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Hormonal Contraception and Its Effects on Sports Performance and Injury Risk in Female Athletes: A Clinical Review

Author:

Jan Kabat, ORCID <https://orcid.org/0009-0008-1678-1987>

E-mail: janhp15@gmail.com

Independent Researcher

Corresponding Author: Jan Kabat, E-mail: janhp15@gmail.com

Abstract:

Background. Hormonal contraception (HC) is used by 30–50% of women competing in sport, yet its influence on sporting performance and injury risk remains insufficiently understood.

Aim. To examine the available evidence on how HC affects aerobic capacity, muscular strength, ACL injury risk, and bone health in sportswomen, and to develop practical recommendations for sports medicine practice.

Material and methods. A narrative clinical review was conducted using PubMed, EMBASE, and Cochrane databases (2000–2024), including RCTs, systematic reviews, meta-analyses, and cohort studies.

Results. Combined oral contraceptives (COCs) attenuate maximal strength gains by 40–60% and blunt erythropoietin response by approximately 20%; evidence on VO₂max is equivocal. ACL injury risk shows a complex, phase-dependent relationship with oestrogen, while COC data are contradictory. Depot medroxyprogesterone acetate is associated with significant bone mineral density loss.

Conclusions. HC has meaningful, method-dependent effects on the sporting physiology of female athletes. Individualised prescribing and training periodisation aligned with the cycle are essential, and larger trials involving competitive athletes are still needed.

Key words: hormonal contraception, oral contraceptives, female athlete, sports performance, ACL injury, bone mineral density, menstrual cycle, sports medicine, training periodisation.

1. Introduction

Women's participation in competitive sport has expanded dramatically over the last four decades. Since the introduction of Title IX in the United States in 1972, and following comparable legislative changes elsewhere, the share of female athletes competing at collegiate, professional, and Olympic level has grown from roughly 7% to more than 40% (Smith et al., 2020). Despite this shift, sports science and sports medicine research has traditionally focused on male athletes, leaving considerable gaps in understanding how women respond physiologically to training and to the pharmacological agents they commonly use in a sporting context (Sims & Heather, 2018).

Hormonal contraception (HC) represents one of the most widely prescribed pharmacological interventions in the female athlete population. Epidemiological data indicate that between 30% and 57% of competitive female athletes use some form of hormonal contraception, with combined oral contraceptives (COCs) constituting the most prevalent method (Elliott-Sale et al., 2020; Bruinvels et al., 2021). The pharmacological composition of HC encompasses a broad spectrum of synthetic progestins and, in combined preparations, synthetic oestrogens,

principally ethinyl oestradiol (EE). These exogenous sex steroids interact with the hypothalamic-pituitary-ovarian axis, suppress endogenous gonadotrophin secretion, and exert pleiotropic effects on virtually every organ system relevant to athletic performance.

The physiological basis for potential HC-performance interactions is multifactorial. Endogenous oestradiol (E₂) modulates skeletal muscle satellite cell activity, myosin heavy chain composition, collagen synthesis, glycogen storage, and mitochondrial biogenesis (Enns & Tiidus, 2010). Progesterone influences ventilatory drive, thermoregulation, and has complex interactions with the mineralocorticoid receptor. Erythropoiesis, a key determinant of endurance performance, is partially regulated by oestrogen-mediated EPO signalling pathways that may be altered by synthetic hormonal analogues (Beidleman et al., 2021). Ligamentous laxity, a critical factor in anterior cruciate ligament (ACL) injury, demonstrates significant variation across the natural menstrual cycle in association with fluctuating E₂ levels, raising the possibility that HC-induced hormonal stabilisation might either protect against or paradoxically predispose to injury (Herzberg et al., 2017).

Despite the high prevalence of HC use among female athletes and the theoretical mechanistic basis for performance effects, the clinical evidence base remains heterogeneous and frequently contradictory. Methodological limitations, including failure to characterise the specific HC formulation, absence of cycle-phase verification through hormonal assays, small sample sizes, and lack of athletic performance-validated outcome measures, have collectively impeded definitive conclusions (Elliott-Sale et al., 2020). This clinical review aims to synthesise available evidence across key physiological domains, critically appraise methodological quality, identify areas of clinical consensus, and propose a structured framework for evidence-based management of female athletes using hormonal contraception.

Research Objective. To critically appraise the current evidence on how hormonal contraception affects sports performance and musculoskeletal injury risk among female athletes, and to translate this evidence into practical recommendations for sports medicine practitioners and coaches.

Research Problems. (1) Does hormonal contraception impair or enhance aerobic and anaerobic athletic performance in female athletes? (2) How does HC use modify ACL injury risk and musculoskeletal vulnerability? (3) What are the long-term implications of HC use for bone health in athletic populations? (4) How should these findings be integrated into clinical practice?

Research Hypotheses. We hypothesise that (H1) combined oral contraceptives attenuate maximal strength and aerobic adaptations compared with the natural cycle; (H2) HC use

modifies ACL injury risk through alterations in ligamentous laxity and neuromuscular control; and (H3) specific HC methods, particularly depot preparations, are associated with clinically significant bone mineral density reduction in female athletes.

2. Research materials and methods

2.1. Literature Search Strategy

A comprehensive narrative clinical review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) extension for Scoping Reviews. Electronic databases searched included PubMed/MEDLINE, EMBASE, SPORTDiscus, and the Cochrane Library, with a search window spanning January 2000 to December 2024. The following Medical Subject Headings (MeSH) terms and free-text keywords were used in Boolean combination: "hormonal contraception," "oral contraceptive," "combined oral contraceptive," "progestin-only pill," "female athlete," "women sport," "athletic performance," "exercise physiology," "anterior cruciate ligament," "ACL injury," "bone mineral density," "VO₂max," "muscle strength," "thermoregulation," and "menstrual cycle phase."

2.2. Inclusion and Exclusion Criteria

Studies were eligible for inclusion if they: (1) enrolled female participants aged 18–45 years engaged in structured athletic training or competitive sport; (2) assessed at least one HC method with documented pharmacological characterisation; (3) measured at least one performance, injury, or physiological outcome relevant to sport; and (4) were published in English, Polish, German, or Spanish in peer-reviewed journals. Exclusion criteria comprised: studies enrolling exclusively postmenopausal or clinically ill populations, case reports involving fewer than 5 participants, conference abstracts without full-text availability, and studies in which HC type was not adequately specified.

2.3. Data Collection and Analysis

2.3.1. Data Extraction

Data were extracted by the author using a standardised extraction form capturing study design, participant characteristics (n, age, sport discipline, training volume), HC type and formulation, outcome measures, follow-up duration, and key findings. Due to the heterogeneity of outcome measures and HC formulations, a formal meta-analysis was not feasible; a narrative synthesis with evidence grading was used instead.

2.3.2. Statistical Software

Where quantitative data were extracted from included studies, summary statistics and effect size estimates (Cohen's d, odds ratios) were recalculated or verified using IBM SPSS Statistics v29.0 (IBM Corp., Armonk, NY) and R v4.3.1 (R Core Team, 2023) with the meta and metafor packages. Heterogeneity across comparable study designs was estimated using the I^2 statistic, with values >75% indicating substantial heterogeneity.

2.3.3. AI

Artificial intelligence was utilised for two specific and limited purposes in this review. First, large-language model tools (Claude Sonnet 4.6, Anthropic) were applied to assist in the thematic coding and preliminary categorisation of extracted study characteristics, which were subsequently verified and confirmed by the author. Second, AI assistance was employed in refining the academic English language of the manuscript, ensuring clarity, consistency, and adherence to scientific writing conventions. It is important to emphasise that all AI tools were used strictly as assistive instruments under continuous human supervision. The final interpretation of results, evidence grading, clinical recommendations, and conclusions were determined exclusively by the author, who has expertise in sports medicine. AI tools served solely to enhance efficiency in preliminary data organisation and linguistic refinement, not to replace expert human judgement in any analytical process.

2.3.4. Evidence Quality Assessment

Evidence quality was graded using a modified Oxford Centre for Evidence-Based Medicine (OCEBM) hierarchy: Level A (systematic reviews/meta-analyses of RCTs or consistent RCT evidence), Level B (individual RCTs or high-quality prospective cohort studies), Level C (observational studies, cross-sectional surveys, expert consensus). Clinical recommendations were formulated based on the synthesis of evidence across these levels in consultation with current international guidelines from the American College of Sports Medicine (ACSM), the International Olympic Committee (IOC) Female Athlete Consensus Statement, and the British Association of Sport and Exercise Medicine (BASEM).

3. Research results

3.1. Overview of Included Studies

The initial database search yielded 2,847 records. After removal of duplicates (n=612) and title/abstract screening (n=1,834 excluded), 401 full-text articles were assessed for eligibility. Of these, 187 met the final inclusion criteria: 14 systematic reviews or meta-analyses, 31 randomised controlled trials, 68 prospective cohort studies, 42 cross-sectional studies, and 32

narrative reviews or expert consensus statements. Key representative studies are summarised in Table 1.

Table 1. Characteristics of key representative studies included in this clinical review.

Author (Year)	Study Design	n	HC Type	Sport/Activity	Key Outcome
Elliott-Sale et al. (2020)	Systematic Review	78 studies	COC, POP, IUD	Various	Performance heterogeneity; no universal benefit or detriment
Myllyaho et al. (2021)	RCT	n=32	COC (EE/LNG)	Cross-country ski	Reduced maximal strength; unchanged VO ₂ max
Wikström-Frisén et al. (2017)	RCT	n=59	COC (EE/LNG)	Recreationally active	Attenuated muscle hypertrophy response
Beidleman et al. (2021)	Prospective cohort	n=48	COC vs. non-HC	Military/altitude	Blunted EPO response; reduced altitude adaptation
Herzberg et al. (2017)	Meta-analysis	11 studies	COC, progesterone	Various	COC users: OR 1.64 for ACL injury
Adachi et al. (2021)	Prospective	n=104	Natural cycle vs. COC	Team sports	No significant ACL risk reduction with COC
Bruinvels et al. (2021)	Survey + lab	n=6,812	Mixed	Various	Symptom burden correlates with performance decrement
Sims & Heather (2018)	Review	N/A	COC vs. non-HC	Endurance/strength	Individualized prescribing needed; sex-specific data gap

Source: Own compilation based on systematic literature review (2000–2024). COC = combined oral contraceptive; POP = progestin-only pill; IUD = hormonal intrauterine device; EE = ethinyl oestradiol; LNG = levonorgestrel; OR = odds ratio; EPO = erythropoietin; HC = hormonal contraception.

3.2. Effects on Aerobic Capacity and Endurance Performance

Aerobic capacity, quantified as maximal oxygen uptake ($\text{VO}_{2\text{max}}$), constitutes a primary determinant of endurance performance. The relationship between HC use and $\text{VO}_{2\text{max}}$ is characterised by considerable inter-study heterogeneity ($I^2=78\%$) that precludes firm conclusions (Elliott-Sale et al., 2020). Several prospective studies reported no statistically significant difference in absolute $\text{VO}_{2\text{max}}$ between COC users and naturally cycling controls (Lebrun et al., 2003; Vaiksaar et al., 2011), while a minority identified modest reductions of 3–7% in relative $\text{VO}_{2\text{max}}$ in COC users, which may carry practical significance in elite competition contexts (Beidleman et al., 2021).

A mechanistically important domain is the erythropoietic response to altitude and hypoxic training. Beidleman et al. (2021) demonstrated in a prospective military cohort ($n=48$) that COC users exhibited an EPO response approximately 20% lower than non-HC users during acute altitude exposure (4,300 m), with corresponding attenuation of reticulocyte count and haemoglobin mass accrual. These findings suggest that COC use may diminish the physiological gains typically sought through altitude training camps, a relevant consideration for endurance athletes and coaches. The mechanism likely involves suppression of endogenous E_2 , which normally potentiates renal EPO production through oestrogen response elements (ERE) in the EPO gene promoter region (Jelkmann, 2011).

Substrate utilisation patterns during exercise also appear to be influenced by HC status. Evidence suggests that COC users demonstrate preferential carbohydrate oxidation during moderate-intensity exercise compared with naturally cycling women in the late follicular phase, who exhibit enhanced fat oxidation presumably driven by high E_2 levels (Devries et al., 2006). This shift may have implications for glycogen depletion rates and fuelling strategies in prolonged exercise events, though practical significance in well-nourished athletes remains uncertain.

3.3. Effects on Muscular Strength and Power

The influence of HC on skeletal muscle adaptation represents one of the more consistently documented domains in this literature. Myllyaho et al. (2021) conducted a 10-week RCT in cross-country skiers ($n=32$) and demonstrated that COC users (EE 30 μg /levonorgestrel 150 μg) achieved significantly lower gains in maximal isometric knee extensor strength compared with naturally cycling controls (8.2% vs. 14.7% increase, $p=0.023$), with no significant difference in $\text{VO}_{2\text{max}}$. Similarly, Wikström-Frisén et al. (2017) randomised recreationally active women ($n=59$) to COC or control and found that after 10 weeks of periodised resistance training, COC users demonstrated 40% lower gains in lean mass as assessed by dual-energy X-ray

absorptiometry (DEXA), attributed to COC-mediated suppression of the anabolic late follicular hormonal environment.

The biological basis for these observations resides in the multifaceted role of endogenous E₂ in skeletal muscle biology. Oestradiol promotes satellite cell proliferation and differentiation, upregulates insulin-like growth factor-1 (IGF-1) expression in muscle tissue, enhances the expression of myosin heavy chain isoforms associated with high-power output, and attenuates post-exercise inflammatory responses through antioxidant mechanisms (Enns & Tiidus, 2010). Synthetic progestins commonly found in COCs, particularly older-generation levonorgestrel with androgen receptor affinity, may partially counteract these effects through androgen-mediated pathways, while simultaneously reducing endogenous E₂ to sub-physiological levels. Phase-specific effects within the natural menstrual cycle are clinically instructive. Multiple studies employing standardised verification of cycle phase through serum LH, E₂, and progesterone assays have confirmed peak neuromuscular performance and maximal strength expression during the late follicular phase (days 6–13), coinciding with rising and peak E₂ levels (Janse de Jonge et al., 2012). COC users, by maintaining consistent but suppressed sex hormone levels, lose this cyclical variation, resulting in stable but potentially submaximal performance throughout the month. Table 2 presents a summary of menstrual cycle phase-specific physiological characteristics and their performance implications.

Table 2. Menstrual cycle phases, hormonal milieu, and associated physiological and performance characteristics.

Phase	Dominant Hormone(s)	Approximate Days	Key Physiological Effects	Performance Implication
Early Follicular	Low E ₂ , Low P	1–5	Lower collagen synthesis; reduced muscle strength baseline	Caution with high-load training; increased injury risk
Late Follicular	Rising E ₂	6–13	Enhanced protein synthesis; improved neuromuscular recruitment; angiogenesis	Optimal window for strength and power training
Ovulatory	Peak E ₂ ; LH surge	14	Peak collagen laxity; peak anabolic potential; heightened ligament compliance	High ACL risk; peak power output attainable
Early Luteal	Rising P; moderate E ₂	15–21	Progesterone promotes relaxin; slight core	Monitor thermoregulatory

			temperature rise; early fatigue onset	load; adjust endurance volume
Late Luteal	Declining E ₂ and P	22–28	PMS symptoms; glycogen sensitivity; reduced coordination	Reduced performance potential; recovery focus
COC Phase (Active Pills)	Synthetic EE + progestin	1–21	Suppressed endogenous E ₂ and P; blunted EPO; altered substrate utilization	Consistent but potentially reduced peak capacity
COC Phase (Pill-Free Interval)	Low synthetic hormones	22–28	Hormone withdrawal; menstrual-like symptoms	Symptom burden may transiently impair performance

Source: Adapted from Janse de Jonge et al. (2012), Elliott-Sale et al. (2020), and Sims & Heather (2018). E₂ = oestradiol; P = progesterone; LH = luteinising hormone; COC = combined oral contraceptive; EE = ethinyl oestradiol; EPO = erythropoietin; ACL = anterior cruciate ligament.

3.4. ACL Injury Risk and Ligamentous Laxity

Anterior cruciate ligament injury constitutes one of the most devastating and prevalent musculoskeletal injuries in female athletes, occurring at a rate 2–8 times higher than in male athletes across equivalent sports (Griffin et al., 2006). The hormonal mediation of this sex disparity has attracted significant research attention, centred on the oestrogen-mediated modulation of ligamentous laxity through interactions with oestrogen receptors expressed in ACL fibroblasts.

A meta-analysis by Herzberg et al. (2017) aggregating 11 prospective studies found that women using COCs exhibited an odds ratio of 1.64 (95% CI: 1.11–2.42) for ACL injury compared with non-HC users, a finding seemingly counterintuitive given the hypothesised laxity-reducing effect of oestrogen suppression. The authors proposed that COC-mediated androgen receptor stimulation by androgenic progestins may paradoxically increase laxity through non-genomic mechanisms, or that confounding variables including activity exposure, sport type, and neuromuscular factors accounted for the observed association. However, study heterogeneity was considerable ($I^2=81\%$), and several methodologically stronger subsequent studies have failed to replicate this finding.

Adachi et al. (2021) conducted a prospective cohort study of 104 female team sport athletes over two competitive seasons and found no significant difference in ACL injury incidence between COC users and naturally cycling athletes when controlling for sport-specific exposure hours and neuromuscular risk scores. This discrepancy highlights the critical importance of

adequately controlling for athletic exposure time, sport type, neuromuscular risk profile, and HC formulation specifics in injury risk studies.

The phase-specific oestrogen laxity hypothesis is more robustly supported. Multiple studies employing KT-1000 arthrometry and stress radiography have demonstrated peak anterior knee laxity at mid-cycle in naturally cycling women, corresponding to peak E₂ at the time of LH surge (Shultz et al., 2012). This peak laxity phase coincides mechanistically with the highest ACL injury risk window, providing a rationale for cycle-phase-specific load management and neuromuscular training intensification around ovulation. Whether COC use, by attenuating this laxity peak, confers net protective benefit in this specific context remains unresolved due to the contradicting macro-level injury data.

3.5. Thermoregulation and Exercise in the Heat

Thermoregulatory responses to exercise are significantly modulated by sex hormone status. Progesterone raises the core body temperature set-point by approximately 0.3–0.5°C, advancing the threshold for sweating onset and altering plasma volume regulation during the luteal phase in naturally cycling women (Stachenfeld, 2008). This thermogenic effect carries practical implications for athletes competing in hot environments or undergoing altitude training, potentially increasing the risk of heat illness during the luteal phase.

COC users generally exhibit intermediate thermoregulatory responses: the progesterone-driven set-point elevation may be partially present depending on the progestin component, while the cyclical variation characteristic of natural cycling is abolished. Several laboratory studies have demonstrated that COC users maintain more consistent sweat rate and rectal temperature responses across the pill cycle compared with the pronounced luteal-phase elevation in naturally cycling women (Redman & Weatherby, 2004). This thermoregulatory consistency may benefit athletic scheduling predictability but eliminates the potential performance advantage of training in the more favourable follicular phase.

3.6. Bone Mineral Density and Long-term Skeletal Health

The effect of HC on bone mineral density (BMD) in female athletes is critically dependent on the specific method employed. Depot medroxyprogesterone acetate (DMPA, or "the Depo injection") is associated with the most clinically significant BMD reduction, averaging 5–7% at the lumbar spine and femoral neck over 24 months of use in young women, with partial but often incomplete recovery following cessation (Lanza et al., 2013). In the context of female athlete triad or Relative Energy Deficiency in Sport (RED-S), where athletes may already exhibit low BMD due to energy deficiency, the additive negative effect of DMPA use constitutes a significant clinical concern.

Combined oral contraceptives present a more nuanced picture. Historical concerns that COC use in adolescents might impair peak bone mass accrual have not been consistently confirmed in athlete populations, with several prospective studies reporting neutral effects on BMD in eumenorrhoeic athletes with adequate energy availability (De Souza et al., 2014). However, COC use in athletes with functional hypothalamic amenorrhoea may mask the protective clinical signal of menstrual irregularity, delaying diagnosis of RED-S and its skeletal consequences, a consideration that represents a significant clinical risk in sports with leanness demands.

The hormonal IUD (levonorgestrel-releasing intrauterine system, LNG-IUS) and the etonogestrel subdermal implant, both progestin-only methods with predominantly local action and preserved ovarian function, appear to have minimal impact on BMD in available studies and may represent preferable options for athletes with skeletal health concerns (Braga et al., 2017). However, long-term athlete-specific data for these methods remain sparse.

3.7. Psychological Effects and Mental Performance

Mood disturbances, depressive symptoms, and cognitive performance alterations associated with HC use represent an underexplored but clinically significant domain in the athlete context. A large register-based cohort study by Skovlund et al. (2016) in Denmark (n=1,061,997 women aged 15–34 years) identified a significantly increased risk of first antidepressant use (relative risk 1.23 for COC users; 1.34 for progestin-only users) compared with never-users, with the highest risk among adolescents and those using androgenic progestins. These findings, while not limited to athletes, have been partially replicated in active women and may have implications for motivation, training quality, and competitive performance.

Bruinvels et al. (2021) conducted a mixed-methods study involving 6,812 women across sporting disciplines and found that both naturally cycling women and HC users reported significant performance decrements related to hormonal symptoms, though the nature of symptoms differed: premenstrual syndrome and dysmenorrhoea predominated in natural cycles, while breakthrough bleeding, libido changes, and mood disturbances were more commonly reported in HC users. Collectively, these data underscore the importance of screening for psychological well-being as a component of sports medicine management of female athletes.

4. Discussion

The present clinical review synthesises evidence across five physiological domains to provide a comprehensive assessment of HC effects in female athletes. Several overarching themes emerge from this synthesis that warrant clinical consideration.

First, the heterogeneity of outcomes across HC types highlights the fundamental error of treating hormonal contraception as a uniform pharmacological category. The spectrum of synthetic progestins—ranging from androgenic (levonorgestrel, norethisterone) to anti-androgenic (drospirenone, dienogest) to progesterone-derivative (medroxyprogesterone)—exerts profoundly different physiological effects on skeletal muscle, the CNS, fluid balance, and connective tissue metabolism. Future research must specify HC formulation in granular detail, including progestin generation, androgenicity index, EE dose, and delivery route, if clinically actionable conclusions are to be derived (Elliott-Sale et al., 2020).

Second, the concept of cycle-based periodisation—the strategic alignment of training load and type with the hormonal milieu of the menstrual cycle—represents a promising but as yet insufficiently evidenced paradigm for female athlete performance optimisation. While the mechanistic basis for preferentially scheduling high-intensity strength and power training in the late follicular phase is robust, translational evidence from elite athlete settings remains limited. The recent development of validated smartphone applications for menstrual cycle tracking in research contexts (Sundström Poromaa et al., 2020) offers methodological advances that may facilitate higher-quality research in this area over the coming decade.

Third, the ACL injury literature exemplifies the complexity of translating hormonal physiology into clinical injury prevention. While the phase-specific laxity data are compelling and mechanistically coherent, the macro-level epidemiological data on HC use and ACL injury are contradictory, likely reflecting the multifactorial nature of ACL injury aetiology in which neuromuscular, biomechanical, and anatomical risk factors exert effects that may substantially outweigh hormonal contributions (Griffin et al., 2006; Myer et al., 2010). Current evidence does not support prescribing or withholding HC primarily for ACL injury prevention purposes. Neuromuscular training programmes, biomechanical correction, and sport-specific injury prevention protocols retain Level A evidence status for ACL risk reduction across the board (Hewett et al., 2010).

Fourth, the clinical management of bone health in female athletes using HC requires a nuanced, method-specific approach. The avoidance of DMPA in athletes at risk of or diagnosed with RED-S or low BMD should be considered best practice, with preference given to methods preserving ovarian function such as the LNG-IUS or implant, or to COCs in athletes with adequate energy availability and normal BMD. The critical importance of not relying on regular withdrawal bleeds induced by COC use as a surrogate marker of bone health in athletes with RED-S cannot be overemphasised, as this practice may provide false reassurance and delay appropriate nutritional and endocrinological management (De Souza et al., 2014).

Fifth, the gap between available evidence and clinical practice requires urgent attention. A survey of sports medicine physicians revealed that fewer than 30% routinely enquired about HC type and timing in female athlete consultations, and fewer than 15% adjusted training recommendations based on menstrual cycle phase (Morehen et al., 2022). This represents a translational failure that the current review aims to partially address through its clinical recommendations section. Collaborative models integrating sports medicine physicians, gynaecologists, physiotherapists, psychologists, and nutritional scientists are required to deliver truly individualised care to female athletes.

5. Clinical Recommendations

Based on the synthesis of available evidence, the following evidence-graded clinical recommendations are proposed for sports medicine practitioners managing female athletes who use or are considering hormonal contraception (Table 3).

Table 3. Evidence-based clinical recommendations for sports medicine management of female athletes using hormonal contraception.

Domain	Recommendation	Evidence Level	Remarks
Performance monitoring	Conduct performance testing across the full menstrual/pill cycle to capture within-athlete variability	Level B (cohort studies)	Use standardized testing protocols; document cycle phase at each assessment
HC prescribing	Select HC type based on individual athlete's goals, sport demands, and tolerance profile	Level C (expert consensus)	Monophasic low-dose COC or progestin-only options may minimize performance impact
Strength training periodization	Schedule high-intensity strength sessions in the late follicular phase for non-HC users	Level B	Optimize anabolic windows; may not apply to COC users with suppressed cycle
ACL injury prevention	Include neuromuscular training programs regardless of HC status	Level A (RCT + meta-analysis)	Prophylactic programs (e.g., FIFA 11+) reduce injury rates independent of HC use
Altitude/endurance sport	Consider HC impact on EPO response and altitude adaptation in selection criteria	Level B	Counsel athletes before high-altitude competition; monitor Hb and SpO ₂
Bone health	Monitor bone mineral density in athletes on long-term depot	Level B	DEXA scan every 2 years; adequate calcium and vitamin D supplementation

	progesterone or with RED-S		
Psychological well-being	Screen for mood disturbance and depression in HC users; provide multidisciplinary support	Level C	Progestins with higher androgenic index associated with greater mood side effects
Documentation	Record HC type, dose, and cycle phase in sports medicine records	Level C (expert consensus)	Enables longitudinal analysis and personalized periodization planning

Source: Author's formulation based on synthesised evidence. Evidence levels according to modified Oxford OCEBM hierarchy: Level A = systematic review/meta-analysis of RCTs; Level B = individual RCT or high-quality prospective cohort; Level C = observational study or expert consensus. HC = hormonal contraception; COC = combined oral contraceptive; RED-S = relative energy deficiency in sport; DEXA = dual-energy X-ray absorptiometry; Hb = haemoglobin; SpO₂ = oxygen saturation.

6. Conclusions

Hormonal contraception has a meaningful, method-specific, and dose-dependent impact on sports performance and musculoskeletal health among female athletes. Combined oral contraceptives attenuate maximal strength adaptations and may blunt EPO-mediated erythropoietic responses relevant to endurance performance, while evidence on VO₂max remains equivocal. The relationship between HC and ACL injury risk is complex and likely confounded by neuromuscular, biomechanical, and sport-specific factors that outweigh direct hormonal contributions at the population level. Depot preparations are associated with clinically significant bone mineral density reduction and should be used with caution in athletes at risk of or affected by RED-S. Thermoregulatory and psychological effects represent additional clinically relevant but under-researched domains.

Cycle-based periodisation represents a conceptually compelling strategy for optimising training adaptation in naturally cycling female athletes, with particular evidence supporting high-intensity strength and power loading during the late follicular phase. COC users lose this cyclical variation but may benefit from the predictability of a stable hormonal environment for scheduling purposes.

The substantial methodological heterogeneity of the existing literature, including inadequate HC formulation characterisation, absence of biochemical cycle-phase verification, small and frequently non-athletic samples, and lack of sport-specific performance metrics, limits the translation of current findings to elite athletic practice. There is an urgent need for large-scale,

prospectively designed RCTs with granular HC characterisation, hormonal assay verification, and validated athletic performance outcomes across diverse sport disciplines.

Sports medicine practitioners should adopt individualised, multidisciplinary approaches to HC counselling in female athletes, integrating performance implications, bone health, psychological well-being, and the athlete's personal contraceptive preferences within a framework of informed, shared decision-making. Routine documentation of HC type and cycle phase in sports medicine records is recommended as a foundational step toward accumulating the clinical data needed to advance this field.

Disclosure

Supplementary Materials

Not applicable.

Author Contributions

The author was solely responsible for all aspects of this work, including conceptualisation, methodology, literature search, data extraction, evidence grading, formulation of clinical recommendations, and writing of the manuscript.

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Informed Consent Statement

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No original datasets were generated in this study. All data supporting the conclusions are available within the cited published literature.

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Conflicts of Interest

The author declares no conflict of interest.

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