


Please cite the Published Version

Runacres, Adam  and Marshall, Zoe A (2024) Prevalence of anxiety and depression in former elite athletes: a systematic review and meta-analysis. *BMJ Open Sport & Exercise Medicine*, 10 (4). e001867 ISSN 2055-7647

DOI: <https://doi.org/10.1136/bmjsem-2023-001867>

Publisher: BMJ Group

Version: Published Version

Downloaded from: <https://e-space.mmu.ac.uk/637775/>

Usage rights:  [Creative Commons: Attribution-Noncommercial 4.0](https://creativecommons.org/licenses/by-nc/4.0/)

Additional Information: This is an open access article which first appeared in *BMJ Open Sport & Exercise Medicine*

Data Access Statement: Data are available in a public, open access repository. The data extraction sheet, the data pooled data sheets and R Code used to conduct all analyses are available here: <https://osf.io/f5uzt/files/osfstorage>.

Enquiries:

If you have questions about this document, contact openresearch@mmu.ac.uk. Please include the URL of the record in e-space. If you believe that your, or a third party's rights have been compromised through this document please see our Take Down policy (available from <https://www.mmu.ac.uk/library/using-the-library/policies-and-guidelines>)

Prevalence of anxiety and depression in former elite athletes: a systematic review and meta-analysis

Adam Runacres ¹, Zoe A Marshall²

To cite: Runacres A, Marshall ZA. Prevalence of anxiety and depression in former elite athletes: a systematic review and meta-analysis. *BMJ Open Sport & Exercise Medicine* 2024;**10**:e001867. doi:10.1136/bmjsem-2023-001867

► Additional supplemental material is published online only. To view, please visit the journal online (<https://doi.org/10.1136/bmjsem-2023-001867>).

Accepted 5 November 2024

ABSTRACT

Objectives To summarise the evidence regarding the prevalence of anxiety and depression in former elite athletes compared with the general population.

Design Systematic review and meta-analysis.

Data sources Five electronic databases (Web of Science, PubMed, MEDLINE, Scopus and SPORTDiscus) were searched from 1970 to 2023.

Eligibility criteria Studies were included in the meta-analysis if they: (1) were written in English; (2) included male or female elite athletes that had been retired ≥ 1 year; (3) included a control group or population reference values; (4) reported the time-point prevalence of anxiety and/or depression; and (5) were of a retrospective, longitudinal or prospective, methodological design. A modified version of the Downs and Black tool was used to determine risk of bias.

Results 37 unique studies including 24 732 former athletes (2% female) were included in the meta-analysis. The time-point prevalence of anxiety (prevalence ratio (PR): 2.08 (95% CI 1.57 to 2.60)) and depression (PR: 2.58 (95% CI 2.04 to 3.12)) in former athletes was over twice that of the general population. Subgroup analyses revealed former American football players and jockeys had the highest time-point prevalence of both anxiety and depression (PR: 2.24–2.88), whereas the time-point prevalence of depression and anxiety was not significantly different to the general population for former rugby players (PR: 1.13–1.30).

Conclusion Our meta-analyses demonstrated the time-point prevalence of anxiety and depression in former elite athletes could be over twice that of the general population, with sport-specific differences evident.

PROSPERO registration number CRD42022347359.

INTRODUCTION

Globally, it is estimated somewhere between 20% and 25% of people meet the criteria for a mental health diagnosis in the last 12 months¹ which cost the global economy approximately \$2.5 trillion annually predicting to rise to \$6 trillion by 2030.² The causes of poor mental health are complex and multifaceted but are thought to be a combination of social factors such as occupation, socioeconomic status, and education level³ and physical factors

WHAT IS ALREADY KNOWN

- ⇒ Current elite athletes have an increased prevalence of anxiety and depression than the general population.
- ⇒ Sport specific stressors of an elite sporting career may increase the long-term risk of mental health conditions compared to non-elite populations.
- ⇒ Anxiety and depression are the most prevalent mental health conditions in retired athletes.

WHAT THIS STUDY ADDS

- ⇒ The time-point prevalence of both anxiety and depression in former elite athletes was over twice that of the general population.
- ⇒ Sport-specific differences in the time-point prevalence of anxiety and depression are evident.
- ⇒ There is a lack of high-quality studies exploring the long-term effects of an elite sporting career on anxiety and depression, especially in female athletes.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ Future research is required to determine the time-point prevalence of anxiety and depression in former female athletes across a range of sports.
- ⇒ Sporting organisations need to consider, and implement, policies which support former elite athletes beyond retirement.

including age, sex, and body mass index and low physical activity levels.^{1 4} Consequently, elite sports athletes were long thought to be immune to mental health disorders due to their high physical activity levels and superior physical fitness.⁵ However, recent research indicates that excessive high intensity physical activity performed at the elite level can potentially compromise mental well-being through overtraining, injury and burnout syndrome.⁶ More specifically, the prevalence of mental health symptoms and disorders among male team sport athletes ranges from approximately 5% for burnout and adverse alcohol usage through to almost 45% for anxiety and depression.⁷ Furthermore, a large-scale study of 1620 current elite athletes reported current athletes were three times more likely to have



© Author(s) (or their employer(s)) 2024. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

¹Institute of Sport, Manchester Metropolitan University, Manchester, UK

²School of Health & Sport Sciences, Liverpool Hope University, Liverpool, UK

Correspondence to

Dr Adam Runacres;
a.runacres@mmu.ac.uk

a subclinical mental health condition compared with a non-elite control group.⁸ This is perhaps not surprising given that Arnold and Fletcher⁹ estimate a typical elite athlete will experience in excess of 640 unique sport-specific stressors during their career, with the majority occurring as they approach retirement.

Retirement out of the elite sport environment, whether voluntarily or involuntarily, can also be challenging for athletes and a time when they have an increased likelihood of developing poor mental health.^{9 10} What remains less clear, however, is the longer-term mental health effects of an elite sporting career and whether the incidence of poor mental health remains higher, recedes back to levels comparable with reference values or is lower than the general population. In the most recent review of mental health in former elite athletes, anxiety and depression were found to be the most common mental health disorders in retired elite athletes (26.4%; 95% CI 21.4 to 31.4%) regardless of sporting discipline.¹¹ However, this review compared the prevalence of anxiety and depression to current elite athletes, so it is unclear whether past elite sports participation has made these athletes more, or less, resilient to mental health outcomes than the general population. Additionally, in Gouttebarga *et al*,¹¹ anxiety and depression could not be separated in the meta-analyses, and while they are related,¹² they are clear and distinct mental health conditions which therefore precludes specific recommendations and interventions for former athletes if required.

Consequently, the current review and meta-analysis had the aim of exploring the time-point prevalence of anxiety and depression in retired elite athletes in comparison to non-athletes and the general population.

METHODS

Patient and public involvement statement

No patients or members of the general public were consulted at any point during the planning, execution and finalisation of this research project. However, this systematic review was registered on PROSPERO (registration number: CRD42022347359) and was conducted in line with the PRISMA 2020 checklist (online supplemental tables 1–3).^{13 14}

Equity, diversity and inclusion statement

The author group is balanced with one male and one female researcher, both of early career stage, from different disciplines; however, both authors are from one country and are not from marginalised communities. Our systematic review and meta-analysis collated studies involving former elite athletes inclusive of differences in sex, gender, ethnicity, race, socioeconomic status and geographical region. However, due to the limited diversity in mental health and elite sport research, it was not possible to split the data according to any of the characteristics above, thereby potentially limiting generalisability, which is mentioned in the discussion.

Eligibility criteria

The inclusion criteria for reports within the systematic review were: (1) written in the English Language; (2) experimental participants were male or female former elite athletes of at least national standard, with some description provided on their sporting history; (3) data were reported on anxiety and/or depression in male and female former elite athletes; and (4) the studies were of a retrospective, longitudinal or prospective, methodological design. Any non-peer-reviewed grey literature including conference papers and theses were not included in the review. Studies were included in the meta-analysis if they met the following additional criteria: (1) the study included a general population reference group or provided population reference values from which to compare the experimental participants, and (2) the study reported the time-point prevalence of anxiety and/or depression, with 95% CIs, or provided sufficient data (observed/expected prevalence) to allow its calculation in former athletes and the control group. Any studies which provided insufficient data to allow the time-point prevalence of anxiety and/or depression to be calculated were not included.

Information sources

Reports were searched for, and identified through, scientific databases and by secondary screening of the reference list of included reports. The literature searches were performed in Web of Science (1970–2023), PubMed (1970–2023), MEDLINE (1970–2023), Scopus (1970–2023) and SPORTDiscus (1970–2023). The last literature search through the databases was performed in October 2023. No limits or restrictions were applied to any search conducted on any database as part of this review.

Search strategy

The search terms were split into three levels and were comprised of the following: (1) *mental health* or *depression* or *anxiety*; (2) *elite* or *athletes* or *Olympic*, and (3) *former* or *retired* or *ex-professional*. Former athletes in this review were defined as elite athletes of at least national standard at their peak who are >1-year postretirement similar to other studies of this type.¹¹ All keywords were used in combination and in different iterations to ensure the capture of all relevant literature. The full search terms can be found in the online Supplementary Material.

Selection process

All potentially relevant records along with their abstracts and reference lists were exported and compiled within the Rayyan QCRI software.¹⁵ After the removal of all duplicates, the authors (AR and ZM) then independently screened all records to identify reports for full-text review. No automated, or semi-automated, processes were used throughout the review process. Authors of primary studies were not contacted to clarify eligibility. On removing the blinding, any disagreements (of which there were 20) were debated between the two authors

until a consensus was reached. In the event that the abstract did not contain enough information to inform a decision, the record was carried through to full-text review. Once all conflicts were resolved, AR and ZM then independently undertook a full-text review of all reports and repeated the process above for the three conflicts that arose.

Data collection process

Both authors developed a data extraction table and, prior to undertaking data extraction on all reports, piloted tested it on one report. Once the final data extraction sheet was agreed, both authors completed the data extraction independently onto a Word document (v10, Microsoft, Redmond, Washington). Once all data extraction was completed, the authors (AR and ZM) double checked each other's data extractions to ensure accuracy and validity. For any reports that were not open access, the corresponding authors were contacted in order to ascertain the data for the meta-analysis.

Data items

In the present systematic review and meta-analysis, the primary outcome of interest was the time-point prevalence of anxiety and depression in former elite athletes compared with the general population. The data was extracted under the following headings: authors and year of publication, number of former athletes followed, their primary sport and their time since retirement (if available), details of control group (if available), study design, mental health outcomes measured and main results of all reports within the systematic review. No data were extracted from figures, only from tables or text from the included studies. For multiple reports including the same cohort, data were extracted from each report separately, but the participants only counted once for any meta-analyses. The full data extraction table can be found in the online supplemental table 4).

Risk of bias assessment

A modified version of the Downs and Black checklist¹⁶ was selected to determine individual study methodological quality and determine risk of bias. A modified Downs and Black checklist was selected as it can be used to assess the methodological quality of non-randomised studies and cohort studies which encompassed the study designs included in this review and meta-analysis. Fifteen items were included within the checklist with each item rated between zero and two (0=not present, 1=limited detail, 2=criterion met). While the Downs and Black checklist does not provide banding levels for study quality,¹⁶ various scoring matrices have been suggested including using the median values of percentage scores or assigning the following ordinal categories: low ($\leq 33.3\%$), moderate (>33.4 to $<66.6\%$) or high ($\geq 66.7\%$) quality.¹⁷ Assigning categories of study quality has been done in previous systematic reviews using the Downs and Black checklist^{18–20} and was used in the present study. Both authors

completed the screening process independently and agreed all scores prior to publication and the full risk of bias table, as well as our modifications to the Downs and Black checklist, can be accessed in online supplemental table 5.

Effect measures

Once all of the data were collated, the average time since retirement was calculated. In cases where studies had reported the median and IQR for retirement, they were transformed to the mean and SD. More specifically, the median was assumed to be equal to the mean, and the SD is calculated using: $SD = \frac{IQR}{1.35}$, where IQR is the interquartile range.²¹ The time-point prevalence ratio (PR) for anxiety and depression is calculated using the formula: $PR = \frac{A_1/T_1}{A_0/T_0}$, where A_1 is the number of cases of anxiety and/or depression former athletes (n), A_0 is the total number of former athletes included within the study (n), T_1 is the number of cases of anxiety and/or depression in the control group (n), and T_0 is the total participants within the control population (n).²² If no control group was available, then the authors (AR and ZM) used publicly available reference values for the mental health conditions reported in the athletes' native countries to determine the expected prevalence. After the PR was calculated, all values were logged and SD calculated using the formula: $SD \left[\ln (PR) = \left(\frac{1}{A_1} + \frac{1}{A_0} \right)^{\frac{1}{2}} \right]$

which consequently allowed the 95% CIs to be calculated as follows: $PR \pm 1.96 * SD$.²² All PRs were then combined to create a pooled PR for each mental health condition. The PR was chosen as the meta-analytical method in this study as it is well documented that the OR between two groups can overestimate true differences between population groups.²³ The PR was also chosen over reporting the percentage prevalence for former athletes and controls respectively as they have the ability to normalise differences in sample sizes between studies and baseline prevalence rates making it easier to compare effects across studies.^{24–25} PRs are also more interpretable and better display the prevalence between groups, for example, a PR of 2.0 clearly indicates that the prevalence is twice as high in one group compared with another, whereas prevalence percentages can be less intuitive when comparing across studies.^{23–25}

All meta-analytical statistics were performed using the *meta*, *metagen* and *metaforest* packages in R (R v4.2.1, Boston, MA) to calculate the pooled PR and create the subsequent forest plots. The R code, and all data sheets, used to conduct these analyses are available here: <https://osf.io/f5uzt/files/osfstorage>. First, all PR values and their 95% CIs were logged to determine their individual effect sizes on a natural scale following which the SE of estimate was calculated. These data were then run through *metagen*, where the pooled PR was back transformed into the original PR scale. The pooled PR indicates the

prevalence of mental health conditions in former athletes compared with the general population with a value of <1 indicating lower prevalence, >1 indicating higher prevalence, and 1 indicating the same risk.

Synthesis methods

To synthesise the results, the authors grouped together studies based on the primary outcome measures (ie, anxiety or depression) in the included studies. Additionally, where possible, studies were grouped by the sport of the athletes, so sub-analyses could be performed to determine sport-specific differences. Subgroup analyses were performed if there was at least one study addressing sport-specific anxiety and/or depression prevalence in former elite athletes. The studies were weighted using a random-effects model to generate a pooled PR with heterogeneity assessed for all meta-analytical outputs using the I^2 and Q statistics. The authors did not conduct an assessment of reporting bias to determine whether there is bias within the meta-analytical result due to studies not being published or determine the certainty of evidence. Meta-regressions were run to establish the relationships between outcome variables, determine statistical heterogeneity and possible confounding factors using the *metareg*

function in R. Sensitivity analyses were decided to be performed pos hoc in order to try and establish the variation in the meta-analytical result due to study quality, year of publication or sport of interest. Risk of publication bias assessed using a combination of the Egger's Statistic and funnel plots (online supplemental figures 1–3).

RESULTS

Study selection

No amendments were made to the study registration on PROSPERO from the date of registration. From an initial search of 4926 records, 515 duplicates were removed through after identification by Rayyan Software¹⁵ and confirmation by the two authors (AR and ZM) that the record was duplicated. Following this, 4411 records remained, and 4287 records were excluded for failing to meet the inclusion criteria. Consequently, 124 articles were taken forward for full-text review of which 51 were included in the systematic review and 37 were appropriate for the meta-analysis (figure 1). Reports excluded at full-text review, with reasons are provided in online supplemental table 6.

Study characteristics

The total number of athletes included within the 37 unique studies included in the meta-analysis was 24 732

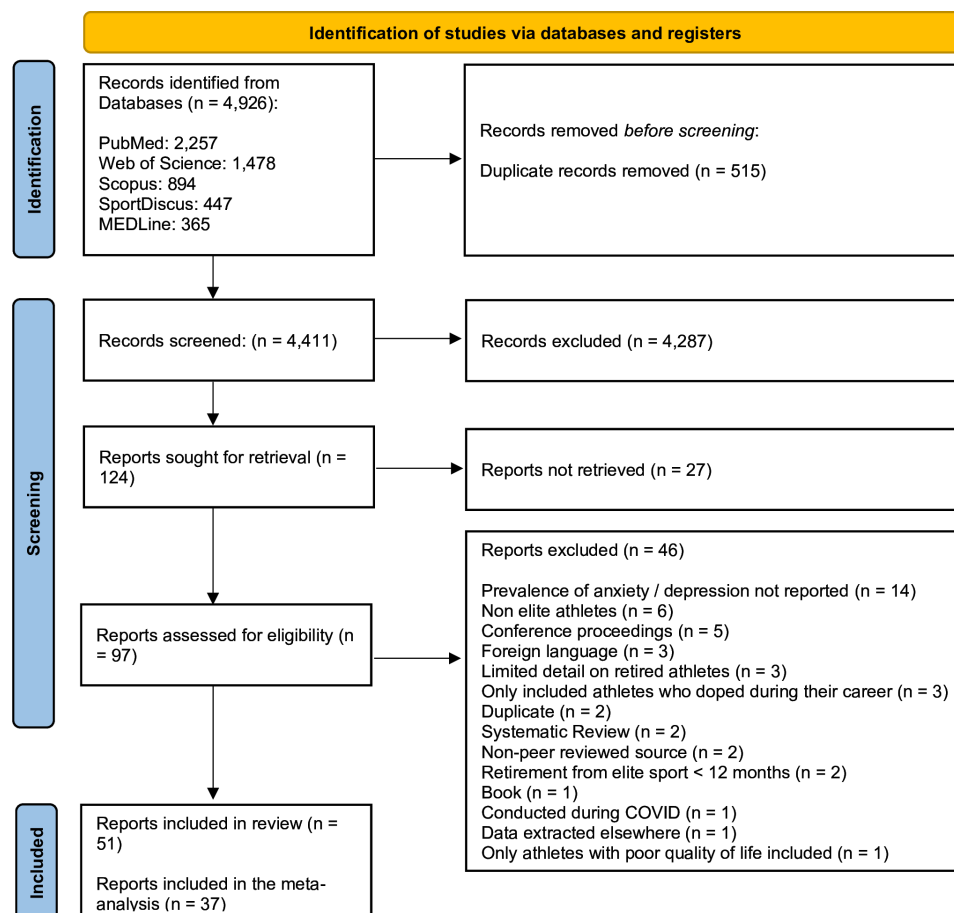


Figure 1 Schematic flow diagram of the systematic review and meta-analysis process.

athletes, with 24240 males (98.0%) and 492 females (2.0%). The majority of the former athletes (22 601, 91.4%) were involved in team sports including American football, rugby, soccer, ice hockey and basketball with only 2131 (8.6%) involved in individual or power sports (jockeys, rowing and athletics). However, some studies measured depression and anxiety separately,^{26–49} while others measured them as a combined score.^{50–59} Therefore, the decision was taken to run three meta-analyses on specific indices on (i) depression, (ii) anxiety and (iii) a pooled analysis where they could not be separated. There was insufficient data to conduct a meta-analysis for female athletes, and so the results should be interpreted as an overview of the prevalence of anxiety and depression in former elite male athletes. An illustrative summary of the study characteristics within the systematic review can be seen in [table 1](#).

Risk of bias in studies

The modified Downs and Black scale was used to assess the methodological quality of studies included within this review and classified studies as either low, moderate or high quality. Of the 51 studies included within this review, no studies were deemed low quality with 20 and 31 studies of moderate and high methodological quality respectively (online supplemental table 6). Funnel plots were also used to assess publication bias with anxiety, depression and anxiety/depression demonstrating publication bias, which was indicated by the wide range of log PRs reported in the included studies.

Results of syntheses

The prevalence of depression was reported in 23 studies^{26–48} (21 791 athletes, 88.1%), creating a pooled PR of 2.58 (95% CI 2.04 to 3.12, [figure 2](#)) which was significantly higher than the general population ($p<0.01$). Within the depression literature, there was no evidence of publication bias ($\beta_0 = -4.10$, $t=-1.17$, $p=0.25$ (online supplemental figure 1)) but significant heterogeneity ($I^2=98.7\%$; $Q=1689.0$, $p<0.01$). The prevalence of anxiety was reported in 14 studies^{27 29 32 33 35 36 39 40 42–44 48 49} (15 727 athletes, 63.6%), creating a pooled PR of 2.08 (95% CI 1.57 to 2.60, [figure 3](#)) which was significantly higher than the general population ($p<0.01$). The anxiety literature showed no evidence of publication bias ($\beta_0 = -5.98$, $t=-1.51$, $p=0.16$ (online supplemental figure 2)) but significant heterogeneity ($I^2=98.5\%$; $Q=754.6$, $p<0.01$).

Anxiety and depression could not be split in 10 studies^{50–59} (2867 athletes, 11.6%), and the pooled PR did not significantly differ from the general population (pooled PR: 2.27 (95% CI 0.85 to 3.69), $p<0.01$, [figure 4](#)). No evidence of publication bias was evident ($\beta_0 = -15.54$, $t=-1.99$, $p=0.08$ (online supplemental figure 3)), but significant heterogeneity ($I^2=98.8\%$; $Q=723.4$, $p<0.01$) was observed.

Sport specific depression and anxiety

Sports-specific pooled PRs were computed for studies that measured either anxiety or depression independently. Sport specific sub-analyses revealed that the highest prevalence of depression was in former American football players with a pooled PR of 2.88 (95% CI 2.27 to 3.66) followed by jockeys, soccer players and cricketers ([table 2](#)). However, former rugby players prevalence of depression did not differ from that of the general population with a pooled PR of 1.30 (95% CI 0.22 to 4.87).

Former cricketers were three times as likely to experience anxiety than the general population (pooled PR: 3.03 (2.57–3.58)). Moreover, former American football players and jockeys were also more likely than the general population to experience anxiety (pooled PR: 2.24–2.68, [table 3](#)). However, former rugby union players and soccer players prevalence of anxiety did not differ from that of the general population ([table 3](#)).

Meta-regression and sensitivity analyses

Sensitivity analyses revealed that when¹ only high-quality studies were included,² only studies published after 2010 were included in the analyses, and³ when only studies examining team sport athletes were included, the pooled PRs remained similar to the overall time-point prevalence for anxiety and/or depression (PR: 1.45–2.60). Moreover, meta-regressions highlighted no significant interaction with the estimated prevalence for any of these three constraints. Additionally, meta-regressions revealed no significant correlation between time since retirement and anxiety PR ($\beta=0.04$, $F_{(1,12)} = 1.79$, $p=0.10$) and depression PR ($\beta=0.02$, $F_{(1,22)} = 0.58$, $p=0.45$) independently or when they could not be separated ($\beta=-0.03$, $F_{(1,8)} = 0.58$, $p=0.76$).

DISCUSSION

This was the first meta-analysis to explore the prevalence of anxiety and depression in former elite athletes and to consider sport-specific differences. The key findings from this systematic review and meta-analysis are as follows: (1) former elite athletes have a two-fold higher prevalence of both anxiety and depression than the general population; (2) there are sport-specific differences in the prevalence of anxiety and depression in former elite athletes; (3) combined anxiety and depression matrices indicated no significant difference between former athletes and the general population; and (4) only 2.0% (492 out of 24 732) of former athletes were female highlighting a major research gap in this area.

Compelling evidence has emerged in recent years, and an argument has been made that chronic, intensive exercise in the general population may be harmful to health,^{60–62} but this has largely been disproved with former elite athletes living longer and having a reduced risk of cardiovascular disease and cancer.⁶³ However, the results of this meta-analysis indicate an opposing trend for mental health outcomes with former elite athletes over twice as likely to experience anxiety and depression.

Table 1 Illustrative summary of study characteristics included within the systematic review

	Number of studies
Number of former athletes	22 ^{28 31–35 40 41 47 49 52 54 56 58 64 66 81–86} 12 ^{26 27 37 45 51 55 57 59 67 87–89} 8 ^{29 36 48 50 53 90–92} 9 ^{30 38 39 43 44 46 68 93 94} Total number of former athletes (n) 24384
Years since athletes' retirement	≤10 years 8 ^{52–54 57 64 67 88 92} 10.1–19.9 years 3 ^{27 49 58} ≥20 years 14 ^{30 38 40 41 43 45 46 48 50 55 59 68 83 90} Not reported 26 ^{26 28 29 31–37 39 44 47 51 56 66 81 82 84–87 89 91 93 94} Average follow-up duration (mean±SD) 18.5±7.7 years
Main sport of former athletes	American football players 20 ^{27 28 30 31 37–39 41 43 44 46–48 66 68 82 85 87 93 94} Basketballers 2 ^{56 81} Cricketers 1 ³⁵ Football/soccer players 7 ^{29 45 54 57 59 64 88} Handball 1 ⁵⁷ Ice hockey players 3 ^{26 52 66} Jockeys 1 ⁴⁰ Not defined (mixed) 11 ^{36 50 53 55 58 84 86 89–92} Rowers 1 ⁴⁹ Rugby players 7 ^{32–34 49 51 67 83} Current athletes 6 ^{26 52 54 55 57 88} General population 22 ^{28 29 31 33 35–37 40 46 48–51 66 68 83–85 89–91 94} No control group 21 ^{27 30 34 38 39 41 43–45 47 53 56 58 59 67 81 82 86 87 92 93} Retired athlete group 2 ^{32 64}
Study design	Cross-sectional 43 ^{26 28–37 39–41 43–49 51 53–57 59 64 66–68 81–83 85–89 92–94} Longitudinal 8 ^{27 38 50 52 58 84 90 91}
Outcome measure reported	Anxiety 19 ^{29 32 35 36 39 40 43 44 48–51 64 66 83 84 90 91 93 94} Depression 33 ^{27–32 35–41 43–49 51 59 64 66 68 83 84 86 87 89 90 93 94} Anxiety and depression 14 ^{26 34 52–58 67 81 82 88 92}

Continued

Table 1 Continued

Measurement tool used	Number of studies
CES-D	2 ^{41 87}
DASS-21	2 ^{26 34}
BSI-53	2 ^{50 90 91}
SF-36	6 ^{27 29 30 38 64 68}
EQ-5D	4 ^{51 56 59 81}
BDI-II	5 ^{28 31 47 66 82}
HADS	3 ^{29 64 83}
GHQ-12	10 ^{32 52-55 57 58 67 88 92}
Self-reported anxiety/depression	2 ^{33 36}
GP diagnosed anxiety/depression	2 ^{35 40}
PHQ-9	4 ^{37 46 49 82}
PHQ-4	3 ^{43 44 93}
PROMIS-GH	1 ³⁹
PROMIS-36	2 ^{84 89}
PROMIS-29	2 ^{48 94}
SDHS	1 ⁴⁵
PAI	1 ⁸⁵
GAD-7	1 ⁴⁹
BAI	1 ⁶⁶
DPA-MSC	1 ⁸⁶

BAI, Beck Anxiety Inventory; BDI-II, Beck Depression Inventory-II; BSI-53, 12-Item Brief Symptom Inventory; CES-D, Centre for Epidemiological Studies Depression Scale; DASS-21, 21-Item Depression Anxiety Stress Scale; DPA-MSC, Disabling of the Physically Active Mental Composite Score; EQ-5D, Euro-Qol 5 Dimension Questionnaire; GAD-7, 7-Item general anxiety disorder questionnaire; GHQ-12, 12-item General Health Questionnaire, General Health Survey; GP, General Practitioner; HADS, Hospital Anxiety and Depression Scale; PAI, Personality Assessment Inventory; PHQ-4, 4-Item Patient Health Questionnaire; PHQ-9, 9-Item Patient Health Questionnaire; PROMIS-29, 29-Item Patient-Reported Outcome Measurement Information System; PROMIS-36, 36-Item Patient-Reported Outcome Measurement Information System; PROMIS-GH, Patient-Reported Outcome Measurement Information System-General Health; SDHS, Short Depression-Happiness Scale; SF-36, Short Form-36 Measurement Model for Functional Assessment of Health and Well-Being.

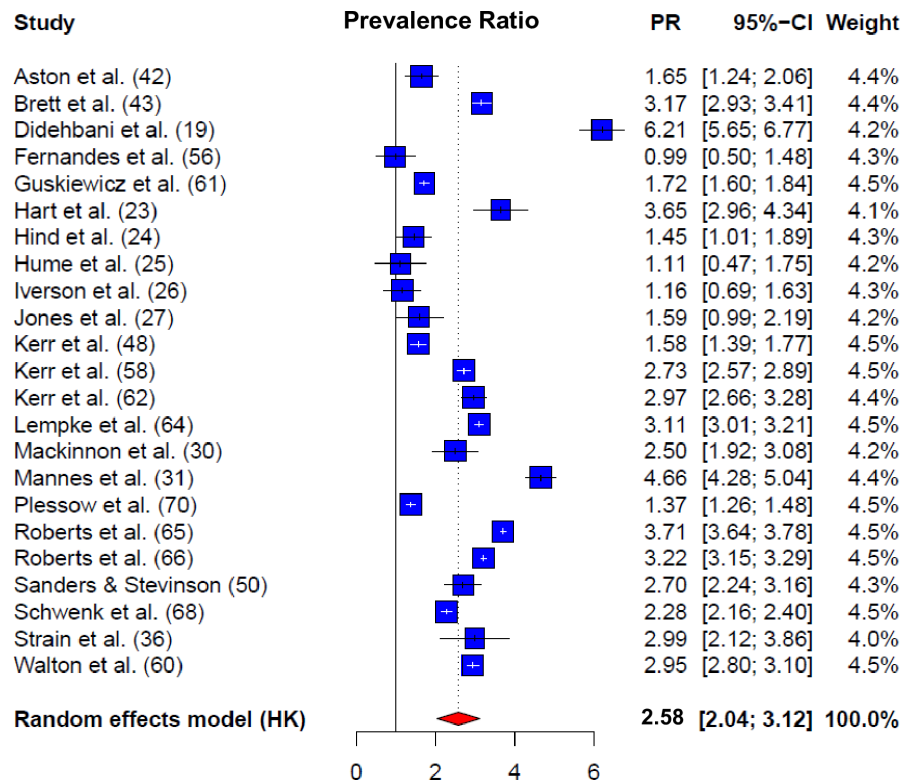


Figure 2 Overall depression forest plot. HK, Hartung-Knapp adjustment; PR, prevalence ratio.

The causes of poor mental health are complex and multifaceted; however, common risk factors in former elite athletes include the number of life-time concussions,^{32 37 41 64–66} loss of athletic identity,^{6 45} career dissatisfaction^{52 55 58 67} and previous injury.^{32 45 49 68 69} While the sport-specific correlates of poor mental health in former elite athletes are well-established, lifestyle factors including socioeconomic, occupational and marital status, which significantly impact mental health outcomes in the general population,^{1 3 4} are rarely considered, or reported, in longitudinal cohort studies. Consequently, without considering changes in lifestyle factors, the true

impact of an elite sporting career on the incidence of mental health outcomes can never truly be ascertained.

Despite the lack of data surrounding lifestyle variables including, but not limited to, alcohol consumption, drug use, socioeconomic status and changes in marital status, these differences seem unlikely to fully explain the increased prevalence of anxiety and depression reported in this meta-analysis. Indeed, previous research investigating the long-term lifestyle habits of former athlete's report that they continued their physically active lifestyle and had more favourable lifestyle habits.^{70 71} More specifically, Kontro *et al*⁷¹ reported that former Finnish

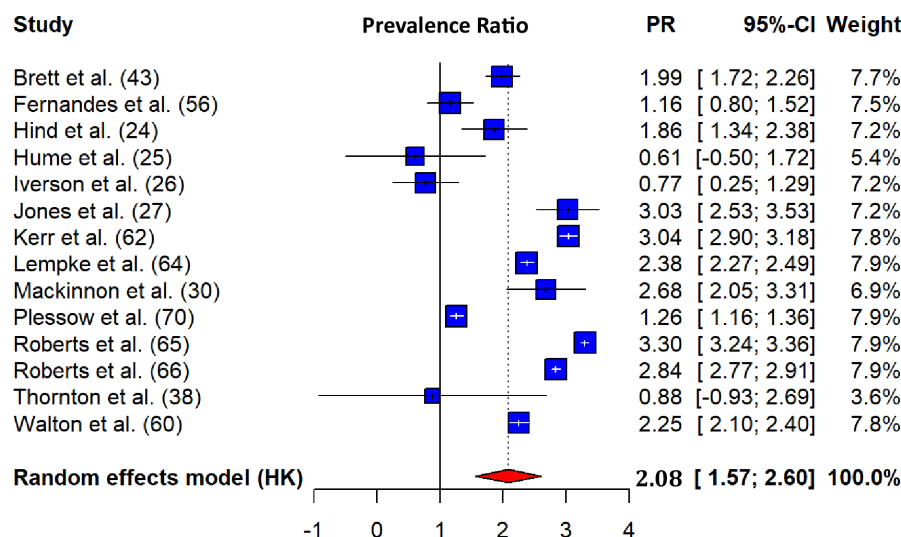


Figure 3 Overall anxiety forest plot. HK, Hartung-Knapp adjustment; PR, prevalence ratio.

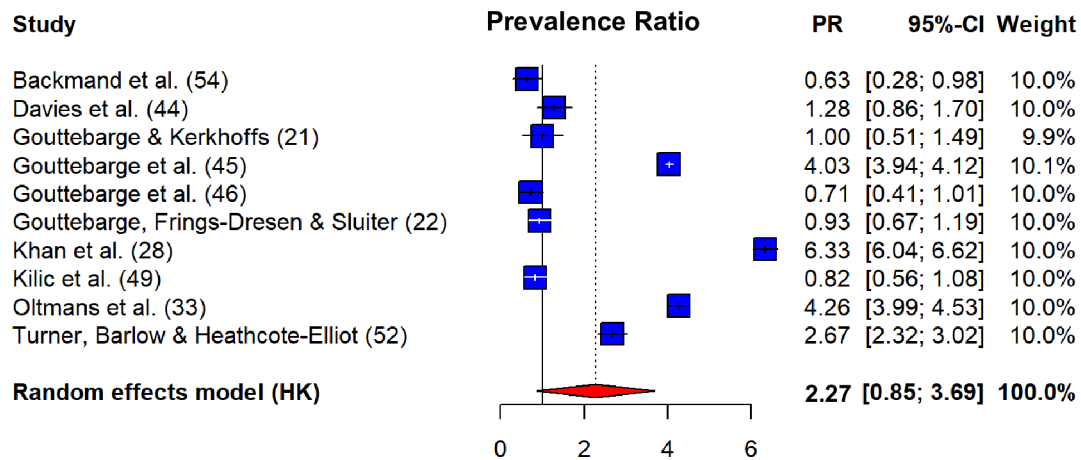


Figure 4 Combined anxiety and depression measures forest plot. HK, Hartung-Knapp adjustment; PR, prevalence ratio.

athletes smoked less, consumed less alcohol and were more physically active than their siblings. Similarly, even though Bäckmand *et al.*⁷⁰ reported that former athletes were occasional-to-moderate alcohol drinkers (77%), it was comparable to the control group (74%), and former athletes were twice as likely to report their self-rated health as 'good' compared with controls. Both of these studies included former athletes who had been retired for a minimum of 36 years indicating that behaviours from an elite sporting career are maintained into later life. Taken together, while lifestyle factors and behaviours were inconsistently controlled for within studies in this meta-analysis, they seem unlikely to fully explain the increased prevalence of anxiety and/or depression given certain lifestyle variables are the same as, or more favourable than, the general population. However, more research controlling for lifestyle factors is needed to investigate this further, so the true effect of an elite sporting career on anxiety and/or depression can be established.

Sport-specific analyses revealed that former NFL athletes had the highest prevalence of depression and anxiety compared with other sports and the general population. Didehbandi *et al.*²⁸ demonstrated a negative dose-response relationship between the number of concussions and the prevalence of depression in former NFL players from 2.8% to players with no concussions up to 10.4% for players with three or more during their career. Moreover, former NFL players with three or more lifetime concussions during their playing career had a five-fold greater risk of mild cognitive impairment compared with those with no concussion history.³⁰ However, the

number of concussions is unlikely to fully explain the sport specific differences in anxiety and depression with former rugby players displaying a similar prevalence of anxiety and depression to the general population despite a similar concussion rate.⁷² Moreover, sport-specific differences in mental health outcomes have been previously reported between former endurance and team sport athletes for alcohol misuse, disordered eating and sleep disturbance^{52 58 70 73} suggesting that lifestyle and/or training demands could impact long-term mental health outcomes of athletes. Given the disparity, and lack of clarity, in the results across the literature, and the small statistical power for most sports within this meta-analysis, more research is needed to fully elucidate the sport-specific long-term effects of competing in elite sport.

When anxiety and depression could not be separated, a decision was made to run a meta-analysis on these measures independently of specific measures of anxiety and depression due to their distinctive features.¹² More specifically, Eysenck and Fajkowska¹² argue that depression is triggered in the general population by major losses (ie, bereavement, traumatic injury) which cannot be reversed leading to anhedonia, whereas anxiety starts with major future threats (ie, retirement) and remains the only focus, which is less likely to lead to anhedonia as there remains probability that these situations can be averted.¹² In the current meta-analysis, the pooled PR for anxiety and depression was 1.67 (95% CI 0.91 to 3.07) which was not significantly different to the general population and lower than the individual indices of anxiety (PR: 2.16) and depression (PR: 2.40). Therefore,

Table 2 Sport-specific pooled depression PRs

	American football	Ice hockey	Soccer	Rugby	Cricket	Jockeys
Number of athletes (studies)	19073 ¹⁴	234 (1)	879 (2)	351 (3)	113 (1)	135 (1)
PR (95% CI)	2.88 (2.27–3.66) *	1.65 (1.28–2.13) *	1.69 (1.37–2.33) *	1.30 (0.22–4.87)	1.59 (1.07–2.37)	2.50 (1.97–3.17) *
*Indicates a significant difference compared with the general population. PR, prevalence rate.						

Table 3 Sport-specific pooled anxiety PRs

	American football	Soccer	Rugby	Cricket	Jockeys
Number of athletes (studies)	14 106 ⁶	572 (1)	351 (3)	113 (1)	135 (1)
PR (95% CI)	2.24 (1.58–3.18) *	1.16 (0.84–1.60)	1.13 (0.25–5.05)	3.03 (2.57–3.58) *	2.68 (2.11–3.41) *

*Indicates a significant difference compared with the general population.
PR, prevalence rate.

future research exploring the prevalence of anxiety and depression in athletic populations should use specific measurement techniques to gain a more representative, and insightful, perspective on athlete's mental health.

This review and meta-analysis also highlighted the lack of research in former female elite athletes with only 492 out of 24 732 participants, or 2.0%, being former female elite athletes. Unfortunately, this follows other disciplines in sport science where women are under-represented in research studies^{74–76} and is an area which urgently needs addressing. While the elite athlete population is smaller than the general population, the present findings still highlight the underrepresentation of women in sports research and in this instance the poor understanding of female mental health. In particular, females in the general population have been found to be twice as likely to be at risk of anxiety and depression than males; the difference attributed to increased gender role stressors and potential genetic risk.^{77 78} In current sporting populations, recent evidence found female athletes to experience greater symptoms of anxiety and depression compared with males, potentially resulting from higher rates of adverse life events, including discrimination and financial insecurity, but also due to females being more likely to report symptoms of mental health issues in general.⁷⁹ Subsequently, the known sex differences in mental health outcomes highlight the need for greater investigation to inform sport and health related outcomes for former, current and future female athletes.

There was a large disparity in the measurement tools used to quantify the prevalence of anxiety and depression across the 51 studies included within this meta-analysis which makes direct comparison challenging. More specifically, the authors identified 20 different measures, and scales were employed across the 51 studies to infer the prevalence of anxiety and depression in this population, the most common of which were the Short Form-36 Measurement Model for Functional Assessment of Health and Well-Being, 12-item General Health Questionnaire, Beck Depression Inventory-II and the 9-Item Patient Health Questionnaire (table 1). While all of these instruments have been validated for use with the general population, very few have been validated specifically in elite populations.⁸⁰ Consequently, the measurement tools used potentially underestimate the true prevalence of anxiety and depression within this population. More specifically, the only two studies within the meta-analyses that used either physician diagnosed or asked athletes to

self-report physician diagnoses both indicated that the prevalence of anxiety and depression was almost three times as high as the general population,^{35 40} which is higher than the overall pooled prevalence (anxiety PR, 2.16; depression PR, 2.40). This heterogeneity in use of diagnostic questionnaires calls for more consistency across the literature and indicates that bespoke questionnaires are needed for use in this population which are highly correlated to physician diagnoses.

While this systematic review and meta-analysis furthers the understanding of the prevalence of anxiety and depression in former elite athletes, there are a number of limitations that need to be acknowledged regarding the evidence used within this review. First, given the evidence within the current meta-analysis is primarily cross-sectional, the present study is only able to describe the incidence of the conditions and not infer the cause of said conditions. As such, future research that explores the causation of a higher prevalence of anxiety and depression is necessary to support the mental health of current and future generations of elite and professional athletes. Second, with the large array of measurement tools deployed within reports making direct comparison difficult, the results of this meta-analysis should be interpreted as an indication of the time-point prevalence of anxiety and depression in former elite athletes. Consequently, this heterogeneity in use of mental health measures calls for more consistency across studies to support valid comparison and harmonisation of data. Moreover, no inferences can be made as to the relative contribution of lifestyle on overall anxiety and depression. Thus, it is hard to distinguish whether any mental health risk observed is because of training, lifestyle choices or, most likely, a combination of both.

There are important limitations which to be acknowledged with the review process as well as with the evidence used within this review process. First, the review process only included evidence from records written in the English language. Even though the majority of scientific publications are written in English, there might have been some important evidence not included within this review. Moreover, our methods to assess the risk of bias may not capture all forms of bias accurately as we cannot differentiate between small study bias and publication bias, introducing uncertainty in interpreting the pooled time-point PRs. Moreover, the ordinal categories used to discern study quality (ie, low, moderate and high risk of bias), while they have been used in previous systematic

reviews;^{18–20} the ranges are arbitrary and have not yet been rigorously assessed, and so it is possible that some evidence might have been misclassified.

CONCLUSIONS

The main conclusions from this systematic review and meta-analysis are as follows: (1) former elite athletes could have a two-fold increased incidence of both anxiety and depression compared with the general population; (2) subgroup analyses revealed that former American football players and jockeys had the highest time-point prevalence of both anxiety and depression; (3) the time-point prevalence of depression in former rugby players and cricketers was not different to the general population; and (4) former rugby and soccer players had a similar time-point prevalence of anxiety compared with the general population. However, more research is warranted in female athletes to ascertain the benefits/consequences of an elite sporting career on mental health outcomes which is currently unknown.

X Adam Runacres @ARunacres_PhD

Collaborators Not Applicable.

Contributors AR was involved in study set up and conception, conducted the literature search, screened all articles, assessed study quality and bias, performed the meta-analysis and compiled the manuscript. ZAM was involved in study set up and conception, screened all articles, assessed the study quality and bias, critically revised the manuscript and approved the final manuscript. AR is the guarantor for this study.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available in a public, open access repository. The data extraction sheet, the data pooled data sheets and R Code used to conduct all analyses are available here: <https://osf.io/f5uzt/files/osfstorage>.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID ID

Adam Runacres <http://orcid.org/0000-0002-8251-2805>

REFERENCES

- Steel Z, Marnane C, Iranpour C, et al. The global prevalence of common mental disorders: a systematic review and meta-analysis 1980–2013. *Int J Epidemiol* 2014;43:476–93.
- The Lancet Global Health. Mental health matters. *Lancet Glob Health* 2020;8.
- Alegria M, NeMoyer A, Falgàs Bagué I, et al. Social Determinants of Mental Health: Where We Are and Where We Need to Go. *Curr Psychiatry Rep* 2018;20:95:1–13.
- Chekroud SR, Gueorguieva R, Zheutlin AB, et al. Association between physical exercise and mental health in 1.2 million individuals in the USA between 2011 and 2015: a cross-sectional study. *Lancet Psychiatry* 2018;5:739–46.
- Bär KJ, Markser VZ. Sport specificity of mental disorders: the issue of sport psychiatry. *Eur Arch Psychiatry Clin Neurosci* 2013;263 Suppl 2:S205–10.
- Rice SM, Purcell R, De Silva S, et al. The Mental Health of Elite Athletes: A Narrative Systematic Review. *Sports Med* 2016;46:1333–53.
- Reardon CL, Hainline B, Aron CM, et al. Mental health in elite athletes: International Olympic Committee consensus statement (2019). *Br J Sports Med* 2019;53:667–99.
- Sundgot-Borgen J, Torstveit MK. Prevalence of eating disorders in elite athletes is higher than in the general population. *Clin J Sport Med* 2004;14:25–32.
- Arnold R, Fletcher D. A research synthesis and taxonomic classification of the organizational stressors encountered by sport performers. *J Sport Exerc Psychol* 2012;34:397–429.
- Souter G, Lewis R, Serrant L. Men, Mental Health and Elite Sport: a Narrative Review. *Sports Med Open* 2018;4:57.
- Goutteborge V, Castaldelli-Maia JM, Gorczynski P, et al. Occurrence of mental health symptoms and disorders in current and former elite athletes: a systematic review and meta-analysis. *Br J Sports Med* 2019;53:700–6.
- Eysenck MW, Fajkowska M. Anxiety and depression: toward overlapping and distinctive features. *Cog Emot* 2018;32:1391–400.
- Moher D, Shamseer L, Clarke M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev* 2015;4:1–9.
- Shamseer L, Moher D, Clarke M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. *BMJ* 2015;350:g7647.
- Ouzzani M, Hammady H, Fedorowicz Z, et al. Rayyan-a web and mobile app for systematic reviews. *Syst Rev* 2016;5:210.
- Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health* 1998;52:377–84.
- Hootman JM, Driban JB, Sitler MR, et al. Reliability and validity of three quality rating instruments for systematic reviews of observational studies. *Res Synth Methods* 2011;2:110–8.
- Swain TA, McNarry MA, Runacres AWH, et al. The Role of Multi-Sensor Measurement in the Assessment of Movement Quality: A Systematic Review. *Sports Med* 2023;53:2477–504.
- Ratcliffe E, Pickering S, McLean S, et al. Is there a relationship between subacromial impingement syndrome and scapular orientation? A systematic review. *Br J Sports Med* 2014;48:1251–6.
- Adesida Y, Papi E, McGregor AH. Exploring the Role of Wearable Technology in Sport Kinematics and Kinetics: A Systematic Review. *Sensors (Basel)* 2019;19:1597.
- Wan X, Wang W, Liu J, et al. Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range. *BMC Med Res Methodol* 2014;14:135.
- Rothman K, Greenland S, Lash TL. *Modern epidemiology*. 3rd edn. Lippincott Williams & Wilkins, 2008.
- Szkulo M, Nieto FJ. *Epidemiology beyond the basics*. 2nd edn. USA: Jones and Bartlett, 2007.
- Balduzzi S, Rücker G, Schwarzer G. How to perform a meta-analysis with R: a practical tutorial. *Evid Based Ment Health* 2019;22:153–60.
- Schwarzer G, Carpenter JR, Rücker G. *Meta-Analysis with R*. 1ed edn. Switzerland: Springer Cham, 2015.
- Aston P, Filippou-Frye M, Blasey C, et al. Self-reported depressive symptoms in active and retired professional hockey players. *Can J Behav Sci / Rev can des sci du comport* 2020;52:97–106.
- Brett BL, Kerr ZY, Walton SR, et al. Longitudinal trajectory of depression symptom severity and the influence of concussion history and physical function over a 19-year period among former National Football League (NFL) players: an NFL-LONG Study. *J Neurol Neurosurg Psychiatry* 2022;93:272–9.
- Didehbani N, Munro Cullum C, Mansinghani S, et al. Depressive symptoms and concussions in aging retired NFL players. *Arch Clin Neuropsychol* 2013;28:418–24.
- Fernandes GS, Parekh SM, Moses J, et al. Depressive symptoms and the general health of retired professional footballers compared with the general population in the UK: a case-control study. *BMJ Open* 2019;9:e030056.

- 30 Guskiewicz KM, Marshall SW, Bailes J, *et al.* Recurrent concussion and risk of depression in retired professional football players. *Med Sci Sports Exerc* 2007;39:903–9.
- 31 Hart J, Kraut MA, Womack KB, *et al.* Neuroimaging of Cognitive Dysfunction and Depression in Aging Retired National Football League Players. *JAMA Neurol* 2013;70:326.
- 32 Hind K, Konerth N, Entwistle I, *et al.* Mental Health and Wellbeing of Retired Elite and Amateur Rugby Players and Non-contact Athletes and Associations with Sports-Related Concussion: The UK Rugby Health Project. *Sports Med* 2022;52:1419–31.
- 33 Hume PA, Quarrie KL, Lewis GN, *et al.* NZ-RugbyHealth Study: Self-reported Injury Experience and Current Health of Former Rugby Union and Non-contact Sport Players. *Sports Med* 2022;52:1701–13.
- 34 Iverson GL, Van Patten R, Terry DP, *et al.* Predictors and Correlates of Depression in Retired Elite Level Rugby League Players. *Front Neurol* 2021;12:655746.
- 35 Jones ME, Davies MAM, Leyland KM, *et al.* Osteoarthritis and other long-term health conditions in former elite cricketers. *J Sci Med Sport* 2018;21:558–63.
- 36 Kerr ZY, DeFreese JD, Marshall SW. Current Physical and Mental Health of Former Collegiate Athletes. *Orthop J Sports Med* 2014;2:2325967114544107.
- 37 Kerr ZY, Thomas LC, Simon JE, *et al.* Association Between History of Multiple Concussions and Health Outcomes Among Former College Football Players: 15-Year Follow-up From the NCAA Concussion Study (1999–2001). *Am J Sports Med* 2018;46:1733–41.
- 38 Kerr ZY, Marshall SW, Harding HP Jr, *et al.* Nine-year risk of depression diagnosis increases with increasing self-reported concussions in retired professional football players. *Am J Sports Med* 2012;40:2206–12.
- 39 Lempke LB, Walton SR, Brett BL, *et al.* Relating American Football Age of First Exposure to Patient-Reported Outcomes and Medical Diagnoses Among Former National Football League Players: An NFL-LONG study. *Sports Med* 2023;53:1073–84.
- 40 Mackinnon A-L, Jackson K, Kuznik K, *et al.* Increased Risk of Musculoskeletal Disorders and Mental Health Problems in Retired Professional Jockeys: A Cross-Sectional Study. *Int J Sports Med* 2019;40:732–8.
- 41 Mannes ZL, Ferguson EG, Perlstein WM, *et al.* Negative health consequences of pain catastrophizing among retired National Football League athletes. *Health Psychol* 2020;39:452–62.
- 42 Plessow F, Pascual-Leone A, McCracken CM, *et al.* Self-Reported Cognitive Function and Mental Health Diagnoses among Former Professional American-Style Football Players. *J Neurotrauma* 2020;37:1021–8.
- 43 Roberts AL, Pascual-Leone A, Speizer FE, *et al.* Exposure to American Football and Neuropsychiatric Health in Former National Football League Players: Findings From the Football Players Health Study. *Am J Sports Med* 2019;47:2871–80.
- 44 Roberts AL, Zafonte RD, Speizer FE, *et al.* Modifiable Risk Factors for Poor Cognitive Function in Former American-Style Football Players: Findings from the Harvard Football Players Health Study. *J Neurotrauma* 2021;38:189–95.
- 45 Sanders G, Stevinson C. Associations between retirement reasons, chronic pain, athletic identity, and depressive symptoms among former professional footballers. *Eur J Sport Sci* 2017;17:1311–8.
- 46 Schwenk TL, Gorenflo DW, Dopp RR, *et al.* Depression and pain in retired professional football players. *Med Sci Sports Exerc* 2007;39:599–605.
- 47 Strain J, Didehban N, Cullum CM, *et al.* Depressive symptoms and white matter dysfunction in retired NFL players with concussion history. *Neurol (Econicon)* 2013;81:25–32.
- 48 Walton SR, Brett BL, Chandran A, *et al.* Mild Cognitive Impairment and Dementia Reported by Former Professional Football Players over 50 yr of Age: An NFL-LONG Study. *Med Sci Sports Exerc* 2022;54:424–31.
- 49 Thornton J, Rosen C, Davenport M, *et al.* Beyond the medals: a cross-sectional study exploring retired elite female athletes' health. *BMJ Open Sport Exerc Med* 2023;9:e001479.
- 50 Bäckmand H, Kaprio J, Kujala UM, *et al.* Physical and psychological functioning of daily living in relation to physical activity. A longitudinal study among former elite male athletes and controls. *Aging Clin Exp Res* 2006;18:40–9.
- 51 Davies MAM, D Judge A, Delmestri A, *et al.* Health amongst former rugby union players: A cross-sectional study of morbidity and health-related quality of life. *Sci Rep* 2017;7:11786.
- 52 Goutteborge V, Kerkhoffs GMMJ. A prospective cohort study on symptoms of common mental disorders among current and retired professional ice hockey players. *Phys Sportsmed* 2017;45:252–8.
- 53 Goutteborge V, Aoki H, Lambert M, *et al.* A history of concussions is associated with symptoms of common mental disorders in former male professional athletes across a range of sports. *Phys Sportsmed* 2017;45:443–9.
- 54 Goutteborge V, Frings-Dresen MHW, Sluiter JK. Mental and psychosocial health among current and former professional footballers. *Occup Med* 2015;65:190–6.
- 55 Goutteborge V, Jonkers R, Moen M, *et al.* The prevalence and risk indicators of symptoms of common mental disorders among current and former Dutch elite athletes. *J Sports Sci* 2017;35:2148–56.
- 56 Khan M, Ekhtiari S, Burrus T, *et al.* Impact of Knee Injuries on Post-retirement Pain and Quality of Life: A Cross-Sectional Survey of Professional Basketball Players. *HSS J* 2020;16:327–32.
- 57 Kilic Ö, Aoki H, Haagensen R, *et al.* Symptoms of common mental disorders and related stressors in Danish professional football and handball. *Eur J Sport Sci* 2017;17:1328–34.
- 58 Oltmans E, Confectioner K, Jonkers R, *et al.* A 12-month prospective cohort study on symptoms of mental health disorders among Dutch former elite athletes. *Phys Sportsmed* 2022;50:123–31.
- 59 Turner AP, Barlow JH, Heathcote-Elliott C. Long term health impact of playing professional football in the United Kingdom. *Br J Sports Med* 2000;34:332–6.
- 60 O'Keefe JH, O'Keefe EL, Lavie CJ. The Goldilocks Zone for Exercise: Not Too Little, Not Too Much. *Mo Med* 2018;115:98–105.
- 61 Armstrong MEG, Green J, Reeves GK, *et al.* Frequent physical activity may not reduce vascular disease risk as much as moderate activity: large prospective study of women in the United Kingdom. *Circulation* 2015;131:721–9.
- 62 Schnohr P, O'Keefe JH, Marott JL, *et al.* Dose of jogging and long-term mortality: the Copenhagen City Heart Study. *J Am Coll Cardiol* 2015;65:411–9.
- 63 Runacres A, Mackintosh KA, McNarry MA. Health Consequences of an Elite Sporting Career: Long-Term Detriment or Long-Term Gain? A Meta-Analysis of 165,000 Former Athletes. *Sports Med* 2021;51:289–301.
- 64 Prien A, Feddermann-Demont N, Verhagen E, *et al.* Neurocognitive performance and mental health of retired female football players compared to non-contact sport athletes. *BMJ Open Sport Exerc Med* 2020;6:e000952.
- 65 Rice SM, Parker AG, Rosenbaum S, *et al.* Sport-Related Concussion and Mental Health Outcomes in Elite Athletes: A Systematic Review. *Sports Med* 2018;48:447–65.
- 66 Willer BS, Tiso MR, Haider MN, *et al.* Evaluation of Executive Function and Mental Health in Retired Contact Sport Athletes. *J Head Trauma Rehabil* 2018;33:E9–15.
- 67 Goutteborge V, Kerkhoffs G, Lambert M. Prevalence and determinants of symptoms of common mental disorders in retired professional Rugby Union players. *Eur J Sport Sci* 2016;16:595–602.
- 68 Kerr ZY, Prim J, DeFreese JD, *et al.* Musculoskeletal Injury History Is Associated With Lower Physical and Mental Health in a Historical Cohort of Former National Football League Players. *J Sport Rehabil* 2021;30:760–7.
- 69 Cowee K, Simon JE. A History of Previous Severe Injury and Health-Related Quality of Life Among Former Collegiate Athletes. *J Athl Train* 2019;54:64–9.
- 70 Bäckmand H, Kujala U, Sarna S, *et al.* Former athletes' health-related lifestyle behaviours and self-rated health in late adulthood. *Int J Sports Med* 2010;31:751–8.
- 71 Kontro TK, Sarna S, Kaprio J, *et al.* Mortality and health-related habits in 900 Finnish former elite athletes and their brothers. *Br J Sports Med* 2018;52:89–95.
- 72 Richardson J, Stanboly D, Moynihan H, *et al.* The Most Dangerous Game: A Review of Head and Neck Injuries in American Football and Rugby. *Craniofac Trauma Reconstr* 2023;16:15–22.
- 73 Montero A, Stevens D, Adams R, *et al.* Sleep and Mental Health Issues in Current and Former Athletes: A Mini Review. *Front Psychol* 2022;13:868614.
- 74 Martínez-Rosales E, Hernández-Martínez A, Sola-Rodríguez S, *et al.* Representation of women in sport sciences research, publications, and editorial leadership positions: are we moving forward? *J Sci Med Sport* 2021;24:1093–7.
- 75 Cowley ES, Olenick AA, McNulty KL, *et al.* "Invisible Sportswomen": The Sex Data Gap in Sport and Exercise Science Research. *Wom in Sport Phys Act J* 2021;29:146–51.
- 76 Costello JT, Bieuzen F, Bleakley CM. Where are all the female participants in Sports and Exercise Medicine research? *Eur J Sport Sci* 2014;14:847–51.
- 77 Seedat S, Scott KM, Angermeyer MC, *et al.* Cross-national associations between gender and mental disorders in the World Health Organization World Mental Health Surveys. *Arch Gen Psychiatry* 2009;66:785–95.

- 78 Kuehner C. Why is depression more common among women than among men? *Lancet Psychiatry* 2017;4:146–58.
- 79 Walton CC, Rice S, Gao CX, *et al.* Gender differences in mental health symptoms and risk factors in Australian elite athletes. *BMJ Open Sport Exerc Med* 2021;7:e000984.
- 80 Foskett RL, Longstaff F. The mental health of elite athletes in the United Kingdom. *J Sci Med Sport* 2018;21:765–70.
- 81 Ekhtiari S, Khan M, Burrus T, *et al.* Hip and Groin Injuries in Professional Basketball Players: Impact on Playing Career and Quality of Life After Retirement. *Sports Health* 2019;11:218–22.
- 82 Kuhn AW, Zuckerman SL, Solomon GS, *et al.* Interrelationships Among Neuroimaging Biomarkers, Neuropsychological Test Data, and Symptom Reporting in a Cohort of Retired National Football League Players. *Sports Health* 2017;9:40:30–40.
- 83 McMillan TM, McSkimming P, Wainman-Lefley J, *et al.* Long-term health outcomes after exposure to repeated concussion in elite level: rugby union players. *J Neurol Neurosurg Psychiatry* 2017;88:505–11.
- 84 Simon JE, Docherty CL. Current Health-Related Quality of Life in Former National Collegiate Athletic Association Division I Collision Athletes Compared With Contact and Limited-Contact Athletes. *J Athl Train* 2016;51:205–12.
- 85 Tarazi A, Tator CH, Wennberg R, *et al.* Motor Function in Former Professional Football Players with History of Multiple Concussions. *J Neurotrauma* 2018;35:1003–7.
- 86 Wright SA, Snyder Valier AR. Health-Related Quality of Life in Former Division II Collegiate Athletes Using the Disablement of the Physically Active Scale. *Athletic Training & Sports Health Care* 2021;13:85–92.
- 87 Alosco ML, Kasimis AB, Stamm JM, *et al.* Age of first exposure to American football and long-term neuropsychiatric and cognitive outcomes. *Transl Psychiatry* 2017;7:e1236.
- 88 Gouttebarga V, Aoki H, Verhagen E, *et al.* Are Level of Education and Employment Related to Symptoms of Common Mental Disorders in Current and Retired Professional Footballers? *Asian J Sports Med* 2016;7:e28447.
- 89 Simon JE, Lorence M, Docherty CL. Health-Related Quality of Life in Former National Collegiate Athletic Association Division I Collegiate Athletes Compared With Noncollegiate Athletes: A 5-Year Follow-Up. *J Athl Train* 2021;56:331–8.
- 90 Bäckmand H, Kaprio J, Kujala U, *et al.* Personality and mood of former elite male athletes--a descriptive study. *Int J Sports Med* 2001;22:215–21.
- 91 Bäckmand H, Kaprio J, Kujala U, *et al.* Influence of physical activity on depression and anxiety of former elite athletes. *Int J Sports Med* 2003;24:609–19.
- 92 Schuring N, Aoki H, Gray J, *et al.* Osteoarthritis is associated with symptoms of common mental disorders among former elite athletes. *Knee Surg Sports Traumatol Arthrosc* 2017;25:3179–85.
- 93 Roberts AL, Taylor HA Jr, Whittington AJ, *et al.* Race in association with physical and mental health among former professional American-style football players: findings from the Football Players Health Study. *Ann Epidemiol* 2020;51:48–52.
- 94 Walton SR, Kerr ZY, Brett BL, *et al.* Health-promoting behaviours and concussion history are associated with cognitive function, mood-related symptoms and emotional-behavioural dyscontrol in former NFL players: an NFL-LONG Study. *Br J Sports Med* 2021;55:683–90.