and designed the study, conducted the statistical analyses, and drafted the manuscript. NA contributed to the literature review and critically revised the manuscript for intellectual content. DKS contributed to data interpretation, figure preparation, and manuscript revision. EEN contributed to the literature search, methodological review, and critical revision of the manuscript. All authors read and approved the final manuscript.

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Figures

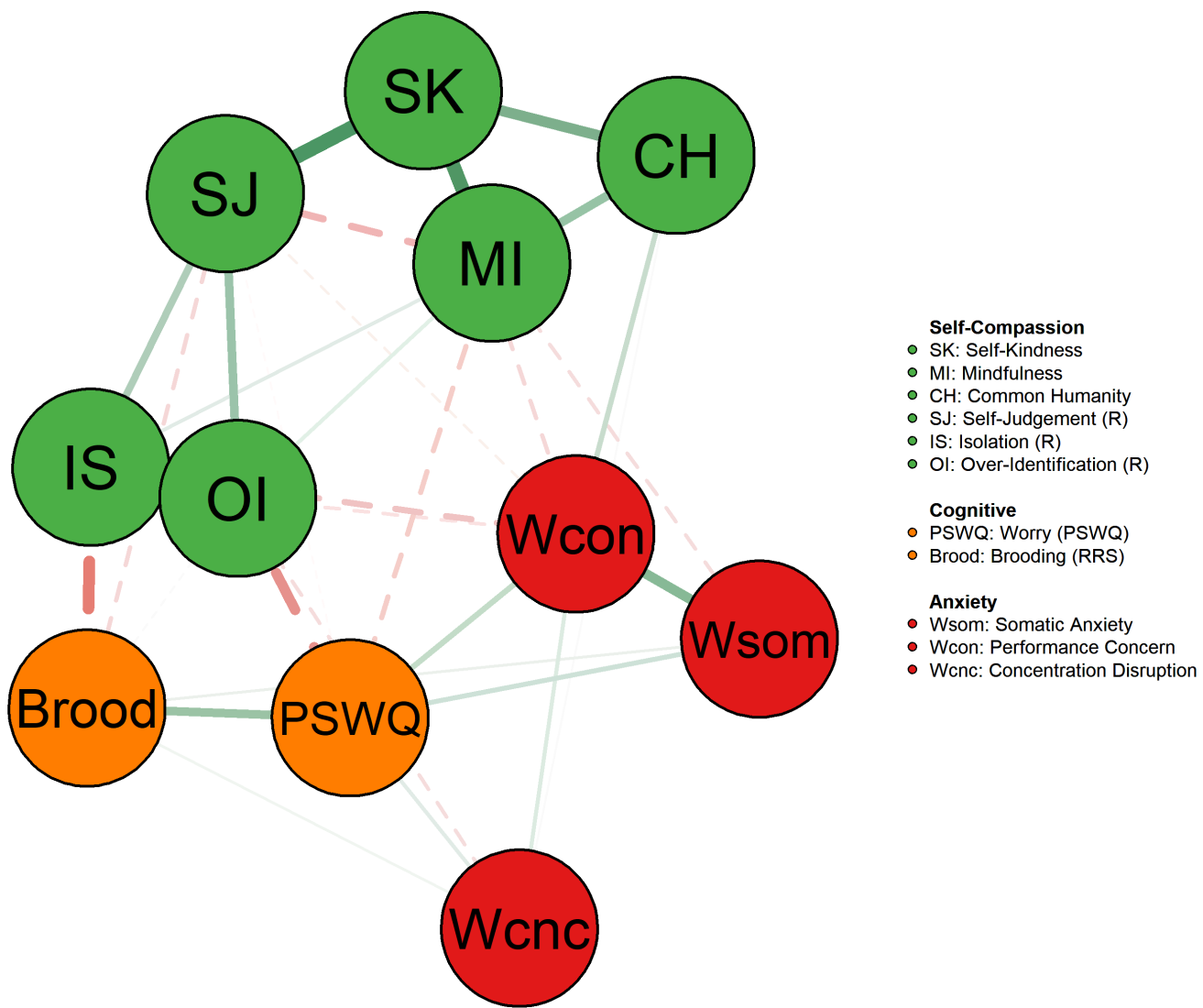


Figure 1

Gaussian graphical model of self-compassion facets, cognitive processes, and competitive anxiety dimensions in athletes (N = 263).

Note. Green nodes represent Self-Compassion Scale facets, orange nodes represent cognitive mediators (worry and brooding), and red nodes represent competitive anxiety subscales. Solid green lines indicate positive edges; dashed red lines indicate negative edges. Edge thickness reflects the magnitude of regularised partial correlations estimated via EBICglasso.

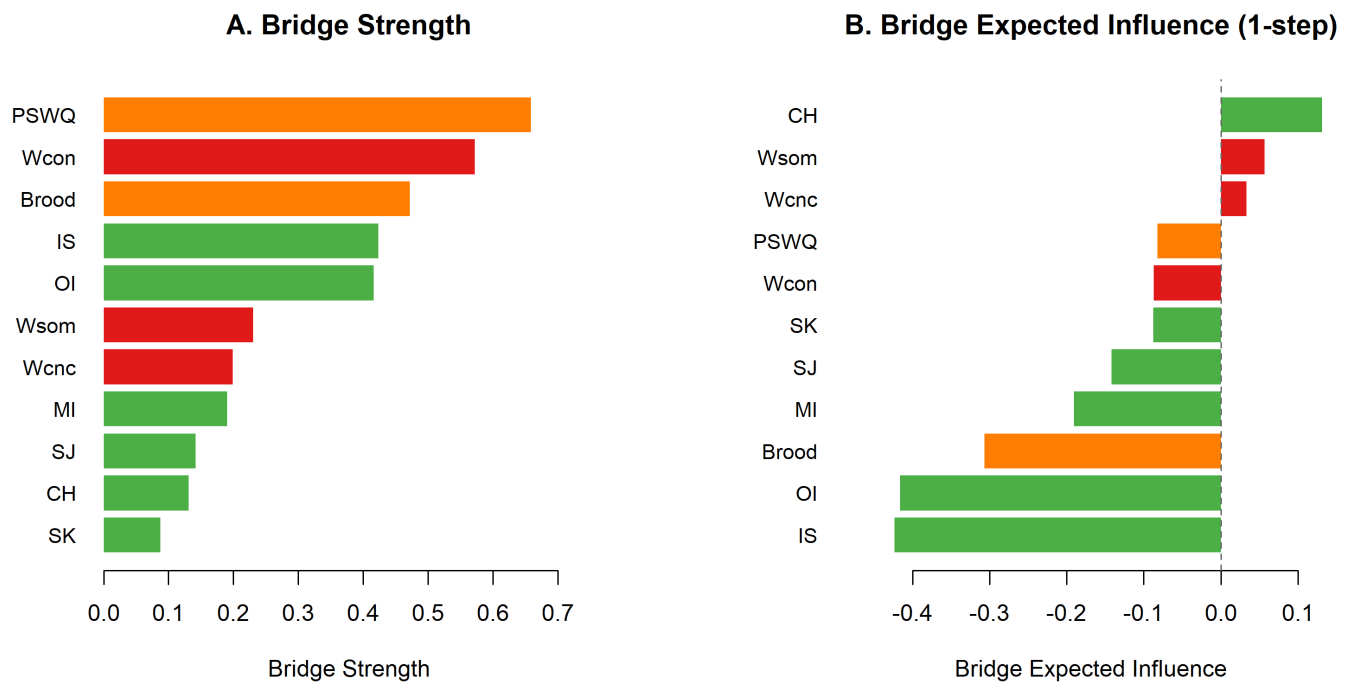


Figure 2

Bridge centrality indices for the 11-node network.

Note. Panel A displays bridge strength; Panel B displays bridge expected influence (1-step). Node colours correspond to community membership: green = Self-Compassion, orange = Cognitive, red = Anxiety. Higher bridge strength indicates greater cross-community connectivity; negative bridge expected influence indicates a dampening effect on activation in other communities.