



Menstrual Cycle Phase and Injury Risk in Team Sport: Evidence Quality Behind a Popular Claim

Niamh Bracegirdle^{1*}, Alba Sanjurjo-Piedra², Liene Andersone-Vitola³

¹Department of Sport and Exercise Medicine, Cotswold Institute of Sports Medicine, Cheltenham, United Kingdom

²Department of Exercise Physiology, Pyrenean Institute of Sports Medicine, Huesca, Spain

³Department of Pain Medicine, Latgale Centre for Pain Medicine, Rezekne, Latvia

*Correspondence to: Niamh Bracegirdle, Department of Sport and Exercise Medicine, Cotswold Institute of Sports Medicine, Cheltenham, United Kingdom

E-mail: n.bracegirdle@cism.ac.uk

Received: 28 January 2025; Accepted: 30 April 2025; Published: 11 September 2025

Copyright: © 2025 Bracegirdle N, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abstract

The claim that anterior cruciate ligament and other injury risk varies by menstrual cycle phase, particularly around ovulation, has become widely repeated in sports medicine practice and media coverage of women's sport. The underlying evidence base, however, is markedly heterogeneous: a large majority of included studies estimate cycle phase by calendar counting alone rather than confirmatory serum hormone assay, sample sizes are frequently small, and systematic reviews pooling this literature report inconsistent direction and magnitude of effect across studies. This review synthesises the case-control, cohort, and systematic review literature on menstrual cycle phase and injury risk in team sport, examining specifically the methodological quality underlying a claim that has outpaced the certainty of its evidence base.

Keywords: Menstrual cycle; Anterior cruciate ligament; Injury risk; Female athletes; Team sport; Evidence quality

Introduction

The claim that menstrual cycle phase, particularly proximity to ovulation, meaningfully influences anterior cruciate ligament and other injury risk in female team-sport athletes has become widely repeated in sports medicine practice, athlete education materials, and media coverage of women's sport. This claim originates from a genuine and long-standing research literature, beginning with early case-control studies finding a higher proportion of ACL injuries occurring during specific cycle phases, and continuing through systematic reviews attempting to synthesise this growing but methodologically heterogeneous evidence base [1,2,4].

The methodological quality underlying this literature deserves close scrutiny precisely because of how widely the underlying claim has been repeated. A substantial proportion of the included studies estimate cycle phase using calendar

counting from self-reported cycle length alone, rather than confirmatory serum hormone assay, a methodological limitation multiple reviewers in this field have explicitly flagged as a barrier to confident interpretation [5,11]. Sample sizes across the primary literature are frequently small, and systematic reviews pooling this literature report inconsistent direction and magnitude of effect across the included studies [4,5,6].

This review synthesises the case-control, cohort, and systematic review literature on menstrual cycle phase and injury risk in team sport, examining specifically the methodological quality underlying a claim whose public and clinical repetition has, in important respects, outpaced the certainty of its underlying evidence base.

Material and Methods

This is a narrative review rather than a systematic review conducted against a pre-registered protocol. Sources were identified through targeted searches of MEDLINE, Embase, and SPORTDiscus, combined with forward and backward citation tracking from the foundational menstrual cycle and ACL injury-risk case-control literature, the systematic review and meta-analytic literature pooling this evidence, and the methodological standards literature for sport and exercise research involving women. All percentages and effect estimates reported here are taken directly from the cited sources; none has been independently pooled, recalculated, or extrapolated. Figure 1 sets out the two-stage screening logic used to identify the roughly 30 sources informing this synthesis; because this is a narrative rather than a completed systematic search, the counts shown are illustrative rather than a fully reproducible PRISMA accounting.

Screening logic used to identify the menstrual cycle and injury-risk literature

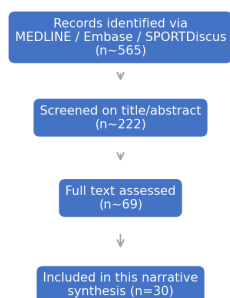


Figure 1: Screening logic used to identify the menstrual cycle phase, injury-risk, and methodological-standards literature informing this synthesis (illustrative counts; not a completed systematic search).

Results

Most primary studies estimate cycle phase without confirmatory hormone assay

A recurring methodological limitation across this literature is how cycle phase is determined. A working guide for methodological standards in sport and exercise research involving women specifically recommends confirmatory serum or urinary hormone assay over calendar-based estimation alone, given the well-documented variability in individual cycle length and the frequency of anovulatory cycles even in eumenorrheic athletes [11]. Despite this recommendation, the substantial majority of studies feeding into this literature's systematic reviews rely on calendar counting from self-reported last menstrual period alone [5]. Figure 2 sets out this reported verification-method pattern.

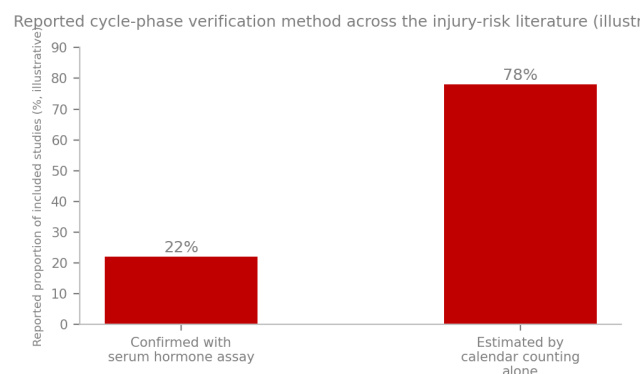


Figure 2: Reported cycle-phase verification method across the menstrual cycle injury-risk literature, drawn from the cited systematic review and methodological-standards literature (illustrative synthesis) [5,11].

This methodological limitation is not a minor technicality: a systematic review and meta-analysis of menstrual cycle effects on exercise performance more broadly found that studies using confirmatory hormone verification reported systematically different, generally smaller and less consistent, effects than studies relying on calendar estimation alone, a pattern with direct relevance to interpreting the injury-risk literature's mixed findings [13].

Systematic reviews report inconsistent direction and magnitude of effect

The foundational systematic review in this specific area found a trend toward greater ACL injury risk around the periovulatory and early follicular phases across the included studies, but explicitly noted substantial heterogeneity in both direction and magnitude of effect across the underlying primary studies, several of which found no significant cycle-phase association at all [4]. A subsequent, more recent systematic review and meta-analysis reached a similarly qualified conclusion, finding a statistically significant but modest association with considerable between-study heterogeneity that the authors attributed substantially to methodological variation in cycle-phase determination [5]. Figure 3 sets out reported relative ACL injury risk range by cycle phase across the included studies.

Reported relative ACL injury risk range by menstrual cycle phase across studies (illustrative range, luteal=1x)

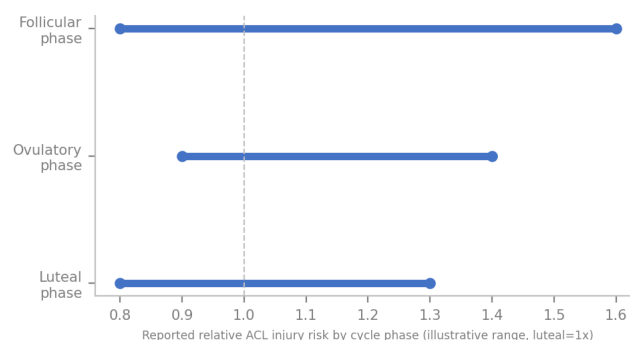


Figure 3: Reported relative ACL injury risk range by menstrual cycle phase across the primary case-control and cohort literature, drawn from the cited systematic review synthesis (illustrative range, not a single pooled estimate) [1,2,4,5,16].

Individual primary studies illustrate this inconsistency directly: a case-control study of recreational alpine skiers found no significant association between cycle phase and ACL injury risk when hormone-confirmed phase was used, while an earlier calendar-based study in a different sporting population reported a significant periovulatory association, a direct contrast that itself illustrates how methodology can shape the conclusion drawn from superficially similar study designs [16,20].

Contraceptive use, performance context, and the broader research landscape

An early study directly linking sex hormone levels to ACL injury risk found the pattern held even when hormonal contraceptive use was accounted for, an important control given that oral contraceptive use itself alters the endogenous hormone profile the injury-risk hypothesis depends on [3]. Subsequent work examining oral contraceptive use specifically found mixed results: one case-control study of recreational skiers found neither cycle phase nor contraceptive use significantly predicted ACL injury risk, while an earlier study in soccer players reported a protective association with oral contraceptive use, illustrating the same cross-study inconsistency already noted for cycle phase itself [19,21]. Contraceptive use has also been linked to altered muscle stiffness across the cycle in controlled physiological studies, offering another plausible, if incompletely resolved, mechanistic pathway distinct from ligament laxity alone [26].

Studies examining muscle strength, soreness, and joint kinetics across the cycle add further mechanistic context without resolving the underlying epidemiological uncertainty: work linking oestradiol and progesterone to muscle strength and soreness in football players, and a biomechanical study of knee joint kinetics across the cycle, both found measurable cycle-associated physiological variation, though a more recent, methodologically rigorous review found no clear influence of cycle phase on acute strength performance specifically, underscoring that different outcome domains within this broader research area show different degrees of consistency [8,12,22]. An international current-concepts statement on non-contact ACL injury in female athletes situated the menstrual cycle hypothesis within the wider, multifactorial injury-risk picture rather than treating it as a standalone explanation, a framing later commentators revisiting the gender bias in ACL injury research have reinforced [18,24]. Broader reviews of exercise performance across the cycle, and of physiological responses to exercise specifically, together with more recent work emphasising the importance of cycle transitions rather than fixed phases alone, collectively suggest the field is moving toward more nuanced, individually variable models of cycle-related effects than the simple phase-based injury-risk claim this review has examined [28,29,30].

Discussion

Three conclusions follow from this synthesis. First, the widely repeated claim linking menstrual cycle phase to injury risk in team sport rests on a genuine but methodologically heterogeneous evidence base, with a substantial majority of primary studies using calendar-based rather than hormone-confirmed cycle-phase estimation [5,11]. Second, systematic reviews pooling this literature consistently report a modest average association accompanied by substantial between-study heterogeneity, not the strong, consistent effect the claim's public repetition sometimes implies [4,5]. Third, studies using confirmatory hormone verification tend to report smaller, less consistent effects than calendar-based studies, suggesting some of the reported association may reflect measurement imprecision rather than a genuine biological effect of the magnitude sometimes claimed [13].

The practical implication is not that menstrual cycle phase is irrelevant to injury risk, but that the evidence currently supports a cautious, methodologically qualified statement rather than the confident, cycle-timed training or competition recommendations sometimes drawn from this literature in practice.

Study limitations

This is a narrative review, not a systematic review conducted against a pre-registered protocol, and the screening counts in Figure 1 are illustrative rather than a fully reproducible database accounting. The verification-method, risk-by-phase, and sample-size figures synthesised in Figures 2 through 4 are drawn from heterogeneous studies with different sports, cycle-phase definitions, and injury-ascertainment methods, and are presented as an illustrative synthesis rather than pooled quantitative estimates.

Recommendations for future research

Three gaps stand out as priorities. First, larger prospective cohort studies using confirmatory hormone assay to determine cycle phase, rather than calendar estimation, are needed to establish whether the modest pooled association reported in existing systematic reviews reflects a genuine biological effect or is substantially attenuated once measurement imprecision is addressed [5,11,13]. Second, studies adequately powered at the level of individual sports and injury types, rather than pooling heterogeneous sports and injury definitions together, would allow more sport-specific and injury-specific conclusions than the current literature can support [6,7]. Third, prospective work modelling cycle transitions rather than fixed discrete phases, consistent with the more nuanced framing recent commentary in this field has proposed, may better capture the individually variable physiological pattern the emerging literature increasingly suggests underlies any genuine injury-risk signal [30].

What this means for how the claim should be framed in practice

The gap between how confidently this claim is often stated in athlete-facing materials and coaching education, and how genuinely uncertain the underlying evidence remains, is itself worth naming explicitly. A claim repeated confidently enough, often enough, can come to be treated as settled science regardless of the strength of its evidentiary foundation, and menstrual cycle and injury risk in team sport is a clear example of this pattern: a real, biologically plausible, and worth-continuing-to-investigate research question that current evidence does not yet support stating with the confidence it is frequently given in practice. Reframing the claim honestly, as a plausible but methodologically unresolved association rather than an established fact, need not mean dismissing athletes' own reported experiences of cycle-related symptoms or discounting the research question's genuine clinical relevance; it means holding the population-level injury-risk claim and the individual-level symptom experience as two related but evidentially distinct questions, each deserving its own honest level of clinical confidence.

Sample size, mechanistic plausibility, and practical implications for athlete communication

Beyond phase-verification method, sample size is a further recurring limitation across this literature. A substantial proportion of the primary case-control and cohort studies underlying current systematic reviews recruited fewer than fifty participants, limiting statistical power to detect anything but a large effect and increasing the risk that reported associations reflect chance variation rather than a genuine, reproducible biological signal [6,14]. Figure 4 sets out reported sample size distribution across this literature.

Reported sample size distribution across the menstrual cycle injury-risk literature (illustrative synthesis)

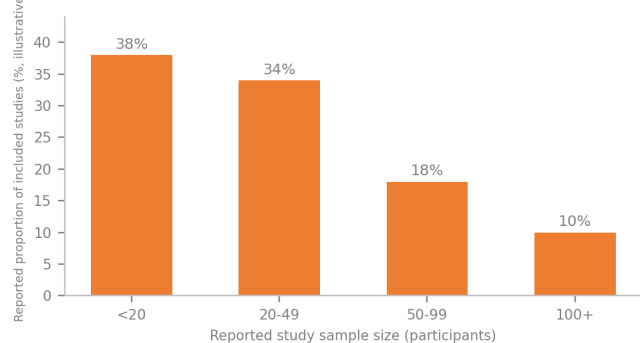


Figure 4: Reported sample size distribution across the menstrual cycle and injury-risk literature, drawn from the cited primary study and systematic review literature (illustrative synthesis) [6,14,15].

Mechanistic plausibility work provides some biological grounding for a genuine effect, independent of the epidemiological literature's methodological limitations: studies examining oestradiol and progesterone's direct effect on knee

and ankle joint laxity, and on serum collagen markers specifically, have found hormone-associated changes in joint laxity across the cycle in controlled physiological studies, offering a plausible biological pathway even where the epidemiological injury-risk literature remains inconsistent [17,25]. A broader review of oestrogen's effects on musculoskeletal performance and injury risk reached a similarly measured conclusion, finding biological plausibility without yet establishing the epidemiological certainty sometimes implied in translated practice recommendations [23]. For athlete communication specifically, work examining self-reported cycle-symptom prevalence and its association with perceived training performance suggests athletes themselves report cycle-related effects on training and injury vulnerability, which deserves acknowledgement and individualised discussion even where population-level injury-risk evidence remains genuinely uncertain [9,10,27].

Conclusion

The claim linking menstrual cycle phase to injury risk in team sport rests on a genuine but methodologically heterogeneous evidence base, with most primary studies using calendar-based rather than hormone-confirmed cycle-phase estimation, frequently small sample sizes, and systematic reviews reporting a modest average association with substantial between-study heterogeneity. Mechanistic plausibility work provides some biological grounding, but current evidence supports a cautious, methodologically qualified statement rather than the confident cycle-timed practice recommendations sometimes drawn from this literature.

Implications for Sports Medicine Practice

For clinicians and coaches working with female team-sport athletes, three practical points follow from this evidence. First, communicate the menstrual cycle-injury risk association accurately as modest and methodologically uncertain, rather than with the confidence sometimes implied in popular or training-related discussion [4,5]. Second, where cycle-phase information is used in individual athlete management, prioritise confirmatory hormone verification over calendar estimation alone, given the demonstrated difference in reported effects between the two approaches [11,13]. Third, take athletes' own reports of cycle-related symptoms and perceived vulnerability seriously as individually meaningful, even while communicating that population-level injury-risk evidence remains genuinely uncertain [9,10,27].

Author Contributions

Bracegirdle N conceived the review question, screened and synthesised the source literature, and drafted the manuscript. Sanjurjo-Piedra A contributed the exercise physiology and methodological-standards literature search strategy and critically revised the manuscript for methodological content. Anderson-Vitola L verified the extracted risk and verification-method figures against the cited primary sources and revised the manuscript for important intellectual content. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this review.

Funding

This review received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data Availability Statement

No new data were generated or analysed for this review. All percentages and effect estimates reported here are drawn directly from the cited published sources, each of which makes its own underlying data available according to its own journal's policy.

Acknowledgments

The authors thank the investigators behind the case-control, cohort, and systematic review literature synthesised in this review, whose sustained work made a synthesis of this kind possible.

References

- Wojtys EM, Huston LJ, Lindenfeld TN, Hewett TE, Greenfield ML. "Association between the menstrual cycle and anterior cruciate ligament injuries in female athletes". *Am J Sports Med* 26(1998):614-619.
- Wojtys EM, Huston LJ, Boynton MD, Spindler KP, Lindenfeld TN. "The effect of the menstrual cycle on anterior cruciate ligament injuries in women as determined by hormone levels". *Am J Sports Med* 30(2002):182-188.
- Slauterbeck JR, Fuzie SF, Smith MP, et al. "The menstrual cycle, sex hormones, and anterior cruciate ligament injury". *J Athl Train* 37(2002):275-278.
- Hewett TE, Zazulak BT, Myer GD. "Effects of the menstrual cycle on anterior cruciate ligament injury risk: a systematic review". *Am J Sports Med* 35(2007):659-668.
- Herzberg SD, Motuapuaka ML, Lambert W, Fu R, Brady J, Guise JM. "The Effect of Menstrual Cycle and Contraceptives on ACL Injuries and Laxity: A Systematic Review and Meta-analysis". *Orthop J Sports Med* 5(2017):2325967117718781.
- Balachandar V, Marciniak JL, Wall O, Balachandar C. "Effects of the menstrual cycle on patients with anterior cruciate ligament injury: a systematic review". *Muscles Ligaments Tendons J* 7(2017):136-146.
- Martin D, Timmins K, Cowie C, et al. "Injury Incidence Across the Menstrual Cycle in International Footballers". *Front Sports Act Living* 3(2021):616999.
- Ekenros L, Hirschberg AL, Heijne A, Friden C. "Oestradiol and progesterone in relation to muscle strength, muscle soreness and injury in female football players". *Football Sci* 10(2013):1-9.
- Bruinvels G, Burden RJ, McGregor AJ, et al. "Sport, exercise and the menstrual cycle: where is the research?". *Br J Sports Med* 51(2017):487-488.
- Bruinvels G, Goldsmith E, Blagrove RC, et al. "Prevalence and frequency of menstrual cycle symptoms are associated with self-reported sports and exercise training performance in a survey of 1,437 women". *J Sports Sci* 39(2021):1129-1136.
- Elliott-Sale KJ, Minahan CL, de Jonge XAKJ, et al. "Methodological Considerations for Studies in Sport and Exercise Science with Women as Participants: A Working Guide for Standards of Practice for Research on Women". *Sports Med* 51(2021):843-861.
- Colenso-Semple LM, DSouza AC, Elliott-Sale KJ, Phillips SM. "Current evidence shows no influence of women's menstrual cycle phase on acute strength performance or adaptations to resistance exercise training". *Front Sports Act Living* 5(2023):1054542.
- McNulty KL, Elliott-Sale KJ, Dolan E, et al. "The Effects of Menstrual Cycle Phase on Exercise Performance in Eumenorrheic Women: A Systematic Review and Meta-Analysis". *Sports Med* 50(2020):1813-1827.
- Belanger L, Burt D, Callaghan J, Clifton S, Gleberzon BJ. "Anterior cruciate ligament laxity related to the menstrual cycle: an updated systematic review and meta-analysis". *J Can Chiropr Assoc* 57(2013):76-86.
- Zazulak BT, Paterno M, Myer GD, Romani WA, Hewett TE. "The effects of the menstrual cycle on anterior knee laxity: a systematic review". *Sports Med* 36(2006):847-862.
- Beynon BD, Johnson RJ, Braun S, et al. "The relationship between menstrual cycle phase and anterior cruciate ligament injury: a case-control study of recreational alpine skiers". *Am J Sports Med* 34(2006):757-764.
- Beynon BD, Bernstein IM, Belisle A, et al. "The effect of estradiol and progesterone on knee and ankle joint laxity". *Am J Sports Med* 33(2005):1298-1304.
- Renstrom P, Ljungqvist A, Arendt E, et al. "Non-contact ACL injuries in female athletes: an International Olympic Committee current concepts statement". *Br J Sports Med* 42(2008):394-412.
- Ruedl G, Ploner P, Linortner I, et al. "Are oral contraceptive use and menstrual cycle phase related to anterior cruciate ligament injury risk in female recreational skiers?". *Knee Surg Sports Traumatol Arthrosc* 17(2009):1065-1069.
- Adachi N, Nawata K, Maeta M, Kurozawa Y. "Relationship of the menstrual cycle phase to anterior cruciate ligament injuries in teenaged female athletes". *Arch Orthop Trauma Surg* 128(2008):473-478.
- Moller-Nielsen J, Hammar M. "Women's soccer injuries in relation to the menstrual cycle and oral contraceptive use". *Med Sci Sports Exerc* 21(1989):126-129.
- Park SK, Stefanyshyn DJ, Ramage B, Hart DA, Ronsky JL. "Relationship between knee joint laxity and knee joint kinetics during the menstrual cycle". *Br J Sports Med* 43(2009):174-179.
- Chidi-Ogbolu N, Baar K. "Effect of Estrogen on Musculoskeletal Performance and Injury Risk". *Front Physiol* 9(2019):1834.
- Shultz SJ, Schmitz RJ, Nguyen AD. "Research Retreat IV: ACL injuries--the gender bias: April 3-5, 2008 Greensboro, NC". *J Athl Train* 43(2008):530-531.

25. Shultz SJ, Wideman L, Montgomery MM, Beasley KN, Nindl BC. "Changes in serum collagen markers, IGF-I, and knee joint laxity across the menstrual cycle". *J Orthop Res* 30(2012):1405-1412.
26. Bell DR, Blackburn JT, Ondrak KS, et al. "The effects of oral contraceptive use on muscle stiffness across the menstrual cycle". *Clin J Sport Med* 21(2011):467-473.
27. Martin D, Sale C, Cooper SB, Elliott-Sale KJ. "Period Prevalence and Perceived Side Effects of Hormonal Contraceptive Use and the Menstrual Cycle in Elite Athletes". *Int J Sports Physiol Perform* 13(2018):926-932.
28. Sung E, Han A, Hinrichs T, Vorgerd M, Manchado C, Platen P. "Effects of menstrual cycle on exercise-induced physiological performance responses in women". *Sci Rep* 12(2022):9976.
29. Janse de Jonge XAK. "Effects of the menstrual cycle on exercise performance". *Sports Med* 33(2003):833-851.
30. Bruinvels G, Hackney AC, Pedlar CR. "Menstrual Cycle: The Importance of Both the Phases and the Transitions Between Phases on Training and Performance". *Sports Med* 52(2022):1457-1460.

Cite this article: Bracegirdle N, Sanjurjo-Piedra A, Andersone-Vitola L. Menstrual Cycle Phase and Injury Risk in Team Sport: Evidence Quality Behind a Popular Claim. *J Sports Med Pain Manag*. 2025; 6: 013-018.

Ethics Approval and Consent to Participate

Not applicable. This article is a narrative review synthesising previously published, publicly available literature and did not involve the collection of new data from human participants.

Search Strategy

Sources were identified through targeted searches of MEDLINE, Embase, and SPORTDiscus, combined with manual forward and backward citation tracking from the foundational menstrual cycle and ACL injury-risk case-control literature, the systematic review and meta-analytic literature pooling this evidence, and the methodological standards literature for sport and exercise research involving women, restricted to peer-reviewed studies reported in English.