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A Five-Timepoint Longitudinal Study of Sports Injury and Mental Health in Elite Sport

Lauren Jane Cleave

ljc63@bath.ac.uk

University of Bath - Claverton Down Campus: University of Bath https://orcid.org/0009-0008-9361-5181

Rachel Arnold

University of Bath - Claverton Down Campus: University of Bath

Sean Williams

University of Bath - Claverton Down Campus: University of Bath

Daniel Brown

University of Bath - Claverton Down Campus: University of Bath

Sam Cumming

UK Sports Institute

Alan Currie

UK Sports Institute

Lee Moore

University of Bath - Claverton Down Campus: University of Bath

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A Five-Timepoint Longitudinal Study of Sports Injury and Mental Health in Elite Sport

Lauren J. Cleave[1], Rachel Arnold[1], Sean Williams[1], Daniel J. Brown[1], Sam Cumming[2], Alan Currie[2], and Lee J. Moore[1]

[1]University of Bath, United Kingdom

[2]UK Sports Institute

Author Note

Lauren J. Cleave, Rachel Arnold, Sean Williams, Daniel J. Brown, and Lee J. Moore, Department for Health, University of Bath, United Kingdom

Sam Cumming and Alan Currie, Mental Health Team, UK Sports Institute, United Kingdom

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Abstract

Background: Elite athletes often report psychological distress following injury, yet longitudinal research on injury and mental health is scarce, and existing studies rarely apply clinically validated mental health measures. Consequently, little is understood about how injury and mental health influence each other over time or which factors shape athletes' mental health during injury. Thus, this study aimed to examine the: 1) relationship between injury and mental health over time, and 2) personal and situational factors that contributed to athletes' mental health during injury. Seventy-two elite athletes (43 female, M_{age} = 25.58±5.79 years) completed questionnaires across five timepoints over 12 months, during which 47 injuries were recorded. Four mental health related outcomes were assessed—psychological distress, symptoms of anxiety and depression, and psychological well-being—alongside personal (e.g., athletic identity) and situational (e.g., social support) factors.

Results: At each timepoint, injury status was significantly associated with distress and well-being. Over time, symptoms of anxiety predicted injury status, and reciprocal effects were observed between injury status and depressive symptoms. Regarding contributing factors, greater intolerance of uncertainty and lower perceived support were associated with poorer mental health for all outcomes, while stronger athletic identity was associated with greater distress and lower well-being. Feeling less able to cope with psychological load in sport was associated with greater distress, more depressive symptoms, and lower well-being. Experiencing more intense life load was associated with lower well-being, and feeling less able to cope with life load was associated with greater distress and depressive symptoms.

Conclusions: Injury and mental health are dynamically and reciprocally related over time in elite athletes, particularly for symptoms of depression. Intolerance of uncertainty and perceived social support were consistent correlates across all mental health and well-being outcomes, whereas perceived coping with sport and life load was associated with mental health outcomes. Practitioners could prioritise (1) routine screening for anxiety and depressive symptoms before and after injury, and (2) interventions that strengthen tolerance of uncertainty, social support, and ability to cope with psychological load.

Key Points

1) Findings demonstrate a bi-directional association between injury status and depressive symptoms over time, highlighting a persistent and reciprocal relationship.
2) Findings suggest experiencing symptoms of anxiety as a prospective risk factor for injury.

3) Findings provide insight into factors that may elevate the risk of mental ill health during injury (e.g., intolerance of uncertainty, perceived lack of social support), which could be monitored by practitioners to identify athletes most at risk.

Keywords: anxiety, depression, athletic identity, Olympic, Paralympic, prevention, psychological load, distress, uncertainty, well-being

A Five-Timepoint Longitudinal Study of Sports Injury and Mental Health in Elite Sport

Athletes can experience many psychological benefits from sport (e.g., improved self-esteem, sense of community) [1]. Nonetheless, elite athletes often experience competitive (e.g., underperformance), organisational (e.g., selection), and personal (e.g., career transition) stressors that increase their susceptibility to psychological distress and mental ill health [2]. While the prevalence of mental ill health symptoms in elite athletes appear comparable, or slightly higher than, that of the general population (e.g., anxiety, depression) [3], elite athletes remain more susceptible to certain mental ill health disorders (e.g., disordered eating) [4]. Many prevalence studies focus on specific mental health disorders (e.g., depression), offering only a partial representation of mental ill health, which can encompass a range of pathologies (e.g., anxiety) rather than isolated symptoms. Furthermore, focusing on mental ill health in isolation inadvertently reinforces mental health as merely the absence of illness, whereby an individual is either mentally ill or *presumed* mentally healthy [5]. In response, scholars have increasingly adopted conceptual models that simultaneously prevent mental ill health *and* promote high levels of psychological well-being [6].

To prevent conceptualising mental health solely as the absence of illness, Keyes' [5] dual-continuum model posits mental illness and mental health as existing on related but separate continua. Keyes' [5] suggests a *complete* state of mental health is characterised by the joint experience of psychological well-being and the absence of illness. This is relevant within the high-performance context considering elite athletes with diagnosed mental disorders may still be able to engage with their sport and experience positive states of well-being (e.g., vitality) [6]. Accordingly, incorporating well-being into mental health assessments is essential to recognise not only the absence of mental ill health but the presence of positive psychological functioning, aligning with contemporary conceptualisations of mental health in elite sport [7]. In this way, future research should assess multiple measures of mental ill health alongside measures of psychological well-being to develop a more comprehensive understanding of elite athletes' complete mental health in relation to the types of stressors they may encounter (e.g., injury). Hereafter, the term *mental health* is used to reflect the dual-continuum perspective, acknowledging mental ill health *and* psychological well-being.

Sports injury, defined as 'a physical complaint resulting from relevant sports participation regardless of its consequences' [8: p.1], is widely recognised as an antecedent of mental health issues [9]. For example, Leyland et al. [10] report that four in 10 elite UK athletes experience high or very high distress following an injury. The psychological impact of experiencing an injury has also been documented in sport-specific cohorts (e.g., football) [11] and in relation to specific injury pathologies (e.g., concussion) [12], thereby demonstrating

the injury-mental health relationship across distinct athletic contexts**.** Notwithstanding the value of these contributions, most previous research has been cross-sectional in nature, thus providing a 'snapshot' of the injury-mental health relationship at a single point in time, which may limit insight into how the relationship may change over time. Adopting longitudinal designs would allow researchers to examine how injury and mental health relate across different timepoints and describe the temporal pattern of this relationship [13].

To address the limitations of cross-sectional research, longitudinal studies have started to extend our understanding of the injury-mental health relationship. For example, severe injuries (e.g., musculoskeletal time-loss) have been associated, over time, with mental ill health (e.g., distress, anxiety, depression) in male professional football players [11, 14]. Yet the translation of these findings remains constrained by sport- and gender-specific cohorts. More recently, Bentzen et al. [15] reported that Swedish Paralympic athletes experienced a higher prevalence of anxiety and depressive symptoms in the same week as sustaining an injury, although this was a predominantly male cohort (i.e., 64.4%). Additionally, variability in the psychometric measures used to assess mental health across studies limits the ability to establish meaningful comparisons of the injury-mental health relationship in elite sport [16]. Building upon the current literature, future longitudinal research could use multiple validated and recommended measurements of mental health to better understand the relationship between injury and mental health in a more diverse sample of elite athletes (i.e., Olympic and Paralympic, multi-sport, both sexes and all gender identities).

Although the psychological impact of injury is relatively well-established, limited research has implicated mental ill health as a potential risk factor [17]. For instance, Li et al. [18] found that athletes experiencing anxiety symptoms pre-season, compared to non-symptomatic athletes, were almost twice as likely to experience an injury in the season. More recently, Lyon-Monk et al. [17] found that elite athletes with a mental ill health episode in the past 12 months had an 18% increased risk of injury, after adjusting for covariates (e.g., sport type). While an important contribution, these studies do not collect evidence to explain the observed mental health-injury relationships. This limitation underscores the need to further contextualise how and why mental health may fluctuate during injury to better identify at-risk individuals and inform targeted support.

Contextualising the Injury and Mental Health Relationship

One conceptual model that helps explain how and why injury impacts mental health is the Integrated Model of Psychological Response to Sport Injury (IMPRSI) [19]. This model comprises four parts: (1) potential antecedents to injury (e.g., personality, history of stressors, coping resources), (2) post-injury psychological response and rehabilitation process (i.e., personal and situational factors influence how an athlete cognitively

appraises their injury, which, in turn, impacts emotional states and behavioural responses), (3) post-injury psychological care (e.g., interventions), and (4) post-injury outcome (e.g., re-injury, return-to-play). While the model provides a comprehensive overview of certain personal (e.g., athletic identity) and situational (e.g., social support) factors that may influence psychological response to injury and rehabilitation adherence, other potentially relevant factors remain underexplored within the context of injury (e.g., intolerance of uncertainty, psychological load). Thus, quantitatively examining various factors that could contribute to elite athletes' mental health during injury could not only extend current theory and evidence, but also inform evidence-based interventions that optimally support athlete mental health during injury.

Turning to a traditional personal factor, athletic identity is defined as "the degree to which a person identifies with the role of being an athlete" [20: p.237]. After injury, athletic identity can be detrimental to mental health (e.g., sadness) due to identity foreclosure, whereby athletes neglect other external roles and responsibilities in favour of the athlete role [21, 22]. Athletic identity has also been associated with retirement difficulties [23], adverse return-to-sport behaviours (e.g., premature return and re-injury) [24)], and as a barrier to help-seeking [25]. Notably, most existing quantitative studies have captured a relatively narrow sample of athletes (e.g., Caucasian, male, able-bodied) and are often sub-elite (e.g., youth athletes, collegiate) [26]. Furthermore, studies quantitatively assessing athletic identity and its influence often retain a narrow focus on specific mental health disorders (e.g., depression) [26], rather than adopting a holistic perspective of mental health [7].

Beyond well-established personal factors, intolerance of uncertainty is underexamined in relation to mental health following injury. Intolerance of uncertainty is defined as "a dispositional characteristic that results from a set of negative beliefs about uncertainty and its implications and involves the tendency to react negatively on an emotional, cognitive, and behavioural level to uncertain situations and events" [27: p.216]. In the general population, intolerance of uncertainty has been associated with generalised anxiety, and is a central factor in the treatment of anxiety disorders [28]. Moreover, intolerance of uncertainty has been linked with psychological distress, depression, and post-traumatic stress disorder [29]. Among athletes, Robinson and Freeston [30] found that intolerance of uncertainty was positively associated with performance anxiety and negatively associated with sports confidence. However, there is a dearth of research examining the influence of intolerance of uncertainty during other stressful events (e.g., injury). This is noteworthy given prior evidence indicates injury as an experience of heightened uncertainty (e.g., financial insecurity, selection status) which could result in emotional volatility (e.g., fear, distress) [31].

Continuing to examine personal factors that may influence response to injury, the assessment of psychological load may provide additional insight into individual differences. Mellalieu et al. [32: p.783] define psychological load as the "total psychological demands that an athlete faces in terms of the type, intensity, duration, and frequency with which the demands are experienced", and is further split into sport load (e.g., high expectations, close rivalries) and life load (e.g., relationship difficulties, financial troubles). The experience of elevated psychological load, including daily hassles, negative life events, and sports-related stress can significantly increase injury risk in athletes [33]. Despite recognition that psychological load may act as an antecedent to injury, less is known about how psychological load *following* injury may relate to athletes' mental health [32].

In addition to personal factors, a key component of the IMPRSI is the influence of situational factors [19]. Social support is a widely recognised situational factor that can shape emotional (e.g., confidence) and behavioural (e.g., adherence to rehabilitation) responses to injury [34]. Although elite athletes are typically embedded in extensive support systems [35], sustaining an injury can evoke feelings of loneliness and disconnection [36]. Discrepancies between how support is organised within high-performance sport, and how it is experienced by injured athletes, suggest that mental health may be influenced not only by what support is structurally provided, but also by athletes' perceptions of its availability, accessibility, and suitability [34]. While some studies show greater perceived social support can aid rehabilitation experiences, this work has largely focused on beliefs and behaviours [37] or return-to-sport outcomes [38] rather than broader mental health indicators.

Against this backdrop, and the limitations of extant literature, the present study aimed to longitudinally examine injury and mental health in an elite athlete cohort. Specifically, the aim of this study was two-fold. First, the study aimed to examine the relationship between injury and mental health (i.e., psychological distress, anxiety, depression, and well-being) over time in elite athletes. In relation to this first aim, there are three hypotheses (see Supplementary Materials):

- 1a) injury status will be positively associated with greater psychological distress and symptoms of anxiety and depression; and negatively associated with well-being.
- 1b) injury status will predict subsequent mental ill health and poorer well-being.
- 1c) mental ill health and poorer well-being will predict subsequent injury status.

Second, the study aimed to investigate personal and situational factors that may contribute to athlete mental health during injury. In relation to this second aim, it is hypothesized that higher athletic identity (2a),

greater intolerance of uncertainty (2b), and more intense psychological load (sport and life load) (2c) will be positively associated with mental ill health and negatively associated with well-being, whereas higher perceived ability to cope with psychological load (sport and life) (2d) and greater perceived social support (2e) will be negatively associated with mental ill health and positively associated with well-being during times of injury.

Method

Study Design

A longitudinal design was used to examine injury status, mental ill health symptoms, well-being, and related variables over time. Data were collected over 12 months at five timepoints, each spaced three months apart: March 2023 baseline (TP1), June 2023 (TP2), September 2023 (TP3), December 2023 (TP4), and March 2024 (TP5). The temporal spacing was informed by conceptual and logistical considerations [39]. Conceptually, the IMPRSI model highlights psychological responses as highly individualised and dynamic [19]. Therefore, it is difficult to estimate how quickly, and over what timespan, changes may occur [40]. Additionally, although it is understood that elite athletes typically sustain 2.19 injuries per athlete year [17], it is almost impossible to predict when injury will occur [41]. In this way, it seemed sensible to adopt a longer overall timeframe to ensure data collection had the potential to capture multiple injury events, and potential psychological changes relating to the injuries sustained. Logistically, variation in participant availability across a multi-sport cohort, and the proximity of data collection to Olympic and Paralympic Games (e.g., selection processes, qualifying events), limited the feasibility of a more intensive longitudinal design. As such, it was important to mitigate risks arising from sampling too frequently (e.g., recruitment difficulties, participant attrition) or infrequently (e.g., difficulty detecting effects, reduced strength of relationships) [39]. Accordingly, three-month spacing between measurements was chosen to minimise participant burden while attempting to capture change processes within and between variables.

Study Procedure

Approval was obtained from a University of Bath Research Ethics Committee (EP 23 004). The UK Sports Institute (UKSI) Head of Mental Health introduced the study to senior leaders (i.e., Head of Performance Support; HoPS), representing a total of 49 sports (~1040 athletes). Of these, 29 HoPS expressed an interest in participating but did not distribute the study (~775 athletes), while 17 HoPS shared the study with their athletes (~414 athletes). Specifically, each HoPS shared an introductory video in which the lead researcher explained the aims of the study, what the study involved, and why athlete input was important. Each HoPS made it clear that participation in the study was voluntary, and declining would not disadvantage athletes (e.g., reduced support).

Seventy-two hours before each timepoint, each HoPS were sent an email reminder of the upcoming survey. At the start of each timepoint, each HoPS received an email containing the survey link and were asked to distribute this to eligible participants (e.g., via email, WhatsApp). Throughout each data collection period (i.e., 3-week window), the lead researcher sent each HoPS two reminder emails about the ongoing survey: one at the halfway mark and one 24-hours before closure. Each reminder included updated recruitment numbers for their sport. This approach was adopted throughout the study to offer all athletes the chance to participate (i.e., including those who did not complete the survey at earlier timepoints) and to maximise data collection.

Before starting each online survey, participants were informed of their ethical rights (e.g., anonymity, confidentiality, right to withdraw) via an information sheet and provided informed consent. The survey, created using Jisc Online Surveys, took approximately 12 to 15 minutes to complete. After completing their first survey, participants provided their email and consented to future reminders regarding when the next survey would become available. At each timepoint, participants were contacted a total of four times: when the survey went live, halfway through the 3-week survey window, 72 hours before survey closure, and 24 hours before survey closure. If participants produced escalatory ('high-risk') scores on any mental health measure, they were emailed a written debrief signposting them to support (e.g., general practitioner, Samaritans UK).

Participants

In relation to the participant classification framework of McKay et al. [42], participants were ranked within Tier 4 (elite/international level) or Tier 5 (world-class level). The following paragraphs present participant characteristics corresponding to the study aims: 1) participants who answered two or more timepoints and were therefore eligible for inclusion in the longitudinal analyses, and 2) athletes who reported an injury during the data collection period.

Aim 1: 72 elite athletes (43 female, 29 male) aged between 16 and 41 years (M_{age} = 25.58 years, SD_{age} = 5.79 years) comprised the longitudinal sample of the study. Participants represented a range of sports (e.g., hockey, curling, aquatics) from both Olympic (n = 45) and Paralympic (n = 27) programmes, and competitive levels (i.e., elite/international and world-class) [42]. Based on their current UK Sport Athlete Performance Award (APA)[1], 47.2% were performing at podium level, 40.3% at podium potential level, and 12.5% at entry level.

[1] 'Podium' athletes are those profiled to have a strong prospect of medalling at the next Olympic or Paralympic Games and are already achieving international results within the medal zone. 'Podium potential' athletes are profiled to possess the potential, and commitment, to achieve medal success. 'Entry-level' athletes are within their first 1-2 years of inclusion within a high-performance programme [43].

Aim 2: 30 participants (19 female, 11 male) aged between 16 and 38 years (M_{age} = 27.04 years, SD_{age} = 5.24 years) reported 47 instances of injury across the 12-month period. Participants comprised Olympic (n = 20) and Paralympic (n = 10) sports (e.g., curling, aquatics, Para badminton). Example injuries sustained in training (76.6%), competition (12.8%), or other contexts (e.g., at home; 10.6%) included concussion, posterior cruciate ligament tear, and fractured scaphoid. The number of weeks injured ranged from 1 to 61 (M = 15.53 weeks, SD = 17.28), with 76.6% athletes describing their injury as acute, 12.8% as chronic, and 10.6% as unsure.

Measures

At each timepoint, participants first provided demographic (e.g., age) and sport-specific (e.g., competitive level) information. Participants were then asked if they were currently injured (i.e., binary; yes or no), in line with a 24-hour time-loss injury definition [44]. Injured participants were then directed to answer questions relating to their injury (e.g., injury type, occurrence date). Next, informed by the SMHAT-1 [45] measurements of mental ill health (i.e., psychological distress, symptoms of anxiety and depression) and well-being were completed. To address the second aim of this study, at each timepoint, participants were then asked to answer questionnaires measuring personal (i.e., athletic identity, [46]; intolerance of uncertainty, [47]; psychological load, [32]) and situational (i.e., perceived social support, [48]) factors.

Outcome Measures

Psychological Distress. The Athlete Psychological Strain Questionnaire (APSQ) [49] was used to assess psychological distress over the last 30 days[2]. The APSQ includes 10 items (e.g., "I found it difficult doing what I needed to do"), with each item scored on a 5-point Likert scale ranging from 1 (*none of the time*) to 5 (*all the time*). Total scores were calculated by summing participants' responses for all items (range = 10-50), and higher total scores indicated greater symptoms of distress. Scores on the APSQ have previously demonstrated adequate to good internal consistency, as well as good construct and structural validity [50]. In this study, the APSQ demonstrated good internal consistency across timepoints (mean α = .83, range = .79 to .88).

Anxiety symptoms. The Generalised Anxiety Disorder-2 scale (GAD-2) [51] was used to assess symptoms of anxiety over the past two weeks. The GAD-2 includes two items (e.g., "feeling nervous, anxious, or on edge"), with both scored on a 4-point Likert scale ranging from 0 (*not at all*) to 3 (*nearly every day*). Total scores were calculated by summing participants' responses for both items (range = 0-6), and higher total scores indicated greater anxiety symptoms. Previous studies have shown the GAD-2 to possess acceptable

[2] Although the APSQ is named in relation to its three subscales assessing athlete-specific strain (i.e., self-regulation, performance concerns, and external coping), our analyses used the total score, which Rice et al. [49, 50] validated as a composite indicator of psychological distress.

psychometric properties [51] with good internal consistency demonstrated in this study across timepoints (mean α = .86, range = .79 to .89).

Depression symptoms. The Patient Health Questionnaire-2 (PHQ-2) [52] was used to assess symptoms of depression over the past two weeks. The PHQ-2 includes two items (e.g., "feeling down, depressed, or hopeless"), with both scored on a 4-point Likert scale ranging from 0 (*not at all*) to 3 (*nearly every day*). Total scores were calculated by summing participants' responses for both items (range = 0-6), and higher total scores indicated greater depressive symptoms. Previous studies have shown the PHQ-2 to possess sound psychometric properties [53], and, in this study, the PHQ-2 demonstrated good internal consistency across timepoints (mean α = .85, range = .66 to .91).

Psychological Well-being. The World Health Organisation's Well-being Index (WHO-5) was used to assess well-being over the past two weeks [54]. The WHO-5 includes five items (e.g., "I have felt active and vigorous"), with each item scored on a 6-point Likert scale ranging from 0 (*at no time*) to 5 (*all of the time*). A total score was calculated across all five items (range = 0-25), which was then multiplied by 4 to produce a final score (range = 0-100). Higher total scores indicated greater well-being [54]. Previous studies have shown the WHO-5 to demonstrate excellent internal consistency and construct and convergent validity [55]. In this study, the WHO-5 demonstrated excellent internal consistency across timepoints (mean α = .90, range = .86 to .92).

Measurements of Contributing Factors

Athletic Identity. The Athletic Identity Measurement Scale (AIMS-7) was used to assess athletic identity [46]. The AIMS-7 includes seven items (e.g., "most of my friends are athletes"), with each item scored on a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The scores for all items were summed to produce a total score (range = 7-49), and higher scores indicated stronger athletic identity. Previously, the AIMS-7 has demonstrated psychometric integrity, with good internal consistency (α = .81) [46]. In this study, the AIMS-7 demonstrated acceptable internal consistency across timepoints (mean α = .65, range = .59 to .78).

Intolerance of Uncertainty. The Intolerance of Uncertainty Scale-short form (IUS-12) was used to assess intolerance of uncertainty [47]. The IUS-12 includes 12 items (e.g., "unforeseen events upset me greatly"), with each item scored on a 5-point Likert scale from 1 (*not at all characteristic of me*) to 5 (*entirely characteristic of me*). The scores for all items were summed to produce a total score (range = 12-60), and higher scores indicated greater intolerance of uncertainty. Previously, the IUS-12 has demonstrated excellent internal

consistency, in addition to clinical, convergent, and psychometric validity [47]. In the present study, the IUS-12 demonstrated excellent internal consistency across timepoints (mean α = .94, range = .92 to .99).

Psychological Load. The Psychological Load-12 Questionnaire (PL-12) was used to assess psychological load [56]. Definitions and examples of sport load (e.g., close rivalries) and life load (e.g., financial troubles) were provided based on the conceptual paper by Mellalieu et al. [32]. Participants then responded to four items, two assessing sport and life load intensity (i.e., "how intense is the overall sport/life load you are experiencing right now?") and two items assessing sport and life load coping (i.e., "how well are you able to cope with this overall level of sport/life load"?). The two items assessing sport and life load intensity were scored on a Likert scale from 0 (*not at all intense*) to 5 (*very intense*), while the two items measuring sport and life load coping were scored on a Likert scale from 0 (*not at all well*) to 5 (*very well*). While early in its development, the PL-12 has shown good face, construct, and predictive validity (e.g., linked to athlete mental health) [56].

Perceived Available Social Support. The Perceived Available Support in Sport Questionnaire (PASS-Q) was used to assess perceived social support [48]. The PASS-Q includes 16 items (e.g., "if needed, to what extent would someone instil you with the confidence to deal with pressure"), with each item scored on a 5-point Likert scale ranging from 0 (*not at all*) to 4 (*extremely so*). The scores for all items were summed to produce a total score (range = 0-64), and higher scores indicated greater perceived support availability. Previously, the PASS-Q has demonstrated structural validity and acceptable-to-good internal consistency [48]. In the present study, the PASS-Q demonstrated excellent internal consistency across timepoints (mean α = .95, range = .93 to .96).

Data Analysis

The data were initially screened for univariate outliers (i.e., minimum and maximum scores on the raw data items). For each variable, all observed values fell within the expected response ranges of their respective scales (e.g., GAD-2 scores range from 0 to 6), indicating that no values constituted true outliers. As all data points were plausible and reflected participants responses, they were retained to preserve the authenticity of the dataset. Accordingly, no observations were removed or modified.

Relationship Between Injury and Mental Health Over Time

To address the first study aim, statistical analyses were conducted using SPSS 31 [57] and Mplus 8.11 [58]. All analyses in Mplus 8.11 were conducted using maximum-likelihood estimation [58]. Point-biserial correlations were computed to examine associations between injury status and mental health outcomes owing to

the binary (i.e., injury; yes or no) and continuous (e.g., psychological distress; score between 10 and 50) level of data, respectively. Mplus syntax and outputs from all analyses can be viewed in Supplementary Materials.

Examination of covariates were conducted to examine whether demographic characteristics (i.e., age, gender, parental education, and competitive level) were associated with the endogenous variables (i.e., injury status, mental ill health outcomes, and well-being) across measurement timepoints (TP1 to TP5). These variables were selected based on prior research identifying them as potential confounders in elite athletes [59]. Age and gender have been associated with differences in injury risk [33] and mental health [3] among elite athletes. Parental education, as a proxy for socioeconomic status, has also been linked to mental health [60]. Finally, competitive level has been associated with variation in injury [61] and mental health [3]. For injury status, chi-square tests were used to assess associations with categorical demographic variables (i.e., gender, parental education, competitive level), and an independent-samples t-test was used to examine differences by age. For mental ill health outcomes (i.e., psychological distress, symptoms of anxiety and depression) and psychological well-being, nonparametric tests (i.e., Mann–Whitney U, Kruskal–Wallis and Spearman correlations) were conducted to assess associations with demographic characteristics.

Mplus 8.11 was used to construct four Cross-Lagged Panel Models (CLPM) [62] containing freely estimated situation-specific and cross-lagged paths. Situation-specific effects are predicted from a variable measured at the same timepoint (e.g., can injury status at TP1 predict psychological distress at TP1?). Cross-lagged effects are predicted from temporally preceding variables (e.g., can injury status at TP1 predict distress at TP2, and can distress at TP1 predict injury status at TP2?). When examining the cross-lagged effects between injury status and mental health outcomes over time, models were estimated using maximum likelihood estimation based on a covariance matrix derived from the original data comprising means, standard deviations, and correlations for each variable. This approach was deemed appropriate as injury status represented both a predictor and outcome, which precluding the use of the Weight Least Squares Mean and Variance (WLSMV) estimator typically used in models where binary variables act solely as outcomes.

Various indices were used to assess model fit, including the Chi-Square to Degrees of Freedom Ratio (i.e., X^2/df), an absolute fit index (i.e., Standardised Root Mean Squared Residual, SRMR), incremental fit indices (i.e., Comparative Fit Index, CFI; Tucker-Lewis Index, TLI), and a parsimony correction index (i.e., Root Mean Square Error of Approximation; RMSEA). In the empirical literature, model fit indices have often been measured in relation to cross-sectional work, which may contextualise why many longitudinal models display a poor fit in relation to conventional threshold values [63]. Moreover, standardised threshold values

continue to be contested, as research has highlighted various reasons for why model fit may remain suboptimal (e.g., model complexity) [64]. Considering these limitations, model fit indices were interpreted with caution and in line with empirical evidence available: acceptable values were considered close to or above 0.90 for CFI and TLI, close to or below 0.08 for RMSEA, and close to or below 0.08 for SRMR [65].

To achieve the most parsimonious model, each freely estimated CLPM was compared with a fully constrained CLPM (i.e., pathways were set to be equal across timepoints) [66]. After constraining each pathway, model fit was compared using the chi-square difference test and the constrained model was retained when the standard CLPM did not provide a significantly better fit [67]. Results were considered statistically significant at $p < .05$. Conducting a priori power analysis was not feasible as the planned CLPM and LLM analyses require model-specific effect size (CLPM) [68] and variance-covariance (LMM) [69] parameters that are typically derived from prior data. Following recommendations for longitudinal designs, sample size was based on feasibility and estimates from prior research [70, 71] and is expected to permit meaningful interpretations.

Contextualising the Relationship Between Injury and Mental Health

To address the second study aim, we used R 4.3.2 [72], with analyses carried out via the lme4 package (v1.1-26) [73]. Separate linear mixed-effect models (LMM) were estimated for each mental health outcome (i.e., psychological distress, symptoms of anxiety and depression, and well-being). In each model, athletic identity, intolerance of uncertainty, sport load intensity, sport load coping, life load intensity, life load coping, and perceived social support were entered simultaneously as fixed effects, with age, gender, parental education, and competitive level included as covariates. A random intercept for participant was specified to account for the non-independence of repeated observations within athletes. Results are reported using standardised coefficients.

Results

Data from 17 participants were excluded from both analyses as they did not provide data for the minimum two timepoints required to run a CLPM [74], nor did they report any injuries. Twenty-two participants completed two timepoints, 14 participants completed three timepoints, 17 participants completed four timepoints, and 19 participants completed five timepoints. Descriptive statistics for all variables can be found in Table 1.

INSERT TABLE 1

Examination of covariates were undertaken for the CLPM analyses to see if demographic characteristics should be included as time-invariant covariates in the models. None demonstrated consistent

associations with the endogenous variables across timepoints; therefore, these variables were not included in the CLPM analyses.

Relationship Between Injury and Mental Health Over Time (Aim 1)

Standardised factor loadings and statistical significance for the situation-specific and cross-lagged effects appear in Figures 1-4, and each figure represents one outcome (i.e., psychological distress, symptoms of anxiety and depression, and well-being) and their relationship with injury status. Fit indices for the standard and constrained CLPM analyses are provided in the Supplementary Materials.

Injury and Psychological Distress

Standard and constrained CLPM analyses for injury status and psychological distress showed a poor fit across multiple indices. The chi-square difference test indicated no significant improvement in fit for the unconstrained model ($\Delta\chi^2(16) = 22.69$, $p = .12$), so the constrained CLPM was retained for interpretation ($\chi^2(40) = 145.418$, $p < .001$; CFI = .618; TLI = .580; SRMR = .161; RMSEA [90% CI] = .191 [.158, .225]). The results showed significant situation-specific effects at each timepoint, and no cross-lagged effects across time (see Figure 1).

INSERT FIGURE 1

Injury and Anxiety Symptoms

Standard and constrained CLPM analyses for injury and anxiety symptoms showed a poor fit across multiple indices. The χ^2-difference test revealed no significant differences ($\Delta\chi^2 = 15.92$, $\Delta df = 16$, $p = .46$), so the constrained CLPM was retained for interpretation ($\chi^2(40) = 237.497$, $p < .001$; CFI = .457; TLI = .403; SRMR = .175; RMSEA [90% CI] = .262 [.230, .295]). The results showed no situation-specific effects at any timepoint, but significant cross-lagged effects, with anxiety symptoms predicting subsequent injury status across timepoints (see Figure 2).

INSERT FIGURE 2

Injury and Depression Symptoms

Standard and constrained CLPM analyses for injury and depressive symptoms showed a poor fit across multiple indices. The χ^2 difference test revealed no significant differences ($\Delta\chi^2 = 23.16$, $\Delta df = 16$, $p = .11$), so the constrained CLPM was retained for interpretation ($\chi^2(40) = 195.316$, $p < .001$; CFI = .555; TLI = .510; SRMR = .151; RMSEA [90% CI] = .232 [.200, .265]). The results showed no situation-specific effects at any timepoint, but significant reciprocal cross-lagged effects between all timepoints (i.e., injury status predicting symptoms of depression and symptoms of depression predicting injury status) (see Figure 3).

INSERT FIGURE 3

Injury and Psychological Well-Being

Standard and constrained CLPM analyses for injury and well-being showed a poor fit across multiple indices. The χ^2 difference test revealed no significant differences ($\Delta\chi^2 = 23.16$, $\Delta df = 16$, $p = .11$), so the constrained CLPM was retained for interpretation ($\chi^2(40) = 116.294$, $p < .001$; CFI = .706; TLI = .677; SRMR = .142; RMSEA [90% CI] = .163 [.129, .198]). The results showed significant situation-specific effects at each timepoint, but no cross-lagged effects (see Figure 4).

INSERT FIGURE 4

Contextualising the Relationship Between Injury and Mental Health (Aim 2)

Linear mixed-effect models (LMM) examined which personal (i.e., athletic identity, intolerance of uncertainty, psychological load) and situational (i.e., perceived social support) factors predicted mental health when injured. Continuous predictors were standardised (z-scores) prior to analysis, and results are reported as standardised β coefficients with 95% confidence intervals and Wald-derived p-values (Table 2). A random intercept for athlete_id accounted for repeated observations. Model fit is summarised using marginal and conditional R^2 (Supplementary Materials).

Athletic Identity and Mental Health During Injury

There was a significant positive effect of athletic identity on distress (β [95% CI] = 0.33 [0.03, 0.63], p = .030), and a significant negative effect of athletic identity on well-being (β = -0.25, 95% CI [-0.48, -0.03], p = .029). There were no significant effects for athletic identity and symptoms of anxiety or depression.

Intolerance of Uncertainty and Mental Health During Injury

There was a significant positive effect of intolerance of uncertainty on distress (β [95% CI] = 0.65 [0.41, 0.90], $p < .001$) and symptoms of anxiety (β [95% CI] = 0.49 [0.22, 0.76], $p < .001$) and depression (β [95% CI] = 0.54 [0.26, 0.81], $p < .001$). There was a significant negative effect of intolerance of uncertainty on well-being (β [95% CI] = -0.51 [-0.77, -0.25], $p < .001$).

Psychological Load and Mental Health During Injury

There were no significant effects of sport load intensity on distress, symptoms of anxiety or depression, or well-being. There was a significant negative effect of sport load coping on distress (β [95% CI] = -0.56 [-0.85, -0.27], p < .001) and depressive symptoms (β [95% CI] = -0.37 [-0.68, -0.07], p = .018), and a significant positive effect of sport load coping on well-being (β [95% CI] = 0.29 [0.00, 0.57], p = .047), but no significant effects on symptoms of anxiety.

Turning to life load, there was a significant negative effect of life load intensity on well-being (β [95% CI] = -0.26 [-0.51, 0.00], p = .048), but no significant effects for distress nor symptoms of anxiety or depression. There was a significant negative effect of life load coping on distress (β [95% CI] = -0.31 [-0.61, 0.00], p = .047) and depressive symptoms (β [95% CI] = -0.34 [-0.61, -0.07], p = .015), but no significant effects on symptoms of anxiety or well-being.

Perceived Social Support and Mental Health During Injury

There was a significant negative effect of perceived social support on distress (β [95% CI] = -0.48 [-0.76, -0.21], p < .001) and symptoms of anxiety (β [95% CI] = -0.31 [-0.58, -0.04], p = .027) and depression (β [95% CI] = -0.40 [-0.66, -0.15], p = .003), and a significant positive effect of perceived social support on well-being (β [95% CI] = 0.38 [0.15, 0.61], *p* = .002).

Discussion

The aims of the present study were to 1) examine the relationship between injury and mental health over time in elite athletes, and 2) explore personal and situational factors that may contribute to athlete mental health during times of injury. Regarding study aim 1, situation-specific effects were found between injury and psychological distress and well-being. Cross-lagged panel analyses showed anxiety symptoms predicted injury status over time and a reciprocal effect between injury and depressive symptoms (i.e., injury status predicted depressive symptoms and vice versa). In terms of study aim 2, intolerance of uncertainty and perceived social support were associated with all mental health outcomes (i.e., psychological distress, symptoms of anxiety and depression, and psychological well-being), while athletic identity was associated with psychological distress and well-being. Sport load coping was associated with psychological distress, symptoms of depression, and well-being. Life load coping was also associated with psychological distress and symptoms of depression.

Injury and Mental Health Relationship

Regarding situation-specific effects, injury was associated with higher psychological distress and lower well-being at each timepoint, but not with symptoms of anxiety or depression. These results are both congruent and contrasting with existing literature. For example, they are similar to the results of Leyland et al. [10] who found that injured elite British athletes had a higher prevalence of distress and poorer well-being. Similarly, Boneti Moreira et al. [75] found injury was negatively associated with quality of life in adult athletes across physical (e.g., pain) and social (e.g., inability to participate in activities) domains. In relation to symptoms of anxiety and depression, Bentzen et al. [15] observed that elite Swedish Paralympic athletes experienced significantly higher rates of anxiety and depressive symptoms in the same week as an injury, which contrasts

503 with our findings. This difference may reflect the unique characteristics of a Paralympic-specific sample rather
504 than differences in elite sport more broadly. To explain, injuries may exacerbate unique functional and
505 environmental stressors faced by Paralympic athletes (e.g., reduced function) [10], resulting in higher rates of
506 anxiety and depressive symptoms. Our findings may indicate that mental ill health symptoms reported
507 concurrently with injury are relatively transient, consistent with broader evidence that distress is a common
508 initial reaction to an adverse or traumatic event (e.g., injury) whereas mental ill health symptoms may manifest
509 over time [76]. Overall, clarifying which facets of mental health are most sensitive to injury–and under what
510 conditions–is essential for developing tailored support.

511 Beyond concurrent associations, our cross-lagged findings showed a reciprocal relationship between
512 injury and depressive symptoms, and that symptoms of anxiety predicted subsequent injury across all
513 timepoints. Our finding that injury status could repeatedly predict depressive symptoms builds on previous
514 research linking injury to an increased risk of mental ill health. For example, Lyon-Monk et al. [17] reported
515 each injury to increase the likelihood of experiencing an episode of mental ill health by 10%; however, the
516 authors did not specify if, and what, mental ill health was most prevalent in relation to injury. More broadly,
517 previous studies examining the injury-mental health relationship have been constrained in two ways. First, by
518 focusing on a single mental health disorder (e.g., depression) [77], previous research has been unable to
519 determine whether other mental health outcomes exhibit differing temporal associations with injury. This is
520 important given that mental health disorders are conceptually and clinically distinct and may therefore respond
521 differently to injury. While our study adopted separate CLPMs for each mental health outcome, the inclusion
522 and measurement of mental ill health symptoms and well-being enabled comparison, showing that bidirectional
523 associations were not uniform but instead specific to symptoms of depression. Second, existing research linking
524 injury and mental health often focuses on specific injury types (e.g., concussion) [12]. While informative, this
525 limits generalisability and constrains our understanding of whether bi-directional associations extend beyond
526 specific injuries. Our study extends previous research by showing that depressive symptoms, relative to other
527 mental ill health symptoms (e.g., distress) and well-being, were associated with injury across multiple
528 timepoints in a sample that included a range of injury types, severities, and durations. As such, it appears
529 particularly important for practitioners to recognise and monitor depressive symptoms in injured elite athletes.

530 Considering the reverse pathway, our findings indicated that symptoms of depression may be predictive
531 of subsequent injury, thereby extending previous research. For instance, Li et al. [18] found that collegiate
532 athletes with preseason anxiety symptoms had a significantly higher injury incidence rate compared to non-

533 symptomatic athletes. More recently, Lyon-Monk et al. [17] found that athletes who experienced an episode of
534 mental ill health in the past 12-months had an 18% increased injury risk[3]. However, whilst clinically recorded
535 episodes of mental ill health can be informative (e.g., [17]), they may underestimate the impact of subclinical
536 symptoms, which are common in elite sport [78]. To elaborate, clinically diagnosed conditions may overlook
537 athletes experiencing meaningful symptoms below diagnostic thresholds, potentially underestimating the true
538 burden of mental ill health and poorer well-being, and their relative association with injury [79]. Our findings
539 also extend previous work indicating that mood-related disturbances (e.g., anger, tension) are associated with
540 adverse injury outcomes (e.g., risk, severity) [80]. By highlighting that depressive symptoms may predict injury,
541 our results broaden the range of non-clinical mental ill health symptoms associated with injury. Taken together,
542 our results emphasise the importance of recognising mental ill health as a potential precursor to injury and the
543 value of integrating mental health surveillance in athlete-care frameworks.

544 ***Contextualising the Injury and Mental Health Relationship***

545 In relation to factors contributing to mental health while injured, several key influences were identified
546 including intolerance of uncertainty, athletic identity, sport load coping, life load intensity and coping, and
547 perceived social support. First, intolerance of uncertainty was associated with mental ill health (i.e., greater
548 distress, symptoms of anxiety and depression) and poorer well-being during times of injury. These findings align
549 with previous work that showed athletes who were more intolerant to uncertainty were more likely to experience
550 poorer well-being [81]. Furthermore, intolerance of uncertainty has been negatively associated with sports-
551 specific performance states such as higher anxiety and lower confidence [30]. The present study, to our
552 knowledge, is the first to demonstrate intolerance of uncertainty to be associated with multiple markers of
553 mental health during times of injury, an experience often characterised by increased vulnerability and reduced
554 perceived control [9]. Our finding that intolerance of uncertainty is associated with indicators of mental ill
555 health is consistent with research in the general population, which has linked intolerance of uncertainty to
556 generalised anxiety [82] and psychological distress [83]. Overall, these findings underscore intolerance of
557 uncertainty as a salient construct with the potential to influence athlete mental health during injury. As such,
558 screening for intolerance of uncertainty may be critical for identifying athletes most at risk of experiencing
559 mental ill health and poorer well-being while injured.

[3] Specifically, an episode of mental ill health was described as a clinically recorded complaint or disorder not related to injury, recorded by a qualified practitioner, and categorised as a mental health 'problem' [17].

The findings from the present study show athletic identity was associated with psychological distress and well-being when injured, but not symptoms of anxiety or depression. As a result, practitioners could implement interventions that proactively develop athletes' coping resources (e.g., resilience, sense of coherence, social support) to reduce psychological distress and enhance well-being following an injury [84]. Regarding non-significant findings, the absence of associations with symptoms of anxiety or depression differs from a recent scoping review, which reported that studies employing the AIMS typically find a positive association between athletic identity and depressive symptoms in athletes [26]. Additionally, previous research has typically found a strong athletic identity to be associated with higher levels of distress and depression throughout injury rehabilitation [46]. Yet, these studies typically utilise a range of tools to identify a specific type of mental disorder, such as depression (e.g., Beck Depression Inventory) [85] or anxiety (e.g., Competitive State Anxiety Inventory [86], which may limit comparisons across studies and explain inconsistencies in observed associations between athletic identity and mental health outcomes in the present study.

Regarding the concept of psychological load, sport load intensity was not associated with mental ill health outcomes or psychological well-being, whereas feeling less able to cope with sport load was associated with greater distress, fewer depressive symptoms, and better well-being, but not anxiety symptoms. In this way, our findings suggest it is not the perceived intensity of sport-specific pressures per se, but rather athletes perceived *inability to cope* with these pressures that is more strongly associated with mental ill health and poorer well-being. One explanation for this may be the stigma surrounding help-seeking, whereby athletes perceive disclosing physical or mental health difficulties as a sign of weakness, reinforcing expectations to portray themselves as impenetrable [87]. This perception may cause athletes to view coping with stressors as solely their own responsibility, which may encourage them to adopt maladaptive coping strategies (e.g., suffering in silence, wearing a mask) [88] and avoid seeking help [25]. This may, in turn, worsen mental health (6, 84]. Given that some sport-specific stressors are inescapable in elite environments, there is a joint responsibility between athletes and the wider performance system to ensure athletes feel well equipped to cope with the psychological load they encountered in sport to protect mental health [89].

Beyond sport load, life load intensity was only associated with well-being, whereas life load coping was associated with distress and depressive symptoms, but not symptoms of anxiety or well-being. Our findings that life load intensity and coping were associated with mental ill health are supportive of recent research showing that elite athletes perceive various personal pressures (e.g., work demands, relocation) as conducive to distress and mental health difficulties [88]. Extending previous work [90], our finding suggest that perceived

intensity of athletes' *current* life load may be relevant for well-being, offering a complementary perspective to research linking cumulative lifetime stressors to athlete mental health [90]. This highlights life load intensity as an additional, underexplored dimension of stress that may impact mental health. In relation to life load coping, McLoughlin et al. [91] indicated that cumulative distress depleted an athlete's ability to cope (e.g., avoidance, overtraining), which contributed to worry and anxiety. Our findings complement this existing work by highlighting that experiencing more intense life load is associated with poorer well-being, and feeling overwhelmed and unable to cope with life load is associated with greater distress and more depressive symptoms during injury. The association between reduced coping capacity and poorer mental health during injury aligns with allostatic load processes, whereby experiencing an injury adds to existing stress and, when this exceeds perceived coping capacity, mental health might be negatively impacted [92]. However, more research is needed to test this assertion.

Turning to situational factors, lower perceived social support was associated with mental ill health (i.e., greater distress, more symptoms of anxiety and depression) and poorer well-being. To our knowledge, this study is the first to highlight the crucial role of perceived social support for athlete mental health during injury, a finding that may be explained by the stress buffering hypothesis, which posits that social support protects individuals from the adverse effects of psychological stress [93]. Indeed, if an athlete perceives that support is accessible and responsive to a significant event (e.g., injury), they may appraise the situation as more manageable, which may mitigate mental ill health. This interpretation is congruent with Davies et al. [94], who found that athletes with higher perceived social support exhibited better well-being and increased cognitive flexibility, enabling them to view difficult situations as controllable and solvable. Broader evidence also links perceived social support to multiple domains of human thriving, including better mental and physical health, improved work performance and educational functioning, and lower risk-taking behaviours [95]. While previous literature has underscored the benefits of received support for athletes' well-being [96], our findings extend the literature by demonstrating the *perception* of available support is a critical determinant of mental health during injury. This aligns with broader evidence that suggested the availability of social support during adversity, rather than the adversity itself, was important for Olympic success [97]. Overall, practitioners should foster the provision of support *and* athletes' confidence that the support offered is available and will meet their needs.

Theoretical and Applied Implications

From a theoretical perspective, our findings both extend and support the IMPRSI [19]. First, our findings suggest symptoms of anxiety and depression predict future injury status, which is reflective of

retrospective evidence showing mental ill health as a risk factor for injury [17, 18]. In this way, the IMRPSI could be expanded to include mental ill health as a psychological risk factor in addition to an individual's personality, coping strategies, and history of stressors [19]. In relation to our second study aim, our findings showed effects for established (e.g., athletic identity, perceived social support) and novel (e.g., intolerance of uncertainty, psychological load) personal and situational factors from the IMRPSI that may contribute to injured athletes' mental health. Consequently, our findings suggest that mental health outcomes may not be attributable to injury status alone but instead relate to a broader range of variables (e.g., personal and situational characteristics). While we did not directly examine interaction effects, this finding is consistent with the IMPRSI, which emphasises psychological responses to injury emerge from multiple interacting influences [19].

Turning to applied implications, our findings emphasise the need for practitioners to implement mental health screening as a core component of the injury prevention and management process. Our findings show concurrent and prospective associations between injury status and multiple mental health outcomes (e.g., anxiety, depression). Comprehensive and routine mental health screening in advance of, and throughout, injury may be beneficial to identify athletes whose mental health profiles place them at risk of injury and later mental ill health following injury, which may help facilitate timely referral for support and treatment tailored to the mental health challenge identified (e.g., distress, anxiety, depression) [17]. Our results also identify factors that may make an athlete more vulnerable to mental ill health during injury (e.g., greater intolerance of uncertainty, stronger athletic identity, perceived lack of social support). Therefore, early screening for these characteristics may enable practitioners to identify injured athletes 'at-risk' and provide proactive, targeted support.

Given the results relating to intolerance of uncertainty, the incorporation of therapeutic techniques, such as mindfulness [98] and cognitive reframing [99], may help athletes better manage injury-related uncertainty, which may protect them from mental ill health and reduced well-being. Moreover, given the findings linked to athletic identity, adopting a social identity approach to athlete development – where athletes foster their personal identity and multiple social identities across different groups – may protect injured athletes' mental health by providing multiple sources of belonging and support [100]. In addition, given the results related to psychological load, athletes could, with the support of practitioners, identify sport and life stressors and develop effective coping strategies (e.g., mental skills, time-management strategies) to mitigate mental ill health and poorer psychological well-being during injury rehabilitation [84]. Furthermore, support staff and organisations should recognise, and seek to remove or reduce the intensity of, prevalent stressors among injured athletes (e.g., fears regarding deselection) [9]. Finally, this study underscores the importance of perceived social

support and, as such, organisations may reflect on how the support available to injured athletes is communicated (e.g., visible, regularly reminded).

Strengths, Limitations and Future Research

Regarding the strengths of this study, by using clinically validated measurements of mental ill health (i.e., anxiety and depressive symptoms) and well-being, our study offers a comprehensive representation of mental health. This approach aligns with Keyes dual-continuum model, which positions mental health and mental illness on separate but related continua [5], thereby avoiding defining mental health solely as the absence of pathology [7]. Additionally, utilising measurements of mental ill health symptoms and psychological well-being that have been extensively used in athlete populations, may aid future comparison and synthesis across studies [16]. Finally, the inclusion of elite athletes across a wide variety of sports, including typically under-represented groups (i.e., women, Paralympic athletes), enhances the relevance of findings for elite sport settings.

Nevertheless, several limitations warrant noting. First, the relatively small sample size (n = 72) and model complexity may provide an explanation for why the CLPMs had poor fit [101]. We advocate for future research to further examine the longitudinal relationship between injury and mental health using larger, more strongly powered samples. Second, while the study had to consider logistical concerns (i.e., athlete engagement, time constraints during Games year), relatively long lags between timepoints may limit our ability to determine causality and attribute changes in mental health to injury occurrence. To elaborate, athletes may have experienced other influences between timepoints (e.g., training load fluctuations, selection pressures), which may have impacted athletes' mental health. Future studies may more accurately capture dynamic changes in mental health around injury by reducing the lag between measurements (e.g., measuring outcomes every two-weeks) [39]. Third, sport-specific analyses were not possible due to the sample size and implications for athlete anonymity. Such analyses may have contextualised the injury-mental health relationship further by potentially revealing differences between sports (e.g., contact versus non-contact) [17], which could inform future tailored injury and mental health support.

Conclusion

The aims of the present study were to 1) examine the relationship between injury and mental health over time in elite athletes, and 2) explore personal and situational factors that may contribute to athletes' mental health during injury. The results highlight injury as a complex experience, reflected in the distinct temporal associations observed between injury status and psychological distress, symptoms of anxiety and depression, and well-being. Specifically, reciprocal associations between injury status and depressive symptoms were

observed, symptoms of anxiety predicted subsequent injury status, and situation-specific (i.e., cross-sectional) effects were identified for distress and well-being in relation to injury status. Our results reveal how different aspects of mental health relate to injury over time, and thus illustrate the value of longitudinal, time-structured approaches for understanding the injury-mental health relationship. We also provide support for established (i.e., athletic identity, social support) and novel (i.e., intolerance of uncertainty, psychological load) factors which might contribute to athlete mental health during injury, thereby supporting and extending the IMPRSI. Finally, this work offers suggestions for researchers looking to examine injury and mental health further (e.g., quantitative longitudinal design over a shorter timeframe), as well as ways practitioners can prevent injury (e.g., screening for anxiety and depression symptoms) and better support athlete mental health during injury rehabilitation (e.g., reducing uncertainty).

Abbreviations List

AIMS-7 = Athletic Identity Measurement Scale-7

APA = Athlete Performance Award

APSQ = Athlete Psychological Distress Questionnaire

CFI = Comparative Fit Index

CLPM = Cross Lagged Panel Model

IMPRSI = Integrated Model of Psychological Response to Sport Injury

GAD-2 = Generalised Anxiety Disorder-2 scale

HoPS = Head of Performance Support

IUS-12 = Intolerance of Uncertainty Scale-12

LMM = Linear Mixed-Effect Model

PASSQ = Perceived Available Support in Sport Questionnaire

PHQ-2 = Patient Health Questionnaire-2 scale

PL-12 = Psychological Load-12 Questionnaire

RMSEA = Root Mean Square Error of Approximation

SMAHT-1 = Sport Mental Health Assessment Tool 1

SRMR = Standardised Root Mean Square

TP = Timepoint

TLI = Tucker-Lewis Index

UKSI = UK Sports Institute

WHO-5 = World Health Organisation Well-being scale

Declarations

Ethics: Approval was obtained (01/02/2023) from the Biomedical Sciences Research Ethics Committee of the University of Bath (EP 23 004). The study was performed in accordance with the standards of ethics outlined in the Declaration of Helsinki.

Consent for Publication: Consent for publication was obtained electronically from all participants.

Availability of Data and Materials: The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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Authors Contributions: The first author, LC, conceptualised and designed the study, collected the data, and was lead on the analysis and writing. RA, SC, AC, and LM contributed to the conception and design of the study, drafted and revised the manuscript. SW and DB contributed to the analysis and writing of the manuscript. All authors read, revised, and approved the final manuscript.

Consent to Participate: Online informed consent was obtained from all participants.

Code Availability: The code created for the analyses used within the current study are provided in the Supplementary Materials.

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Table 1

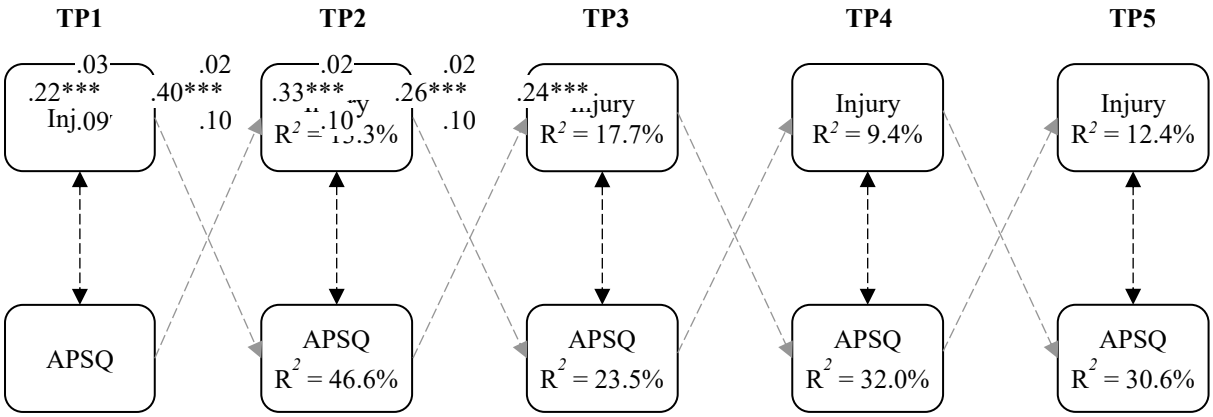
Descriptive Statistics of Mental Health Outcomes and Contributing Factors

	Timepoint 1 (*n*=41) March 2023			Timepoint 2 (*n*=51) June 2023			Timepoint 3 (*n*=61) September 2023			Timepoint 4 (*n*=46) December 2023			Timepoint 5 (*n*=50) March 2024		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
APSQ	19.20	5.82	10-35	18.49	5.54	10-37	17.74	5.78	10-39	17.50	6.26	10-31	17.36	17.36	10-44
GAD-2	1.63	1.63	0-6	1.41	1.44	0-6	1.28	1.56	0-6	1.24	1.49	0-6	1.20	1.31	0-6
PHQ-2	1.10	1.10	0-5	0.75	1.31	0-6	0.90	1.39	0-6	0.76	1.14	0-4	0.92	1.63	0-6
WHO-5	55.61	20.84	8-88	61.18	20.02	20-100	61.84	21.27	8-88	61.39	20.35	12-100	61.12	22.18	8-100
AI	36.78	5.86	19-47	36.43	5.82	21-47	36.72	5.22	24-47	31.72	4.67	19-42	35.78	4.35	26-45
IU	27.44	10.21	12-53	27.77	11.73	0-42	28.07	10.18	12-55	26.74	9.41	13-49	26.66	9.13	14-52
SL-I	3.22	1.39	0-5	3.35	1.02	0-5	3.00	3.90	0-5	2.78	1.40	0-5	3.46	1.07	0-5
SL-C	3.76	1.07	1-5	3.82	1.03	0-5	1.35	0.91	0-5	3.72	1.05	1-5	3.98	1.07	0-5
LL-I	2.76	1.56	0-5	2.67	1.35	0-5	2.36	1.38	0-5	2.70	1.31	0-5	2.60	1.41	0-5
LL-C	3.41	1.38	0-5	3.47	1.27	0-5	3.89	1.16	0-5	3.70	0.96	0-5	3.68	1.24	0-5
PSS	41.44	11.28	11-60	43.04	12.61	19-64	44.52	13.64	2-64	45.98	13.85	6-64	46.44	12.38	20-64

Note. Range = observed participant responses; APSQ = Athlete Psychological Strain; GAD-2 = Generalised Anxiety Disorder Questionnaire-2; PHQ-2 = Patient Health Questionnaire-2; WHO-5 = Psychological Well-Being Scale; AI = Athletic Identity; IU = Intolerance of Uncertainty; SL-I = Sport Load Intensity; SL-C = Sport Load Coping; LL-I = Life Load Intensity' LL-C = Life Load Coping; PASS = Perceived Social Support.

Figure 1

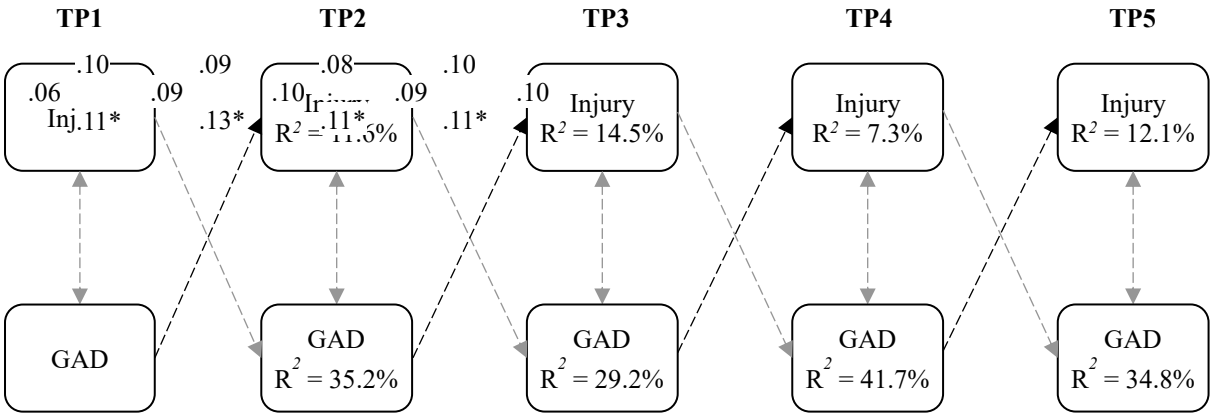
The Relationship Between Injury Status and Athlete Psychological Strain Over Time



Note. All direct path coefficients are standardised. Black paths indicate statistically significant effects; grey paths indicate non-significant effects. *p < .05, **p < .01, ***p < .001. APSQ = Athlete Psychological Strain Questionnaire.

Figure 2

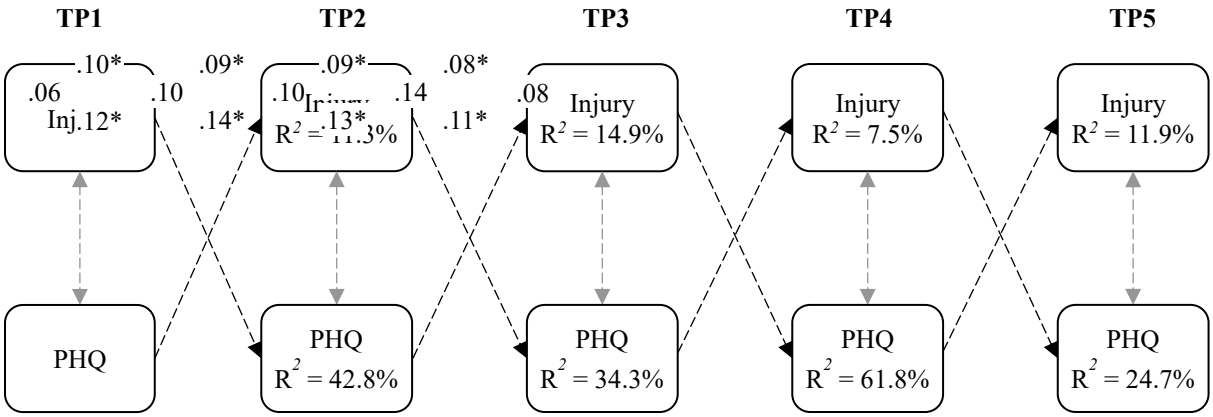
The Relationship Between Injury Status and Symptoms of Anxiety Over Time



Note. All direct path coefficients are standardised. Black paths indicate statistically significant effects; grey paths indicate non-significant effects. *p < .05, **p < .01, ***p < .001. GAD = Generalised Anxiety Disorder-2 Questionnaire.

Figure 3

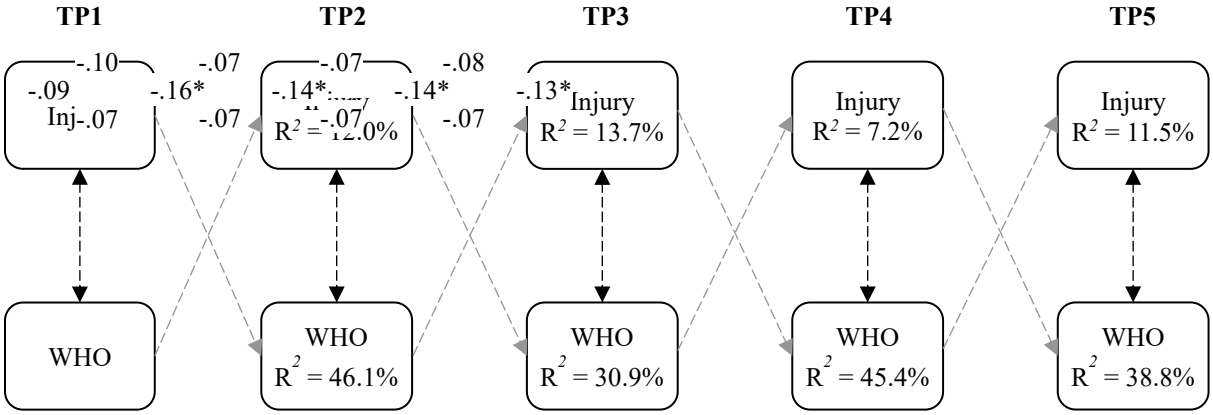
The Relationship Between Injury Status and Symptoms of Depression Over Time



Note. All direct path coefficients are standardised. Black paths indicate statistically significant effects; grey paths indicate non-significant effects. *$p < .05$, **$p < .01$, ***$p < .001$. PHQ = Patient Health Questionnaire-2.

Figure 4

The Relationship Between Injury Status and Psychological Well-being Over Time



Note. All direct path coefficients are standardised. Black paths indicate statistically significant effects; grey paths indicate non-significant effects. *$p < .05$, **$p < .01$, ***$p < .001$. WHO = World Health Organisation Well-Being Index-5.

Table 2

Predictors of Mental Ill-Health and Psychological Well-Being During Times of Injury in Elite Athletes (n = 47 instances of injury, n=31 participants)

	Psychological strain			Symptoms of anxiety			Symptoms of depression			Psychological well-being		
Contributing factors	β [95% CI]	t	*p*	β [95% CI]	t	*p*	β [95% CI]	t	*p*	β [95% CI]	t	*p*
Athletic identity	0.33 [0.03, 0.63]	2.25	.030*	0.08 [-0.21, 0.37]	0.58	.563	0.22 [-0.05, 0.48]	1.65	.106	-0.25 [-0.48, -0.03]	-2.27	.029*
Intolerance of uncertainty	0.65 [0.41, 0.90]	5.42	< .001*	0.49 [0.22, 0.76]	3.62	< .001*	0.54 [0.26, 0.81]	3.90	< .001*	-0.51 [-0.77, -0.25]	-4.02	< .001*
Sport load intensity	0.22 [-0.05, 0.50]	1.63	.112	-0.06 [-0.32, 0.21]	-0.43	.671	0.11 [-0.14, 0.35]	0.89	.379	0.07 [-0.15, 0.29]	0.64	.524
Sport load coping	-0.56 [-0.85, -0.27]	-3.86	< .001*	-0.13 [-0.45, 0.20]	-0.79	.435	-0.37 [-0.68, -0.07]	-2.48	.018*	0.29 [0.00, 0.57]	2.06	.047*
Life load intensity	0.29 [-0.03, 0.61]	1.81	.079	0.15 [-0.15, 0.46]	1.01	.318	0.21 [-0.08, 0.50]	1.45	.156	-0.26 [-0.51, 0.00]	-2.04	.048*
Life load coping	-0.31 [-0.61, 0.00]	-2.05	.047*	-0.21 [-0.50, 0.07]	-1.51	.138	-0.34 [-0.61, -0.07]	-2.56	.015*	0.20 [-0.05, 0.45]	1.65	.108
Perceived social support	-0.48 [-0.76, -0.21]	-3.58	< .001*	-0.31 [-0.58, -0.04]	-2.29	.027*	-0.40 [-0.66, -0.15]	-3.21	.003*	0.38 [0.15, 0.61]	3.37	.002*

Note. (*) represents statistically significant results.

Supplementary Files

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