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Hang up your cleats and hope for the best? A cross-sectional study of five health domains in retired elite female rugby players

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ABSTRACT

Objectives To investigate retired elite female rugby players' health outcomes (and their relationships) in five key areas (musculoskeletal, cognitive, mental, reproductive/endocrinological and cardiovascular) and how those compare with the general population.

Methods Female rugby players aged ≥18 years old and retired from elite competition ≥2 years were recruited via email or social media to complete a 179-item online questionnaire and neurocognitive assessment. Data from general population controls (matched for age and sex) were obtained where available.

Results 159 participants responded (average age 43 (±5) years). 156 (98%) reported a hip/groin, knee, foot/ankle or lower back injury during their career, of which 104 (67%) reported ongoing pain. Participants reported worse hip and knee outcomes compared with the general population (p<0.0001). 146 (92%) reported sustaining one or more concussions. History of concussion was associated with lower-than-average scores on neurocognitive assessment. Compared with general population data, retired female rugby players reported less anxiety (OR=0.079 (95% CI 0.03 to 0.19)), depression (OR=0.67 (95% CI 0.57 to 0.78)) and distress (OR=0.17 (95% CI 0.15 to 0.19)). Amenorrhoea rates were higher compared with matched controls, and the age at menopause was younger. The prevalence of hypertension was higher. The rugby players perceived that their health decreased in retirement and cited a lack of physical activity as a main contributor.

Conclusion Our findings point to the potential value of screening and monitoring, and identifying preventative measures during sporting careers to promote health and long-term quality of life for athletes.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Knee osteoarthritis is prevalent among former elite rugby players.
⇒ Female athletes have a higher risk of concussion than male athletes, and a history of multiple concussions may negatively impact cognitive performance and long-term cognitive health.
⇒ Athletes often experience stress, anxiety and depression on retirement.
⇒ Limited research exists on retired female rugby players across all health domains.

WHAT THIS STUDY ADDS

⇒ This study is the first to advance knowledge across several domains of health for retired female rugby players.
⇒ Retired female rugby players reported a high rate of sustaining at least one concussion. Those who did scored below average for composite memory, verbal memory, visual memory, psychomotor speed, reaction time, simple attention and motor speed.
⇒ Among retired players who had sustained musculoskeletal injuries, 67% continued to have ongoing pain in the last year.
⇒ Retired players reported higher lifetime rates of amenorrhoea than the general population, and an earlier age at menopause.
⇒ Several athletes perceived their health as deteriorating after they retired from elite rugby; they attributed this to a lack of physical activity.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study advances knowledge across five domains of health for retired female rugby players and provides a foundation for future prospective/longitudinal research. Stakeholders in rugby union including researchers, healthcare practitioners and policymakers should prioritise injury and illness prevention in female rugby players during their careers and transition to retirement to ensure player health and well-being across the lifespan.

INTRODUCTION

Despite significant progress in injury prevention among elite athletes, a knowledge gap remains in long-term health outcomes—both positive and negative—in retired female athletes.[1] Women participants are poorly represented in research,[1] which can impact illness and injury prevention and overall health. Retired athletes can experience considerable changes to their identity, social networks and career ambitions, along with

potential risks to physical and mental health,[2] further impacting health outcomes.

Little is known about the long-term health of rugby players, and this knowledge is mostly on male players. We previously described preliminary findings across four health domains in Canadian retired female athletes, which included 44 former rugby players.[3] Women rugby players may have impaired health in retirement across different domains: (1) *musculoskeletal:* former elite rugby players have significantly higher rates of osteoarthritis and joint replacement surgery than the general population.[4] Female football (soccer) players are at higher risk of anterior cruciate ligament injury and subsequent early knee osteoarthritis than their male counterparts,[5 6] while rates in rugby are unknown; (2) *cognitive*: retired female football players may have impaired cognitive health due to their higher risks of concussion during their careers than male athletes[7]; (3) *mental*: retired elite male football players have a higher prevalence of mental health disorders than current players,[8] but similar prevalence data in female athletes is largely unavailable; (4) *reproductive:* relative energy deficiency in sport (REDs) may impair reproductive/endocrine function and contribute to irreversible bone mineral density loss,[9 10] but prevalence and long-term sequelae are unknown among retired female rugby players. Little is known about female rugby players' (in)fertility rates, pregnancy and postpartum outcomes or age at menopause[11–13] and (5) *cardiovascular (CV):* a systematic review of 13 studies and 4350 male retired field-based athletes demonstrated that retired athletes had a similar CV risk profile as the general population,[14] yet risk profiles of female athletes were not reported.

To fill these critical knowledge gaps, our study aimed to investigate retired elite female rugby players' health outcomes (and their relationships) in five key domains (musculoskeletal, cognitive, mental, reproductive/endocrinological and CV) and how those compare with matched controls from the general population.

METHODS

Design and data collection

Using a cross-sectional study design, we collected self-report data through an online questionnaire in English via Qualtrics (Qualtrics, 2005, Copyright 2024, Provo, Utah, USA; versions: July 2022–March 2023; available

Table 1 List of questions asked in the survey for each health domain. Validated questionnaires are in normal text and non-validated questions are in italic font

Health domain	Questionnaire
Musculoskeletal health	► Hip Disability and Osteoarthritis Outcome Score (HOOS) ► Knee Injury and Osteoarthritis Score (KOOS)[17] ► Foot and Ankle Outcome Score (FAOS)[18] ► Oswestry Disability Index (ODI)[19] ► Brief Pain Inventory (BPI) —Pain Interference Scale
Cognitive health	► Verbal memory test (VBM) ► Visual memory test (VSM) ► Finger tapping test (FTT) ► Symbol digit coding (SDC) ► Stroop test (ST) ► Shifting attention test (SAT) ► Continuous performance test (CPT)
Mental health	► Kessler Psychological Distress Scale (K10)[20] ► Generalised Anxiety Disorder-7 (GAD-7)[21] ► Patient Health Questionnaire-9 (PHQ-9)[22] ► Alcohol Use Disorders Identification Test for Consumption (AUDIT-C)[70] ► Cut, Annoyed, Guilty and Eye Adapted to Include Drugs (CAGE-AID)[24] ► Harassment and abuse—witnessed and experienced
Reproductive health	► Eating Disorder Examination Questionnaire (EDE-Q)[71] ► Low Energy Availability in Females Questionnaire (LEAF-Q) (modified version)[26] ► Weight loss ► REDs history ► Fertility/pregnancy history
Cardiovascular health	► Pittsburgh Sleep Quality Index (PSQI)[30] ► Cardiovascular diagnoses ► Cardiovascular tests/treatment history
Self-reflection	► Self-rating of health ► External influences on health

REDs, relative energy deficiency in sport.

at https://www.qualtrics.com). The survey was open between 4 July 2022 and 29 March 2023. Methodological information is reported in accordance with the Checklist for Reporting Results of Internet E-Surveys (see online supplemental appendix 1).[15] Ethical approval was obtained from Western University Research Ethics Board (#120795).

Neurocognitive assessment

After completion of the online questionnaire, participants received via email a unique code and link to complete a neurocognitive assessment through CNS Vital Signs (CNS VS Copyright 2024, Morrisville, North Carolina, USA; versions: July 2022–April 2023; available at https://www.cnsvs.com). The test battery comprised seven tests (provided in table 1), which scored respondents in 11 neurocognitive domains: composite memory, verbal memory, visual memory, psychomotor speed, reaction time, complex attention, cognitive flexibility, processing speed, executive function, simple attention and motor speed. Participants were asked to complete the CNS VS test within 1 week of completing the Qualtrics questionnaire. Data was collected from 5 July 2022 to 21 April 2023.

Study population and recruitment

Participants were retired elite female rugby players who participated in at least five international matches and/or played for a professional team or their national team prior to 2020. Participants were included if they were at least 18 years old, at least 2 years retired from elite competition, able to communicate in and understand English and have access to a computer with a working keyboard.

We contacted potential participants through two pathways. We emailed national member federations affiliated with World Rugby and requested an email be sent to retired female players with a link to receive more information about the project. Our research team also promoted the link on social media.

Potential participants responded to a series of screening questions that were designed to determine their eligibility (as above). If the participant was eligible, the letter of information appeared prior to starting the questionnaire. If the participant was not eligible, the survey ended. Informed consent was implied through participation in the questionnaire, and all responses were anonymised.

Patient and public involvement

The survey was pretested by a retired athlete focus group (n=5). We tested survey flow, content and 'burden' (of time). As a result of this pilot, we improved the way participants could move through the survey and change their answers if needed; it also led us to include the letter of information within the survey itself rather than as a separate document.

Measurement instruments and definition of constructs

A group comprised of researchers, sports medicine experts and retired athletes with content expertise (JST, KC, MLM and VG) developed, pretested and assessed the survey for length and flow to minimise response burden. A focus group of five retired elite female athletes pretested the content and clarity of the survey. The survey included 179 items taking approximately 30 min to complete. We included 12 validated questionnaires to capture career-related data in musculoskeletal, mental, reproductive and CV health[16–27] (see table 1). To determine the physical activity levels, we provided participants with definitions and examples regarding light, moderate and vigorous physical activity as per WHO guidelines[28] and asked participants how many minutes per week they engaged in these activities. As adaptive questioning was employed via skip logic, the number of questions applicable to each respondent varied. Blank text boxes with no

Table 2 Demographic information of survey respondents (n=159)

	N	Mean (SD)	95% CI
Current age (years)	159	43 (5)	(42 to 44)
Number of games played on national team	158	32 (11)	(30 to 33)
Weight (kg)	158		
Current		63 (9)	(62 to 65)
Playing		61 (6)	(60 to 62)
Height (cm)	158	167 (4)	(166 to 167)
	N	**n (%)**	
Continental affiliation	159		
Africa		2 (1%)	
Asia		1 (1%)	
Europe		6 (4%)	
North America		148 (93%)	
South America		2 (1%)	
Racial or cultural group	159		
Asian		9 (6%)	
Black		19 (12%)	
Indigenous		15 (9%)	
Mixed		35 (22%)	
Unknown		1 (1%)	
White		80 (50%)	
Retirement age (years)	159		
20–29		14 (9%)	
30–34		37 (23%)	
35–39		75 (47%)	
40–49		31 (19%)	
>50		2 (1%)	
Under the care of a medical doctor	159		
Yes, currently		113 (71%)	
Yes, currently (have not seen >2 years)		36 (23%)	
Not currently		10 (6%)	

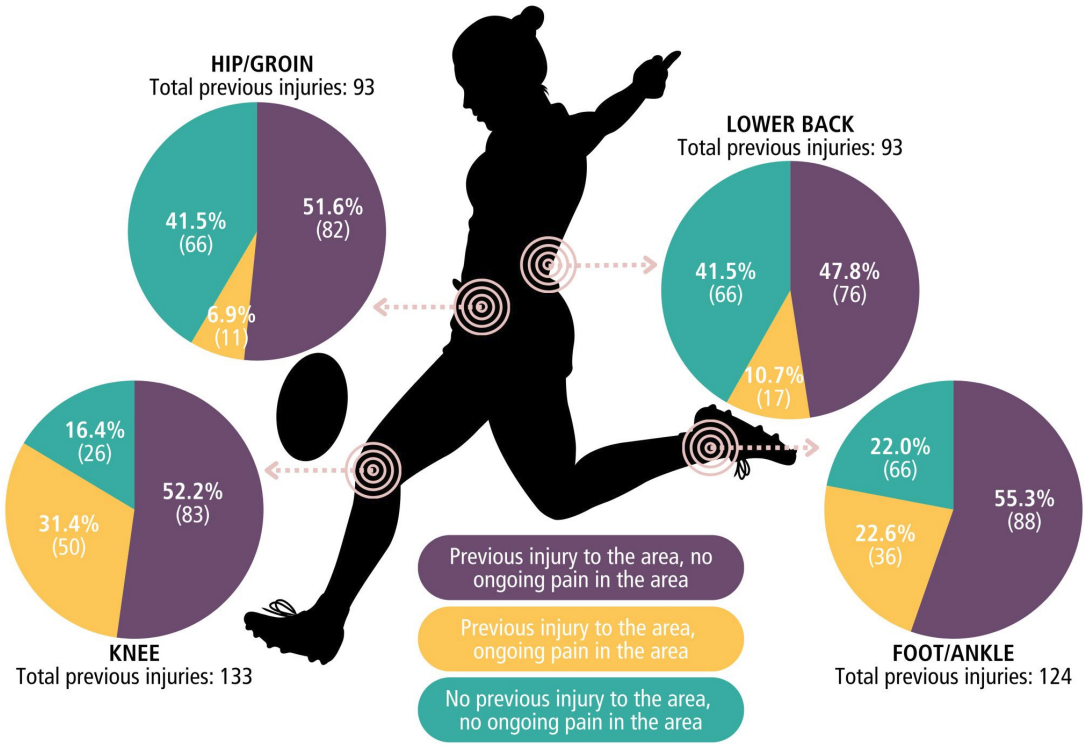

Figure 1 Number of reported injuries during competition and ongoing pain in the hip/groin, knee, foot/ankle and lower back.

word limits were provided for all open-ended questions. Participants could choose to skip any questions they did not feel comfortable answering. Respondents could navigate back through the survey to change and review their answers as needed.

Statistical analysis

We generated descriptive statistics to describe the sample using SAS software V.9.4 (Cary, North Carolina, SAS Institute).[29] Incomplete survey submissions and submissions where significant data were missing (eg, only the demographics section completed) were removed. Means, SD and 95% CI summarised continuous data; percentage and counts summarised categorical data. χ^2 tests determined the statistical significance of the unadjusted associations between dichotomous variables. Cohen's d and Cohen's h expressed effect sizes for differences in group means for continuous and dichotomous variables, respectively, such that values >0.8 were determined to be clinically meaningful. Respondents without complete responses for both variables were excluded from the analysis. Unadjusted ORs with 95% CI are presented. Two-tailed t-tests at the 0.05 alpha level were performed to test for statistically significant differences in means of continuous variables in the sample population compared with general population data.

We obtained general population data from Statistics Canada when identical outcome measures were available and from women with matched age ranges. When appropriate Statistics Canada surveys could not be retrieved, we identified general population studies with compatible characteristics through a literature review.

Sample size calculation

G*power (G*power, Copyright 2007, Düsseldorf, Germany; V.3.1.9.6; available at https://www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/gpower.html) was used to conduct post hoc power analysis to verify the sample size required to perform hypothesis tests with the results of the various validated questionnaires. The calculations indicated that the required sample size to achieve 80% power for detecting a clinically meaningful effect (d=0.8) at a significance criterion of α=0.05 was n=26.

Open-ended data analysis

Due to the limited number of open-ended responses received, we were unable to perform a conventional content analysis as planned. Instead, we extracted exemplar quotes from the survey data and presented them with corresponding frequencies and proportions.

RESULTS

Sample characteristics

287 respondents consented to the survey; 159 completed it in its entirety. All reported female sex and identified as women. Of these, 87 (57%) completed the CNS VS test. Average age was 43 (±5) years. Athletes from a total of nine countries participated in the survey, with 147 (92%) from North America. Athletes participated on a national or professional team for an average of 16 years (range 3–30 years) and in 32 international events (range 2–80). Table 2 displays the demographic data of all respondents.

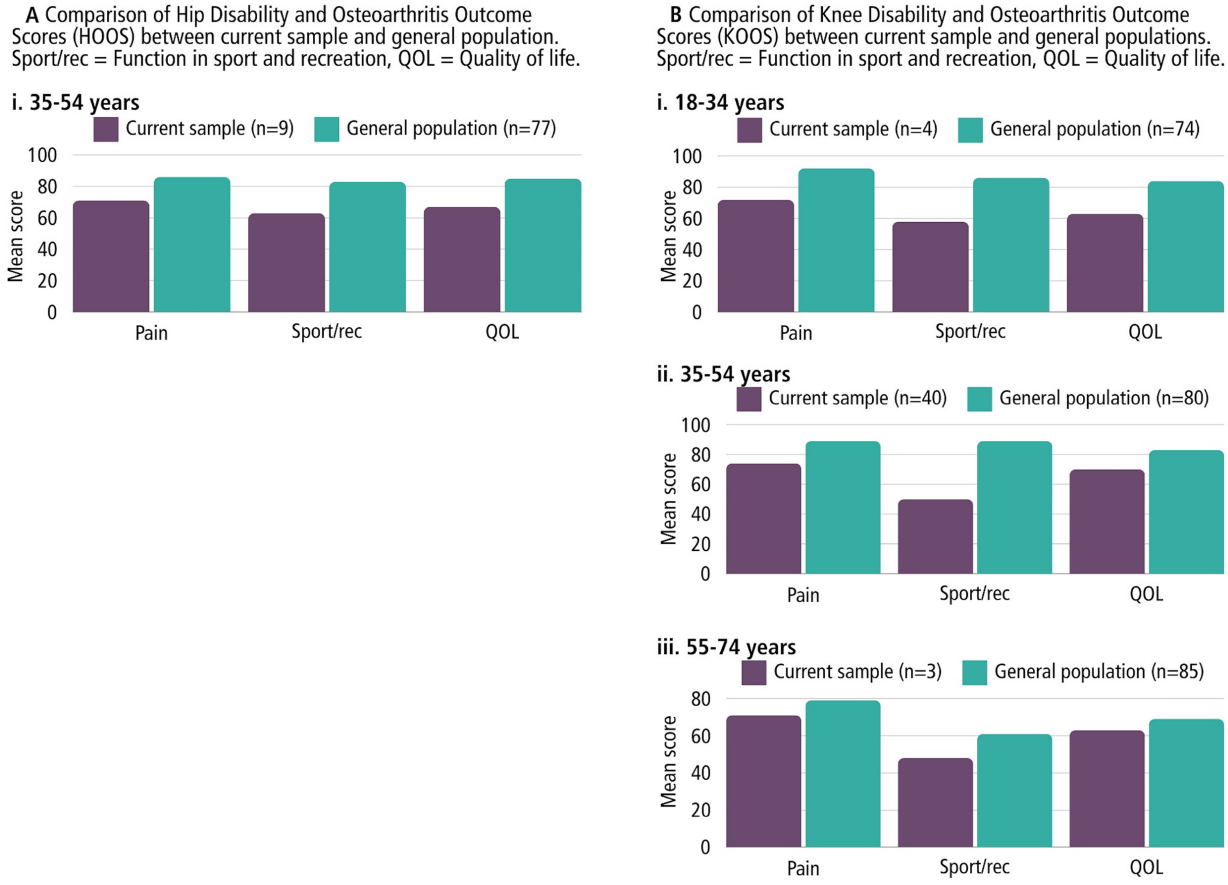

Figure 2 Average musculoskeletal outcome scores for hip and knee pain among respondents reporting injuries during their career and ongoing pain within the last year. (A) Reported HOOS between participants in current study sample who reported ongoing hip pain compared with samples of the general population for pain, sport/rec and QOL in 35–54 year-olds. (B) Reported KOOS between participants in current sample who reported ongoing knee pain compared with samples of the general population for pain, sport/rec and QOL in 18–34, 35–54 and 55–74 year-olds.

Injury history and musculoskeletal health

156 (98%) respondents reported a combined total of 443 musculoskeletal injuries that either altered their ability to perform or kept them out of training/competition for more than 1 week during their career (figure 1). 133 (30%) were reported in the knee, 124 (28%) in the foot/ankle, 93 (21%) in the lower back and 93 (21%) in the hip/groin (figures 2 and 3). Three athletes (2%) reported no injury during their careers.

Of the 156 respondents who reported they had sustained an injury during their career, 104 (67%) reported ongoing pain in the same region within the last year. 50 reported knee pain, 36 reported foot/ankle pain, 17 reported lower back pain and 11 reported hip/groin pain.

Cognitive health

146 participants (92%) reported having been diagnosed with at least one concussion during their professional career (average 2±1). 127 respondents (80%) reported suffering a suspected concussion but were not formally diagnosed by a medical professional. Overall, participants scored below the average standard score in composite memory (73% of tests below the average standard score range, SD=24), verbal memory (75%, SD=23), visual memory (58%, SD=21), psychomotor speed (62%, SD=10), reaction time (78%, SD=19), simple attention (65%, SD=34) and motor speed (85%, SD=23). When categorised by concussion history, athletes with no concussion (n=3) had higher test scores than those with a history of concussion (n=84) in composite memory, verbal memory, visual memory, psychomotor speed, reaction time and motor speed. Because of low numbers in this group, tests for statistically significant differences could not be performed.

Mental health

Psychological distress

Six (4%) respondents reported current moderate to severe psychological distress with a K10 Score of 25 or more and 10 (6%) reported current mild psychological distress with a score of 20–24.[20]

Anxiety and depression

Five respondents (3%) reported current moderate to severe anxiety with a Generalised Anxiety Disorder-7 Score of 10 or more and 18 (11%) reported

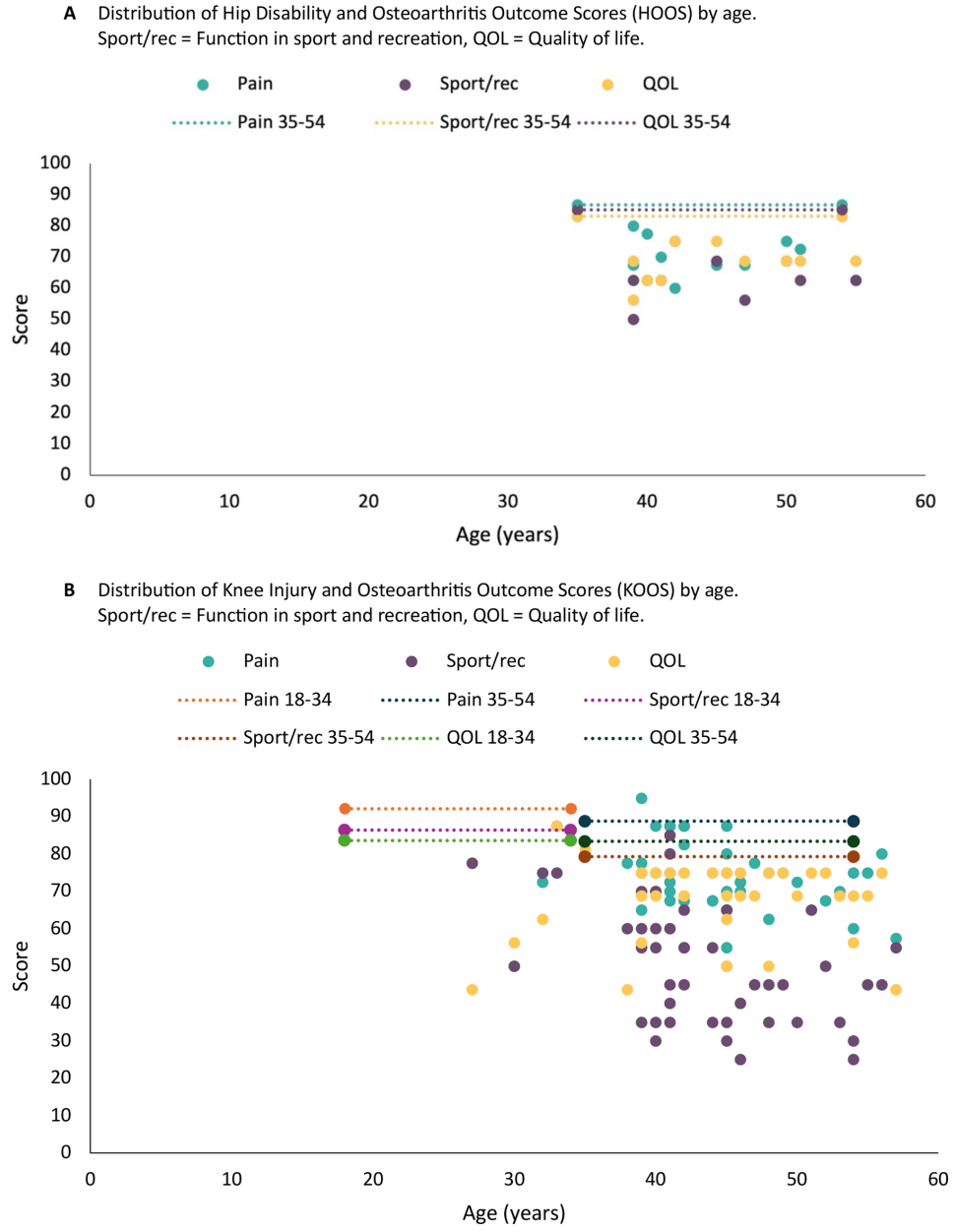

Figure 3 Distributions of outcome scores for hip and knee pain by age among respondents reporting injuries during their career and ongoing pain within the last year. (A) Reported HOOS among participants in current sample who reported ongoing hip pain for pain, sport/rec and QOL. (B) Reported KOOS among participants in current sample who reported ongoing knee pain for pain, sport/rec and QOL. Mean score among age-matched and sex-matched general populations are denoted by trendlines.

mild anxiety with scores between 5 and 9.[21] Seven respondents (4%) reported current moderate to severe depression with a Patient Health Questionnaire Score of 10 or more.[22]

Substance use

39 respondents (27%) reported an Alcohol Use Disorders Identification Test for Consumption Score of 3 or more, suggesting potential alcohol misuse.[23] 19 respondents (12%) reported current alcohol and drug use habits consistent with abuse, with a Cut, Annoyed, Guilty and Eye Adapted to Include Drugs Score of 2 or more.[24]

Disordered eating/eating disorder history

37 respondents (23%) reported that a coach or staff member advised that they lose weight on at least one occasion. Most of the time (80%) it was advised for a specific performance or health-related reason, and nutritional support was subsequently offered.

Harassment and abuse

64 (41%) respondents indicated that they likely (11%) or very likely (30%) experienced or witnessed some form of harassment and/or abuse in their sports environment (figure 4). The most common form was unwanted comments about body or appearance, which

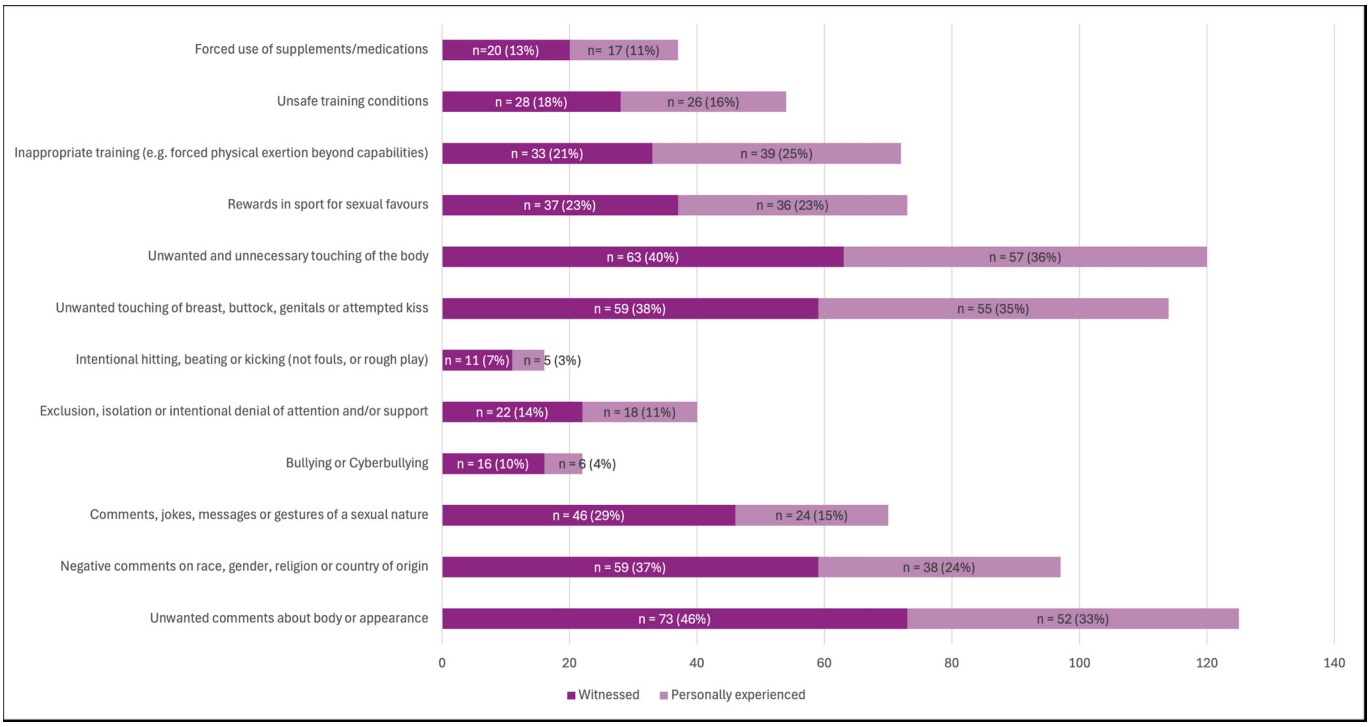

Figure 4 Number of respondents who reported witnessing each type of harassment and/or abuse to another athlete or experienced it occurring to themselves.

was witnessed by 73 (46%) athletes and experienced by 52 (33%). Most of the time, these comments were perpetrated by another athlete and/or a coach (60 (82%) witnessed and 45 (87%) experienced). When a case of harassment or abuse was witnessed or experienced, most athletes (51 (62%) witnessed and 41 (59%) experienced) did not report the incident to anyone.

Reproductive/endocrine health

Menstrual history

140 (88%) respondents reached menarche between the ages of 12 years and 14 years. 28 respondents (18%) experienced amenorrhoea (cessation of menstrual cycles for at least three consecutive months) outside of pregnancy during their athletic career. Eight (5%) athletes also experienced amenorrhoea after retirement. Of the 20 athletes who had reached menopause, the mean age of first symptom onset or diagnosis of menopause was 48 years.

Pregnancy history

23 (15%) respondents had never tried to conceive, 82 participants (52%) delivered at least one child, 50 (32%) were as yet unable to conceive and 2 (1%) were currently pregnant. Of the 84 who had been or were currently pregnant, 15 (18%) took longer than 12 months to conceive. During pregnancy, three (4%) athletes were diagnosed with gestational diabetes and two (2%) with pre-eclampsia or gestational hypertension. Four (5%) athletes experienced twin pregnancies and 20 (24%) underwent a Caesarean section. Four (5%) experienced postpartum depression. Figure 5 presents a visual comparison of pregnancy and postpartum complications. The average age of first-time mothers was 32 years old (range 20–43 years).

CV health

Hypertension (34%), diabetes (type not specified) (21%) and elevated cholesterol (20%) were the three most reported chronic conditions in this population. 58 participants (40%) were identified as 'poor sleepers' with a Pittsburgh Sleep Quality Index Score of 5 or higher.[30] Most participants (91%) reported being currently sedentary. 70% of participants reported currently exercising and 2% reported currently training and competing in masters' competitions.

Self-reported quality of health

When reflecting on their time on their national or professional teams, 142 respondents (89%) rated their general health as above average or excellent (table 3). Many described their focus on fitness and performance at the time as being beneficial to their health. At the time of retirement, this number fell to 110 (69%) and further decreased for quality of health at the time of reporting to 58 (36%). Several athletes described their lack of physical activity as a contributor to their diminished perception of personal health.

DISCUSSION

This study provides preliminary insights into the musculoskeletal, cognitive, mental, reproductive/

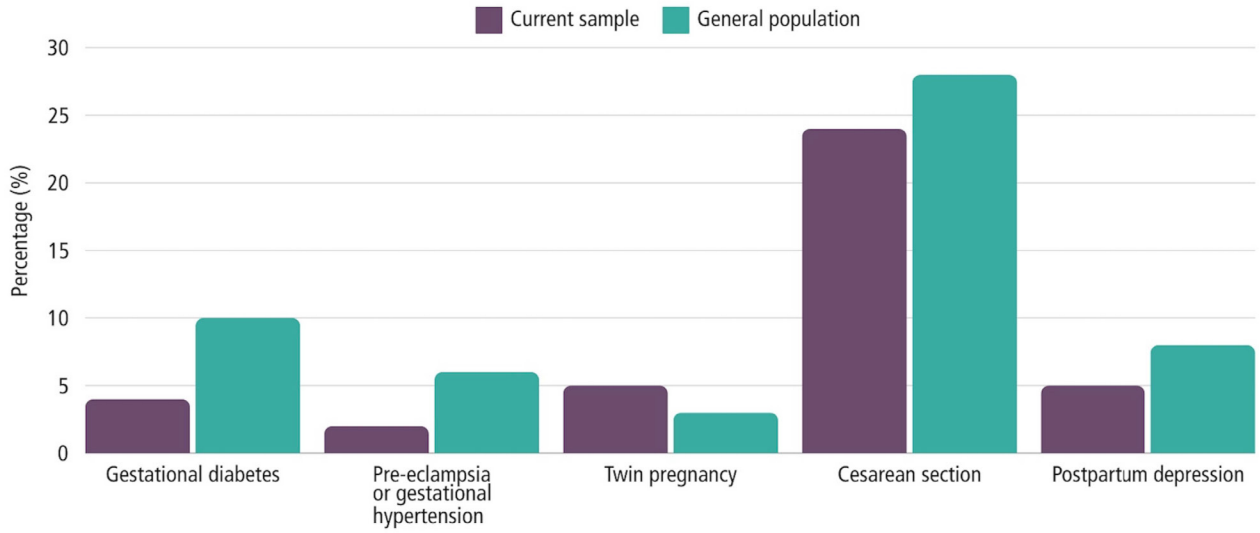

Figure 5 Percentage of respondents who reported experiencing conditions during pregnancy, delivery or post partum compared with samples from general populations. n=84 for the current study sample for pregnancy complications and n=79 for the current study sample for postpartum complications.

endocrinological and CV health of retired elite female rugby players. We explored health outcomes in these domains both during athletes' careers and postretirement, as well as athletes' perception of their health throughout their careers. Rugby players experience a high frequency of musculoskeletal injuries and concussions, higher rates of amenorrhoea compared with the general population, as well as a higher prevalence of diabetes and hypertension. At the point of retirement, respondents reported a decrease in self-perception of health, which has further declined when considering current health. The lack of physical activity postretirement was expressed as a significant contributor to diminished quality of health.

Injury history and musculoskeletal health

The proportion of rugby players who reported a musculoskeletal injury during their career was higher than that reported in studies on athletes in varying Olympic sports.[31 32] The most reported region of injury among female rugby players was the knee. This extends findings in studies of retired athletes in various sports; in the current study, more athletes reported current/ongoing pain as a result of sport injury.[31 32]

Compared with rugby players in our previous study, a higher proportion sustained an injury in the same regions—hip/groin, knee, foot/ankle and lower back.[3] In both studies, the knee was the most commonly injured region, and participants aged 34–54 years had worse knee outcome scores than the general population.[3] Two-tailed t-test results suggested that participants aged 35–54 (n=40) years reported significantly worse Knee Injury and Osteoarthritis Score (KOOS) than in a general population study (n=80) across all three evaluated domains ($p<0.0001$; pain, sport and recreation and quality of life).[33 34]

Athletes with a history of hip or knee injury have higher odds of osteoarthritis in those joints than do controls.[35] As osteoarthritis affects physical activity, sleep, mental health,[36] quality of life and rate of hospitalisation,[37] these findings underscore the importance of addressing joint pain as an important contributor to overall health.

Cognitive health

Most participants were diagnosed with at least one concussion during their career. Those without a history of concussion had higher test scores for composite, verbal and visual memory, motor and psychomotor speed as well as reaction time; yet due to the limited number of athletes in this group we were unable to test for statistical significance. Only 87 participants completed the test in full. Partial tests are deemed not valid by CNS VS and therefore could not be analysed. Our data are consistent with a study of retired football (soccer) players (n=425), which reported that players with a history of multiple concussions performed worse on verbal memory tests.[38] These findings suggest implications for long-term cognitive health and performance.

Mental health

The proportion of mild and moderate to severe psychological distress was comparable to results from the 2017 to 2018 Canadian Community Health Survey (Statistics Canada) (mild: 10% and moderate-severe: 9%).[20 39] Rugby players had significantly lower odds of anxiety, depression and psychological distress than the general Canadian population.[39 40] Rates of moderate to severe depression in the present study were comparable with the Canadian general population.[22 39]

When compared with the 35% of respondents (n=12 634) in the United States general population

Table 3 Summaries of open-ended responses about self-rated health currently and recalled immediately postretirement and during training and competition

Self-rated health	Sample excerpt
Current	
Excellent (n=6)	'I cannot complain of anything.'
Above average (n=52)	'I currently feel good. Continuing to work of getting more exercise, sleeping better, drinking a bit less, dating more, trying to continue to work on the balance of life and at the moment I'm doing well with it!'
Average (n=86)	'Overall pretty good, considering adjustment to motherhood. Coming to terms and learning how to adjust to diagnosis of gestational diabetes/pre-diabetes has had a large effect on my mental health, approaches/feelings to food/exercise. I stress about transition back to work (currently on mat leave) and how I will make it all work. I hope by seeking medical guidance and mental health support I will have improved sense of health.'
Below average (n=15)	'While I have not been diagnosed (with) health issues (haven't seen a doctor in years) I don't feel healthy in any way. Not exercising is a big factor; unless necessary most days I don't get out of bed. I have a very irregular schedule and go through phases of different levels of activity/eating habits that generally range between 3 days and 1 month. Lack of finances has a huge impact on what I do. This was also true during my time on the national team.'
Poor (n=0)	None
Immediately Postretirement	
Excellent (n=12)	'I had just completed (the) World Cup and was in top shape.'
Above average (n=98)	'I felt happy, I had served my country and most of all was to finally rest from all the hectic training and body aches.'
Average (n=47)	'Physically, I was still in great shape however it had a huge impact on my mental/social health. I felt very isolated and felt I needed to reestablish my identity.'
Below average (n=2)	None
Poor (n=0)	None
During Training & Competition	
Excellent (n=46)	'Focused to start fit and healthy.'
Above average (n=96)	'I was happy where I was. I was handling the stress sand pressure pretty well. I always looked at it as I'm doing the best I can as a professional athlete who still had a fulltime teaching and coaching job. I was extremely busy and burning the candle at both ends, but I was able to get it all done with the support system I had at home'.
Average (n=15)	'At the time, I probably would have said my health was excellent or above average. I now realise that the stress of wanting to perform, managing ongoing injuries etc. impacted my mental health. Socially, my community was very rugby focused.'
Below average (n=2)	'I was under so much pressure, worrying about selection, training, performance and my body weight. Also, time management coupled with the level of rugby development in my country- we don't really get paid and more often than not we take care of our injuries- no clear paths of how athletes are treated during injury.'
Poor (n=0)	None

from the 2012 to 2013 National Epidemiologic Survey of Alcohol and Related Conditions-III, rugby players reported lower alcohol misuse. Rugby players had significantly lower odds of having hazardous alcohol use.[41] Current alcohol and drug use habits consistent with abuse were comparable with 14% (n=1329) in a study of adults in the USA.[41] The odds of alcohol and drug abuse among rugby players did not significantly differ from the general population.[42] A study of retired male rugby players showed similar rates of substance abuse.[43]

Rugby players scored higher on the Eating Disorder Examination Questionnaire (EDE-Q) when compared with a sex-matched general Norwegian population

(non-athletes).[25] However, when compared with a study of female endurance athletes, fewer had a global EDE-Q Score ≥2.5, which is suggestive of disordered eating behaviour.[44]

Witnessing or experiencing harassment and abuse was prevalent in this study. Unwanted comments about body or appearance were higher than in a previous sample of Canadian rowers and rugby players, as were negative comments on race, gender, religion or country of origin.[3] Physical abuse including intentional hitting, beating or kicking was more prevalent in the current study.[3] Sexual harassment was considerably more prevalent in the current study, with more players reporting having witnessed unwanted and unnecessary intimate touching, and rewards in sports for sexual favours.[3] Compared with our previous study, there were more reports of inappropriate training, unsafe training conditions and forced use of supplements or medications.[3]

Results from this study suggest that the prevalence of mental health symptoms in retired female rugby players is lower than in the general population; whereas previous research found that roughly one-quarter of retired male professional rugby players suffered depression/anxiety and/or stress.[39 43] Differences may be due to different ages and years in sport or the use of different questionnaires. Further research would likely be beneficial to improve the understanding of mental health outcomes and differences in this population.

Reproductive health

The higher prevalence of amenorrhoea and higher EDE-Q scores may signify that rugby, although not traditionally thought of as a high-risk sport for REDs, is not immune to the sequelae of exposure to unintentional and/or intentional problematic low energy availability (LEA). A similar proportion (16%) of athletes were advised to lose weight in our previous study.[3]

The age of menarche was consistent with a study using general US population data (n=10 590) for the majority of participants in the current study.[45] The rate of amenorrhoea among rugby players was considerably higher than the US rate of secondary amenorrhoea of 3%–4%, but lower than the 39% of elite rugby players in our previous study.[3 46] Participants who reported first symptom onset or diagnosis of menopause were generally younger than the general Canadian population (n=7719) mean (51 years).[47] This finding is consistent with that of our previous study.[3]

Compared with a study using data from the US National Survey of Family Growth, our study population had a lower proportion of women who were unable to conceive by 12 months.[48] The prevalence of both gestational diabetes and pre-eclampsia or gestational hypertension were lower when compared with general Canadian population data (10% and 6%, respectively).[49 50] Rates of twin pregnancies and Caesarean sections are comparable to the general Canadian population provided by Statistics Canada (3% and 28%, respectively).[51] The prevalence of postpartum depression was similar to the 7.5% reported among the general postpartum Canadian population.[52] The average age of fist-time mothers was 2.6 years older than the general Canadian population of 29 years.[51]

In our previous study, more athletes (65%) delivered a child and fewer took >12 months to conceive.[3] The average age of first-time mothers was comparable (33 years), although more gave birth during their competitive career in the current study.[3]

Previous studies, although limited, have not detected an association between menopausal age and infertility.[53 54] Together, these findings continue to suggest a potentially narrower reproductive window that necessitates further research.

CV health

While retired male field-based athletes have similar CV risk profiles as the general population, the relationship in female athletes remains underinvestigated.[14] Due to the high proportion of sedentary athletes following retirement in the current study and the general observed decline in physical activity postretirement, retiring athletes may benefit from counselling on the cardioprotective effect of physical activity.[14 38 55] Athletes reported better sleep quality compared with a sex-matched and age-matched German population (n=4864).[27] Previous studies have detected an association between abnormal sleep quality and quantity and elevated risk of adverse CV events.[56 57] Compared with the general Canadian female population, the prevalence of hypertension (21.5%, n=1720, Statistics Canada) and diabetes (7.6%) is higher among rugby players; however, they have a lower prevalence of hypercholesterolemia (28% vs 34% in the general Canadian population, Statistics Canada).[58–60] However, previous studies have conflicting results which may be related to current physical activity levels.[28 58 59 61–63] Lifelong physical activity is a well-established lifestyle factor to protect CV health.

Self-reported quality of health and overall health

This study cohort's perceptions of their health decreased over time. Though not possible to perform a formal content analysis for this study, in reviewing the responses provided to the open-ended questions, we identified some preliminary concepts that add context to the findings of this study. Reasons for reported suboptimal health during competition and immediately postretirement tended to be psychosocial in nature (eg, pressure to perform, financial strain and social isolation) as opposed to being driven by injury and physical ailments. The factors affecting respondents' current health appeared to relate more to their lifestyle (eg, diet and exercise). Fewer than 10% of athletes reported being currently physically active or participating in master's competition. This aligns with other literature demonstrating that elite athletes have lower current health-related quality of life, greater limitations in daily activities, and increased chronic injuries compared with non-athletes.[64] To appropriately support

athletes through retirement and beyond, it is crucial to understand their lived experiences and contexts, which requires further investigation through qualitative analytical approaches.

Despite fewer mental health symptoms in this study sample relative to the general population, other outcomes including cognitive health, musculoskeletal and reproductive outcomes are not as desirable. This may reflect that while high athletic prowess is necessary to make it to the elite level, it may not be sufficient. A combination of other factors including resilience and adaptability may contribute to this apparent disconnect.

Strengths and limitations

We worked in collaboration with our research team and retired athletes to develop and test a seven-part, anonymised questionnaire. Based on the findings from our previous study, we adjusted the wording and added multiple questions to improve data capture for this current study.[3] The findings contribute to the growing body of evidence aimed at improving sports injury prevention practices.

The intent was to obtain a global representation of rugby players; however, 148 (93%) participants were from North America, limiting the generalisability of our results. Despite several attempts, we were unable to reach many national member federations. This reflects the challenge of recruiting retired athletes when there are few or no existing databases. As a result, we were also unable to calculate a response rate. Limitations in using social media as a recruitment strategy include the inability to confirm if participants outside of our eligibility criteria participated, therefore potentially biasing our results. The small sample size of certain subgroups (eg, age and concussion history) within our population limited the ability to detect the statistical significance of some of our findings. As a result of insufficient sample sizes and/or lack of comparator populations, we were only able to perform t-tests for the KOOS. As a strength, we have used population-based controls (where possible) which permit some adjustment for age; however, the controls are not 'concurrent' (ie, sampled from the same population at the same time and ideally equal in every way other than elite athletic experience).

We defined a significant injury as an injury that altered players' ability to perform or kept them out of training/competition for more than 1 week during their career. When comparing injury to previous studies on retired Olympians, significant injuries were defined as injuries causing pain or dysfunction for 1 month or longer.[31 32] The difference in definitions may be a limitation in the comparability of results.

While we did ask about the history of amenorrhoea outside of pregnancy, we did not qualify that this should include the postpartum period and breastfeeding. Future studies should include this nuance.

Finally, while overall CNS VS can detect valid results with high accuracy, previous studies of CNS VS testing on athletes have found poor test-retest reliability for the verbal memory domains, with participants improving their scores after retesting.[65–67] Sex-based differences may exist within CNS VS domain scores; a previous study found that women scored higher on executive function, processing speed, cognitive function, reaction time and verbal memory, while men scored higher on motor speed.[68]

Clinical significance

The large data gap that exists on the health of the retired female athlete demands the attention of researchers and clinicians alike. Effective injury prevention strategies implemented during a player's career, particularly around concussion and MSK health, may help preserve lifelong health. Our data provide a rationale for clinicians to promote healthy eating behaviours, adequate energy intake, and long-term reproductive health and pregnancy planning as needed—these conversations should begin prior to retirement. Current athletes may benefit from the implementation of end-of-career health consultations. Understanding retired athletes' current contexts, preferences and needs through qualitative methodologies will help ensure these initiatives are appropriate and effective. Follow-up and prospective studies are needed with objective measures, as are clinical and implementation trials including codesigned interventions to address priority areas. Future studies should include the 'lived expertise' of the athlete's voice at each stage of research.[69]

CONCLUSION

Our study expands the knowledge of the health of retired female rugby players. Retired female rugby players experienced a high incidence of knee and ankle injuries, with the majority experiencing ongoing pain in retirement. Nearly all participants in our study suffered at least one concussion with potential associations with long-term cognitive health. Rates of amenorrhoea were higher among rugby players than the general population, and the age at menopause was earlier. Future longitudinal (prospective cohort) studies and elite athlete registries are needed to facilitate sampling and follow-up. The findings of this study show a decline in self-reported health status among retired female rugby players from the time they competed to retirement to the present day. Targeted support in each of the five domains may be important for the improvement of quality of life after retirement.

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