

TESTOSTERONE

The highs and lows of being a male runner

We know that all forms of exercise have beneficial effects on our body and mind. Like any other exercise, running increases the circulation of hormones in our bodies. The two main sex hormones that help our bodies function are testosterone and estrogen. While moderate exercise can be beneficial, too much or too little exercise can have a negative effect on the production of these hormones.

As a male distance runner there are still times when you feel the Testosterone flowing!



ENDURANCE TRAINED athletes of both sexes generally experience low levels of their respective predominant sex hormones. Low levels of these hormones can have a significant effect on our general wellbeing and particularly on our reproductive systems and bones.

The sports medicine community has conducted numerous studies into the negative impact that endurance training can have on the female reproductive system. Fewer studies, however, have focused on men and the evidence is less conclusive. Endurance sports such as marathon running are generally thought to decrease levels of testosterone in male athletes, potentially affecting reproductive function and bone mineral density (BMD).

What is testosterone?

Testosterone is the main male steroid hormone or androgen. Mainly produced in the testes, with a smaller amount produced in the adrenal glands, an adult male produces an average of 6-7mg of testosterone per day. Testosterone is carried in the bloodstream to the hypothalamus and the pituitary, where levels are measured and controlled. This system is known as the hypothalamic-pituitary-testicular (HPT) axis (Figure 1). Testosterone is also important in women, just as estrogen is important in men. However, men have 14 times more testosterone circulating in their bodies than women.

Male fertility, libido and potency are all controlled by testosterone. It is responsible for maintaining secondary characteristics such as body hair and voice. It increases metabolic rate, decreases body fat, and maintains muscle volume, tone and strength. It is also important in the maintenance of bone. Importantly, testosterone stimulates the production of red blood cells which transport oxygen around the body, and also plays a role in the absorption of sodium in the kidneys.

by Ingelise Jones

The production of testosterone is influenced by the circadian cyclic rhythm, peaking early in the day and reaching its lowest levels in the evening. While women experience a rapid decline in estrogen levels with age, men experience a gradual decline in testosterone of about 1-2% per annum from around the age of 40.

Levels of testosterone are defined by the amount entering and leaving the blood. The hormone is taken up by tissues in the body and degraded by the liver before passing out through urine. This removal of testosterone from the body is known as metabolic clearance. Moderate exercise is thought to reduce the rate of metabolic clearance.

Low levels of testosterone

Men with low testosterone levels can suffer headaches, irritability and fatigue. Abnormally low levels of testosterone in men can also result in reproductive dysfunction. This can include a reduced libido, sperm count and potentially reduced fertility. Older men with low testosterone levels may also have a greater risk of heart attack. Low testosterone levels are also increasingly recognised as a risk factor for osteoporosis in men.

It should be noted that it is not only those who exercise excessively that can experience low testosterone levels. Men who are extremely inactive can also experience the negative effects of low levels of testosterone. Both extremes in our society indicate it is an issue worth further investigation.

Exercise and testosterone

It seems that scientists in the sports community agree that moderate exercise can stimulate testosterone production. Testosterone increases after about

20 minutes into an exercise session and may remain elevated for up to three hours afterwards.

In sports which involve short bursts of high energy, such as sprinting, levels of testosterone and growth hormone are elevated. Higher testosterone levels can stimulate feelings of strength and perhaps even self confidence. As the hormone responsible for muscle tone and strength, testosterone may be a key factor in performance for many athletes, and the reason why illicit drug use involving testosterone supplements has increased in some sports.

Testosterone is also generally thought to affect overall mood but just how this occurs is not clear. It may have an indirect effect on mood because it increases metabolism. For example, if a person feels more energised due to an increase in metabolism, they may feel in a good mood. An increase in testosterone such as that experienced during moderate exercise could therefore promote feelings similar to the endorphin based "runner's high". Or perhaps direct correlations between androgens and mood may be found in the brain where levels of hormones such as testosterone are adjusted. The levels of these androgens can affect a number of mood related proteins and hormones in our bodies. Testosterone is also linked to libido in both men and women.

Interestingly, a relationship between testosterone levels and inactive sports fans has been hypothesised. St. John's University suggested that men may experience an increase in testosterone as a spectator not an athlete, simply by anticipating and watching their favourite sports team (9).

Running and the male reproductive system

So how can long distance running influence testosterone levels? There is growing evidence that endurance training such as marathon running impacts testosterone levels in men in a negative way. Low testosterone levels due to excessive exercise, however, may only be temporary. The long term effects are unknown. Various studies have shown a link between long distance running and reduced fertility. While the connection is not definitively clear, a popular theory is that there is a reduction in blood supply to the testes during running. Another theory is that training or excessive sport can cause an impairment of the secretion of testosterone by the hypothalamus.

A study of 18 male runners by De Leo from the University of Siena showed that testosterone levels dropped during a marathon. The study measured testosterone levels in the blood before, during and after the run, showing an initial increase in the hormone, followed by a decline after completion of the race. The decrease in testosterone was proportionate to the distance ran. (5)

Dutch researchers from the University of Limburg studied 25 males and 11 females over an 18-20 month period. Their training distance was gradually increased during the study. The male subjects experienced a temporary decrease in testosterone depending on the distance ran. However, the overall concentration of testosterone measured in their blood was actually increased during the

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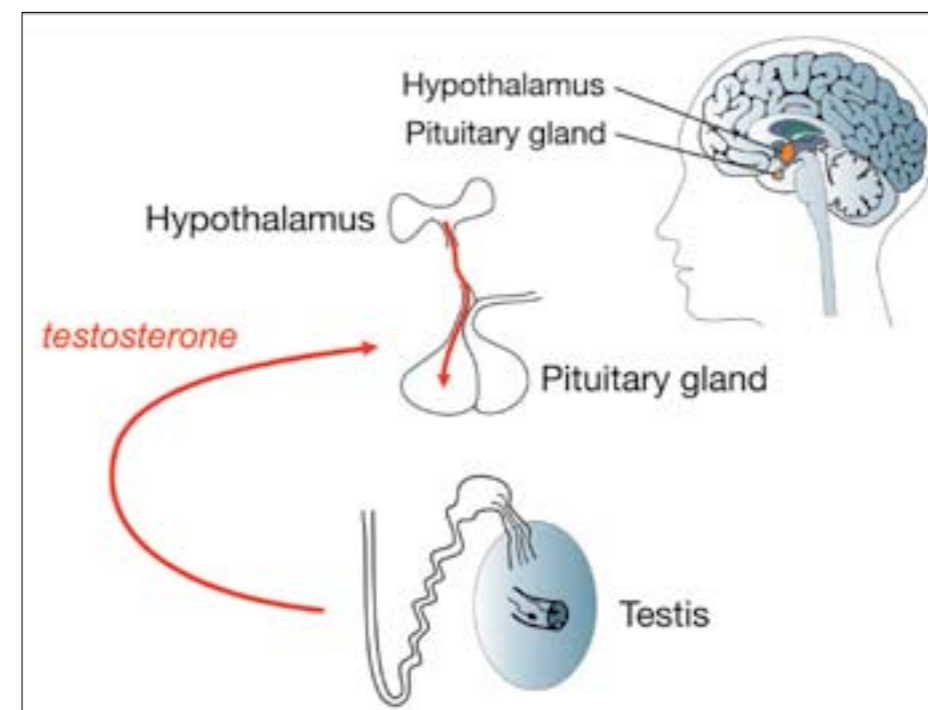


Figure 1. Hypothalamus – Pituitary – Testicular (HPT) axis: Testosterone is carried in the bloodstream to the hypothalamus and the pituitary, where levels are measured and controlled. Designed by Sue Panckridge.

course of the study suggesting that the longer term effects could be quite beneficial. No such correlations were found with the women. (8)

According to Cumming from the University of Alberta, some studies showed that endurance training prompted an initial increase in blood testosterone followed by an increase of blood cortisol. An increase in cortisol may have a direct effect on the testicular function of men, revealing that it may not just be testosterone levels affecting male reproductive function in long distance runners. Other factors that can cause a suppression of the HPT axis include starvation, a vegetarian diet, and a low fat, high fiber diet. (4)

Hackney from the University of North Carolina agrees that prolonged endurance training does decrease testosterone levels and can induce dysfunction

within the HPT axis. This dysfunction, however, could be influenced by how well athletes are physically conditioned and the length of time they may have trained over months or even years. (6)

Furthermore, De Leo suggested that while low testosterone levels can reduce sperm count, the long-term effects of a drop in testosterone after strenuous exercise such as marathon running might only be temporary (5). Cumming concluded that while low testosterone levels may reduce sex drive, running is unlikely to have a serious effect on male reproductive function, therefore not affecting fertility (4).

Sex drive

Evidence of a reduced libido due to long distance running remains largely anecdotal. Hackney suggested that while several studies have reported that endurance trained men have lower sex drive, there is little evidence to directly link the two. Instead, Hackney suggests that reduced sex drive may be caused by chronic fatigue in runners who have undertaken intense endurance training. (6)

A couple of recent US surveys revealed some interesting data on sex drive. One claimed that almost one quarter of the male participants were prepared to put running ahead of sex, and showed a correlation between an increase in mileage and a decrease in sex drive. Another speculated that people could run their way to a better sex life, and endorsing running as part of a healthy lifestyle that can improve a man's sex drive. Both surveys implied that moderate exercise, including regular running, could help increase libido.

An increase in libido stimulated by moderate exercise is most likely due to increased hormone circulation, improved cardiovascular and reproductive function, better fitness and self image. Interestingly, male sex drive is not only influenced by testosterone, just as testosterone is an important factor in female libido, recent research by Prince Henry's Institute in Melbourne has shown that estrogen is a key factor in male libido.

Sex of your children

Could the potential impact of endurance training on the male reproductive system also influence the sex of our children? Rumour has it that long distance runners have fewer male children than their non-distance running counterparts! This is most likely due to lower testosterone levels. A study by the University of Glasgow compared the gender of offspring in 139 male runners who ran varying mileage per week. Results showed 62 cent of children produced by men who ran less than 30 miles per week were boys. While men who ran 30 – 50 miles per week, produced only 40 per cent boys! (3) Some food for thought for those hoping to start a family.

Bone mineral density

The impact that long distance running could have on bone mineral density (BMD) is also an area of concern. Testosterone is important in the maintenance of bone, which highlights a potential risk factor for men with low levels of testosterone. Men, like women, experience a decrease in bone mineral density with age. High mileage runners particularly

in their fourth or fifth decade should be aware of the increased risk of osteoporosis. Moderate running, however is believed to benefit BMD in both women and men.

A bone mass study of 12 male runners aged 40–55 years by the University of British Columbia revealed that men who ran more than 64km per week experienced a decline in testosterone levels. These testosterone levels, however, remained within the normal range for men of this age. The results actually showed that those men who ran less than 80km per week experienced a positive effect on their BMD. (10)

The Centre for Clinical and Basic Research in Denmark investigated the impact of running on bone mass in 120 healthy active men aged 19-56 years. It was found that elite athletes had an increase in bone turnover and reduced bone mass. They concluded that male long distance runners had accelerated bone loss and hence an increased risk of osteoporosis. They were not able to clearly explain why this occurred, though testosterone did not appear to play a major role. They suggested that testosterone levels may only be impaired on days of endurance training and that recovery had most likely occurred by the time blood tests were done. (7)

Comparing the evidence

It is difficult to compare these different studies of testosterone because the variation in timing, size and method of taking blood samples. The tests themselves also differ, creating more inaccuracies. Obtaining data on testosterone in women is even more difficult because their levels are so low. A research review by a group of Australian scientists concluded that the impact of long distance running on the male reproductive system was not as extreme as that which can occur in women, but they did find a correlation between the distance run and bone mass. The review pointed out other factors that can affect BMD such as low calcium, stress and body fat, as well as highlighting inconsistencies between studies which make different studies difficult to compare. (2)

It is hard to ignore the many variables from runner to runner. Just because you're a runner with low testosterone levels does not mean it is necessarily caused by your running. Underweight men can often have low levels of testosterone, and some runners may therefore experience low testosterone levels due to their weight, rather than their actual training.

Testosterone levels can also be influenced by factors other than running. Testosterone works interdependently with other hormones that also influence reproductive function. The production of testosterone may vary according to whether there is a dysfunction in the testes, hypothalamus or pituitary. However, the main cause of a decline in testosterone levels in men is age.

Testosterone and the ageing male

Often referred to as the grumpy old men syndrome or the speculative male menopause, men may experience fatigue, poor concentration and memory, irritability, and reduced libido as their hormone levels change with age. While a decline

in testosterone production with age is normal, it is estimated that one man in 200 under the age of 60 suffers a deficiency in testosterone, known as androgen deficiency or hypoandrogenism.

Androgen deficiency is difficult to diagnose because it is often influenced by medications, other medical illness and obesity. Androgen deficiency in younger men may be caused by poor production of testosterone in the testes, diseases of the pituitary or hypothalamus, genetic disorders and steroid abuse.

Untreated testosterone deficiency can lead to reduced fertility, decreased muscle mass, osteoporosis and anemia. Researchers from Prince Henry's Institute in Melbourne have shown that men over the age of 55 with low levels of testosterone may also have a greater risk of heart attack. (1)

Can you increase your testosterone levels?

Exercise and diet are both important in maintaining health, and specifically the production and function of testosterone. If you are experiencing symptoms that you think may be related to testosterone levels, it is a good idea to seek professional advice from your GP or an endocrinologist. Those diagnosed with androgen deficiency or abnormally low levels of testosterone may require testosterone treatment. However the solutions for some runners may be much simpler.

Low levels of testosterone can be influenced by diet, stress levels, calcium intake, body fat and adaptation to training. Healthy testosterone levels can be maintained with a moderate diet of both

protein and fat, and moderate exercise that includes strength training to help prevent muscle loss and build muscle strength. Consultation with a sports trainer and a dietitian is recommended.

It appears that moderate exercise has a positive effect on BMD and sex hormone levels in both men and women. While the evidence supporting the negative impact that endurance training has on women is proven, it is difficult to draw concrete conclusions on male athletes due to inconsistent data.

The results from these studies suggest that a temporary decrease in testosterone experienced by male athletes during long distance running is proportionate to the distance run. The long term effects of endurance training are unknown. It is unlikely that there is any serious male reproductive dysfunction caused specifically by running, and any influence on male sex drive is anecdotal only. Intense training, however, may influence BMD, though it is unlikely to be due to testosterone levels alone, and most probably due to other lifestyle and medical factors, as well as age.

The interest in the topic is certainly increasing which indicates a need for more research. For most runners, however, there is no doubt that running is good for you!

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