

# Optimal Cardio Intensity for Fat Metabolism & VO2 Max Calculator (Semi-Technical)

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## Abstract

Several studies have examined and compared the effect of exercise intensity on substrate utilization. The purpose of this paper was to provide insight on these findings. The following recommendations will be based on the work of Wilson J. and Wilson G. (2005), [Direct Comparisons of Fuel use during Low, Moderate, and High Intensity Exercises](#). For a more comprehensive review on studies and mechanisms on this topic, refer to that article. References listed on the bottom are additions to this series on exercise intensity and fuel utilization. For all other sources cited in the body of this article, but not referenced, refer to the aforementioned article.

## Introduction

Today, an historical battle exists. Across countries exercise participants purport the superiority of high intensity interval training (HIIT) which is short over low to moderate intensity long duration training. One of the purposes of this article is to analyze the evidence for this claim and allow the reader to conclude from there. Shawn Phillips, one of the leading spokesman for HIIT stated that

You knew deep down, anyhow, that busting your butt burned off more fat than an exercise that allowed you to read at the same time, didn't you? Well, research shows our instincts were right...

HIIT speeds up your metabolism and keeps it revved up for some time after your workout. The bottom line is HIIT training burns a greater number of total calories than low-intensity training, and more calories burned equals more fat lost. What I'm suggesting is you forget about the "calories burned" readout on the stairstepper or Lifecycle; if you practice HIIT training, the majority of calories burned will come after your workout!

The above statement paints an appealing picture. In reality however, the scientific evidence suggests that it is unequivocally false (Laforgia et al., 1997, Gore and Withers, 1990, Freedman-Akabas, 1985).

Laforgia et al. (1997) suggests that a comparison of the excess calories above moderate intensity exercise 'for the interval treatment is of little physiological significance to the energy balance of athletes because this amount of energy is equivalent to the kilojoules in only 75 ml of orange juice (1/3<sup>rd</sup> cup).' They further conclude that 'the major contribution of both treatments to weight loss was via the energy expended during the actual exercise. The excess post exercise energy expenditure is therefore of negligible physiological significance as far as weight loss is concerned.'

And there are hundreds of studies which support this (again, refer to the said article for a massive review on this topic). Even for the most intense exercise sessions, Excess Post Exercise Oxygen Consumption (EPOC) is always negligible in comparison to the amount of calories metabolized during physical activity.

### **Exercise Intensity and Fuel Utilization**

Since the EPOC argument has been dismantled, the next question is, what exercise intensity optimizes fat utilization?

Evidence suggests that as exercise intensity decreases, there is an increased reliance on the peripheral adipose depot, with a concomitant sparing of carbohydrates, particularly intramuscular glucose polymers. It appears that total fat oxidation becomes optimal within the range of 60% VO<sub>2</sub> max.

For instance, Romijn et al. (1995) examined fuel utilization during 25, 65, and 85% VO<sub>2</sub> max. To elaborate, Vo<sub>2</sub> max can be defined as the greatest amount of oxygen you can take in, transport, and utilize at the cellular level for energy.

Results found that over 85 % of the fuel during 25 % VO<sub>2</sub> max was provided by fatty acids from adipose, while 7.5 % was provided by intramuscular triglycerides. Carbohydrate oxidation provided approximately 7.5 % of the fuel used. Further, muscle glycogen stores did not contribute significantly to this number, suggesting almost complete reliance on peripheral glucose.

In the 65 % condition, 50 % of the fuel was derived from lipid oxidation, in equal measure from adipose and intramuscular stores. Carbohydrate utilization provided approximately 50 % of the fuel utilized, with 80 % of this coming from intramuscular glycogen stores.

The lowest percentage of fat metabolism was found in the 85 % condition, with only 25 % of the fuel coming from lipid oxidation from equal measures of adipose and intramuscular TGs.

However, total calories utilized increased as exercise intensity increased. Of those calories, total fat oxidation was highest in the 65 % VO<sub>2</sub> max condition, while there was no significant difference between the 25 and 85 % VO<sub>2</sub> max conditions. Of those fats utilized, the greatest amount of lipid oxidation derived from adipose tissue came from the 25 % VO<sub>2</sub> max condition, followed by the 65 % VO<sub>2</sub> max condition. Adipose derived fat oxidation was lowest in the 85 % VO<sub>2</sub> max condition.

It would be helpful to elaborate on this with an example. Say someone exercises for 20 minutes at 25, 65, and 85% VO<sub>2</sub> max. And say that the total amount of calories metabolized were 100, 250, and 300 for the 25, 65, and 85% VO<sub>2</sub> max conditions, respectively. Now, to calculate the amount of fat metabolized during each session, simply multiply by the percentages listed above. For instance, during the 25% VO<sub>2</sub> max condition, 85% of the fuel probably came from fat, which would mean the person metabolized 85 calories from fat. For the 85% VO<sub>2</sub> max condition, of the 300 calories metabolized, 75 calories of fat were also metabolized, but an additional 225 calories from carbohydrates were also metabolized. Finally, in the 65% vo<sub>2</sub> max condition, a whopping 125 calories were metabolized from fat during the same period of exercise. This is 40% more total fat than both the high and low intensity conditions.

Other studies confirm these results, with deviations.

In summary evidence suggests that 65%  $\pm$  5 VO<sub>2</sub> max is optimal for total fat oxidation.

### **Exercise Intensity and Muscle Catabolism**

All body builders have a sworn mortal enemy—cortisol. This hormone acts to breakdown muscle tissue, and creates a catabolic environment, contrary to growth.

The question is: what is the effect of exercise intensity on cortisol?

Davies (1973) examined the effect of duration and intensity on plasma cortisol levels. It was found that as duration and intensity increased, cortisol increased. However, they found what appeared to be a threshold for cortisol secretion at 60 % VO<sub>2</sub> max intensity. Therefore at lower intensities cortisol is primarily controlled by metabolic need. In this context Sotsky et al. (1989) investigated the effect of hypoglycemia on moderate intensity exercise, below 60 VO<sub>2</sub> max over 50 minutes of cycling in participants with normal blood glucose levels of 87 mg / dl, and in participants with low blood glucose levels of 59 mg / dl. No significant difference in cortisol levels were found in the normal glucose condition, while a 400 % increase (!) was found in the low glucose condition. Therefore it appears that under normal dieting conditions that cortisol secretion may not significantly rise during an hour of low intensity exercise, suggesting that it is an effective tool for fat metabolism, without high catabolic effects.

In summary, cortisol increases proportionally with exercise intensity, with a threshold at 60% vo<sub>2</sub> max; meaning that below 60% VO<sub>2</sub> max, cortisol will be kept at bay. Thus, displaying an advantage to very low intensity exercise. However, this is not the case under a hypoglycemic condition. During such a condition, cortisol will increase dramatically no matter what intensity you train at, displaying the importance of proper nutrition.

### **Exercise Intensity and Performance**

To briefly summarize this, exercise intensity appears to be the number one factor for maintaining performance. For instance, if you were to lower your volume for 4 weeks, but maintain your intensity (i.e. lift just as heavy) then you would actually improve in various adaptations. However, if you were to lower your intensity (i.e. drop from 300 to 250 pounds in the squat lift) adaptations—muscular, strength, enzymatic, etc.—would quickly be lost.

Incidentally, evidence suggests that glycogen stores (the stored form of glucose) is directly related to being able to maintain exercise intensity. Thus, if you are glycogen depleted, intensity, and therefore, adaptations, will drop.

In this context, high intensity cardio sessions, which have been shown to deplete your body of precious glycogen stores, would seem inadvisable for performance in the weight room, demonstrating another problem with high intensity workouts.

### **High Intensity Exercise Followed by Low intensity Exercise**

During high intensity exercise, lipolysis (the breakdown of triglycerides into its glycerol and fatty acid components) is potently stimulated, because catecholamines (fat metabolizing hormones) are highest during this intensity. However, alpha receptors (receptors stimulated by catecholamines) inhibit these fatty acids from being transported by its protein carrier albumen to the musculature that it may be oxidized. What Wilson J. and Wilson G. (2005) found, was that when intensity is lowered sympathetic tone lowers proportionally, and a high rise in plasma fatty acids is seen (Romijn et al., 1993.) For this reason, we suggest that a combination of high intensity and low intensity training protocols may be a highly effective technique for fat metabolism.

In addition to this, results show that fat oxidation is increased proportionally to concentrations of fatty acids. For instance, they have done studies where they have fed participants fat closely to an event, and this increased fat oxidation during exercise. Thus, this rapid rise in FFA's should enhance fat oxidation.

To give an example, performing a 10 minute high intensity cardio session, followed by a 30 minute low to moderate intensity cardio session, could prove highly efficacious for fat metabolism.

## **Practical Applications**

Evidence suggests that as exercise intensity decreases, there is an increased reliance on the peripheral adipose depot, with a concomitant sparing of carbohydrates, particularly intramuscular glucose polymers. It appears that fat oxidation becomes optimal within the range of 60% VO<sub>2</sub> max. However, training below this range (>50% VO<sub>2</sub> max) may be beneficial, if optimal muscle sparing is a priority, as catabolic hormones are minimized during low intensity cardio; so long as you are in a euglycemic state (e.g. your blood glucose levels are stable).

An analysis of scientific literature demonstrates that the maintenance of adaptations are intensity specific. The reader is therefore, cautioned to avoid over reliance of high intensity, glycogen depleting protocols.

High intensity training may prove beneficial if used properly. For example, its potent stimulation of whole body lipolysis during exercise leads to a rapid influx of plasma free fatty acids after intensity is lowered. In this context, it is postulated that performing a notably short, high intensity session, followed by a long duration, low to moderate intensity workout, may optimize lipid oxidation.

Amidst hypertrophic growth cycles, in which there is a caloric surplus, short, high intensity workouts may elicit a supplementary anabolic stimulus. This is attributed to preferential recruitment of type II fibers, which have the greatest capacity for growth, as well as an increase in anabolic hormones.

## **That's all fine but...How the heck do I calculate my VO<sub>2</sub> max!?!?**

Glad you asked!

Well, it is not practical for most to directly measure oxygen consumption during all exercise sessions. Therefore, an alternative method is needed.

What results show, is that there is a very close correlation between heart rate reserve (HRR) and vo2 max (Shepard & Astrand, 2000, p.g., 14).

To elaborate, HRR is calculated by subtracting your maximum heart rate by your resting heart rate. A classic example of maximum heart rate is the Karvonen formula, which is 220 minus your age. Say you have a 20 year old, with a resting heart rate of 60 beats per minute, this individuals maximum HR would be 200 (220-20) and his HRR would be 140 (200-60).

So, say this individual wants to train at 65% of his VO2 max. He simply would times his HRR by .65, which would be 91 beats per minute. To translate this to a normal heart rate, simply add the resting heart rate to the heart rate reserve. This would add to 150 beats per minute, or 75% of his maximum heart rate.

## **VO2 Max Calculator**

Does this still not make sense?

No problem! Just use our quick and easy to use VO2 max calculator, created by Adam "Old School" Knowlden. Simply plug in your age, and desired VO2 max, and a formula will pop up for what heart rate you should train at. Click below to use this:

[VO2 Max Calculator](#)

Sincerely,

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## **References**

Shepard & Astrand (2000). Endurance in Sport. 2<sup>nd</sup> addition. The Encyclopedia of Sports Medicine. Blackwell science. p.g., 14