

Wearable Technology in Female Athletes: Monitoring Physiology for Individualised Training and Injury Prevention: A Review

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ABSTRACT

Women first competed in the Olympics in Paris in 1900, comprising just 2.2% of athletes. This has grown to 49% in Paris 2024, making the understanding of female-specific performance factors crucial. Sleep, energy expenditure, and menstrual cycle changes significantly influence outcomes, yet individualised monitoring remains a challenge. Wearable devices now enable real-time tracking of these parameters, supporting physiotherapists in optimising recovery, performance, and injury prevention.

To investigate how sleep, energy expenditure, and menstrual cycle variations affect female athletic performance and to explore the role of wearable devices in individualised monitoring for adaptive physiotherapy, injury prevention, and performance optimisation.

A retrospective review, following PRISMA guidelines, analysed studies on the effects of sleep, energy expenditure, and menstrual cycle changes on sports performance and injury risk. Research on wearables, including the Apple Watch, Fitbit, Oura Ring, Whoop, EmbracePlus, and Empatica E4 were assessed for their role in personalised monitoring and adaptive therapy programmes.

Performance and injury risk are strongly influenced by sleep, energy expenditure, and menstrual cycle changes. Each hour of sleep loss raises injury risk by 39%, while low energy availability increases it by 36%. Wearables such as Fitbit and Apple Watch, Oura Ring, which is most reliable for sleep, Whoop for energy expenditure and Empatica E4 and Embrace Plus, which monitors menstrual cycle parameters, enable real-time tracking of body temperature, heart rate, heart rate variability, and electrodermal activity. This data guides training: strength and skill work in the follicular phase, peak power during ovulation, endurance and recovery in the luteal phase, and low-intensity focus during menstruation.

Evidence supports wearable technology for real-time physiological monitoring, enabling individualised and preventive physical therapy. By adapting training and rehabilitation to sleep, energy, and menstrual cycle variations, physiotherapists can enhance performance, reduce injury risk, and support athletes' long-term health.

Keywords: Energy expenditure, Menstrual Cycle, Sleep, Physical therapy, Wearable devices

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