15 (2) (2026) 1354-1365

Journal of Physical Education, Sport, Health and Recreations

http://journal.unnes.ac.id/journals/peshr

Doping and Reproductive Health in Female Athletes: A Narrative Literature Review

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Keywords

doping;
female athlete;
reproductive health;
anabolic-androgenic steroids

Abstract

Doping is not only a violation of sport integrity but also a health-risk behaviour with specific implications for female athletes. This narrative literature review synthesises peer-reviewed studies, consensus statements, and official anti-doping documents published mainly between 2014 and 2026. The review focused on prohibited substances and methods that may affect endocrine regulation, menstrual function, fertility potential, virilisation, sexual health, and athlete well-being. The strongest evidence concerns anabolic-androgenic steroids, which can disrupt the hypothalamic-pituitary-ovarian axis, impair ovulation, cause oligomenorrhea or amenorrhea, reduce fertility potential, and produce androgenic changes such as acne, hirsutism, voice deepening, breast atrophy, and clitoromegaly. Human growth hormone, stimulants, hormone modulators, diuretics, and masking practices may contribute to reproductive-health risk indirectly through metabolic disturbance, cardiovascular strain, neuroendocrine stress, appetite suppression, low energy availability, and substance stacking. Menstrual dysfunction should not be interpreted as direct proof of doping because relative energy deficiency in sport, psychological stress, training load, eating disorders, pregnancy, and endocrine disease may produce overlapping symptoms. Prevention therefore requires gender-responsive anti-doping education, confidential medical referral, menstrual-health monitoring, supplement-risk counselling, therapeutic-use guidance, psychological support, and consistent anti-doping control. The review concludes that clean-sport policy should be integrated with reproductive-health protection so that female athletes receive both fair-competition safeguards and clinically appropriate support.

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p-ISSN 2460-724X
e-ISSN 2252-6773

INTRODUCTION

Sport is commonly associated with physical fitness, achievement, discipline, and social development. However, competitive sport can also generate pressure to win, obtain selection, recover rapidly from injury, maintain scholarship status, or achieve a particular body composition. Under these conditions, some athletes may encounter performance-enhancing substances through peers, coaches, informal supplement markets, online forums, or gym-based drug cultures. Performance-enhancing substance use has been described as a persistent problem in sport, while global epidemiological evidence indicates that non-medical anabolic-androgenic steroid (AAS) use is not restricted to elite athletes but also appears in recreational and appearance-oriented settings (Momaya et al., 2015; Sagoe et al., 2014).

The World Anti-Doping Code defines doping through anti-doping rule violations rather than through a positive test alone. These violations include presence, use or attempted use, evasion, refusal or failure to submit to sample collection, whereabouts failures, tampering, possession, trafficking, administration, complicity, prohibited association, and acts that discourage reporting (World Anti-Doping Agency, 2021). This broader definition is important for sport-health research because athlete risk can begin before a formal violation is detected. It may begin when athletes normalise unsafe practices, obtain substances without medical supervision, receive misleading advice, or conceal symptoms because they fear sanctions.

The WADA Prohibited List is updated annually and classifies substances and methods that are prohibited at all times, prohibited in competition, or prohibited in particular sports. The 2026 list includes categories such as anabolic agents, peptide hormones and growth factors, beta-2 agonists, hormone and metabolic modulators, diuretics and masking agents, stimulants, narcotics, cannabinoids, glucocorticoids, blood manipulation, and gene or cell manipulation (World Anti-Doping Agency, 2026). These regulatory categories are clinically relevant because different substance classes produce different mechanisms of harm. AAS can directly alter androgenic signalling, while stimulants, human growth hormone (HGH), hormone modulators, and masking practices may increase risk through metabolic, cardiovascular, behavioural, or neuroendocrine pathways.

Female reproductive health should be understood broadly. It includes regular ovulatory menstrual cycles, balanced hypothalamic-pituitary-ovarian (HPO) signalling, fertility potential, healthy secondary sexual characteristics, sexual function, pregnancy safety, bone health, psychological well-being, and access to confidential care. In athletes, menstrual-cycle changes may affect training interpretation and health monitoring, while systematic review evidence suggests that menstrual-cycle phase can have small or variable effects on exercise performance (McNulty et al., 2020). Reproductive symptoms should therefore be taken seriously as health signals, not dismissed as a normal cost of training.

At the same time, menstrual dysfunction in sport has multiple possible causes. Relative energy deficiency in sport (REDs), low energy availability, overtraining, rapid weight loss, eating disorders, psychological stress, pregnancy, thyroid disease, polycystic ovary syndrome, medication use, and prohibited substances may produce overlapping symptoms (Mountjoy et al., 2023). This overlap requires careful interpretation. A review of doping and female reproductive health must avoid two errors: attributing every menstrual problem to doping, or ignoring doping exposure when reproductive symptoms appear.

AAS are the most relevant and best-documented class of doping substances in relation to female reproductive health. These synthetic derivatives of testosterone are used to increase muscle mass, strength, recovery, and sometimes appearance. In women, supraphysiological androgen exposure can disturb HPO-axis feedback, alter gonadotropin signalling, impair ovulation, and create a hyperandrogenic state (Anawalt, 2019; Christou et al., 2017; La Vignera et al., 2018). Clinical and qualitative literature reports outcomes such as oligomenorrhea, amenorrhea, anovulation, acne, hirsutism, clitoromegaly, breast atrophy, voice deepening, libido changes, and psychological distress (Havnes et al., 2021; Santos et al., 2024).

The topic is also important because women's participation in competitive sport, strength training, physique sport, and fitness culture has continued to increase. This growth is positive, but it is accompanied by body-image pressure, social-media exposure, and easier access to performance- and image-enhancing drugs. Women who use AAS may face specific barriers to

disclosure, including stigma, fear of sanctions, limited women-specific medical information, and the assumption that steroid misuse is mainly a male issue (Piatkowski et al., 2023). In addition, female AAS users may experience psychopathological symptoms and health-service barriers that require sensitive clinical management rather than judgemental communication (Scarth et al., 2022).

Previous studies have addressed performance-enhancing drugs, AAS endocrinology, anti-doping ethics, and athlete education. However, women remain underrepresented in many clinical and epidemiological studies of AAS and other prohibited substances. Available evidence often comes from case reports, clinical reviews, qualitative studies, cross-sectional surveys, non-elite athlete samples, or recreational strength-training populations (Christou et al., 2017; Skrzypiec-Spring et al., 2024). This limitation does not indicate that the risk is minor. It indicates that sport-science scholarship needs a more gender-responsive synthesis that connects anti-doping regulation with reproductive-health protection.

Based on these considerations, this review addresses four questions: (1) how is doping defined and classified in sport; (2) which prohibited substances are most relevant to female reproductive health; (3) how may these substances affect menstrual function, fertility potential, virilisation, sexual health, and psychological well-being; and (4) what prevention strategies are appropriate for sport organisations, coaches, medical staff, lecturers, and athletes? The objective is to provide a literature-based synthesis that is useful for clean-sport education and female athlete health protection.

METHODS

This study used a narrative literature review with a structured search strategy. A narrative approach was selected because the topic combines sport science, anti-doping regulation, endocrinology, reproductive health, psychology, and athlete education. The purpose was not to calculate pooled effect sizes, but to synthesise mechanisms, reported outcomes, practical implications, and evidence gaps relevant to female athletes.

The literature search was conducted in June 2026 through PubMed, Google Scholar, SpringerLink, ScienceDirect, open-access journal repositories, WADA documents, and sport-integrity education resources. The core Boolean search string, adapted to the syntax of each database, was: ("doping" OR "anabolic-androgenic steroid*" OR "performance-enhancing substance*" OR "human growth hormone" OR stimulant* OR "hormone modulator*" OR diuretic* OR "masking agent*") AND ("female athlete*" OR women) AND ("reproductive health" OR menstru* OR fertility OR ovulation OR virilisation OR "sexual health" OR endocrine OR "relative energy deficiency in sport" OR REDs). Reference-list screening and targeted supplementary searches were used to identify relevant anti-doping education and athlete-health guidance.

The inclusion criteria were: peer-reviewed articles, systematic reviews, clinical reviews, qualitative studies, consensus statements, official anti-doping documents, and sport-health authority materials; publications discussing doping, performance-enhancing substances, endocrine effects, menstrual function, fertility, virilisation, sexual health, pregnancy-related risk, psychological effects, or prevention; sources published mainly from 2014 to 2026; and sources written in English or Indonesian. Sources published before 2014 were eligible only when they provided irreplaceable historic or foundational clinical evidence on female androgenisation or documented doping exposure that cannot be ethically reproduced in contemporary experimental research; otherwise, more recent evidence was prioritised.

The exclusion criteria were non-academic blogs, unsourced opinion pieces, sources focused only on male fertility without relevance to female athlete health, articles discussing legal supplementation without a link to prohibited substances, and duplicate materials. Articles were not excluded merely because they examined recreational strength athletes rather than elite athletes, because women-specific evidence in elite sport remains limited. However, population differences were considered when interpreting the findings.

Data were extracted into thematic categories: substance class, intended performance effect, endocrine mechanism, reproductive-health outcome, psychological or social pathway, evidence strength, and prevention implication. The synthesis was descriptive and comparative.

Findings were grouped into regulatory, physiological, clinical, psychological, and preventive themes. Because many studies on women who use AAS involve small samples or self-reported histories, this review uses cautious language and avoids unsupported claims of universal or permanent infertility.

The credibility of the synthesis was strengthened by prioritising official WADA documents, peer-reviewed medical and sport-science literature, and recent consensus statements. Nevertheless, this review does not replace a systematic review with meta-analysis. Its value lies in integrating evidence for a practical sport-science audience, especially coaches, lecturers, athlete-support personnel, and undergraduate or postgraduate researchers preparing anti-doping education materials.

Table 1. Search strategy and review procedure

Review componen	Description
Design	Narrative literature review with structured search and thematic synthesis.
Main databases and sources	PubMed, Google Scholar, SpringerLink, ScienceDirect, open-access journal repositories, WADA documents, and sport-integrity education resources.
Core Boolean search	Doping-related terms AND female-athlete/women terms AND reproductive-health terms; wildcards and syntax were adapted for each database.
Inclusion focus	Peer-reviewed and official sources on doping, endocrine function, menstrual health, fertility, sexual health, psychological effects, and prevention.
Analysis	Descriptive comparison by substance class, biological mechanism, reported outcome, evidence limitation, and prevention implication.

RESULTS AND DISCUSSION

The literature synthesis produced five major findings. First, doping is both a regulatory violation and a health-risk behaviour. Second, AAS provide the clearest evidence of direct reproductive risk for female athletes. Third, HGH, stimulants, hormone modulators, diuretics, and masking practices may increase reproductive-health risk indirectly through metabolic, cardiovascular, behavioural, and neuroendocrine pathways. Fourth, menstrual dysfunction in athletes must be interpreted carefully because doping, REDs, stress, training load, and endocrine disease can overlap. Fifth, prevention must combine testing and sanctioning with education, medical monitoring, confidential referral, and gender-responsive support.

The evidence is not uniform across substance classes. For AAS, there is a stronger mechanistic basis and more consistent reporting of menstrual and virilising outcomes. For HGH and stimulants, the reproductive-health pathway is more indirect and depends on metabolic disturbance, appetite suppression, sleep disruption, stress activation, dehydration, or stacking with other substances. Therefore, the discussion below separates direct androgenic mechanisms from indirect pathways.

Table 2. Evidence map of selected literature used in the review

Source	Type	Contribution to the review
WADA (2021, 2026)	Official anti-doping standards	Defines anti-doping rule violations and current prohibited substance categories.
Momaya et al. (2015)	Clinical review	Summarises performance-enhancing substance categories, motives, and health risks in sport.
Sagoe et al. (2014)	Meta analysis/meta-regression	Shows that non-medical AAS use is a global public-health issue beyond elite sport.
Pope et al. (2014)	Scientific statement	Summarises cardiovascular, psychiatric, metabolic, endocrine, neurological, hepatic, renal, and infectious consequences of PED use.
Anawalt (2019)	Clinical review	Explains diagnosis and management of AAS use and endocrine feedback effects.
Christou et al. (2017)	Systematic review/meta-analysis	Reports reproductive-system effects of AAS, including menstrual irregularity and subfertility.
Nieschlag & Vorona (2015)	Endocrine review	Explains systemic adverse effects of AAS outside the reproductive system.
La Vignera et al. (2018)	Review	Connects sport, doping, HPO-axis disruption, and female fertility.
Havnes et al. (2021)	Qualitative study	Describes women's experiences of masculinising, gonadal, and sexual effects.
Piatkowski et al. (2023)	Qualitative study	Explains gendered practices, stigma, and women-specific harm-reduction needs.
McNulty et al. (2020)	Systematic review/meta-analysis	Clarifies menstrual-cycle considerations in exercise performance and monitoring.
Mountjoy et al. (2023)	IOC consensus statement	Explains REDs as an overlapping cause of menstrual and systemic dysfunction.
Santos et al. (2024)	Review	Summarises mechanisms and potential effects of AAS on female health and offspring.
Scarth et al. (2022)	Observational study	Discusses psychopathology among AAS-using and non-using female athletes.
Skrzypiec Spring et al. (2024)	Case-report analysis/review	Shows the clinical relevance of AAS abuse as a reproductive-health and social problem.
United States Anti-Doping Agency (n.d.)	Sport-integrity education resource	Provides athlete-facing education on the health effects of performance-enhancing drugs.

Definition and regulatory classification of doping

Doping is often simplified as the use of banned drugs to win competition. This explanation is useful for public education but incomplete for scientific discussion. The World Anti-Doping Code recognises doping through a set of anti-doping rule violations that include substance presence, use, possession, trafficking, administration, evasion, tampering, complicity, and prohibited association (World Anti-Doping Agency, 2021). This legal-regulatory framing is important because athlete health can be endangered not only by the substance itself but also by networks of supply, concealment, misinformation, and pressure.

The WADA Prohibited List distinguishes substances prohibited at all times from substances prohibited only in competition or in particular sports (World Anti-Doping Agency, 2026). This distinction prevents inaccurate generalisation. For example, anabolic agents and many peptide hormones are prohibited at all times because their performance effects and health risks are not limited to the competition day. Some stimulants are prohibited in competition because they may increase alertness, reduce fatigue, or alter risk-taking. Meanwhile, legal ergogenic aids should not be described as doping unless they are prohibited or used through a prohibited method.

From a reproductive-health perspective, classification matters because each substance class has a different pathway of harm. AAS expose the female body to supraphysiological androgenic signals. HGH and metabolic modulators may influence reproductive health through glucose metabolism, fluid balance, and endocrine instability. Stimulants may affect sleep, appetite, stress, and energy availability. Diuretics and masking agents may not directly damage ovarian function, but they can intensify dehydration, electrolyte imbalance, and unsafe weight-control behaviour.

Epidemiology, access, and female-athlete vulnerability

Doping behaviour is shaped by more than lack of knowledge. Athletes may be influenced by competition pressure, selection systems, injury recovery demands, physique expectations, scholarships, financial rewards, and social recognition. A review of performance-enhancing substances in sport emphasised that reported use varies by population and substance class, while some substances carry serious medical consequences (Momaya et al., 2015). A global meta-analysis also framed non-medical AAS use as a widespread public-health issue rather than a problem limited to elite competition (Sagoe et al., 2014).

Female athletes may experience additional vulnerability because performance pressure can intersect with gendered expectations about leanness, muscularity, femininity, and appearance. In physique, strength, aesthetic, and weight-category sports, athletes may be exposed to both performance-enhancement motives and appearance-enhancement motives. This distinction is important because some women may not identify their behaviour as doping if the primary motive is body composition rather than competition results.

Qualitative research shows that women who use AAS may rely on partners, gym networks, online forums, or peers for dosing information and side-effect management (Havnes et al., 2021; Piatkowski et al., 2023). Such information is often informal and may not be medically reliable. Products obtained outside regulated medical channels may be counterfeit, contaminated, mislabeled, or stacked with other substances. These risks can be intensified by fear of disclosure, because athletes may delay medical consultation until symptoms become visible, persistent, or psychologically distressing.

Athlete-facing education materials from anti-doping agencies are useful because they translate complex medical information into accessible prevention messages, but education must be linked with confidential support. Information about performance-enhancing drugs should include both fairness and health consequences, including cardiovascular, psychological, endocrine, and reproductive risks (United States Anti-Doping Agency, n.d.). For female athletes, reproductive-health education should be explicit rather than assumed.

AAS and disruption of the HPO axis

The HPO axis regulates menstrual function through coordinated signalling between the hypothalamus, pituitary gland, and ovaries. Pulsatile gonadotropin-releasing hormone stimulates pituitary release of luteinising hormone and follicle-stimulating hormone, which support follicular development, ovulation, and ovarian hormone production. AAS misuse can disrupt this system by exposing the body to androgen levels above normal female physiology (Anawalt, 2019; La Vignera et al., 2018).

When HPO-axis signalling is disrupted, ovulation may become irregular or absent. This can appear as oligomenorrhea, amenorrhea, unpredictable bleeding, or anovulation. A systematic review and meta-analysis on AAS and reproductive outcomes reported clitoromegaly, menstrual irregularities, and subfertility among the reproductive-system effects associated with AAS use (Christou et al., 2017). These outcomes should not be dismissed as normal adaptation to hard training because they indicate endocrine disturbance requiring assessment.

AAS-related risk is not limited to reproductive organs. Reviews of performance-enhancing drugs and AAS report broader cardiovascular, hepatic, dermatological, psychiatric, metabolic, and endocrine consequences (Nieschlag & Vorona, 2015; Pope et al., 2014). These systemic effects matter for female reproductive health because ovarian function is sensitive to overall metabolic and neuroendocrine status. A substance that increases blood pressure, dyslipidemia, mood disturbance, or metabolic stress can indirectly worsen the health environment in which reproductive function operates.

The degree of recovery after discontinuation varies by individual. Factors that may influence recovery include dosage, duration of use, compound type, stacking, age, nutritional status, genetic sensitivity, and underlying endocrine conditions. It is therefore more accurate to state that AAS misuse can reduce reproductive function and may cause persistent effects in some women, rather than claiming that all exposed women will develop permanent infertility. This cautious language is important for scientific accuracy and ethical communication.

Table 3. Conceptual pathway linking doping exposure and reproductive-health outcomes

Exposure	Primary pathway	Possible outcomes	Clinicalinterpretation
AAS use or stacking	Supraphysiological androgen exposure and HPO-axis disruption	Oligomenorrhea, amenorrhea, anovulation, subfertility, virilisation, sexual-health changes	Requires confidential endocrine and reproductive health assessment.
HGH or metabolic modulators	Metabolic and endocrine instability; possible interaction with AAS, insulin, or thyroid hormones	Cycle vulnerability through systemic stress, glucose disturbance, or combined-drug effects	Interpret cautiously because direct reproductive evidence is less clear.
Stimulants or weight-control substances	Appetite suppression, sleep disruption, dehydration, sympathetic activation, low energy availability	Menstrual disturbance, stress symptoms, REDs overlap	Assess nutrition, training load, stress, medication, and prohibited-substance exposure.
Diuretics or masking agents	Rapid weight change, electrolyte imbalance, dehydration, concealment behaviour	Metabolic stress and unsafe weight-control pattern	Refer for sport-medicine, nutrition, and anti-doping guidance.

Menstrual dysfunction, ovulatory health, and fertility potential

Regular menstruation is a practical indicator of athlete health. Menstrual-cycle disturbance may signal low energy availability, pregnancy, thyroid disease, polycystic ovary syndrome, psychological stress, medication effects, or prohibited substance exposure. McNulty et al. (2020) showed that menstrual-cycle phase can be relevant to exercise-performance interpretation, although individual variability is substantial. This finding supports the need for individualised monitoring rather than simplistic assumptions about female performance.

For AAS, menstrual dysfunction is typically linked to androgen excess and disrupted gonadotropin regulation. La Vignera et al. (2018) emphasised that sport, doping, and female fertility are difficult to separate because strenuous training and low energy availability can also affect ovarian function. Therefore, menstrual irregularity alone should never be used as proof of doping. However, the presence of acne, hirsutism, rapid muscle gain, voice change, clitoral enlargement, mood change, or unexplained endocrine findings should increase clinical suspicion and justify confidential assessment.

REDs is particularly important in differential interpretation. The 2023 IOC consensus statement defines REDs as impaired physiological and/or psychological functioning caused by problematic low energy availability, with consequences for menstrual function, bone health, metabolism, immunity, cardiovascular health, and mental health (Mountjoy et al., 2023). This means that menstrual dysfunction in a female athlete must be evaluated through a multidimensional history: training load, energy intake, body-mass changes, injury, stress, sleep, supplements, medication, and possible exposure to prohibited substances.

Fertility depends on coordinated ovulation, hormonal balance, uterine receptivity, and general health. AAS misuse can reduce fertility potential by disrupting ovulation and producing hyperandrogenic effects. Case-report analysis and review evidence also indicates that AAS abuse has reproductive-health consequences that may appear across clinical contexts,

including infertility-related presentations (Skrzypiec-Spring et al., 2024). Because athlete-specific pregnancy exposure data are limited for ethical reasons, prevention should follow the precautionary principle: non-medical use of anabolic hormones, growth factors, stimulants, and hormone modulators is unsafe during pregnancy planning or pregnancy unless legitimate medical treatment is managed by qualified clinicians.

Therapeutic use should be distinguished from self-administered doping. Athletes with genuine medical indications require appropriate clinical care and may need therapeutic use exemption guidance. Coaches, lecturers, and anti-doping educators should avoid giving medical advice beyond their competence. Their role is to refer athletes to sports physicians, obstetrician-gynaecologists, endocrinologists, nutritionists, and mental-health professionals when reproductive symptoms appear.

Virilisation, sexual health, and psychological consequences

Virilisation is one of the most distinctive consequences of AAS exposure in women. It may include acne, hirsutism, androgenic alopecia, deeper voice, breast atrophy, clitoromegaly, altered fat distribution, and changes in libido. Havnes et al. (2021) showed that women's experiences of masculinising, gonadal, and sexual effects are complex because some effects may initially be interpreted as acceptable or useful but later become distressing, visible, or difficult to reverse.

Voice deepening is clinically important because it may persist after AAS discontinuation. Clitoromegaly may also persist and may influence sexual comfort, body image, relationship dynamics, and willingness to seek medical care. Hirsutism and acne may improve after discontinuation but can require dermatological or endocrine treatment. Santos et al. (2024) emphasised that AAS can affect female physiology through multiple mechanisms and may also raise concerns for offspring health, although the evidence base includes preclinical and heterogeneous human data. This reinforces the need for caution rather than overgeneralisation.

Psychological consequences are also central. Performance-enhancing drugs have been associated with psychiatric and behavioural risks, including mood disturbance and aggression in some contexts (Pope et al., 2014). In female athlete populations, Scarth et al. (2022) reported psychopathology concerns among AAS-using and non-using athletes, suggesting that substance use should be interpreted in relation to broader mental-health and sport-pressure environments. A punitive-only approach may detect violations but fail to address the psychological and social pathways that lead to use.

Gender-responsive prevention should address body image, stigma, misinformation, fear of sanctions, and low access to women-specific medical advice. Piatkowski et al. (2023) argued that women's AAS practices and harm-reduction needs differ from men's, which means anti-doping education should not simply adapt male-focused material by changing examples. It should explicitly discuss menstrual health, virilisation, fertility potential, sexual health, and confidential referral.

HGH, stimulants, hormone modulators, and indirect reproductive pathways

HGH is prohibited because it may be misused to support body composition, tissue growth, perceived recovery, or anti-aging effects. Unlike AAS, HGH does not masculinise the body through androgen-receptor pathways. Its reproductive relevance is more indirect. Chronic misuse may disturb glucose metabolism, promote insulin resistance, increase fluid retention, and contribute to systemic health problems (Pope et al., 2014). When stacked with AAS, insulin, thyroid hormones, or stimulants, HGH can become part of a complex endocrine-risk environment.

Stimulants may be used to increase alertness, reduce fatigue, improve concentration, or suppress appetite. Their direct risks include increased heart rate, hypertension, anxiety, insomnia, dehydration, and impaired judgement. Their reproductive effects are usually indirect rather than purely ovarian. Appetite suppression and sleep disruption can contribute to low energy availability and stress activation, both of which may destabilise menstrual-cycle function. This pathway is especially relevant in weight-category, aesthetic, endurance, and physique-oriented sports.

Hormone and metabolic modulators may be misused to alter endocrine profiles, manage side effects, or conceal prohibited substance use. Such practices can interfere with normal ovarian signalling and complicate clinical interpretation. Diuretics and masking agents may also contribute to risk through rapid weight change, dehydration, electrolyte imbalance, and concealment behaviour. Because WADA categories are updated annually, athletes and support personnel should verify medications and supplements through official anti-doping channels rather than relying on informal advice (World Anti-Doping Agency, 2026).

The strongest conclusion is not that every non-AAS substance directly causes infertility in female athletes. The stronger and more defensible conclusion is that prohibited substances can create endocrine, metabolic, cardiovascular, psychological, and behavioural conditions that increase reproductive-health vulnerability, particularly when combined with under-fuelling, dehydration, excessive training load, or AAS stacking.

Table 4. Substance classes and reproductive-health risk pathways

Substance/method	Performance motive	Potential reproductive-health concern
Anabolic-androgenic steroids	Muscle mass, strength, recovery, physique	HPO-axis disruption, oligomenorrhea, amenorrhea, anovulation, fertility reduction, virilisation, and sexual-health changes.
Human growth hormone	Recovery, body composition, tissue growth	Indirect metabolic disruption, insulin resistance, fluid retention, and endocrine instability, especially when stacked with AAS or insulin.
Stimulants	Alertness, fatigue reduction, appetite suppression	Sleep disruption, sympathetic activation, appetite suppression, low energy availability, and menstrual-cycle vulnerability.
Hormone/metabolic modulators	Masking or manipulating hormonal profile	Interference with ovarian signalling, endocrine interpretation, and menstrual regularity.
Diuretics/masking agents	Rapid weight change or concealment	Dehydration, electrolyte imbalance, unsafe weight-control behaviour, and metabolic stress.

Prevention through education, monitoring, and referral

Anti-doping prevention has three connected goals: protecting fair competition, protecting athlete health, and supporting informed decision-making. Testing and sanctions are necessary for deterrence and accountability, but they are insufficient as health protection. Athletes also need education about substance categories, supplement contamination, therapeutic use exemptions, menstrual-health warning signs, and the specific reproductive risks faced by women.

Education should include athletes, coaches, parents, sport administrators, medical staff, nutritionists, and strength-conditioning personnel. Coaches are important because they shape training culture and may be the first to observe rapid body-composition change, mood change, injury patterns, or menstrual-health disclosure. However, coaches should not diagnose endocrine problems. Their role is to create a safe referral pathway and avoid a training culture that rewards unsafe body manipulation.

Menstrual-health monitoring can be integrated into athlete-health programmes while respecting privacy. Athletes can be encouraged to track cycle regularity, symptoms, energy intake, sleep, and training response. Abnormal patterns should trigger confidential clinical

follow-up rather than public judgement. For anti-doping purposes, education should also explain medication checking, supplement risk, prohibited-list updates, and therapeutic-use exemption procedures.

A balanced prevention model should avoid two extremes. The first is moral panic that stigmatises athletes and discourages disclosure. The second is normalisation that treats performance-enhancing drug use as an acceptable shortcut. A stronger model is firm on clean-sport rules and supportive in health care. It communicates that doping is prohibited, dangerous, and unfair, while also ensuring that athletes can seek help before harm becomes severe.

Table 5. Warning signs and recommended support responses

Warning sign	Possible interpretation	Recommended response
Skipped or irregular menstruation	REDs, stress, endocrine disease, pregnancy, medication effect, or doping-related HPO-axis disruption	Confidential medical assessment; menstrual history; nutrition, training, stress, medication, and supplement review.
Rapid strength or muscle gain with acne or hirsutism	Possible androgen exposure or other endocrine disturbance	Non-judgemental screening and referral to sports physician or endocrinologist.
Voice deepening or clitoral enlargement	Possible virilising effect of AAS	Urgent clinical referral; counselling on reversibility, sexual health, and psychological support.
Insomnia, anxiety, appetite suppression	Possible stimulant misuse, under-fuelling, psychological stress, or overtraining	Mental-health support, nutrition review, sleep assessment, and anti-doping education.
Fear of reporting symptoms	Stigma, sanction anxiety, or unsafe team culture	Create confidential support pathway separate from public punishment-oriented discussion.

Practical implications for sport organisations

Sport organisations should develop gender-responsive anti-doping policies. Such policies should include confidential reporting options, clear referral pathways, access to female-health professionals where possible, and educational materials that mention reproductive health explicitly. If anti-doping education only lists banned substances without explaining women-specific health risks, it may fail to communicate the consequences most relevant to female athletes.

At the club, school, university, and regional-sport levels, practical steps include annual anti-doping seminars, supplement-risk screening, menstrual-health literacy sessions, collaboration with sports physicians, and mental-health support. For adolescent and young adult athletes, education should also address social-media misinformation and pressure to achieve unrealistic body ideals. For elite athletes, education should be connected with testing procedures, whereabouts requirements, medication checking, and therapeutic-use exemption guidance.

A sport organisation should also avoid using menstrual irregularity as a tool for suspicion or punishment. Menstrual dysfunction is a clinical signal, not automatic evidence of wrongdoing. The appropriate response is assessment and referral. This approach protects athlete welfare while maintaining clean-sport standards.

Limitations and future research

This review has limitations. The evidence base on female athletes and doping is smaller than the evidence base on male users. Many studies are qualitative, cross-sectional, or based

on self-reported histories. Elite female athletes may be underrepresented because disclosure of prohibited use can carry legal, career, and reputational consequences. As a result, the true prevalence and long-term reproductive outcomes of doping in female athletes remain difficult to estimate.

Another limitation is the difficulty of separating doping effects from other sport-related reproductive risks. Menstrual dysfunction may result from AAS, REDs, psychological stress, high training load, eating disorders, endocrine disease, pregnancy, or combinations of these factors. Future research should use longitudinal designs, confidential recruitment methods, interdisciplinary clinical assessment, and women-specific outcome measures. Studies should also distinguish elite sport, recreational strength training, bodybuilding, and fitness communities.

Despite these limitations, the available literature consistently indicates that AAS misuse can disrupt reproductive function and produce virilising effects in women. The absence of large randomised trials should not be interpreted as safety because ethical research cannot expose athletes to harmful doses of prohibited substances. Prevention should therefore be based on clinical evidence, cautious inference, and the principle of athlete health protection.

CONCLUSION

This narrative literature review concludes that doping is a significant threat to female athletes' reproductive health. AAS present the clearest and most direct risk because they can disrupt the HPO axis, impair ovulation, cause menstrual irregularity, reduce fertility potential, and produce virilising effects such as acne, hirsutism, voice deepening, breast atrophy, and clitoromegaly. Some changes may persist after discontinuation, although recovery varies by dose, duration, compound type, stacking pattern, nutritional status, and individual susceptibility.

HGH, stimulants, hormone modulators, diuretics, and masking practices may increase reproductive-health risk indirectly through metabolic disturbance, cardiovascular strain, psychological stress, neuroendocrine activation, low energy availability, dehydration, and substance stacking. Menstrual disruption should not be interpreted as a normal cost of high performance or as automatic evidence of doping. It is a clinical signal that requires confidential, multidisciplinary assessment.

The practical implication is that anti-doping must be integrated with athlete health protection. Testing and sanctions should be accompanied by gender-responsive education, menstrual-health monitoring, supplement-risk counselling, therapeutic-use guidance, psychological support, and confidential medical referral. Clean sport is achieved not only by detecting violations but also by reducing the pressures, misinformation, and health-service barriers that make doping more likely. Future research should prioritise anonymous, community-based longitudinal cohort studies to track long-term endocrine and reproductive recovery among former female users of performance-enhancing substances. Female-specific anti-doping surveillance and multidisciplinary clinical registries involving sport medicine, endocrinology, obstetrics-gynaecology, psychology, and nutrition are also needed to generate robust evidence while minimising regulatory, professional, and social stigma.

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