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Slow Down to Speed Up: Using Intensity Threshold Indicators to Optimize Lipid Utilization during Exercise

Declan AJ Connolly*

University of Vermont, USA

The incidence of diabetes both in the United States and worldwide is alarming. Estimations for worldwide prevalence range 200 -366 million people [1] with current estimates in the United States at @ 30 million [2]. Estimations are for a worldwide prevalence of 551 million by 2030 [2]. This accounts for approximately 10% of the US population. In the US alone the estimated costs of diabetes, both direct and indirect, are a staggering $245billion [2]. These figures are particularly alarming for a condition that by and large is caused by lifestyle and therefore for many people has a potentially straightforward remedy. Simply put in the CDC National Diabetes Statistics Report "Many people with type 2 diabetes can control their blood glucose by following a healthy meal plan and a program of regular physical activity, losing excess weight, and taking medications" [2]. The increase in diabetes is particularly disturbing given the abundance of information available on exercise, diet, lifestyle choices etc. To date these educational materials appear ineffective in treating the larger issue.

Arguably the most effective approach to treatment of diabetes is through a balanced program of exercise and dietary adjustment [3]. The interest of this short paper is primarily in the use of exercise as a treatment mechanism. While exercise is widely regarded as a therapy for many ailments, particularly diabetes, not all exercise programs appear to be effective and there are gross misunderstandings in the practice of exercise prescription. I would suggest that this may be due to the complexity of metabolic energy production and substrate usage that changes during exercise. In layman's terms, many people assume that more intense exercise is better exercise. In the case of exercise as a treatment for diabetes and weight control, I would argue that exactly the opposite is true. In previous work I have suggested that the anaerobic threshold, a commonly used term in exercise and sports physiology, might be of great benefit to the weight loss population [4]. A brief review of this phenomenon would help place its value in perspective.

The anaerobic threshold (AT) is also known by numerous other terms including lactate threshold and ventilatory threshold [5]. Typically, whichever term is used indicates how it was assessed clinically. As humans exercise energy must be produced to facilitate muscle contraction. At lower intensities, slow oxidative (slow twitch) muscle fibers produce most force and energy. They do this as oxygen to the mitochondria is in ample supply and this allows most energy to be produced using lipid (or fat) metabolism. However, as exercise intensity increases and relative oxygen supplies diminish, muscle force and energy production levels must still increase to allow continued performance and this demand is met by an increasing recruitment of fast glycolytic (fast twitch) muscle fiber. As the term implies these fibers are more glycolytic in nature and the preferred fuel substrate is carbohydrate. The metabolic by-product of glycolysis is an accumulation in lactic acid. Hence the term lactate threshold. In essence, the point occurs on the time-intensity continuum whereby the body must markedly elevate respiration, energy production, hydrogen ion buffering and measurably heart rate, to continue performing. This point is invariably known as the anaerobic threshold and is ably measured using blood markers, ventilation gases, or heart rate [5]. For the purposes of this short commentary, one could argue that it signifies

the point where metabolically there is a reduction in lipid metabolism and an increase in carbohydrate metabolism. In practical terms, it indicates the intensity or work-rate that an individual should not exceed if losing weight (burning fat) is the primary objective. In other words, if people work too hard they will reduce their potential weight loss benefits.

The anaerobic threshold is a scientific marker that has been traditionally used only in sports performance settings, where athletes have focused on training programs to improve their AT. However, I am confident that this marker has significant value in the exercise prescription realm for the treatment of diabetes and overweight. Moreover, properly used it can significantly increase the level of lipid metabolism for a given exercise bout thereby enhancing fat reduction. To illustrate this point consider the use the 'respiratory quotient' (RQ) an often used indicator of substrate utilization in sports performance laboratory measures. The RQ is the ratio of carbon dioxide produced to oxygen consumed and allows one to calculate the percent of energy production that comes from either lipids or carbohydrates at any given work-rate (with the assumption of limited protein metabolism). Strictly speaking the RQ occurs at the cellular level and is not easy to determine. Therefore, we use gas exchange at the mouth and refer to it as the respiratory exchange ratio (RER). The Table 1 below shows an adapted RQ Table [6] along with some illustrative calculations examples of how it can be used.

Let's assume we have a 95 kg male who exercises under two typical exercise conditions.

1.   A brisk speed of 5 mph for 30 minutes. This represents hard exercise intensity and elicits at RER of .94. (O_2=3.8 L/min, VCO_2 4.04 L/min).

RQ Value	Kcals L/O_2	% Carbohydrate	% Fat
0.70	4.686	0.0	100.00
0.76	4.751	19.2	80.8
0.80	4.801	33.4	66.6
0.86	4.875	54.1	45.9
0.90	4.924	67.5	32.5
0.94	4.973	80.7	19.3
1.00	5.047	100.0	0.0

Table 1: An adapted RQ Table.

*Corresponding author: Declan AJ Connolly, Professor, University of Vermont, USA, Tel: 0018026568468; E-mail: Declan.Connolly@uvm.edu

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Kcals/L at 0.94 = 4.973

4.973 kcals/min x 3.8 L/min = 18.89 kcals/min

So, we calculate at this intensity @80.7% of calories came from carbohydrates and only 19.3 came from lipids. Total energy expenditure over the 30 minutes is 30×18.89 = @566 kcals. In real terms this amounts to 456 kcals from carbohydrate and 109 kcals from fat.

2. A moderate/easy speed of 3.5 mph for 30 minutes. This represents an easy intensity for him and elicits an RER of .86 (O_2 = 3.0L/min, VCO_2 = 3.48L/min).

Kcals at 0.86 = 4.875

4.875 kcals/min x 3.0 L/min = 14.62 kcals/min

So, we calculate at this intensity 54.1% of calories came from carbohydrate and 45.9% of calories came from lipids. Total energy expenditure over the 30 minutes is 30×14.62 = @439 kcals. In real terms this amounts to 237 kcals from carbohydrate but 202 kcals from fat.

We can see that in condition 2 significantly more lipids are used despite a reduction in the total kcals used during the exercise session. Admittedly, this is a simplification of a more complex occurrence. However, what is significant is that if subjects can select a more appropriate intensity of exercise they can dramatically increase the total lipid usage during exercise. In addition, there are several other points to consider.

1. The anaerobic threshold occurs is most untrained individuals at around 85% of maximum heart rate and actually serves as a convenient threshold where the substrate usage is approximately 50/50 for carbohydrate and fat. Therefore, it would serve well as an exercise intensity gauge for selecting intensity with a high lipid oxidation rate.

2. Exercising at a more moderate intensity will result in less fatigue and increases the likelihood that subjects can exercise for a longer period of time thereby expending more energy. Higher exercise intensities result in shorter exercise bouts.

3. Exercising at lower intensities results in more cardiovascular versus biochemical adaptation resulting in greater lipid oxidation ability overall.

There is a general belief that harder exercise is better. However, that depends on the population and their objectives. While higher intensity exercise may indeed be preferred for sports performance objectives, I do not believe this is the case for subjects primarily interested in weight loss. In fact, some basic number crunching suggests that lower intensity exercise may in fact be more beneficial. I would therefore conclude that clinicians, working specifically with patients whose primary objective is weigh reduction, consider using the concept of anaerobic threshold as a mechanism to regulate exercise intensity and thereby maximize lipid utilization during exercise.

References

1. International Diabetes Federation (2011) IDF Diabetes Atlas (5thedtn). International Diabetes Federation, Brussels, Belgium.

2. Centers for Disease Control and Prevention (2014) National Diabetes Statistics Report: Estimates of Diabetes and Its Burden in the United States, 2014. Atlanta, GA: US Department of Health and Human Services, USA.

3. Donnelly JE, Blair SN, Jakicic JM, Manore MM, Rankin JW, et al. (2009) Appropriate physical activity intervention strategies for weight loss and prevention of weight regain for adults. American College of Sports Medicine. Med Sci Sports Exerc 41: 459-471.

4. Connolly DAJ (2012) The anaerobic threshold: over-valued or under-utilized. A novel concept to enhance lipid optimization? Curr Opin Clin Nutr Metab Care 15: 430-435.

5. Benson R, Connolly DAJ (2011) "Raising anaerobic threshold' in Heart Rate Training. Champaign, Ill, USA. Human Kinetics. 67-84.

6. Plowman SP, Smith DS (2013) "Energy Production" in Exercise Physiology for Health, Fitness and Performance. Lippincott, Williams & Wilkins, Philadelphia, PA, USA.