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Article Title: Unlocking the Potential: Hormone Testing for Optimizing Athletic Performance

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Unlocking the Potential: Hormone Testing for Optimizing Athletic Performance

Have you ever wondered how hormones affect athletic performance? There is no arguing that hormones play a crucial role in athletic performance and overall well-being. Diving into the intricate interplay between hormones and athletic performance won't give you superpowers, but it can yield valuable knowledge in harnessing their powers. By tracking and learning to decipher the subtle indicators of hormone fluctuations, athletes and healthcare providers can gain critical knowledge to improve performance, train efficiently, improve recovery, and spot early signs of overtraining.

The process of testing hormone levels is scientifically complex and nuanced, raising the question of whether to test or not and which testing method is superior to others, a topic debated by healthcare providers and scientists alike.

For athletes, hormones are essential for regulating energy levels, muscle growth, recovery, immune function, menstrual cycles, metabolism, mental health, and overall well-being. Hormones such as growth hormones and thyroid play a key role in supporting a healthy body composition and bone health, while testosterone is essential for building muscle mass and strength. Additionally, releasing certain hormones during exercise can promote favorable adaptive changes, improving performance.

Laboratory medicine in sports is an important preventative and protective science, fundamental for evaluating an athlete's condition. However, most sports research is still under lock and key (partly because gold medals depend on it often), and very little has been done focusing on women. Among 12,511,386 participants in 5,261 manuscripts published in six sport and exercise science journals between 2014 and 2020, females accounted for 34% of the study population; only 6% of total publications were conducted exclusively on females.¹ The impact of constantly changing hormone levels in females.

Hormone testing can provide insight into how an individual's unique hormonal profile may impact their ability to reach specific performance goals, allowing for more informed and targeted training approaches. Testing can help athletes and healthcare providers identify any underlying hormonal imbalances that could affect their performance and track changes over the season.

The interplay between workload and recovery is important for athletes to prevent injury while maintaining the highest level of competitiveness and growth. This balance can be monitored and optimized using laboratory medicine and other data (i.e., wearables, athlete symptoms, and performance), particularly in identifying overtraining. It has been established that healthy athletes have adaptations to their hormonal conditions.² By addressing identified imbalances through targeted treatment plans, athletes can

Introduction should introduce readers to the topic, illustrate its importance in the field of sports pharmacy, and outline what your article will be covering.

In text citations should be numbered.

experience improved energy levels, increased muscle mass, and enhanced recovery, leading to better overall performance.

Several key hormones are important for athletic performance.³ These include:

- *Testosterone* – essential for building muscle, increasing strength, maintaining energy stores and oxygen capacity, and decreasing fatigue
- *Growth hormone* – important for muscle growth and repair
- *Cortisol* – regulates the body’s stress response, impacts muscle breakdown, affects metabolism, blood sugar, and water/salt balance
- *Thyroid hormone* - regulated metabolism, cardiac function, calcium homeostasis, and energy levels
- *Insulin* – impacts blood sugar levels
- *Estrogen and Progesterone* – play a role in bone health injury prevention, and impact thyroid health, inflammation, and the menstrual cycle

Hormones and Performance

Overtraining syndrome (OTS) is when the training continues before an athlete recovers. When training and recovery. If stages of OTS, athletes report fatigue and performance declines occur. In the early stages of OTS, athletes report fatigue and performance declines, which can be overcome with a longer recovery period. If OTS continues, long-term problems brew and changes to the body’s physiology take place, taking months to correct.⁴ Sex and adrenal hormones must be used as biomarkers of OTS in athletes. They can be used if an athlete is in the early or late stages of OTS.⁵ Estradiol and testosterone levels and their ratio have also been shown to be diagnostic in OTS.⁶ Increasing sex-hormone binding globulin (SHBG) in response to lowered testosterone levels from under-recovery can be indicative of OTS.⁷ In female athletes, OTS can also show low levels of estrogen and progesterone, manifesting as menstrual disorders.⁴

Suppose athletes have a mismatch between the energy going in (nutrition) and energy going out (movement). In that case, athletes can find themselves in the spectrum of Relative Energy Deficiency in Sport, known as RED-S. Previously, this was known only as the Female Athlete Triad. One of the pillars of RED-S is hormonal changes, as the body chooses survival over reproduction. Female athletes often see menstrual changes or amenorrhea as an outward sign, but negative hormone changes in labs often show up sooner.

Hormone Variation During Menstrual Cycles

Men and women vary in many ways regarding sports and exercise. Still, the biggest difference, which can have far-reaching effects, is the cyclical change in hormones that

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occur in women throughout the menstrual cycle. Almost half of all women believe their menstrual cycle hurts their training and performance.⁸

We are beginning to learn about the impacts of the menstrual cycle on female athletes. While it's never a bad day for a PR or gold medal performance, athletes can't help if competitions are on particular days of the menstrual cycle. Knowing the ebbs and flows of our cycle can help keep motivation up. Also, ensure athletes have menstrual cycles, as up to 40% of female athletes falsely believe that losing their period is a normal or positive sign of being an athlete.⁹

Tracking hormones for female athletes can help note changes over time or if symptoms arise. It can also help with screening for menstrual irregularities, polycystic ovary syndrome, heavy menstrual cycles, and fertility issues.

Different Types of Hormone Testing

Hormone testing allows a better understanding of how the body operates under the surface and unravels the complicated internal reality that symptoms alone can't always reliably reveal. Four commonly used tests for hormone levels are blood serum, dried blood spot, saliva, and urine. Each has advantages and disadvantages, and there is likely no single "best" method for evaluating hormone levels.

Saliva

Saliva tests present a straightforward and accessible method for hormone assessment, particularly because they are easy to collect. Patient athletes can also easily provide multiple samples by simply spitting into a tube over a day, making it a practical and user-friendly option.

International researchers initially employed saliva tests in remote areas where blood samples were impractical due to stability. In 1990, they were redefined for home test kits and direct-to-consumer testing.

Saliva testing helps measure the hormones available to use in tissue vs blood serum, which identifies levels of hormones circulating in the bloodstream. Research shows that saliva hormone levels often do not reflect serum blood levels for many female hormones.¹⁰ Saliva tests are not the preferred method for assessing hormones in young women with menstrual irregularities, as they often have naturally lower levels of hormones in their saliva. Saliva is not helpful with testing hormones administered sublingually or transmucosal, as it can concentrate in the salivary glands and give falsely elevated results.

Blood serum

Serum blood tests are the oldest form of hormone testing and probably the most conventional method. Established reference ranges for both female and male hormones help interpret results. Insurance companies often cover this type of test.

In serum testing, a blood sample is taken via a laboratory blood draw and sent to a lab for analysis. Once in the lab, they determine the concentration of specific hormones in the bloodstream. Most serum tests measure the level of “free” hormone, which is the hormone that can easily enter the cell; “total” hormone, which is attached to substances that carry hormones in the bloodstream; or a calculated combination of both free and total levels of hormones.

This method's limitation is that it does not accurately reflect bioavailable hormones, the hormones that are active in the organs and tissues. The collection method can also make these tests difficult, logistically challenging, and time-consuming depending on what hormones are being tested, for example, cortisol over the day or hormones throughout a menstrual cycle.

Blood Spot

Initially developed in 1960 to screen newborns for phenylketonuria (PKU) with a heel stick, the dried blood spot (DBS) test is simple and convenient for testing hormones. DBS test kits require you to prick your finger, drop it directly onto a filter card, and let it dry. The card is then mailed in for analysis, making it suitable for home testing. Once at the lab, samples are rehydrated and tested similarly to blood serum.

Dried blood-spot testing measures hormone levels in your small blood vessels (capillaries) vs whole blood, which evaluates venous blood levels. It's a small — but important — distinction, as there are likely variances in hormone levels throughout the circulatory system.

One distinct advantage of DBS over whole blood (serum) is that DBS is stored as dried blood and rehydrated for analysis; blood serum is analyzed in its original form. Conversely, DBS has a longer shelf life but is more limited in the variety of hormones and other analytes it can test accurately for.

Urine

Urine testing is hormone testing that allows practitioners to assess how the body metabolizes hormones. This provides an opportunity to identify risks when hormones are not breaking down optimally in the body.

Urine collection can occur in two ways, but all involve collecting multiple samples of urine multiple times a day in the privacy of your home. Most commonly, with hormone testing, urine is collected on a small piece of filter paper, dried, and mailed to the lab for evaluation.

Urine samples are not a direct measure of bioavailable hormones but measure hormones and their metabolites.¹¹ An analogy would be measuring how much food people eat by going through their trash cans. Hormone levels in urine can be affected by many variables, including kidney function, diet, and drug use (of any kind). The Endocrine Society, American Association for Clinical Chemistry, and the Partnership for Accurate Testing of Hormones have complained about the lack of standardization for accurately measuring hormone metabolites, especially those at deficient concentrations.^{12,13} Research supports taking four dried-urine spots throughout the day is an effective alternative to 24-hour urine collection for measuring cortisol.¹⁴

Which is the best type?

In short, there is no “one size fits all” option when it comes to hormone testing, and many variables are involved in dealing with hormones including:

- Symptoms
- Medical history
- Current medication regimen
- Lifestyle
- Suspected hormone imbalances
- Personal preferences and limitations

Examining all these elements and considering how they work together is critical. But it takes more than simply reading lab levels to put pieces together; often, more in-depth study of hormones is needed. We are all unique as people and athletes. In some cases, using more than one type of hormone test could even be beneficial.

Conclusion

Your conclusion should summarize your article and provide a takeaway related to the field of sports pharmacy practice.

With a thorough understanding of an individual's hormonal profile, healthcare professionals can start working on dietary modifications, supplementations, training adjustments, and correcting imbalances to optimize performance and overall health. By addressing everyone's unique hormonal needs, our experts can help their patients and athletes achieve better health outcomes and reach their performance goals more effectively.

If you are an athlete and think you may be experiencing a decrease in performance, loss of muscle mass, or just not feeling yourself, it's a good idea to begin recording symptoms. Identifying hormone imbalances and designing an effective treatment plan can be complex and go beyond lab reports. Healthcare providers can work with sports pharmacists, trainers, and nutritionists to create a comprehensive plan for regaining balance and health.

I recommend labs in both off-season, and if problems arise or you feel like you are “hitting the wall” during the season, you have a baseline comparison to help understand what is

happening. Some athletes will also test during the season to be aware of changes and adjust. Overall, getting a general health baseline of your hormonal and nutritional status is important annually.

But, of course, there's no magic pill when it comes to peak performance. It's a combination of training, nutrition, rest, and well-being. Hormones intricately weave into the fabric of athletic performance. Testing hormone levels is not just a tool for optimizing performance, but a window into the broader landscape of health and well-being.

References should be included at the end of the article and cited in APA format.

References

1. Zhu, J. W., Reed, J. L., & Van Spall, H. G. (2022). The underrepresentation of female athletes in sports research: Considerations for cardiovascular health. *European Heart Journal*, 43(17), 1609-1611. <https://doi.org/10.1093/eurheartj/ehab846>
2. Luger A, et al. Acute Hypothalamic-Pituitary-Adrenal responses to the stress of treadmill exercise. *N Engl J Med*. 1987;316:1309-1315. doi: 10.1158/1055-9965.EPI-09-0643. PMID: 20056650; PMCID: PMC2836837.
3. Lombardo B, et al. Laboratory medicine: health evaluation in elite athletes. *Clin Chem Lab Med*. 2019;March 5:ePub.
4. Kuipers H, and Keizer HA. Overtraining in elite athletes. *Sport Med*. 1988;6:79-92.
5. Cadegiani FA, et al. Basal hormones and biochemical markers as predictors of overtraining syndrome in male athletes: the EROS-BASAL study. *J Athl Train*. 2019;54:ePub.
6. Cadegiani FA. Et al. Novel insights of overtraining syndrome discovered from the EROS study. *BMJ Open SP Ex Med*. 2019;5:1-11.
7. Urhausen A, et al. Blood hormones as markers of training stress and overtraining. *Sport Med*. 1995;20:251-276.
8. Oleka CT. Use of the menstrual cycle to enhance female sports performance and decrease sports-related injury. *J Ped Adol Gyn*. 2019; pii:S1083-3188(19)30319-5.
9. Armento A, VanBaak K, Seehusen CN, Sweeney EA, Wilson JC, Howell DR. Presence and Perceptions of Menstrual Dysfunction and Associated Quality of Life Measures Among High School Female Athletes. *J Athl Train*. 2021 Oct 1;56(10):1094-1099. doi: 10.4085/624-20. PMID: 33626156; PMCID: PMC8530419.
10. Sood R, Shuster L, Smith R, Vincent A, Jatoi A. Counseling postmenopausal women about bioidentical hormones: ten discussion points for practicing physicians. *J Am Board Fam Med*. 2011 Mar-Apr;24(2):202-10. doi: 10.3122/jabfm.2011.02.100194. PMID: 21383221; PMCID: PMC6014967.
11. Faupel-Badger JM, Fuhrman BJ, Xu X, Falk RT, Keefer LK, Veenstra TD, Hoover RN, Ziegler RG. Comparison of liquid chromatography-tandem mass spectrometry, RIA, and ELISA methods for measurement of urinary estrogens. *Cancer Epidemiol Biomarkers Prev*. 2010 Jan;19(1):292-30
12. Demers LM, Hankinson SE, Haymond S, Key T, Rosner W, Santen RJ, Stanczyk FZ, Vesper HW, Ziegler RG; Endocrine Society; PATH (Partnership for Accurate Testing of Hormones); AACC (American Association for Clinical Chemistry). Measuring Estrogen Exposure and Metabolism: Workshop Recommendations on Clinical Issues. *J Clin Endocrinol Metab*. 2015 Jun;100(6):2165-70. doi: 10.1210/jc.2015-1040. Epub 2015 Apr 7. PMID: 25850026; PMCID: PMC5393513.
13. Rosner W, Hankinson SE, Sluss PM, Vesper HW, Wierman ME. Challenges to the measurement of estradiol: an endocrine society position statement. *J Clin Endocrinol Metab*. 2013 Apr;98(4):1376-87. doi: 10.1210/jc.2012-3780. Epub 2013 Mar 5. PMID: 23463657; PMCID: PMC3615207.
14. Newman M, Curran DA, Mayfield BP. Dried urine and salivary profiling for complete assessment of cortisol and cortisol metabolites. *J Clin Transl Endocrinol*. 2020 Nov 27;22:100243. doi: 10.1016/j.jcte.2020.100243. PMID: 33354516; PMCID: PMC7744704.