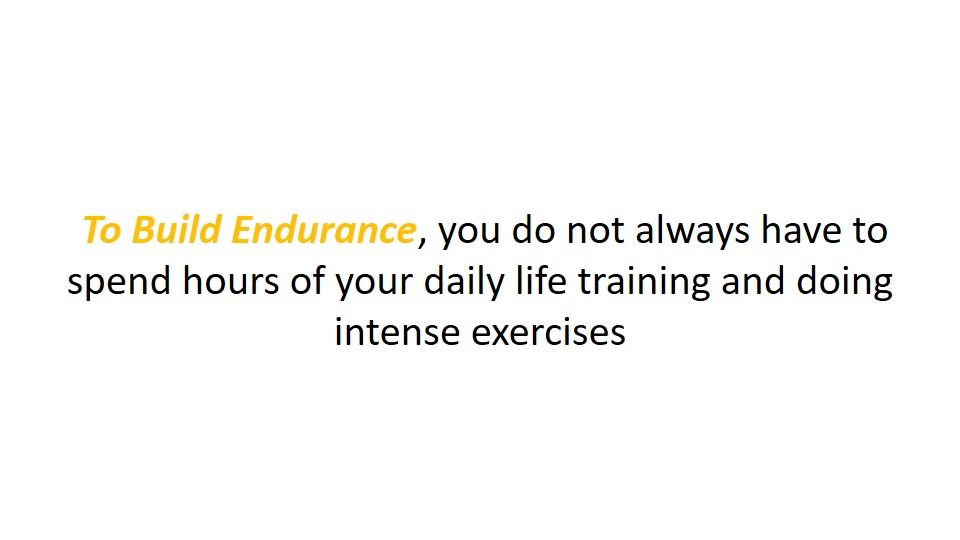
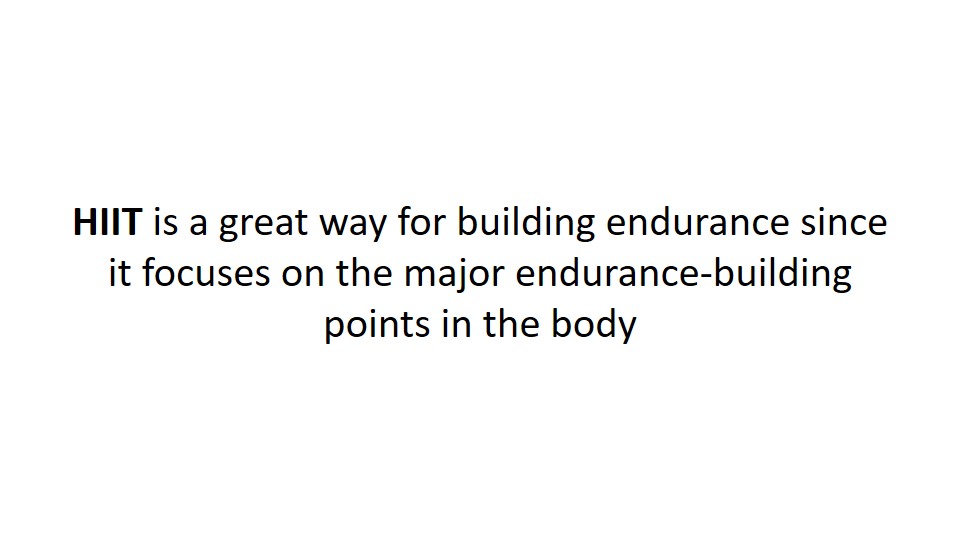
# Chapter 5: HIIT for Endurance



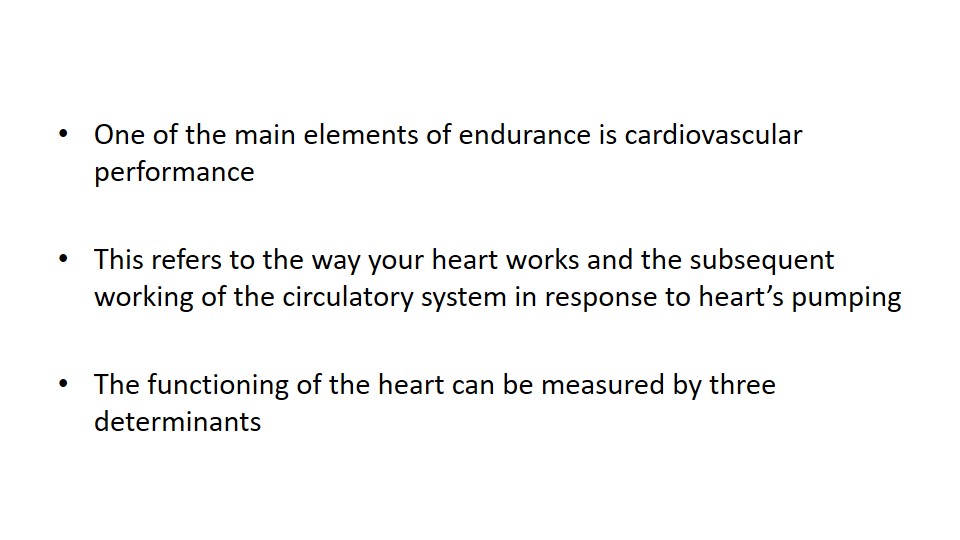
**S1**: In this video, we’ll talk about HIIT for endurance.



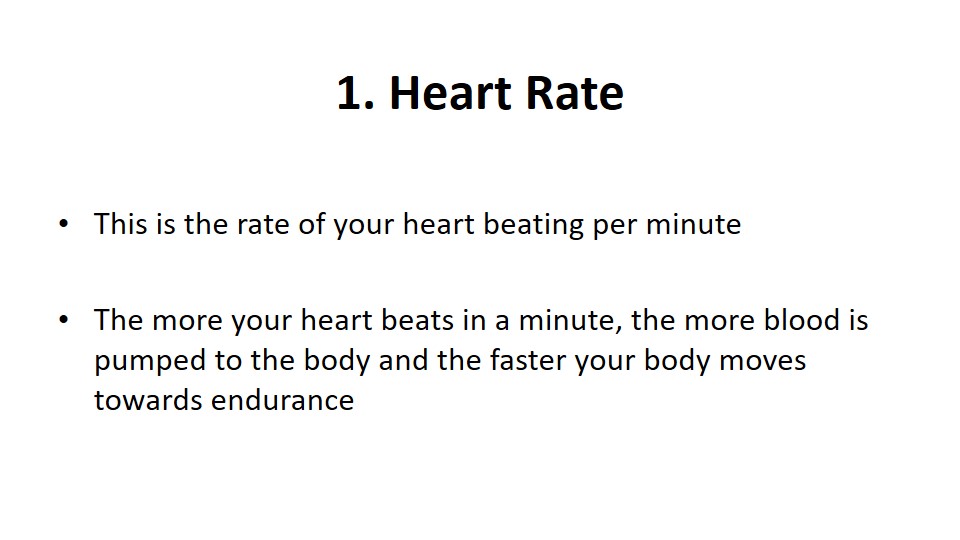
**S2**: To build endurance, you do not always have to spend hours of your daily life training and doing intense exercises.



**S3:** HIIT is a great way for building endurance since it focuses on the major endurance-building points in the body.



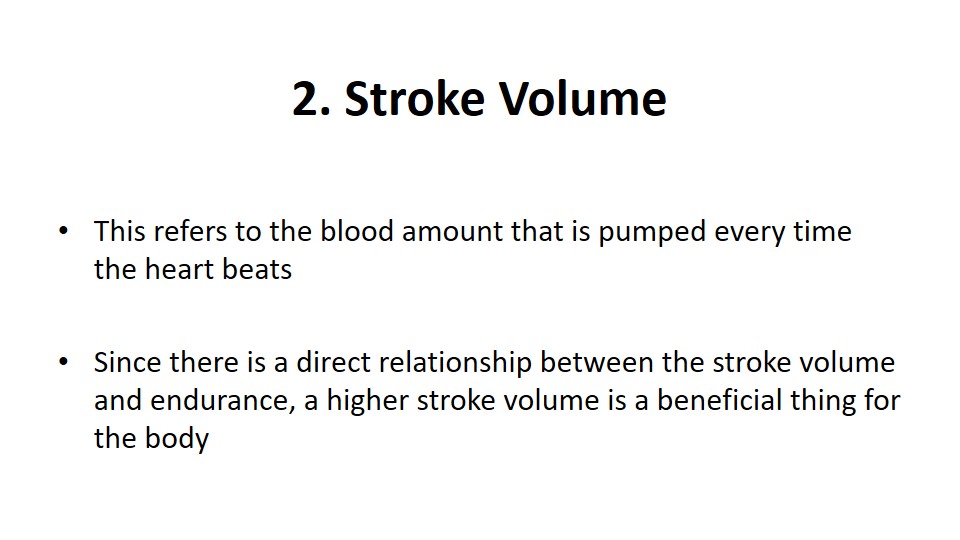
**S4**: One of the main elements of endurance is cardiovascular performance. This refers to the way your heart works and the subsequent working of the circulatory system in response to heart’s pumping. The functioning of the heart can be measured by three determinants.



**S5:**

1. **Heart Rate**

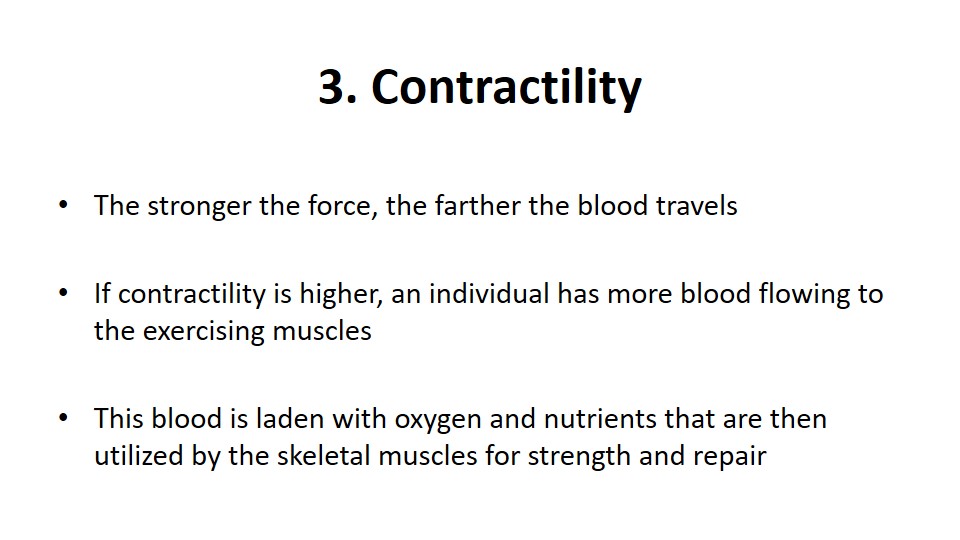
This is the rate of your heart beating per minute. The more your heart beats in a minute, the more blood is pumped to the body and the faster your body moves towards endurance.



**S6:**

1. **Stroke Volume**

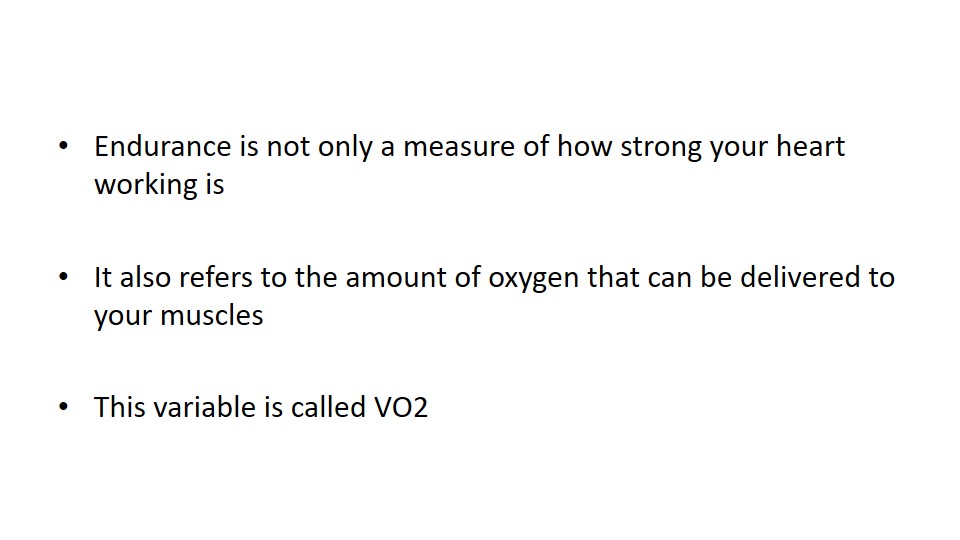
This refers to the blood amount that is pumped every time the heart beats. Since there is a direct relationship between the stroke volume and endurance, a higher stroke volume is a beneficial thing for the body.



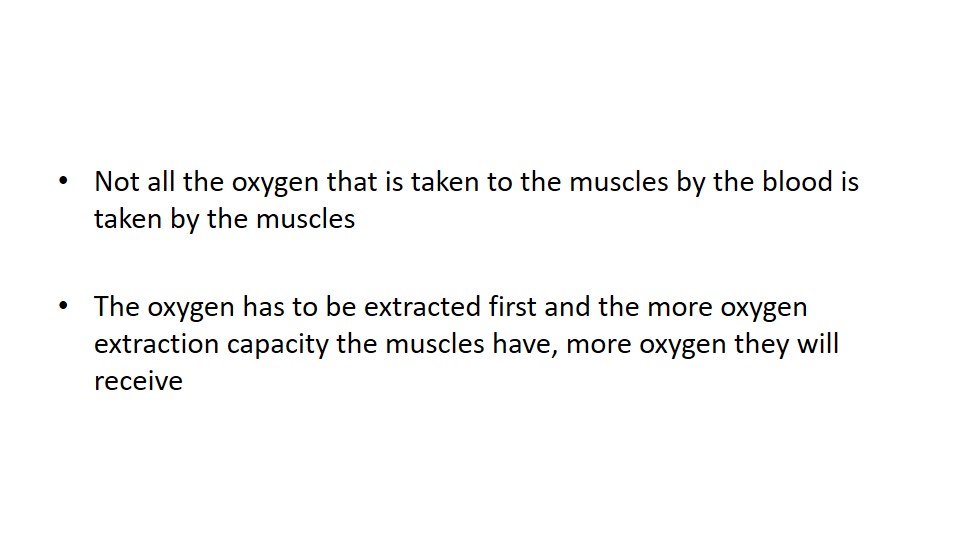
**S7:**

1. **Contractility**

This refers to the force with which your heart pumps blood to the body. The stronger the force, the farther the blood travels. If contractility is higher, an individual has more blood flowing to the exercising muscles. This blood is laden with oxygen and nutrients that are then utilized by the skeletal muscles for strength and repair.

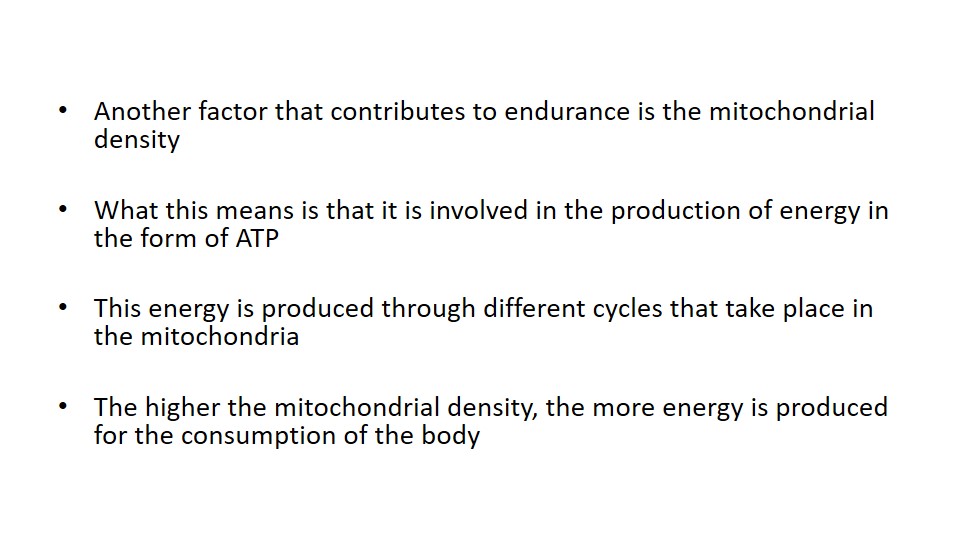


**S8:** Endurance is not only a measure of how strong your heart working is. It also refers to the amount of oxygen that can be delivered to your muscles. This variable is called VO2.

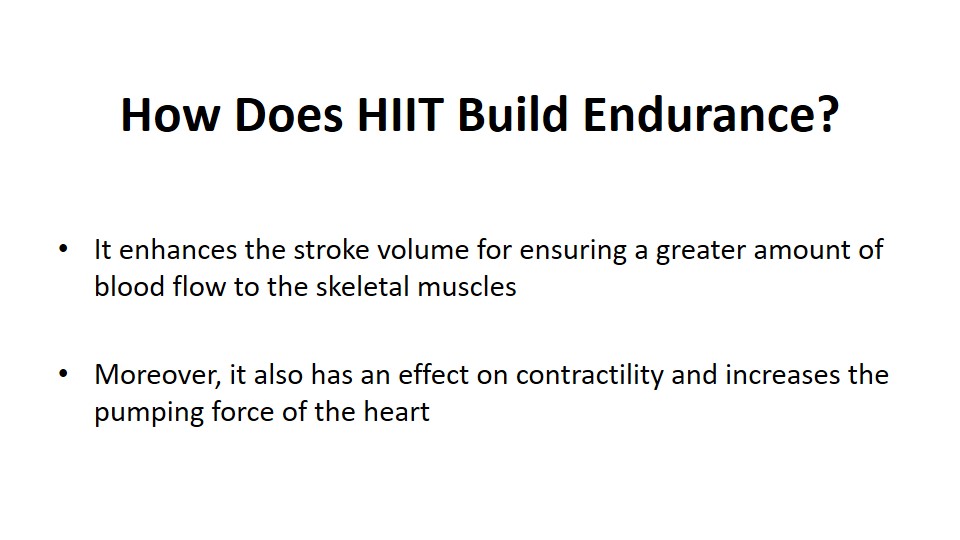


**S9:** This variable depends on the factors mentioned earlier as well as on the amount of oxygen that is extracted from the blood that enters the muscles. Not all the oxygen that is taken to the muscles by the blood is taken by the muscles. The oxygen has to be extracted first and the more oxygen extraction capacity the muscles have, more oxygen they will receive.

**S10**: Another factor that contributes to endurance is the mitochondrial density. It is common knowledge that mitochondria is the power house of the cell. What this means is that it is involved in the production of energy in the form of ATP. This energy is produced through different cycles that take place in the mitochondria. The higher the mitochondrial density, the more energy is produced for the consumption of the body.

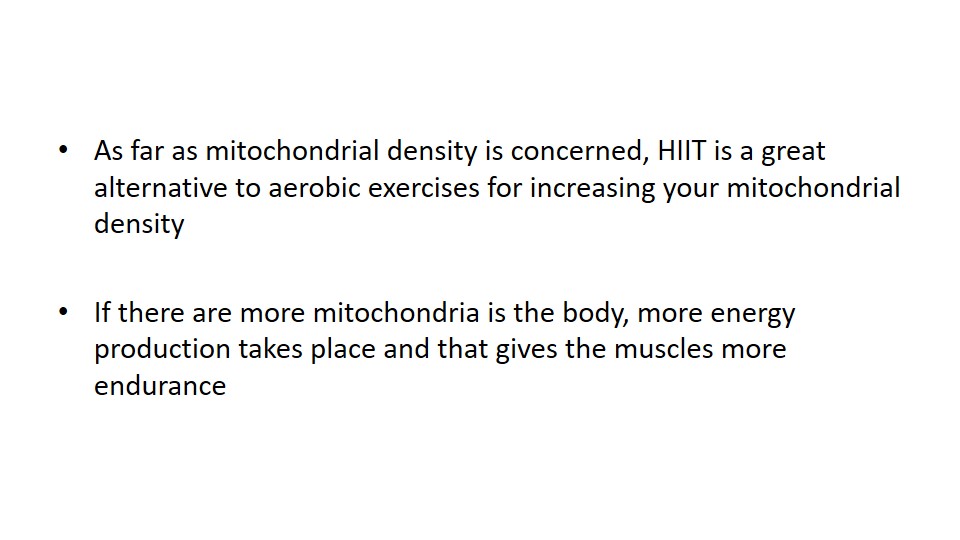


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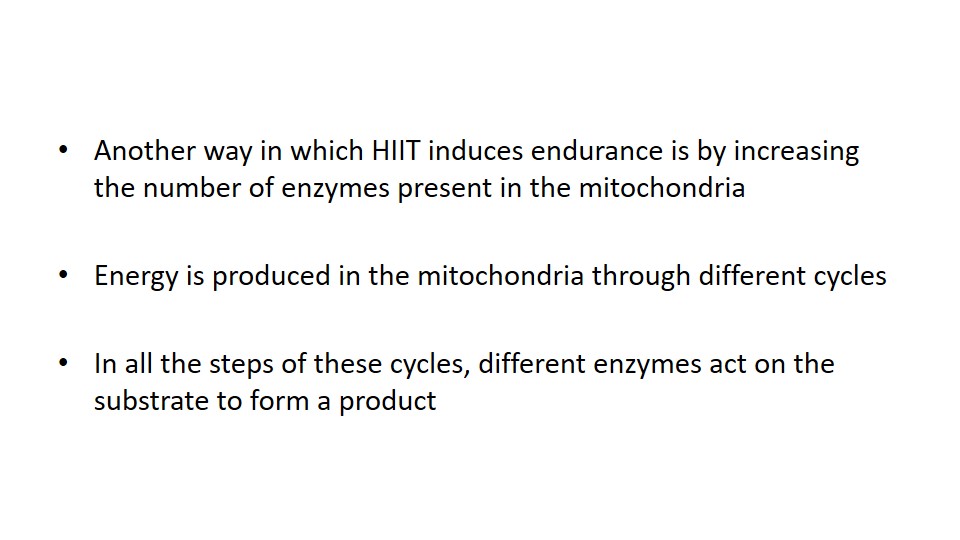


## How does HIIT build endurance?

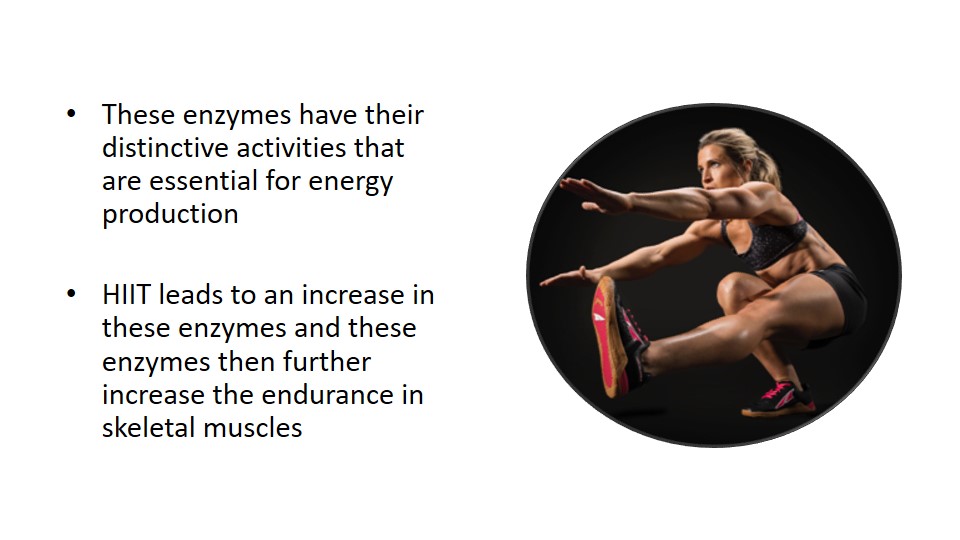
**S11:** HIIT builds endurance by working on all the variables that are mentioned earlier. It enhances the stroke volume for ensuring a greater amount of blood flow to the skeletal muscles. Moreover, it also has an effect on contractility and increases the pumping force of the heart.



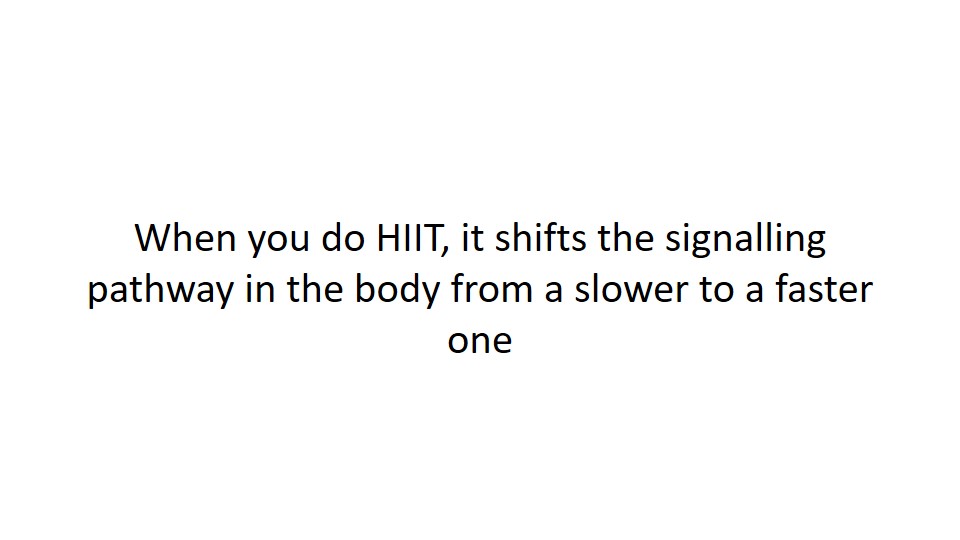
**S12**: As far as mitochondrial density is concerned, HIIT is a great alternative to aerobic exercises for increasing your mitochondrial density. If there are more mitochondria is the body, more energy production takes place and that gives the muscles more endurance.



**S13**: Another way in which HIIT induces endurance is by increasing the number of enzymes present in the mitochondria. As mentioned earlier, energy is produced in the mitochondria through different cycles. In all the steps of these cycles, different enzymes act on the substrate to form a product.

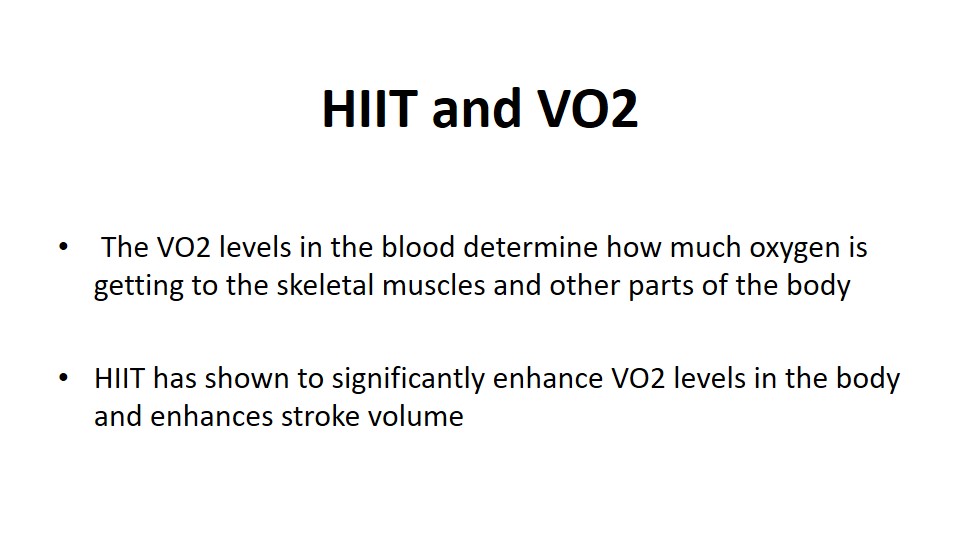


**S14:** These enzymes have their distinctive activities that are essential for energy production. HIIT leads to an increase in these enzymes and these enzymes then further increase the endurance in skeletal muscles.



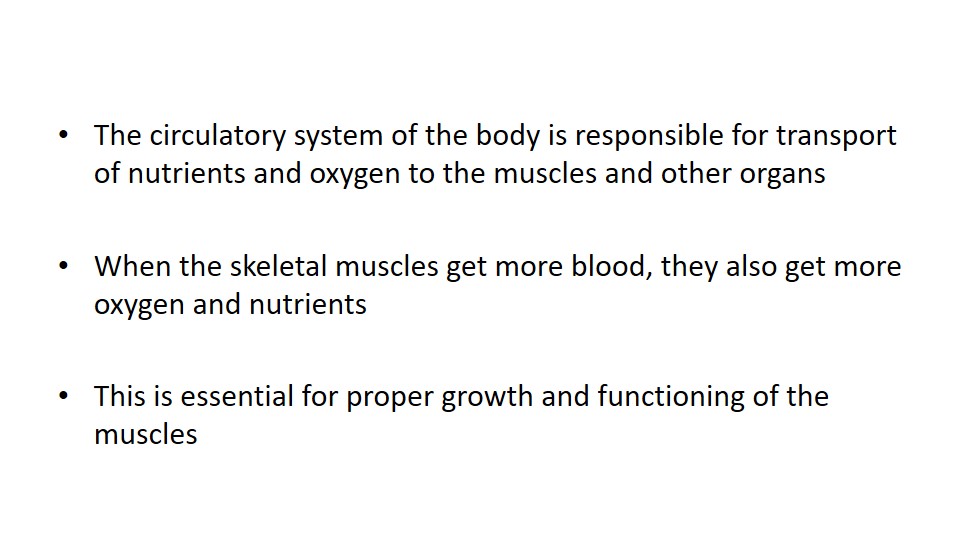
**S15**: When you do HIIT, it shifts the signalling pathway in the body from a slower to a faster one. For breakdown of nutrients and extraction of energy from them, the mitochondria are activated through a ‘switch’ in the body called PGCa. During high intensity exercises, the signalling pathway for activation of this switch is a faster one. As a result of that, the enzymes’ activity is enhanced and the mitochondrial density is also increased.

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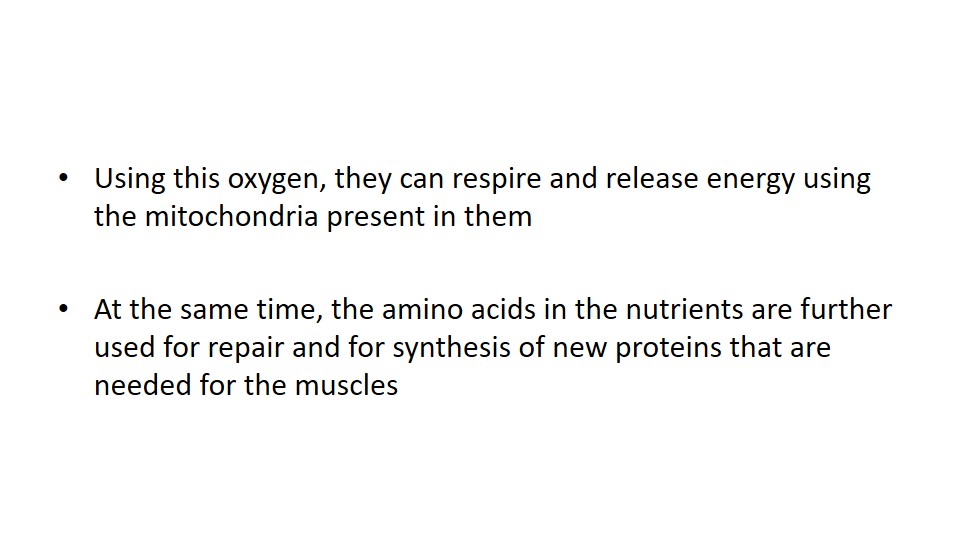


## **S16**: HIIT and VO2

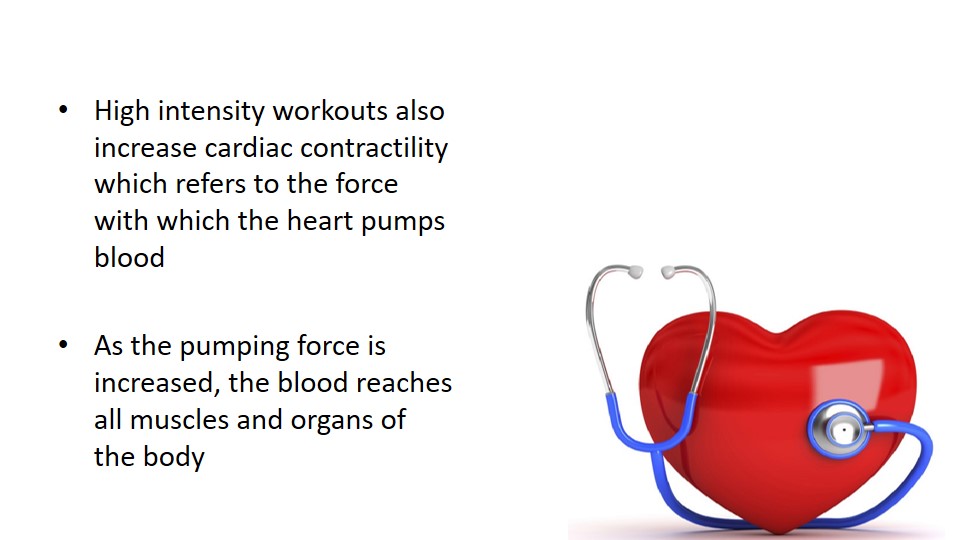
As mentioned earlier, the VO2 levels in the blood determine how much oxygen is getting to the skeletal muscles and other parts of the body. HIIT has shown to significantly enhance VO2 levels in the body and enhances stroke volume. Since the stroke volume is enhanced through high intensity workouts, more blood gets sent to the body every single time the heart contracts. This is a good thing for the skeletal muscles since they start getting more blood.



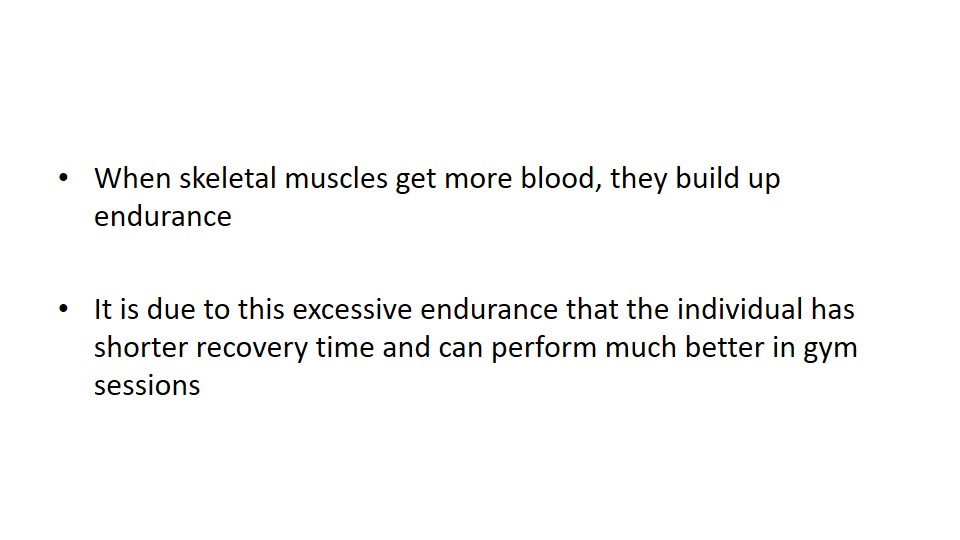
**S17:** The circulatory system of the body is responsible for transport of nutrients and oxygen to the muscles and other organs. When the skeletal muscles get more blood, they also get more oxygen and nutrients. This is essential for proper growth and functioning of the muscles.



**S18**: Using this oxygen, they can respire and release energy using the mitochondria present in them. At the same time, the amino acids in the nutrients are further used for repair and for synthesis of new proteins that are needed for the muscles.

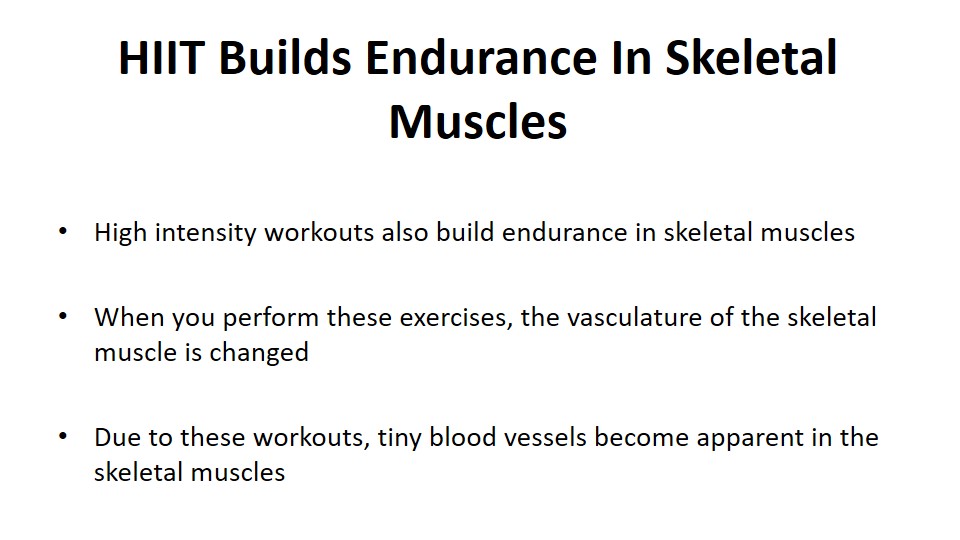


**S19:** High intensity workouts also increase cardiac contractility which refers to the force with which the heart pumps blood. As the pumping force is increased, the blood reaches all muscles and organs of the body.

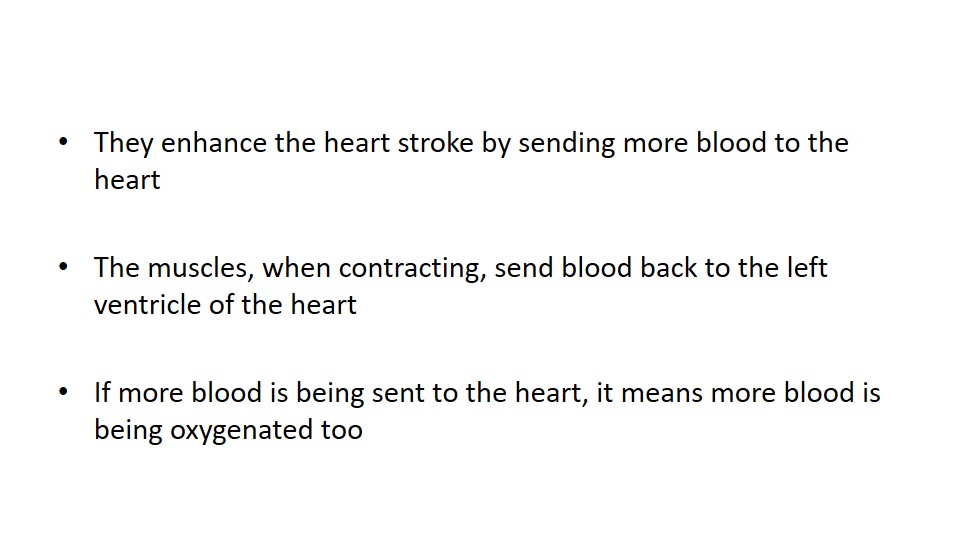


**S20:** When skeletal muscles get more blood, they build up endurance. It is due to this excessive endurance that the individual has shorter recovery time and can perform much better in gym sessions.

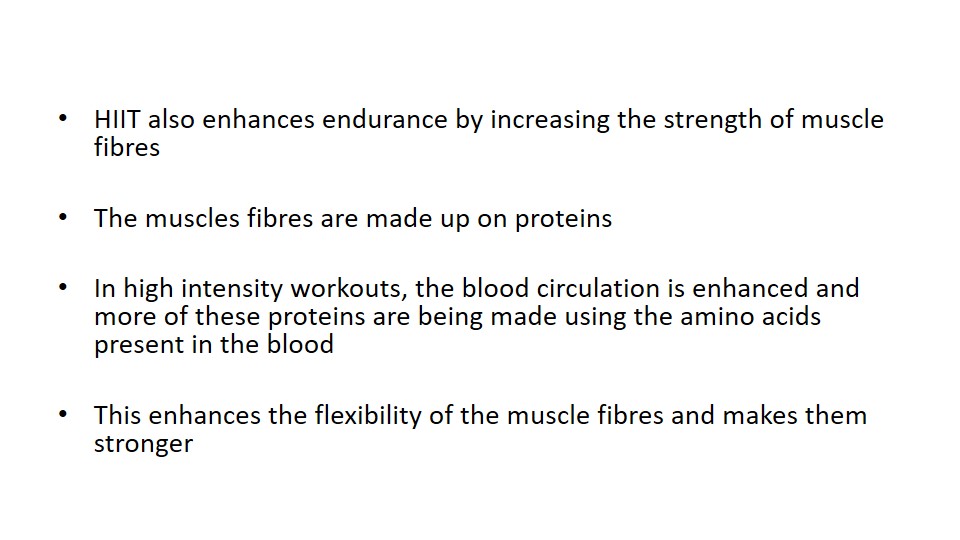
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**S21**: High intensity workouts also build endurance in skeletal muscles. When you perform these exercises, the vasculature of the skeletal muscle is changed. The vasculature refers to the size and number of blood vessels that are present in the area. Due to these workouts, tiny blood vessels become apparent in the skeletal muscles.

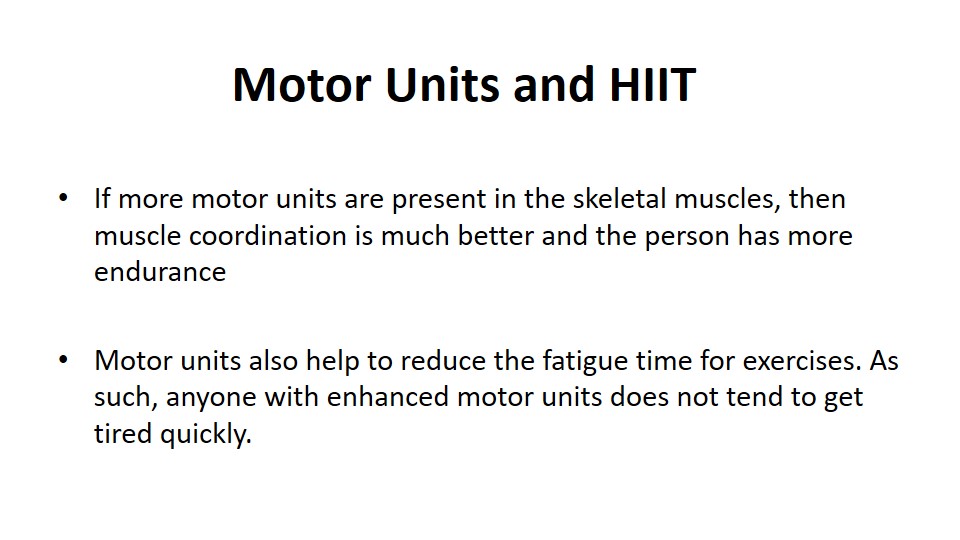


**S22:** They enhance the heart stroke by sending more blood to the heart. The muscles, when contracting, send blood back to the left ventricle of the heart. If more blood is being sent to the heart, it means more blood is being oxygenated too. Thus, heart stroke is enhanced and more blood is sent back to the body in oxygenated form. This increases the amount of nutrients getting to the muscles.



**S23**: HIIT also enhances endurance by increasing the strength of muscle fibres. The muscles fibres are made up on proteins. In high intensity workouts, the blood circulation is enhanced and more of these proteins are being made using the amino acids present in the blood. This enhances the flexibility of the muscle fibres and makes them stronger.

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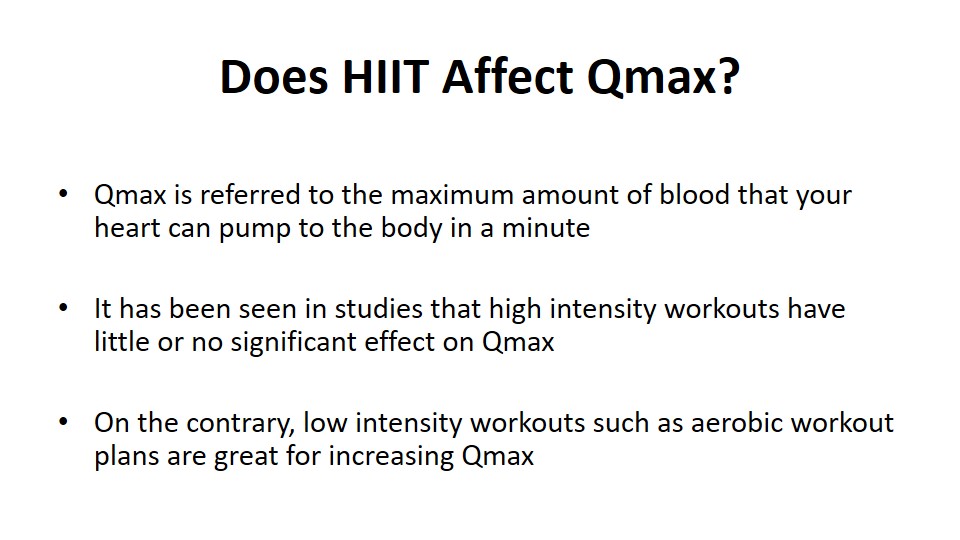


## Motor units and HIIT

**S24:** The skeletal muscle fibres have something called motor units. These units are important for signalling in the muscles and for building endurance. High intensity workouts increase the number of motor units present in the body. This can aid in two things.

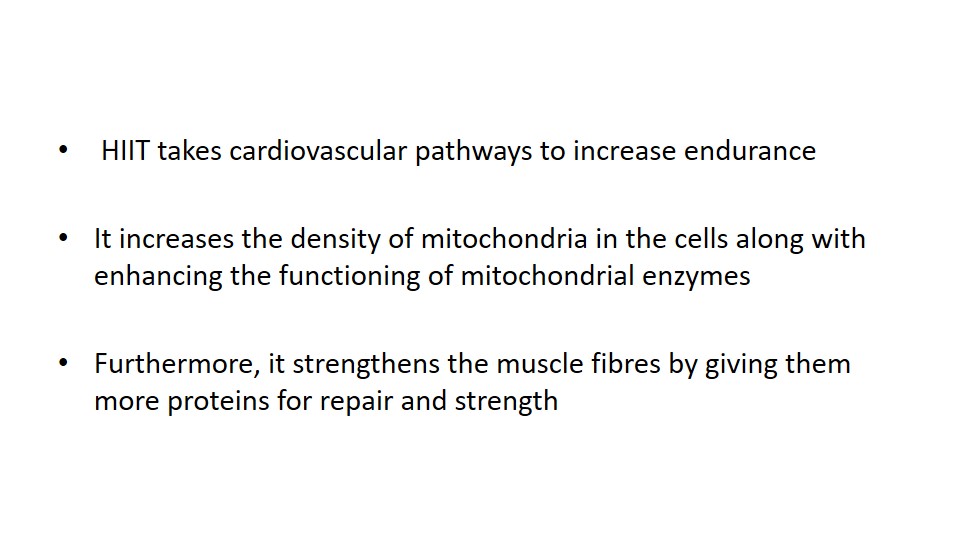
* If more motor units are present in the skeletal muscles, then muscle coordination is much better and the person has more endurance.
* Motor units also help to reduce the fatigue time for exercises. As such, anyone with enhanced motor units does not tend to get tired quickly.

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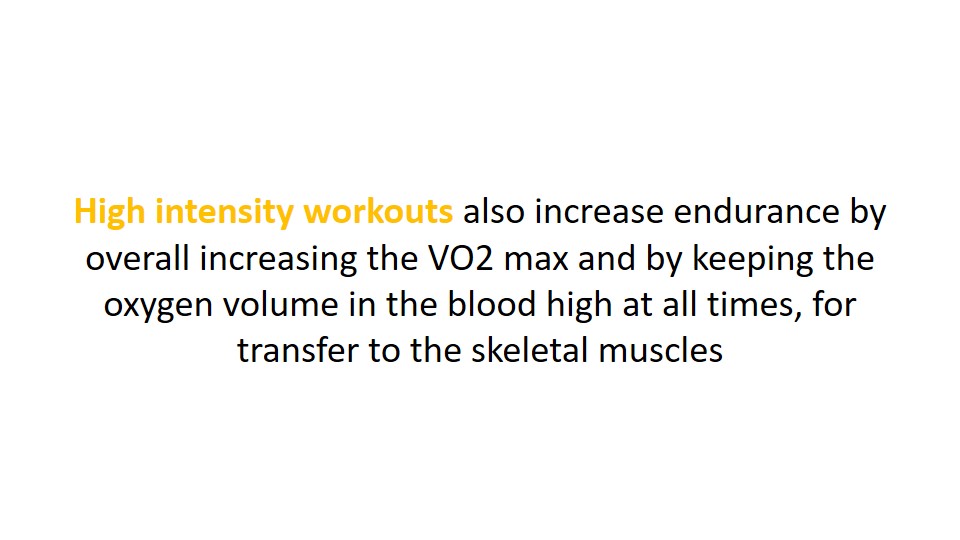


## Does HIIT Affect Qmax?

**S25**: Qmax is referred to the maximum amount of blood that your heart can pump to the body in a minute. It has been seen in studies that high intensity workouts have little or no significant effect on Qmax. On the contrary, low intensity workouts such as aerobic workout plans are great for increasing Qmax.



**S26:** Therefore, HIIT takes cardiovascular pathways to increase endurance. It increases the density of mitochondria in the cells along with enhancing the functioning of mitochondrial enzymes. Furthermore, it strengthens the muscle fibres by giving them more proteins for repair and strength.



**S27:** High intensity workouts also increase endurance by overall increasing the VO2 max and by keeping the oxygen volume in the blood high at all times, for transfer to the skeletal muscles.