Sport in Female Athletes

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Tiana Raoul, Clémence Coll, and Patricia Thoreux

3.1 Background

Women have physiological, morphological, biomechanical and mental specificities that are very different from men. The "Female Athlete Triad", first described in 1992, summarizes the consequences of eating disorders and menstrual cycle disorders, associated with osteoporosis in female athletes. This chapter focuses on the specificities of sportswomen: we will discuss the effect of hormones in this triad, but also other female specificities and pathologies, still poorly known.

T. Raoul · C. Coll
Service de Médecine de l'Exercice et du Sport—APHP, Hôpital Jean Verdier, Bondy, France

P. Thoreux (✉)
Service de Médecine de l'Exercice et du Sport—APHP, Hôpital Jean Verdier, Bondy, France

Centre d'Investigations en Médecine du Sport (CIMS)—APHP, Hôpital Hôtel Dieu, Paris, France

Département médical de l'INSEP (Institut National du Sport, de l'Expertise et de la Performance), Paris, France

Institut de Biomécanique Humaine Georges Charpak—Arts et Métiers ParisTech—Université Paris 13, Villetaneuse, France
e-mail: patricia.thoreux@aphp.fr

3.2 Physiological Influence of Hormonal Variations on Sports Performance

Ovarian secretions of steroids vary during the menstrual cycle. These secretions are useful for the proper functioning of energy metabolisms (carbohydrate, lipid and protein) involved in sports activity, and one can imagine that their variations could induce changes in physical abilities. For example, respiratory flow has been observed to increase with luteal phase progesterone. However, these hormonal variations, between the first and second phase of the cycle, are not sufficient to cause a change in muscle strength or an impact on energy metabolism or maximum oxygen consumption. There is no observed variation in either hemoglobin or hematocrit during the cycle. Therefore, there is no actual change in physical performance during the cycle (except for heavy menstruation that can lead to a decreased hemoglobin or even iron deficiency anemia).

3.2.1 Dysmenorrhea

Dysmenorrhea is pain related to hypercontractility of the myometrium, due to a decrease in progesterone, and can be associated with increased psychological sensitivity to stress. It affects one sportswoman out of two, (same prevalence as in the general population), and there is no influence

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of the type of sport. Some studies have shown that athletes often noted a decrease in the intensity of dysmenorrhea symptoms during sports competitions: this can be related to the secretion of beta-endorphins, which acts as analgesics.

3.2.2 Premenstrual Syndrome (PMS)

It occurs at the end of the cycle (5–8 days before the menstruations), and is defined by:

- Physical symptoms: ligamentous hyperlaxity, cramps, headache, weight gain, mastodynia, bloating
- And psychological symptoms: fatigue, mood disorder, increased sensitivity to stress.

It can be responsible of social and professional discomfort in one woman out of three in the general population, and can have a significant impact on sports performance.

A study by questionnaire conducted at INSEP in 2008 revealed that 83% of the 400 sportswomen interviewed had a premenstrual syndrome (PMS) (with bloating, weight gain, mastodynia, mental fatigue, irritability, and loss of energy). Sixty-four percent of them thought that PMS significantly reduced their physical performance.

3.2.3 Arrangement of Cycles and Hormonal Contraception

This consists of lengthening the cycle to offset menstruation on request of the sportswoman. It is necessary to specify her motivations:

- Reduce dysmenorrhea
- Limit premenstrual syndrome
- To control the risk of iron deficiency anemia in case of excessively heavy menstruation.

Oral hormonal contraception is the best fit to match all these goals. However, a particular attention must be paid to the type of contraceptive, in order to limit the undesirable effects potentially detrimental to physical performance:

- Avoid triphasic pills, which have a greater impact on body composition.
- Pay attention to the type of progesterone used, especially the level of norethisterone, which may cause hyperandrogenicity in some patients.

We therefore prefer to use a monophasic estrogen-progestogen, or a third-generation progestin without androgenic effect.

3.2.4 Sports and Hormonal Disorders

The “female athlete’s triade” (anorexia, amenorrhea, osteoporosis) is actually a continuum of symptoms, ranging from luteal insufficiency to amenorrhea, and anovulation. It is due to a reduced activity of the gonadotropic axis, caused by a poor energy reserve and an imbalance between inputs and energy expenditure (lack of inputs).

The prevalence of hormonal disorders is higher among sportswomen than the general population: luteal insufficiency and anovulation are found in almost half of the female athletes (all sports combined), and amenorrhea is present in 7% of sportswomen, compared to 2–5% in the general population. Its prevalence does not increase with intensity or training volume, if the energy balance is preserved.

The possible clinical expressions are, depending on the age of occurrence:

- Pubertal delay/primary cycle disorders

  The age of menarche is frequently delayed for high-performance girls (13.4 ± 1.4 years) compared to the general population (13 ± 1.3 years). The delay of menarche is more significant in slimming sports (13.7 ± 1.5 years) than in other sports (13.1 ± 1.4 years).

  A primary amenorrhea can also appear when there is a deficiency of nutritional

contributions, which leads to a significant slowdown of the gonadotropic axis.
- Secondary cycle disorders/amenorrhea: they usually appear because of a weak energy reserve, with a lean mass threshold <15% of the total body mass. There are three stages of secondary cycle disorders, of successive chronology and of increasing gravity:
  Luteal insufficiency: short cycles ± premenstrual syndrome.
  Oligomenorrhea/spaniomenorrhea, with long cycles.
  Amenorrhea: (absence of menstruations >3 months).

The most affected sports are:

- "Aesthetic sports": because of the search for thinness and aesthetics (gymnastics, figure skating, dance, synchronized swimming).
- Endurance sports: requiring lightness and strength, and in which body fat can decrease performance (athletics, running, cycling).
- Weight class sports (judo, karate, boxing, wrestling, weightlifting, rowing): in which weight control is necessary.

3.2.5 Consequences of Cycle Disorders

- Osteopenia, or even osteoporosis, which increases the risk of stress fractures. It is recommended to measure the bone mass density (BMD) score in all amenorrheas lasting over 6 months, stress fractures or eating disorders.
- Infertility due to the slowing of the gonadotropic axis (anovulation).
- Increased cardiovascular risk by reducing the protective effects of estrogen on endothelial function and no secretion.

3.2.6 Physical Activity and Menopause

Physical activity is recommended after menopause as it decreases cardio-vascular morbidity and mortality (coronary and stroke), via:

- Improvement of lean mass/fat mass ratio and improvement of the lipid profile.
- Control of weight gain.
- Lower blood pressure.
- Improvement of insulin sensitivity.
- Decreased thrombotic risk.
- Reduced anxio-depressive symptoms and improved self-image.

3.2.7 Sport and Pregnancy

3.2.7.1 Is Physical Activity a Risk During Pregnancy?

Doing sports is not a risk during a physiological pregnancy, in respect of medical contraindications. It does not increase the risk of peripartum complications, nor does it change the quality and quantity of milk or the growth of the child postpartum.

On the contrary, the practice of a physical activity is recommended during pregnancy, as it contributes to maintaining and improving health status by:

- Limiting weight gain
- Reducing the risk of gestational diabetes
- Decreasing the venous symptoms of the gestational vascular pathology (fluid retention and increased risk of thromboembolism)

Physical activity has shown a greater benefit when started in the year before pregnancy.

3.2.7.2 Sports Safety Tips

The goal must remain the maintenance of a good physical condition, without an objective of performance or competition:

- Adapt the physical activity to the gestational state, and maintain awareness to hydration and adequate energy intake (especially from 13 SA).
- Progressive warm-up.
- No exercise in the supine position from the fourth month (avoid compression of the vena cava).
- Avoid altitude exercises (>1800 m), and formal contraindication to underwater diving.

Table 3.1 Pregnancy contraindications to sports

Absolute contraindications	Relative contraindications
Pre-term work/amniotic fluid loss	History of prematurity/ IUCD/repeated spontaneous miscarriage
Cervico-isthmic stricture/strapping	Malnutrition
HTA pregnancy and pre-eclampsia	Membrane rupture
Cardiovascular and/or severe pulmonary disease	Intrauterine growth retardation (IUGR)
	Placenta praevia >28 SA/ metrorrhagia
	Multiple pregnancy (≥3 fetuses)
	Twin pregnancy >28 SA
	Severe anemia (Hb <10 g/ dL)
	Moderate or mild cardiovascular or respiratory conditions

– Know the symptoms that must make you stop and search for medical advice: metrorrhagia, dyspnea, contractions, headache, vertigo, loss of amniotic fluid or appearance of an intrauterine growth retardation (IUGR) (Table 3.1).

3.2.8 How to Adapt Physical Activity During Pregnancy

The rule of three components:

– Exercise **frequency**: 3–5 times/week, depending on the previous level. It is recommended not to exercise vigorously for two consecutive days.
– **Intensity**:
  Modification of heart rate targets, for the reduction of the max HR reserve during pregnancy: target training is 60–70% of the theoretical maximal HR.
  Borg Scale (perception scale of the felt effort): target 12–14/20.
  Speech test: acceptable intensity is reached when the pregnant sportswoman can have a normal conversation without breathlessness.
– **Duration** of exercises: 15–30 min for sedentary women, 30–40 min for sportswomen, depending on their previous level of practice.

Choice of physical activity:

– Sports not recommended: collective contact sports (basketball, handball, hockey, football, rugby, etc.), combat sports (karate, taekwondo, judo, boxing, wrestling, etc.) and sports with high risk of falling (horse riding, mountain biking, climbing, skating, windsurfing, surfing, etc.).
– Formal contraindication to underwater diving (risk of placental abruption).
– For high-level athletes: a joint and multidisciplinary consultation between doctor, physical trainer and coach is recommended to adapt the training program and objectives (or even propose a substitute sport if the sport practiced is not compatible with pregnancy). The objectives are to preserve the health of the sportswoman, to allow the serene development of the pregnancy and to prepare the return to high level.

3.2.9 Postpartum

Resumption of a physical activity must be adapted to each patient, according to the modalities and complications of childbirth.

In case of an uncomplicated labor, moderate physical activity (walking, pelvic floor exercises and stretching) can be started immediately after delivery.

There are many benefits to postpartum physical activity:

– Cardiovascular training.
– Easy weight loss.
– Improved mood and reduced anxiety and depression.
– Strengthening pelvic floor muscles to reduce pelvic floor disorders and the risk of urinary incontinence.

3.3 Urinary Incontinence

The pelvi-perineal pathologies still remain poorly known in sports. However, the prevalence of urinary incontinence in women varies, according to the studies, between 20 and 52% for high-impact sports. All sports requiring jumps can lead to urinary incontinence. The most concerned sports are:

- Sports with strong perineal constraint with dominant dynamic component: gymnastics-trampoline, aerobics, jump in the disciplines of athletics (jumping hurdles, jumping in length, triple jump, pole), jump in ice sports, running, dancing, ball sports (squash, tennis, badminton, basketball, volleyball, handball).
- Sports with strong perineal constraint with dominant isometric component: athletics and its specialties such as javelin, hammer throw, rowing, fencing, weightlifting, horse riding, windsurfing.

Intense sport activities weaken the pelvic floor. The body weight on the perineum is multiplied by 4 when running, by 9 when throwing a javelin, and by 16 when performing a long jump.

Athletes with urinary incontinence often have hypertonic perineum, so the lack of relaxation of perineal muscles leads to their exhaustion and inefficiency. They also have more tonic abdominal muscles, which increase pressure on the pelvic floor.

3.3.1 Which Treatments Can Be Used Against Urinary Incontinence?

The first treatment is the respect of hygienic and dietary rules:

- Decreasing caffeine, tea, tobacco, and alcohol.
- Avoiding constipation.
- Urinating before training without restricting hydration.

Table 3.2 Treatment against urinary incontinence

Kegel's exercises	Pelvic specific muscle building, (30% of women have difficulties to perform a correct contraction at first test) allowing hypertrophy of these muscles: Isolated contraction of the perineum, without recruitment of the rectus abdominis
Biofeedback	The patient has a visual feedback of her work, in real time, analyzes it and corrects it It is the gold standard method for learning the perineal automatism

- Preferring static reinforcement of the abdominal muscles rather than dynamic.

The use of accessories that strengthen the perineum, such as electrostimulation, is not an appropriate solution, because athletes often have an already hypertonic perineum. The key would be the association of a re-education with autocontraction of the perineum, postural work, and respiratory work (the diaphragm ascension impacts on the perineum, Table 3.2):

The cubic pessary can be an alternative solution to improve the comfort of incontinent women, whenever necessary. The patient can use it on demand, while standing, to carry weight, walk, or run. It has to be removed at night and while lying down. It requires a precise vaginal touch to determine the correct size of the pessary.

3.4 Chest and Sports

3.4.1 Dermatological Lesions: The Nipple of the Jogger

Dermatological lesions are related to a friction phenomenon. Their incidence varies from 2 to 16%. The main symptoms are pain, redness, erosion, fissure, and bleeding. The curative treatment consists in the application of vaseline or erythromycin ointment. Preventive treatment involves patching or bandaging the breasts, and wearing silk underwear.

3.4.2 Breast Emergencies

Breast emergencies and their complications include infectious and inflammatory pathologies, following a possible trauma. Initial management is based on the prescription of nonsteroidal anti-inflammatory drugs and the wearing of a well-containing chest support. The hematoma and post-traumatic adiponecrosis impose a control every 6 months until consolidation of the scar tissue and stabilization of the image.

3.4.3 Prevention of Breast Cancer

Several studies have shown that practicing sports for 3–4 h a week reduces the risk of breast cancer by 30–40%, and also decreases the risk of recurrence in cases of proven cancer.

3.4.4 Supportive Underwear and Specific Protections

Specific chest protections have recently been created for contact sports such as rugby, boxing, martial arts, MMA, handball, basketball, etc. The flexible chest of this protection is stiffened and allows absorbing 80–90% of impacts. In addition, a suitable bra that raises and compresses the chest could significantly improve the comfort of the chest compared to a standard encapsulation bra, especially for large breasts (Fig. 3.1).

Fig. 3.1 Technical second-skin chest protection, absorbing the impacts

3.5 Traumatic Specificities

3.5.1 ACL Rupture: Physiological and Neuromuscular Aspects

3.5.1.1 Epidemiology

Anterior cruciate ligament (ACL) rupture is one of the most common serious injuries in athletes. Many studies have shown that for the same level of practice, the risk of ACL injury is 4–7 times higher in women than in men.

Most ACL injuries occur during a non-contact pivot accident, usually during deceleration, a change of direction, or jump reception.

A recent cohort of 1440 athletes showed statistically significant differences in resumption of sport after ACL rupture: male athletes under 35 had significantly higher rates of sport recovery with same-level return to play than female athletes (52% vs. 39% and 37% vs. 18%), while there was no gender difference after 36 years.

3.5.1.2 Female Risk Factors

- *Hyperlaxity*: ACL lesions are more common in patients with hyperlaxity, especially in knee recurvatum. Hyperlaxity is known to be more common in women than men. A prospective biomechanical and epidemiological study in female athletes revealed a higher risk of ACL injury in cases of hyperlaxity.
- *Anatomy of the notch*: According to Griffin et al. the intercondylar notch is narrower and the ACL smaller in women.
- *Neuromuscular factors*: A neuromuscular imbalance could partly explain the mechanism of injury: women have a more "quadriceps dominant" body pattern than men, with weaker hamstrings, and sudden eccentric contraction of the quadriceps is one of the main causes of ACL injury (as the hamstrings are not able to protect the ACL in case of such a trauma).
- *Hormonal factors*: the risk of ACL injuries is not constant during the menstrual cycle: estrogens increase laxity of the ACL and decrease its strength, so there are significantly more injuries during the pre-ovulatory and ovulatory phases than in the post-ovulatory phase.

– *Dynamic Valgus*: During a jump reception, the dynamic valgus risk factor that can be corrected for ACL rupture. This movement combines flexion and medial rotation of the hip, valgus and external rotation of the knee and eversion of the foot. Valgus and internal hip rotation have been identified as the major risk factors for ACL injury in women's non-contact sports.

3.5.1.3 Return to Play and ACL-RSI Score

Returning to sport after anterior cruciate ligament (ACL) reconstruction requires optimal physical and psychological recovery. The main tool validated to quantify the psychological impact after this surgery is the ACL-RSI (Anterior Cruciate Ligament-Return to Sport after Injury) scale.

This ACL-RSI score improves significantly over time (at 2-year follow-up, 74.9% of patients returned to the race and 58.4% to their sport before the same injury) and is correlated to the isokinetic and neuromuscular evaluation of the knee. However, the psychological aptitude to resume the sport does not depend only on the objective physical recovery of the knee but also on psychological recovery.

– To date, no study has examined the ACL-RSI psychological score according to gender, age, and sport level (leisure, competitor, high-level, professional).

3.5.2 Concussions

Concussions are more and more frequent: its rate has increased 4.2 times over the past 11 years (15.5% annual increase), in high school sports.

Most of the feminine data are about soccer with an incidence of 0.59 per 1000 exposures (vs 0.34 in men). In women, dribbling and defense are at risk while in men, it is mainly the rebound and the pursuit of a lost ball. In other sports, the incidence of concussions is probably underestimated.

3.6 Pitfalls

– There is no actual physiological change in physical performance during the normal menstrual cycle. However, premenstrual syndrome can cause fatigue, irritability, and loss of energy.
– We are no longer talking about the triad of the female athlete, rather to be considered as a continuum of symptoms ranging from luteal insufficiency to amenorrhea.

3.7 Fact Box

– Hormonal disorders are due to an energy imbalance between expenditure and insufficient inputs. Their prevalence does not increase with intensity or training volume, if energetic balance is preserved. Their main issues are infertility, osteopenia, and cardiovascular over-risk.
– Sport is recommended after menopause and during pregnancy. Intensity and type of sport have to be adapted according to the term.
– Little data is available about concussions in women's sport in general. But in women soccer players, concussions appear at least as frequent as in male players.
– The risk of ACL injury is 4–7 times higher in women than in men, mainly due to hyperlaxity and dynamic valgus.

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