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ZONE 2 / BASE

TRAINING & YOUR HEALTH

P A R
K E R
PEAK PERFORMANCE



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INTRODUCTION

Walking your dog, hiking, and brisk walking, as well as slow jogs, swims, and cycling, are your best foundation for both health and performance.

This is called **Zone 2 (Z2) Training** and helps you reduce insulin resistance, recover from prolonged or intense training, and minimize injury risk. It's also recommended by the World Health Organization (WHO) to enhance both your health and life span. You can think of it as aerobic or cardiovascular training, but it's at a low enough intensity where your heart rate is elevated, but you're not "huffing and puffing".

Z2 training, also referred to as **base training**, is designed to facilitate better fuel partitioning, so at lower intensities, you are utilizing primarily fat, not sugar, as your primary fuel source. With nearly 50% of people either pre-diabetic or diabetic, this has enormous health benefits, making you less likely to develop insulin resistance. In highly active individuals, this helps to conserve the limited supply of glycogen for when it is needed most during high power or long endurance challenges.



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WHAT IS ZONE 2 OR BASE (LOW-INTENSITY) TRAINING

Base training is also called Low Heart Rate or Zone 1 and/or 2 training (in a 5-Zone model). This is quantified based on which fuel source you are primarily using – fat or sugar. If you're mainly burning fat, and thus keeping lactate levels low, you are below the Zone 2 threshold. Above Zone 2, your body is using less fat and more sugar for fuel, which is in limited supply, and thus only available for short durations.

High volumes of low-intensity training (Z1 & Z2) build your aerobic engine. This is termed in Strength and Conditioning (S&C) the Oxidative approach and is based on the Anti-glycolytic approach of Russian sports scientist Verkoshansky. The longer you can stay oxidative, even as effort rises, the more efficient you are and the longer you preserve your limited supply of glucose for when you need it most.

According to Eric Cressey, “Everyone needs a robust aerobic system to be healthy and effective, regardless of age, activity level, and athletic participation. Aerobic exercise can yield benefits from recovery to cardiovascular health, to mood, to motor learning (and more).” Low-intensity training is the key to building this base or aerobic capacity.

Often under-appreciated is that even in sports requiring great strength and power, like Mixed Martial Arts (MMA), the aerobic, endurance base is still fundamental. As Joel Jamieson says, “All combat sports do have an important anaerobic component, but the aerobic engine is still the key energy driver. This is particularly true the longer the fight or competition goes on... The truth about energy systems is that the aerobic system contributes energy to virtually everything.”

LANCE'S ZONE 2 PEARL

Activities where your heart rate rises too high, remains too low, or fluctuates up and down, are less ideal for maximizing the adaptations from Z2 training since the benefits from Z2 training come from keeping your heart rate steady in your Z2 over an extended period of time.

Functional Overreaching: Train Slow to Run Fast

For endurance athletes, an overrated quality is having the mental toughness to push your body to its limit. While an underrated quality is having the patience to prepare yourself so you can improve over time while pushing yourself at less than 100% of your capacity (Magness). Developing this type of work capacity is the secret to building sustainable athleticism and managing your risk of injury.

TABLE 1: SIGNS OF FUNCTIONAL OVERREACHING

1. Increased soreness
2. Increased fatigue
3. Under-performance

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WHAT IS THE POLARIZED TRAINING APPROACH?

The Polarized training approach is defined as a lot of low-intensity work (about 80% of training done in Zones 1 & 2), a little high-intensity work (about 20% of training done in Zones 4 & 5), and the least amount of middle-intensity work (Zone 3). For many elite endurance athletes, they are closer to 90/10 or 95/5. This is the average amounts for each type of training for an entire year. There may be points in the season where things shift closer to either 65/35 or even 95/5, depending on the specific adaptation that is being targeted.

Two simple rules:

1. Keep intensity low and volume high during aerobic work
2. Keep volume low and intensity high during power work

For most people focused on staying active, training too much middle-intensity, or Zone 3 work, is a typical mistake that's often encountered. When left to their own devices, most people will naturally gravitate toward, and train in, their Zone 3. This is because it's just hard enough to where they feel like they are working, but not so easy to where they feel like they aren't doing anything. This leads to missing the benefits of true, higher-intensity work as well as foregoing the benefits of true lower-intensity work which can lead to plateaus in development. It is human nature to perform:

- aerobic work with too much intensity and not enough volume
- power work with too much volume and not enough intensity

Zone 3 training, is both inefficient and ineffective because:

- It is too easy (i.e. not challenging enough) for acquiring speed or power adaptations,
- It is too hard for optimal mitochondrial growth and fat oxidation, and
- It leads to the release of more stress hormones which blunts your body's ability to recover, not only increasing the likelihood of overtraining, but also leading to fatigue which limits you in pushing as hard as needed during your higher-intensity workouts, (Zone 4 & Zone 5) increasing load and thus injury risk.

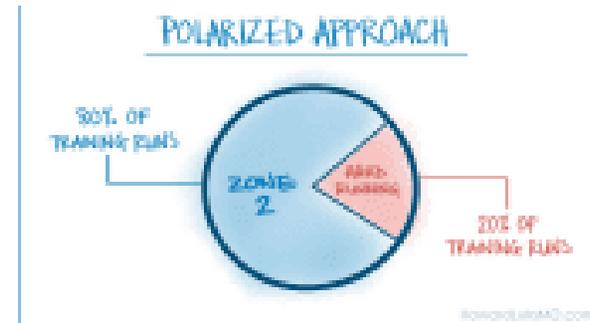


Figure 1 with permission from Luks H. Longevity...
Simplified: Living A Longer, Healthier Life Shouldn't Be Complicated. 2022.

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WHAT IS THE POLARIZED TRAINING APPROACH?

Figure 2 shows how intensity varies from Zone 1 to Zone 5.

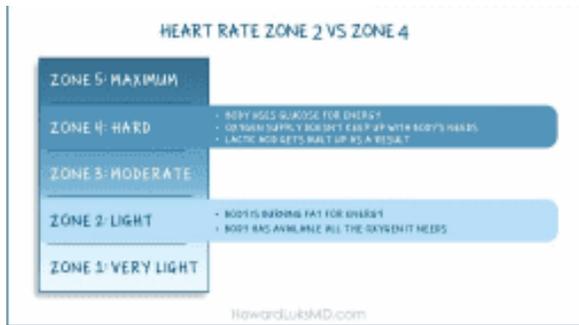


Figure 2 with permission from Luks H.

Cardiovascular training can be done in all 5 Zones, but the majority of benefits come from training at either a low or high intensity. Z1/2 or low-intensity training is what we refer to as base training and should be distinguished from high-intensity training (HIT) or high-intensity interval training (HIIT). Figure 3 summarizes the differences between base training and the popular high-intensity interval training HIIT.

Joel Jamieson states, “The biggest thing people try to use to justify higher intensities all the time is the research that shows greater improvements in various areas when a lower-intensity program is compared to a higher one for a short period of time, i.e. the infamous Tabata study. I always try to get people to understand that there’s always a cost to everything and the cost of these more rapid results is that they quickly slow down and aren’t sustainable. Getting people to shift their conditioning mindset more towards long-term, continuous progress vs. just a few weeks is a challenge, but hugely important I think.”

Referring to people engaged in sport, Steve Magness says, “I’d focus on the extremes with touches of the middle. Meaning lots of easy, work on pure speed, and then dashes of high-intensity work between.” Gareth Sandord similarly states, “Building low to moderate intensity work sequences well with maximal sprint speed mechanics and force development. Both ends can live in the program at the same time.”



Figure 3 (adapted from Joel Jamieson)

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WHAT IS THE POLARIZED TRAINING APPROACH?

According to a recent review by Lehtonen et al (2022), “a combination of HIT and low/moderate intensity training seems more effective in improving cardiometabolic health compared with HIT alone... In elite athletes, a polarized training approach combining moderate and high-intensity training has been shown to be superior to both low-volume HIIT and heavy-intensity training (Stoggl 2014). Laursen (2010) argued that HIIT and more prolonged training sessions at a lower intensity might cause similar aerobic adaptations in the skeletal muscle via different molecular pathways, while low-intensity training might also promote autonomic balance and recovery. Therefore, their combination in a training program might result in the highest performance improvements. These findings from the training practices of high-level athletes have not yet been fully investigated in the context of general population health.”

Dr. Inigo San Milan referring to HIIT training states, “In my humble opinion, after 26 years working with world champions and Olympic medalists in many sports and Tour de France winners, is that HIIT is a very very small percentage (under 5%) of their workload.” Magness says, “The best athletes on the planet, where HIIT is specific training (i.e. middle distance runners) seldom do more than one high-intensity interval workout per week during their most intense training phase. So why does the average Joe think they need/can handle 1 or more HIIT per week?”

“There is limited but emerging evidence that a polarized approach to training might be more effective also in recreational athletes and young overweight and obese subjects (Hydren 2015, Zapata-Lamana 2018). Polarized training targets most training time at exercise intensities below ventilatory threshold 1 (VT1) and above ventilatory threshold 2 (VT2), with limited training between VT1 and VT2, following an undulating, non-linear periodization structure.

Studies reporting endurance performance effect sizes comparing polarized (more training time below VT1 and above VT2 – ES 0.85–2.80) versus threshold training (significant training between VT1 and VT2– ES – 0.42–2.16) have consistently shown greater improvements following polarized training (Laursen 2010, Hydren 2015, Esteve Lanao 2007). In real-life situations, a combination of training intensities might be more practicable and enjoyable, cardiometabolic health benefits more thorough, the physiological training stimulation more varied, and a combination of different training intensities could result in better management of training stress.”

To be clear, while the lactate and ventilatory thresholds usually occur at similar spots within each individual, these thresholds are not the same thing. Luks has found many folks confuse LT1 & LT2 (Lactate Threshold1 & 2) with VT1 & VT2 – “They think they’re interchangeable, and they seem to understand lactate better than ventilatory physiology.” LT1 and LT2 are points where blood lactate levels rise due to an increase in work intensity. LT1 is sometimes taken around 1.9-2 mmol/L or at the first observable rise in blood lactate from baseline. LT2 is usually referenced when blood lactate accumulates to 4 mmol/L. VT1 and VT2 are also measurements of work intensity, however, VT1 and VT2 are measurements of different inflection points of breathing. While both are used to separate slight from moderate intensity (LT1/VT1) and moderate from high intensity (LT2/VT2), and are usually close to one another, they are not the same thing.

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WHAT IS THE POLARIZED TRAINING APPROACH?

LANCE'S ZONE 2 PEARL

Due to there being so many different factors at play regarding how one individual may react to a certain training stimulus, it's difficult to predict exactly how one may respond to a specific training protocol. This is just another reason why it's important to test and retest.

The approach described here presents general guidelines and principles. Being overly fixed on there being a predictable adaptation to specific stimuli, "fails to account for large individual variation in metabolic response to exercise" Lehtonen et al (2022). According to Lehtonen et al (2022) "Threshold-based exercise bouts are, by design, individually modulated to reach the physiological thresholds of each individual..." This is because "Physiological thresholds have a considerable range across individuals...While individual thresholds seem to be superior to establishing appropriate and effective training intensities for aerobic training, their application at a population level may be challenging," Lehtonen et al (2022).

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MITOCHONDRIAL DYSFUNCTION, ZONE 2 TRAINING, & METABOLIC FLEXIBILITY

Zone 2 training has great potential to improve health because it improves mitochondrial function and metabolic flexibility. According to Luks, "Mitochondrial dysfunction is a root cause element of insulin resistance. Since nearly 50% of people have insulin resistance, this is a subject matter we need to pay attention to." (Luks Zone 2 training). Luks says "only 7-12% of people are metabolically fit. (Luks H Insulin Resistance: Are you one of the 50% of people who have it?)

In a related study of over 400,000 people, 3 hours/week of aerobic exercise coupled with 1-2x/week of muscle strength training for major muscle groups had significant mortality risk reduction benefits (BMJ 2022)

Luks says, "People who are poorly trained, sedentary, or those with insulin resistance, Type 2 diabetes, and Metabolic Syndrome (hypertension, abdominal fat, insulin resistance [high A1c]) are very poor at using fat and often go straight to glucose as a fuel source very quickly. This is the picture of metabolic inflexibility. This produces excess lactate, and due to poor mitochondrial function their clearance of the lactate is poor, and the lactate builds rapidly. Accompanying lactate is a hydrogen ion. That hydrogen changes the pH of its local environment, in this case, skeletal muscle, and that produces weakness and exhaustion." (Luks H Zone 2 training)



Figure 4 From CDC

84% of Americans fail to meet the WHO Physical Activity (PA) Guidelines of 150 minutes/week of moderate-vigorous PA plus 2x/week of resistance training (Zhao 2020) (see Figure 4). This is associated with both a reduction in life span and health span (see Figure 5). Individuals who met both arms of the PA guidelines lowered their risk of all causes of mortality by 40% (Zhao). 24% of people meet the aerobic guidelines but only 16% of people meet both the strength and aerobic portions.

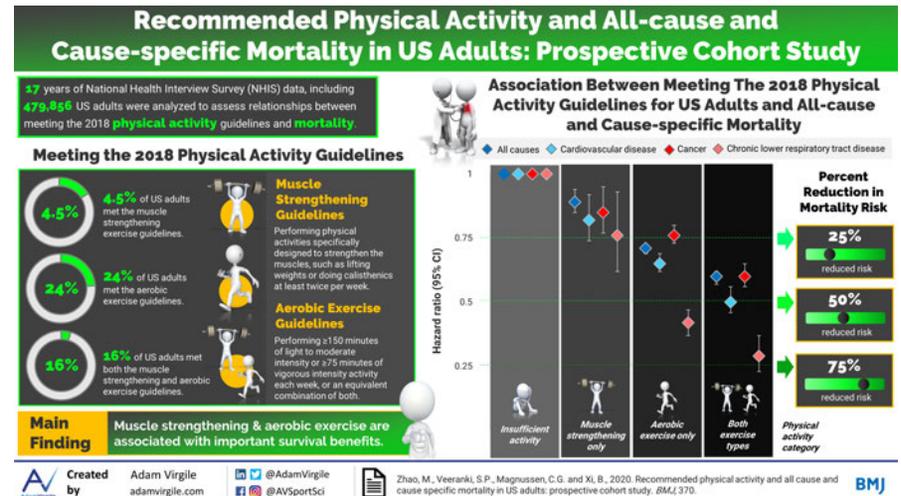


Figure 5 from Adam Virgile

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MITOCHONDRIAL DYSFUNCTION, ZONE 2 TRAINING, & METABOLIC FLEXIBILITY

Luks (Luks H Zone 2 training) defines a few key terms –

“**Metabolic flexibility** refers to the ability of your mitochondria to utilize fat and glucose as an energy source (substrate). At low heart rates, your main source of fuel should be fat... not glucose.”

“Poorly functioning mitochondria, which is likely to be found in ~ 75% of people will result in **metabolic inflexibility**, or the inability to utilize fat versus glucose.”

As a result of Zone 1/2 training, you can use fat as an energy source more efficiently which allows you to preserve your glycogen stores. According to Luks, “mitochondrial health is critical to longevity. Many diseases that affect our lifespan are considered to be due to metabolic dysfunction. Mitochondrial dysfunction is relevant to cancer growth, immune system function, dementia, heart disease, type 2 diabetes, and much more.”

When it comes to mitochondria, the issues we care about are:

- The number of mitochondria you have.
- The metabolic “flexibility” of your mitochondria – in many diseases, the mitochondria can only process glucose, and not fat. This inflexibility leads to significant downstream effects.
- Mitochondrial efficiency. How well do your mitochondria process the various substrates – glucose, fat, and lactate?

CRAIG'S ZONE 2 PEARL

Scientists are now finding evidence of mitochondrial dysfunction nearly 5-10 years before those changes will manifest as Type 2 Diabetes that would show up on your blood tests.

TABLE 2: HOW TO TELL IF YOU'RE PRE-DIABETIC

1. Blood work gives us key baseline metrics?
2. What are the biomarkers of high diabetes (or hyperinsulinemia) risk?
3. Look at your triglycerides and your HDL values
4. Divide your Triglycerides by your HDL
5. If your level is above 3.5 it identifies insulin-resistance

According to Luks (Carbs-triglyceride blog) “Two really important caveats must be stated.”

1. This ratio works best if your BMI is + or > 25 kg/m2.
2. The African American population tends to have lower triglyceride levels. Therefore, different screening tools are needed (Oral OGTT). A normal Trig/HDL ratio does not rule out insulin resistance in African Americans.”

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HOW DOES ZONE 2 TRAINING CHANGE YOUR PHYSIOLOGY?

High volumes of low-intensity training (Z1 & Z2) build your **aerobic engine**. The longer you can stay oxidative, even as effort rises, the more efficient you are and the longer you preserve your limited supply of **glucose** for when you need it most. Sticking with lower intensity Z2 training without spiking it up into Z3, allows you to stay oxidative, which **burns primarily fat** instead of going **glycolytic**, which burns primarily **sugars** as fuel. The longer you burn fat, the better, as sugars are a limited fuel source. In general, a healthy adult only has about 2,000kcal of stored glycogen, while even a skinny adult has 30,000 – 60,000kcal of stored fat that can be used as fuel.

Zone 2 Training is important whether you're a sedentary person or an elite athlete. An athlete who taps into their limited glucose stores too early has nothing left for when they need power or endurance later. An inactive person who is going glycolytic not only never burns fat but easily become exhausted and can develop insulin resistance.

The Role of Slow and Fast-twitch Muscle Fibers

For the most part, Our fuel comes from either fatty acids or glucose. They are oxidized or burned in slow or fast-twitch muscle fibers. The muscle fiber type refers to the time it takes before fatigue sets in, rather than the speed to fire. Type I slow twitch lasts a long time whereas Type II fast-twitch fatigue quickly. Type I is used at low exercise intensity and lasts a long time due to its slow speed to fatigue. Type II are deployed at high exercise intensity and burn out quickly due to their fast speed of fatigue. contain low concentrations of anaerobic enzymes.”

The **slow-twitch aerobic (Type I)** muscle fibers oxidize fats and assist **anaerobic (fast twitch Type II) muscle fibers** in their function during high-intensity efforts. Aging is associated with a progressive loss of skeletal muscle mass and strength. This is termed sarcopenia.

At the muscle fiber level, Type II muscle fiber atrophy correlates with loss of muscle mass with age (Nilwik 2013). It is evident we need BOTH Type I & Type II fibers for health. Z2 training helps build Type I fibers while resistance (strength) training helps build Type II fibers.

Training Slow twitch muscle fibers improves recovery during physically stressful situations (activities requiring power or endurance) (Mark McLaughlin blog)

- They have a higher concentration of mitochondria.
- Increasing their size increases anaerobic threshold
- Increasing their size can produce as much power as fast-twitch fibers with less metabolic cost because they are 100% oxidative.

Joel Jamieson states, “I’m personally convinced that mitochondrial function is probably the single most important aspect of fitness in terms of overall health and longevity. The level of intensity/power output of course dictates muscle fiber recruitment and thus which mitochondria end up getting stressed and thus adapt. So lower intensity work will primarily increase the number and the function of mitochondria in slow twitch muscle fibers and higher intensity work will hit the mitochondria in the faster twitch fibers as well. But if all you do is higher intensity, then you probably don’t get enough volume in to truly develop the slower twitch fibers beyond a certain point.” He continues, “I think a lot of people overestimate how many fast twitch fibers are truly glycolytic. It’s a relatively small percentage and it’s generally the highest in sedentary people. Most fast twitch fibers have the capacity to be a mix of glycolytic and oxidative and doing higher-intensity work that’s repetitive in nature tends to shift them more toward oxidative. I think this is largely what interval training is doing when done right, on a muscular level.”

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HOW DOES ZONE 2 TRAINING CHANGE YOUR PHYSIOLOGY?

Inflammation

Inflammation is important to manage. Some cytokines and interleukins are pro-inflammatory chemicals in our blood that our body produces in response to disease or any other stressors. High exercise intensity, or lack of aerobic fitness, can be one of those stressors both depleting your glycogen stores and your IL-6 levels. This has a negative effect on insulin regulation and fat-burning ability.

IL-6 as an inflammatory mediator influences your ability to recover from high exercise intensity. Consistent low-intensity training modulates the IL-6 response and improves your resilience, endurance, and even your future peak performance.

To better manage recovery and inflammation, build up a base of low-intensity training volume. This builds mitochondrial density (the cell's powerhouse) & helps moderate post exercise inflammation.

Luks (Polarized training blog) says, "Consistent low-intensity training modulates the IL-6 response and improves your resilience and endurance."

CRAIG'S ZONE 2 PEARL

By training your body to utilize fat as its primary fuel source you save glucose (glycogen) for when it's needed most during high power or endurance activities. Plus you enhance how your body recovers from any stress so you minimize inflammation and adapt to training stimuli more efficiently.

The Lactate or Anaerobic Threshold

When the body uses glycolysis to create energy, it is splitting the 6-carbon molecule (glucose) into 2, 3-carbon molecules (pyruvate), to be used as fuel. While in the presence of sufficient oxygen, pyruvate is eventually put through the electron transport chain, in the cell's mitochondria, to produce energy (ATP).

While working at higher intensities, when there isn't sufficient oxygen and the cell's mitochondria is overwhelmed, pyruvate attaches with a hydrogen ion to create lactate, which can then be shuttled to a different cell to be used as fuel. This also acts as a buffer since the pyruvate is helping lower the rising acidic environment by attaching itself to a hydrogen ion which can then be eventually converted to water (H₂O), and help keep the pH (potential Hydrogen) levels at a more homeostatic level.

Your Lactate Threshold (LT₂) or Anaerobic Threshold is the point at which your body starts to accumulate so much lactate that the body can no longer deal with clearing it via the lactate shuttle, and there is a limited amount of time that you can work at an intensity above this before your body has to slow down or stop completely.

Understanding this, we can see how improving fitness in order to improve mitochondrial function and density plays such an important role in our body's ability to work for longer at higher intensities (see Figure 6)

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HOW DOES ZONE 2 TRAINING CHANGE YOUR PHYSIOLOGY?

Understanding this, we can see how improving fitness in order to improve mitochondrial function and density plays such an important role in our body's ability to work for longer at higher intensities (see Figure 6)

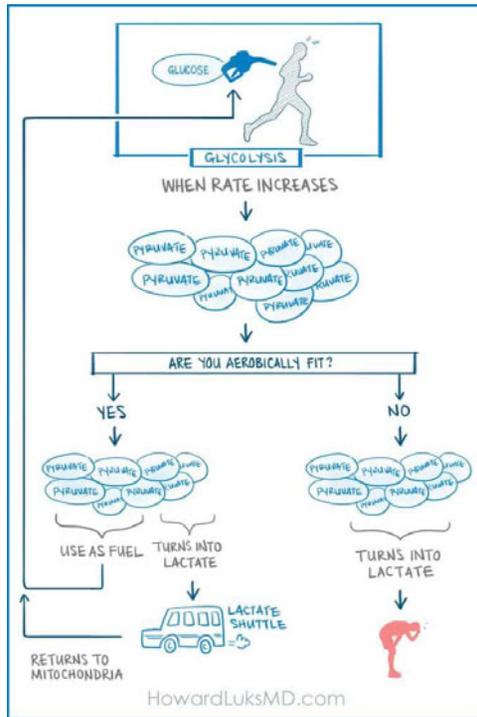


Figure 6 with permission from Luks H

“At higher exercise intensities, the rate of glycolysis rises to a point where the rate of pyruvate formation by glycolysis equals the rate of pyruvate oxidation (i.e., the red pyruvate synthesis line meets the blue pyruvate oxidation line in Figure 7”

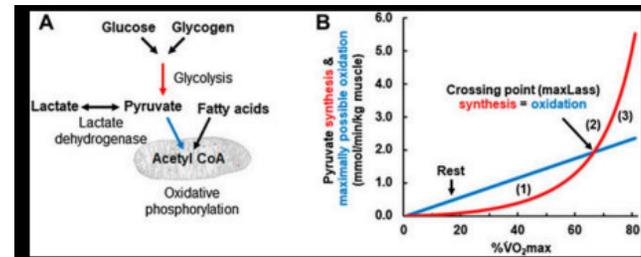


Figure 7

“If the power output rises further, then pyruvate synthesis exceeds the maximally possible rate of pyruvate oxidation and so both pyruvate and lactate will rise with time. The “crossing point” figure also gives a simple explanation for the regulation of fat oxidation.”

“To the left of the “crossing point” in Figure 7, glycolytic pyruvate synthesis is insufficient to provide all of the acetyl-CoA needed for oxidative ATP resynthesis (i.e., the red line is below the blue line).

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HOW DOES ZONE 2 TRAINING CHANGE YOUR PHYSIOLOGY?

“In 1986, Mader and Heck proposed that “the lack of pyruvate [due to insufficient pyruvate synthesis by glycolysis] is covered by fatty acid oxidation” (Mader and Heck, 1986). This is consistent with the observation that fat oxidation is highest at low and medium intensity (i.e., intensity to the left of the crossing point or maxLass) but approaches zero at intensities at and above the maxLass (van Loon et al., 2001).”

“In summary, Mader designed already in the 1980s a mathematical model of human metabolism that realistically simulates human metabolic responses to exercise and explains the metabolic basis for the maxLass and the regulation of fat metabolism... a rightward shift of the lactate curve occurs after several weeks of endurance training (see Figure 8)... George Brooks and coworkers have demonstrated early on that the rate of lactate oxidation increases after endurance training (Donovan and Brooks, 1983).”

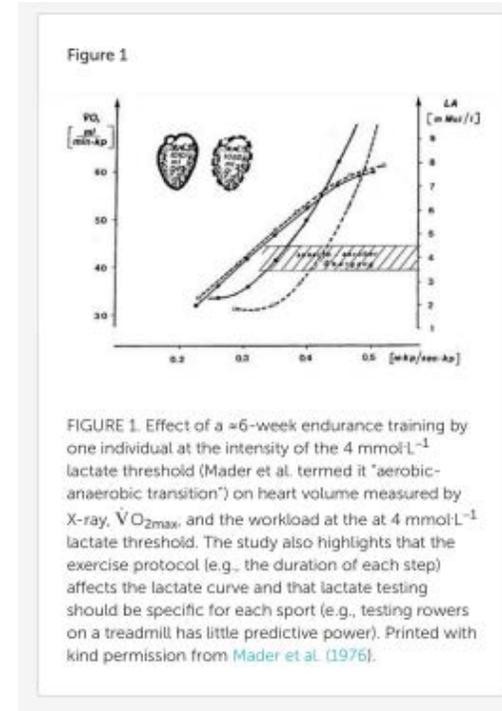


Figure 8

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GUIDELINES FOR ZONE 2 TRAINING

When building your aerobic base with Z2 training, dosage and frequency matter (see Table 3). As little as 150 minutes/week will be beneficial, but bigger gains are seen as you approach the 300 minutes/week mark. Including a multi-hour bike or hike in your routine can be beneficial as a lower impact way of accumulating more time in Z2.

It has been shown that 54% of VO₂max reductions seen in people as they age are due, not to age, but to reductions in training volumes (Burtsher 2022). Perhaps “age is just a number”! (see Figure 9)

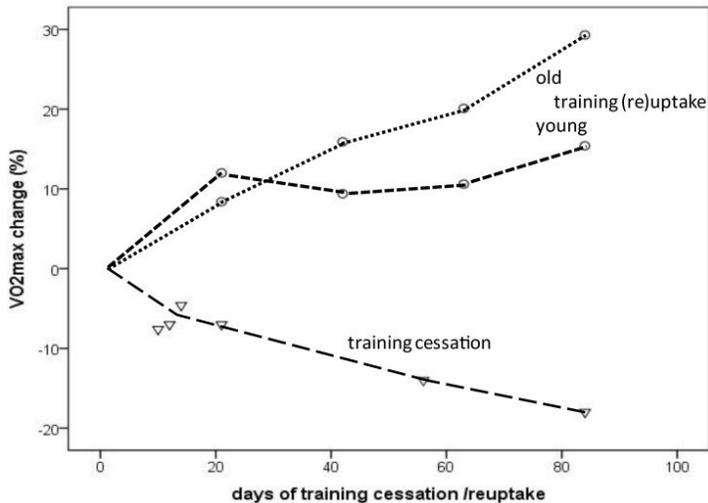


Figure 9 – Training cessation influences VO₂ max more than age does

TABLE 3: DOSE - PROGRAMMING

45-60m sessions

- 2 days/week you maintain
- 3 days/week starts to move the needle
- 5 days/week you push the needle
-

from Dr. Inigo San-Millan, Ph.D. blog

Recovery days are important too. In the Swedish 5:2 model at most 85 days are “on” and at least 34 days “off” (Gordo Byrn). Meaning 85 days are of maximal adaptation value while the other days are more foundational or for recovery.

- Never load for more than 5 consecutive days
- Ensure that each week has at least 2 back to back recovery days.
- The bike is the safest way to increase volume.

According to Luks (Zone 2 blog), “The benefits to our health and our progress as athletes come with long Zone 2 efforts. You do not want to let your heart rate leave Zone 2. When that happens your physiology changes. Your cells are switching to anaerobic pathways and you are making enzymes and compounds to allow for a higher level of effort. Even if you slow down and your heart rate goes back into zone 2, it will take a while for your physiological processes to revert back to fat oxidation. The benefits of Zone 2 training come from staying in Zone 2 the entire time. Hopefully for a 60-90 minute workout.”

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GUIDELINES FOR ZONE 2 TRAINING

In addition to fat and glucose, (healthy) cells also utilize lactate as a fuel source (substrate). We think of lactate as a “waste product” of higher-intensity work, but it’s actually another valuable fuel source. It’s helpful to think of lactate as a “by-product” rather than a “waste product”, as it’s a very valuable fuel source.

Runners may have cardiovascular fitness, but due to limited polarized training or zone discipline, haven’t gained the metabolic fitness which would enhance their recoverability to stress or work capacity. If we were to compare two runners (runner A, having developed their mitochondrial density and efficiency through Z2 training, and runner B, still cardiovascularly fit, but having less efficient and a lesser amount of mitochondria due to spending more time training in Z3), we would see runner A, not only being able to hold a higher intensity for longer, but also be able to recover from repeated higher intensity bouts much quicker. Runner A’s greater density of mitochondria allows their body to shuttle the lactate that’s produced at higher intensity efforts to adjacent slow-twitch muscle fibers where it is then processed in the mitochondria.

Runner B’s limited amount of mitochondria would lead to their mitochondria being overwhelmed with lactate sooner than runner A’s, thereby having the excess lactate being spilled into the bloodstream and creating an acidic microenvironment in the muscles from the increased production of hydrogen ions. This would not only make runner B fatigue more quickly than runner A, but they would also recover more slowly after each high-intensity bout due to clearing the metabolites at a slower rate.

““

“People underestimate how much low-intensity volume it takes to make this amount of work possible at an easy pace. This is called zone discipline and takes patience and months of commitment to achieve.”

Fiorella Dcroz, PT & Olympic Tri-Athlete

””

Can I mix high and low-intensity training?

If you’re limited on the number of training sessions that you can do each week and you’re wanting to combine a longer Z2 run with some higher intensity Z4 or Z5 intervals, it’s best to run your intervals at the end of your Z2 run. Running your Z4 or Z5 intervals in the middle of your Z2 run can be advantageous if the goal is the get your body used to running on tired legs (such as when wanting to train what the last 6 miles of a marathon may feel like), but realize that any adaptations specific to Z2 training will be extremely limited. Couzens states “providing work period is short and rest is long, one can touch higher pace/power zones without leaving aerobic heart rate zones.”

If you’re wanting to mix high and low-intensity training throughout the week, such as with the 80/20 model, realize that this 80/20 split is an average of your total workouts throughout the year. Sometimes, during the offseason, when you’re building your base it may be 100/0 (Z2 training only), while during the higher intensity weeks of the season, your weekly split may look more like 65/35.

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GUIDELINES FOR ZONE 2 TRAINING

It should also be noted that this 80/20 model is only useful once you've built a solid base, which, if starting from nothing, can take 6-9 months. Focus primarily on only Z1/2 training for the first 4-6 months, and then from there, start to sprinkle in the fast stuff (Z4/5) which will start to unlock everything. Couzens says, "While I firmly believe we should "touch" all zones in a training week, always remember that energy is a finite resource. Where are you weak on the curve? Where should you focus that energy for best effect? If in doubt, it's safe to assume you're weak in your lower aerobic zones."

Z2 training increases and builds mitochondria and helps you get more efficient (faster) at that certain intensity, while Z4/5 training improves the effectiveness of your mitochondria. This allows you to last longer working at higher intensities. If you start with doing the hard stuff (speed), all you're doing is refining the mitochondria you already have, which isn't much. You want to focus on improving your biggest limiting factor, and if you're just starting out, that's your base. Your body isn't used to being super active and hasn't adapted to making lots of energy, so the first thing you want to do is build up your mitochondria, THEN you can start to layer on the intensity. Again, it's the higher intensity work of the Z4 and Z5 intervals that is going to really improve your top-end performance, but your high-intensity improvements will quickly plateau if you don't have the base to make improvements upon.

Yes, people can and will make improvements starting off with just higher intensity work, but that's because they're going from 0 to something. If you do anything you're going to make progress, up to a point. But that doesn't mean that that's the optimal thing to do. It just means that if you do anything you're going to make progress. If you don't have the patience to first build your base, then you will always end up hitting a plateau due to training the compensator instead of the underlying physiological limitation.

LANCE'S ZONE 2 PEARL

Training a lot of high-intensity before you have a solid base is like improving the power of a Pomeranian instead of improving the power of a German Shepherd, which has a lot more muscle and energy. You can see the long-term consequence to this approach, as you're going to be working on something that's not going to help you for that much longer.

According to Cam Josse of S&C Indiana University (blog) "You can't avoid entering a lactic state in sport". We know that many sports require multiple medium and high-effort bouts of intensity during play. When we ask our body to create energy at these faster intensities, the build-up of lactate is inevitable, but the athlete with the bigger aerobic base is going to be able to outlast the athlete who has not dedicated time to developing their own base. This is because the athlete with the larger aerobic engine (greater number/size and more efficient/flexible mitochondria) will be able to take this accumulation of lactate back through the electron transport chain and turn it back into energy that the muscle can continue to use. An athlete without this base won't have the physiological structures to accommodate this process, leading to a higher accumulation of lactate in the blood, a more acidic environment for the muscle, and eventual fatigue that will slow them down or stop them completely.

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HOW TO IDENTIFY IF YOU'RE IN ZONE 2

A. Heart Rate

There is a growing consensus among exercise scientists that the dividing line between low and moderate intensities is set at the first ventilatory threshold (VT1), which usually falls between 77% and 81% of maximum heart rate in most trained individuals.

According to Dr. Inigo San Milan (blog) "With your actual max heart rate, your Zone 2 could be close to 70-80% your actual max heart rate. Use that as a starting point, and then adjust off of your rate of perceived exertion. For many, many folks, it is far less than that."

Many popular methods of measuring heart rate (HR) have poor reliability. It's recommended by Couzens, if you're going to measure HR, to use a HR strap to increase reliability.

B. RPE

According to Lehtonen et al (2022), "While popular among athletes and the general population because of accessible technologies, the efficacy of %HR (or %VO2) in guiding exercise intensity has been questioned, and the rating of perceived exertion (RPE) has been shown as a more effective method of targeting exercise intensity corresponding to VT1, particularly in less experienced subjects."

Figure 10 shows the RPE scale made famous in the original Borg scale of exertion (6-20) and the more practical modern version (0-10)

RATING OF PERCEIVED EXERTION (RPE)

Borg's Scale	(Gunner borg 1982):	Modified Borg Scale:
6-		0- at rest
7-	very, very light	1- very easy
8-		2- somewhat easy
9-	very light	3- moderate
10-		4- somewhat hard
11-	fairly light	5- hard
12-		6-
13-	somewhat hard	7- very hard
14-		8-
15-	hard	9-
16-		10- very, very hard
17-	very hard	
18-		
19-	very, very hard	
20-		

Figure 10

Lehtonen (2022) states, "These zones and their correspondent RPE scores have been suggested to implement polarized training models, which have demonstrated superior outcomes compared with threshold models (Hydren)."

TABLE 4: Correlation of Exercise Intensity, RPE (0-10 scale) & VTs (acc to Hydren 2015 & Lehtonen 2022)

Moderate intensity = RPE ≤4 = VT1 and below

Vigorous intensity = RPE 5-6 = VT between VT1 and VT2

Severe intensity = RPE ≥7 = ≥VT2

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HOW TO IDENTIFY IF YOU'RE IN ZONE 2

The relationship between VT1 and RPE has been shown to be reliable in both trained and untrained individuals regardless of body composition (Hill 1987, Fab re 2013, Elsangedy 2013).

According to Tjønnå et al RPE is recommended for monitoring exercise intensity in public health programs. Lehtonen 2022 says, "Supplementing RPE with information on external work (i.e., pace in walking/running) and internal physiological response, such as heart rate from wearable devices, would bring an additional level of sophistication to prescribing and monitoring training."

One limitation of the RPE scale is it doesn't address fatigue. It has been suggested by Mickelwright et al (2017) that adding a rating of fatigue scale could be used to distinguish between fatigue and exertion, thus improving RPE validity. Awareness of the limitations of RPE and some possible solutions are described in Table 5.

TABLE 5: Limitations of RPE & proposed solutions acc to Lehtonen Halperin, Emanuel 2020

- Individuals may understand and perceive the concepts of fatigue, discomfort and heaviness differently
- The development of population-specific scales (aerobic vs resistance exercise, age groups, sports, etc),
- Make use of the CR-10 Borg scale standard
- Provide a simple definition of the scale
- For measurement, ask the simple question 'How effortful is the task?'

C. The Talk Test

According to Lehtonen, "The talk test is an inexpensive, practical, and reliable tool to assess exercise intensity, particularly VT1, in healthy and diseased populations. (Reed 2014, Lyon 2014)"

"The reasoning of this test is grounded in the competitive requirements of ventilation for the gas exchange and metabolism of exercise versus speech, as the first inflection point of ventilation that begins to rise exponentially, VT1, represents the point where speech becomes uncomfortable and difficult due to the increased ventilatory demand from exercise (Reed 2014, Lyon 2014, Rodriquez-Marroyo 2013, Gillespie 2015, Jeanes 2011)."

"While simple, this test has shown meaningful validity and reliability when compared with physiologically assessed VT1 in elite athletes, (Rodriquez-Marroyo 2013, Gillespie (2015), healthy adults (Jeanes 2011, Persinger 2004) and even cardiac patients (Sørensen 2020, Zanettini 2013)."

Athletes who make the effort to determine their VT1 (which can be done simply by finding the highest speed, power, or heart rate at which you can speak comfortably in complete sentences) are often surprised to discover that staying below it in designated low-intensity sessions requires them to go significantly slower than they are accustomed to. Using breathing or the ability to talk is a very rough proxy for effort (see Table 6).

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HOW TO IDENTIFY IF YOU'RE IN ZONE 2

TABLE 6: Determining Your Zone 2 via Breathing Pattern or the Talk Test

- Can you exercise and breathe easily through your nose?
- Can you sing a song or talk to a buddy without having to stop to catch your breath?
- It's the highest level of exertion at which you're still able to carry on a conversation. The person you're talking to will know you are exercising, but you are still able to speak a few sentences at a time.
- Use the maximum effort that still allows you to remain pure-nasal-breathing. However, just because you can breathe exclusively through your nose doesn't mean you need to for it to be Z2. It is merely a self-check on if you're still in Z2 or not. (Couzens).

D. Lactate Measurements

According to Alan Couzens, "You are in Zone 2 when your lactate levels are between 1.7-1.9 mmol. This is both precise and important as "Low lactate is a surrogate for healthy mitochondrial function." It's possible to buy a Lactate Threshold monitor to confirm that you're below this Lactate cut off. However, other surrogate measurements are less expensive and more practical.

E. Confusion in Determining Your Zone 2

According to Couzens Z2 has been defined in a variety of inconsistent ways which has led to confusion.

- The zone above the first rise in lactate (see Figure 11)
- 60-70% of maximum HR
- The zone immediately below 2mmol/L
- 85% HR of a max effort 30-minute test

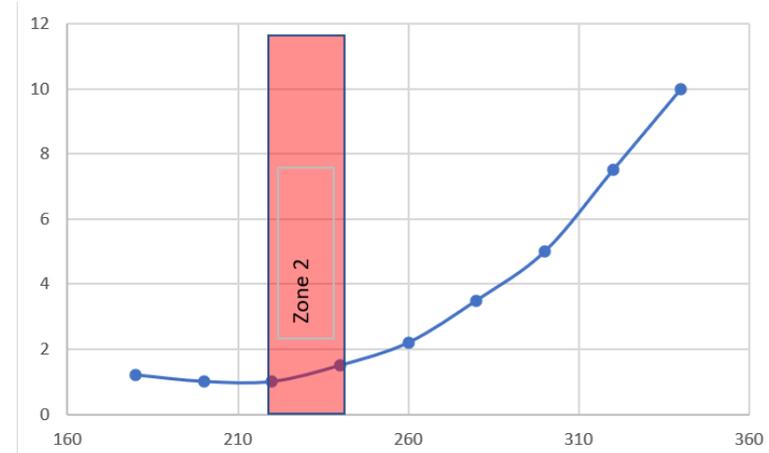


Figure 11
Z2 is the zone above the first rise in Lactate (from Couzens)

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HOW TO IDENTIFY IF YOU'RE IN ZONE 2

CRAIG'S ZONE 2 PEARL

Using mathematical calculations of %HR to determine your Z2 is highly unreliable. It is far better to use the Talk Test for a low-tech approach, or as a Gold Standard, using Indirect Calorimetry and/or Lactate testing for establishing your exact Z2 range.

According to Couzens, 60-70% of maximum HR is Z2 for a fit person. While Z2 could also be 85% of your average HR during a 30-minute max effort test. "In the lab I've seen LT1 anywhere from 45-70% of max HR and LT2 anywhere from 70-93%." There's so much individual variation that this is a pointless guide.

Couzens is very honest about the challenges of measurement. "Since zone conversations can quickly go off the rails due to differences in definitions, here's what I mean when I say "Zone 2":

The zone immediately above the first inflection in the lactate curve. How wide is it? Wide enough to be a practical zone

- 10-15bpm
- 20-30W
- 30s/k

Thus, Steve Magness says, "There's nuance in training... Don't drive yourself nuts measuring things that may not matter. For example, for Zone 2 work, go easy, talk lots. Don't measure lactate."

“

"My Training Almost Haiku"

Lots of easy

Occasionally go hard, vary it up

Very rarely, go see God

Steve Magness

”

Magness goes on to say "there are no magic zones... everything is a stimulus that can potentially lead to an adaptation... aerobic or cardiovascular development is simple: a lot of easy work... do that consistently for a really long time."

It's important not to over-interpret the science; rather apply this physiologic understanding of training zones with some flexibility. According to Gareth Sandford, "No one training prescription model covers all bases. Use principles of each to form a tool box". Table 7 outlines general principles for low-intensity sessions.

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HOW TO IDENTIFY IF YOU'RE IN ZONE 2

TABLE 7: Rules for Successful Low-Intensity Training Session
(according to Matt Fitzgerald)

- Don't exceed the VT1, or the highest speed, power, or heart rate at which you can speak comfortably in complete sentences.
- Make sure that you keep your heart rate at the intensity described above for the entire workout duration. Your body doesn't understand pace and it doesn't understand power, it only understands intensity (which is what drives the physiological effects that we're looking at creating in our body). So, if it's hotter than usual outside, you're going uphill, you're under-recovered, etc., make sure to adjust your speed/power as necessary (even if that means walking).
- Train in Zone 2 for at least 45 minutes for each Z2 training session (unless you are just beginning and have to build up to that amount of time).

Some experts refer to a 3 Zone framework rather than the 5 Zone framework referred to throughout this article. Table 8 and Figure 12 give a simplified overview of both the 3 Zone & 5 Zone systems and how they relate to each other.

TABLE 8: Distinguishing Your Zones

Here are how the models compare: (3 Zone Model vs. 5 Zone Model, respectively)

- Z1 = Z1 & Z2 (recovery and steady state cardio/aerobic work)
- Z2 = Z3 (gray zone where we don't want to train too often)
- Z3 = Z4 & Z5 (threshold and VO2max efforts)

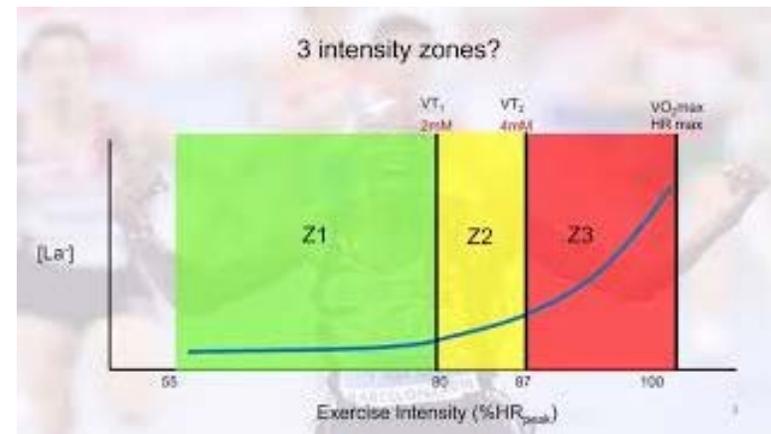


Figure 12 – Simplified 3 Zone Model based on Exercise Intensity (%HR) & Ventilatory Threshold (VT)

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HOW TO IDENTIFY IF YOU'RE IN ZONE 2

According to Magness weather you use a 3-zone or 5-zone model “they are a way to classify and categorize training. They distinguish between variations of hard and easy. That’s it.”

Here are some other terms that are used to describe the different thresholds (see Figure 13)

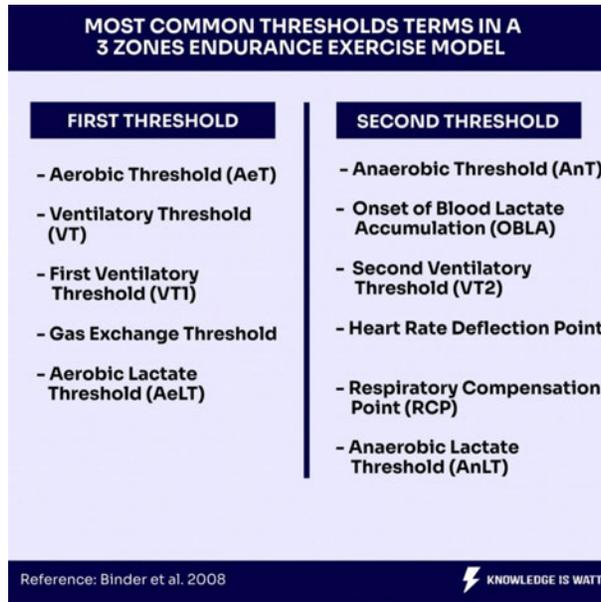


Figure 13

The following image shows the breakdown of training the 3 different Zones (of a 3-Zone Model) for most professional cyclists (see Figure 14). What this shows is that most of an elite cyclist's year is spent focused on training below VT1 (base training). During the pre-competition and competition training phases, more time is devoted to higher intensity training, but it is still close to only ~ 20% of overall training. Thus, the percentage of training occurring above base training intensity is much lower than most non-elite endurance athletes would think.

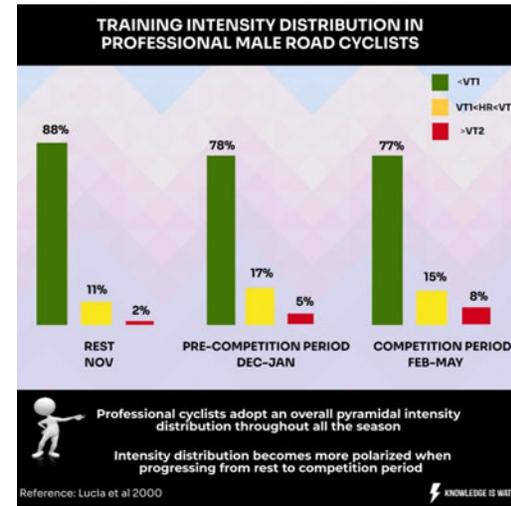


Figure 14

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HOW TO IDENTIFY IF YOU'RE IN ZONE 2

In a broad sense, low intensity training can be distinguished from HIIT training based on intensity as well as sustained efforts vs. interval efforts. HIIT builds aerobic power whereas longer distance, lower intensity Z2 training builds aerobic capacity (see Figure 15)

LONG, SLOW DISTANCE VS. HIIT

WHICH DO YOU SHOULD YOU DO?

HIIT

Develops aerobic *power* and builds your ability to sustain higher heart rates for longer without fatigue.

LONG DISTANCE

Increases your aerobic *capacity* and your efficiency, allowing you to keep your heart rate lower at a given power output.

There should not really be a debate about which one is better. They lead to different adaptations, and each has unique benefits.

You need both.

Figure 15 from Joel Jamieson

As you can see, there are many different methods to use when identifying when someone is training in their Z2, each of them having their pros and cons. Figure 16 goes even further and gives a rough estimation of how each of these different methods of measuring intensity compare to others, not only in the lens of Z2 training, but across the entire intensity spectrum. Understanding this will hopefully help you be able to identify your correct training intensity zones, no matter which method you prefer to use.

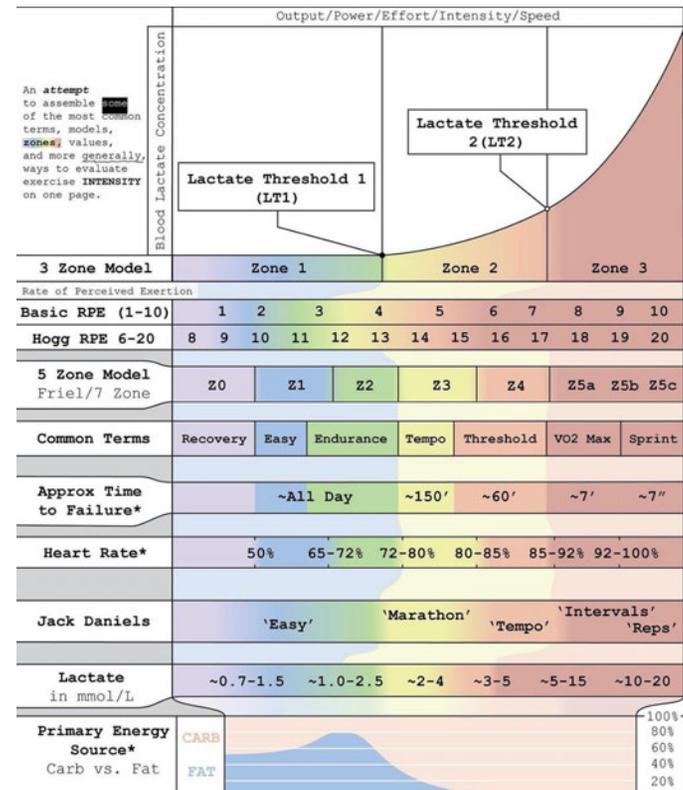


Figure 16 from Fluid Athletics

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GENERAL HEALTH BENEFITS OF LOW-INTENSITY TRAINING

Cardiovascular (aerobic) training has tremendous health benefits. “Cardiorespiratory fitness (i.e., VO2max) is an independent predictor of cardiovascular and all-cause mortality and sets the upper limit for aerobic metabolism.” Langan SP, Grosicki GJ

“San Milan and Brooks were able to demonstrate marked differences in metabolic flexibility in professional cyclists compared to moderately active individuals and those with metabolic syndrome (San-Millán and Brooks, 2018). While enormous training volumes are required to achieve that level of metabolic performance and are not feasible for the average individual, constructing modified exercise programs modeled similarly to that of endurance athletes will surely benefit those plagued with chronic disease.”

Joel Jamieson states, “When it comes to aerobic/metabolic work and life expectancy, there’s an obvious and clear benefit to being physically active vs. not. The endurance athlete populations tend to see the greatest increases in longevity with much of the research around team sports or strength sports, of which there isn’t much, showing very little gain and in some cases, a decrease. This all may be more correlation than causation and I’m sure that endurance athletes live healthier lifestyles than the average person and perhaps other types of athletes, but it’s still valuable to see. There also does not appear to be an obvious ceiling, or upper limit, where higher levels of aerobic fitness don’t correlate with greater longevity.”

Phil Maffetone, a pioneer in this field explains, “Lower-intensity exercise has been described as “regenerative” since it activates and develops the organs, systems, and processes that together exhibit a series of interrelated functions. These include:

- Endurance exercise capabilities.
- Protection from metabolic syndrome.
- Recovery from high-intensity activity.
- Resilience to oxidative stress (aging)

Maffetone says, “All these abilities stem from the body’s ability to reliably and continuously draw from an abundant fuel source (fats) and a near-limitless supply of reactant (oxygen). A high level of fat-burning bolsters the metabolism and creates positive health outcomes due to its epigenetic effects on gene expression.”

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AEROBIC & ANAEROBIC EXERCISE

High-intensity activity is associated with using a more powerful fuel (sugar) which is nevertheless much more limited than fats. Using sugar for energy allows the body to increase its energy production and work rate far beyond what the rate of oxygen uptake allows.

Aerobic Activity: a lower-intensity activity in which the body has enough oxygen to continue to make energy (ATP) from primarily fats and less glucose (sugar).

Anaerobic Activity: a higher-intensity activity in which the body is needing to create ATP faster than what the aerobic pathways can handle. This leads to using more glucose to make energy, rather than fats.

Most all activities have an aerobic component to them except for things such as powerlifting – what changes is the fuel you use for energy. Anaerobic activity occurs in the absence of SUFFICIENT oxygen for the aerobic pathway.

Besides the general health benefits and advantages for distance athletes that come from improving upon base fitness, one of the most important benefits is recovery from high-intensity activity. When you have a bigger aerobic base you can recover more quickly and successfully from strength or power training. According to Joel Jamieson, “Most people know that lifting weights is entirely anaerobic. What they often miss, however, is that the recovery in between every single set and every single workout is 100% aerobic.” Your ability to recover from workouts or during sports is dependent on what’s called your work capacity. Work capacity is basically your aerobic base.

LANCE'S ZONE 2 PEARL

Oxygen plays a vital role in both the aerobic and anaerobic metabolic systems. While oxygen is required as a direct energy source in the aerobic system, it is also essential for oxygenating lactate to be used as a fuel in the muscle (lactate shuttle). Lactate reutilization relies on oxygen in order to use lactate as a fuel but is still considered part of anaerobic metabolism.

According to Maffetone, “Anaerobic function creates higher levels of physical and biochemical stress, decreases immune function and muscle repair, increases inflammation, increases the risk of muscle injury (most common in fast-twitch fibers), and impairs fat burning. These conditions are also associated with poor (or a lack of) recovery and are common components of and contributors to the overtraining syndrome.”

“Greater fat oxidation is, therefore, a hallmark of low-intensity training and aerobic activity. It corresponds to a lower Respiratory Exchange Ratio (RER) and occurs at a lower percentage of maximum oxygen consumption (VO₂max) than sugar-burning (typically around 75 percent, although health, fitness, age, and other factors can raise or lower this number). As activity levels (and therefore RER and oxygen consumption) rise, so does sugar-burning.”

According to Maffetone, “A good aerobic base isn’t important only for endurance athletes. The system that controls the body’s stress response is functionally linked to the anaerobic system. In other words, if you depend too much on your anaerobic system, you’ll be more stressed, and therefore more likely to overtrain or become injured.”

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CONDITIONING VS AEROBIC TRAINING

Base training is crucial, even for short-distance athletes. This is because the better your base, the better you are at shuttling lactate, which enhances your ability to continue to contract your muscles at a higher rate, for longer. Also, if you have a good foundation built, the amount of volume that you're able to tolerate from your speed work will also increase. If you have a poor foundation and jump right into speed work you might find yourself in a situation where you've limited how much speed work your body is able to tolerate and you've lowered that stress/recovery dosage that you are personally able to do.

An important distinction should be made between aerobic training and conditioning. According to Jamieson, "You can have a high level of aerobic fitness and still have poor conditioning." Aerobic training improves how much energy you can generate whereas conditioning is about how much energy you use – i.e. energy expenditure. Aerobic training involves metabolic systems whereas conditioning also involves movement efficiency, skill, mental performance, etc. Conditioning, according to Jamieson, involves "the brain and the central and autonomic nervous systems." If sport involves an aerobic component then building aerobic capacity is crucial. If it involves conditioning then you also require "efficient movement patterns, pacing strategies, and autonomic control."

Conditioning is required in sports, especially where repeated higher intensity efforts are required. However, for sedentary people, conditioning is not a factor, whereas having and building aerobic capacity is perhaps the single most valuable thing they can do to improve their health.

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CONCLUSION

The WHO Guidelines suggest increasing physical activity (PA) is a cornerstone of reducing the Years Lived with Disability (YLD) in an aging population (WHO 2020). They also contend we are in the midst of an inactivity crisis due to social constraints (cities built for cars not pedestrians or bikes; lack of green spaces, safety, etc) and lifestyle (home and work stress, lack of sleep, etc). Improved cardiorespiratory fitness is associated with a lower risk of metabolic diseases such as type 2 diabetes mellitus (Jadhav 2017) all-cause mortality, cardiorespiratory disease and coronary heart disease related mortality (Kodama 2009).

While tremendous health benefits accrue to those engaging in high volumes of low intensity exercise we mustn't lose sight of the the social limitations preventing the WHO from achieving its goals of reducing the worldwide inactivity crisis. People shouldn't be shamed into thinking they are lazy or "weak" for not being more active. As a result, international authorities on increasing PA are focusing less on getting the public to move more or performing resistance training, and instead, putting more emphasis on positive messages such as the benefits of breaking up long periods of sitting by light activity or even by standing to favorably influence metabolic parameters (Gao, 2017). While accumulating long bouts of Z2 training has great value, even just performing short "movement snacks" of only 10 minutes duration has great utility (Chastin).

In addressing sedentarism, a step-ladder approach is needed from breaking up long periods of inactivity such as sitting. "Every move matters" is a motto of the WHO. If possible, those who are active should be educated about the benefits of larger volumes of activity and occasionally more intensity (e.g. resistance training) (Ekelund 2009, Pulsford 2017, Lehtonen 2022). Increasing Z2 training is a goal, not only for endurance athletes, but also for anyone engaged in sports as well as sedentary people hoping to improve metabolic flexibility and lower their risk of diseases such as diabetes and cancer.

Z2 training has a very low barrier to entry. You can walk in a park or go for a hike. You can ride a bike or go for an easy jog or swim. According to Couzens, building a low intensity base is beneficial for anyone regardless of activity level due to "developing high levels of fat oxidation at rest and low intensity and also increasing the levels of mitochondria and well developed capillary density in slow twitch muscle fibers". He goes on to say, "45 minute blocks of Z0/1 movement might be one of the most important things you're not doing for your metabolic health... long, easy warm ups."

Most active people don't have an aerobic base and are relying too much on HIIT training. Most people with persistent pain are sedentary. In both cases, even though at times it may seem boring, Z2 training is potentially invaluable for them if they can commit to the 6-9 months required to change their resting heart rate and primary fuel source while working at lower intensities and at rest.

In addition, a better base is also crucial to your health span and longevity as it trains your body to increase mitochondrial density and metabolic flexibility resulting in improved cellular health. Performing Z2 training is as simple as doing activities where your effort feels somewhat challenging and you could carry on a normal conversation (or breathe exclusively through your nose) during the activity. A minimum of 150 minutes/week of such activity, independent of higher intensities, is a good starting point, while building up to a goal of 300 minutes/week is preferred. And remember that if you're limited with the amount of time you have for training each week, your higher intensity exercise, such as sprinting, can be tacked on to the end of any Z2 training session.

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