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Zone Training for Endurance Athletes

Zee Lake, B.S. in Biology (UCLA)
Michael Shara, B.S. in Electrical Engineering (UCLA)
crusadezone.com | crusadesportsmed@gmail.com

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Abstract

Athletic training is often categorized into five different training Zones ranging from 1 to 5. Each zone is based on different heart rates, starting at a heart rate of 50-60% of your maximum heart rate (MHR) and going up to 90-100% of your MHR. Each zone places specific demands on your body's energy systems, muscle fibers, and cardiovascular system, causing unique physiological changes that prepare you for different types of sports performance. By understanding these zones and the muscle fibers they target, athletes can balance their training more effectively to improve key areas like endurance, speed, and power. Endurance sports, for example, rely heavily on longer periods of training at lower intensities to strengthen slow-twitch muscle fibers and build up mitochondrial density in the muscle cells. In this article, we break down each zone, explain how they affect the body, and show how combining training zones strategically can help an athlete become stronger, more powerful, and more efficient.

Backround Information

These catagorized training zones are designed to target the training of certain types of muscle fibers in the body: Slow-twitch muscle fibers (Type 1), and fast-twitch muscle fibers (Type 2). Slow-twitch muscle fibers are better for endurance sports, as they use aerobic respiration to generate more energy over longer periods of time. Fast-twitch fibers are better for sports with rapid movements, as they use anaerobic respiration to generate energy much more quickly for short bursts of power.

Zone 1 training focuses on working at about 50–60% of your MHR. Exercising in this zone is very light and is often used for warm-ups, cool-downs, or recovery sessions. At this lower intensity, your body relies mostly on aerobic energy production and burns a high percentage of fat as fuel, while also increasing blood flow to the muscles. This greater blood supply delivers more oxygen and nutrients while also helping remove metabolic byproducts. As a result, your muscles become warmer, more pliable, and better prepared for higher-intensity efforts.

Zone 2, at around 60–70% MHR, is still quite easy to maintain. Although you shift slightly toward using more carbohydrates for fuel, you still rely heavily on fat oxidation (the process of breaking down fats for energy) and maintain a strong aerobic focus. Spending time in this zone supports improvements in your endurance base by increasing the efficiency of your heart and lungs, as well as enhancing the endurance of your slow-twitch muscle fibers.

Zone 3 training, at about 70–80% MHR, brings you closer to your "threshold," which is the point where your body starts producing more lactate (a byproduct of intense exercise) than it can clear. This is often called the "tempo" or "threshold" zone and is tougher to sustain than Zones 1 and 2. It pushes your body to become more comfortable at higher intensities and teaches your muscles and cardiovascular system to handle moderate amounts of fatigue. Although it can improve your aerobic capacity, spending too much time in Zone 3 can lead to increased overall fatigue, so it must be balanced carefully within your training regimen.

Zone 4, at roughly 80–90% MHR, is a high-intensity zone where you will feel significant effort. Here, your body shifts away from primarily using fat as fuel and relies more on carbohydrates, as it needs quick energy to maintain the effort. This training intensity targets more fast-twitch muscle fibers and trains your anaerobic energy systems (those that work without oxygen) to handle short bursts of harder work. Although not sustainable for long periods, Zone 4 sessions help you increase your speed, power, and your body's ability to handle tough race paces or breakaways.

Zone 5, at 90–100% MHR, represents your maximum or near-maximum intensity. This is where you reach close to your absolute limit. Your muscles rely almost entirely on quick energy sources such as stored carbohydrates and the ATP-PC system (a very fast energy pathway in the muscles), and your brain is fully engaged to maintain form and technique under stress. This zone is often used for very short, intense intervals that push both your aerobic and anaerobic systems to their extremes, helping you develop top-end speed and explosive power. Because it's so demanding, it's used sparingly in training.

ZONE	% OF MAX HR	Purpose
1	50-60%	Active Recovery
2	60-70%	Heart Efficiency- SLow Twitch Mussle Fiber Endurance
3	70-80%	Pushing Intensive Aerobic Capacity
4	80-90%	Pushing Intensive Anaerobic Capacity - Fast Twitch Mussle Fiber Endurance
5	90-100%	Maximum Intensity

Methods

Literature Search and Selection

We conducted a systematic literature search using academic databases, adhering to predefined inclusion and exclusion criteria. Inclusion criteria focused on relevance to the research question, publication in peer-reviewed journals, and robust methodological design. Studies were excluded if they lacked clear methodologies, or relevance, or were not peer-reviewed.

Data Collection and Expert Consultation

Alongside the literature review, we engaged with field experts through structured interviews to validate findings and gather additional insights. These consultations focused on addressing specific research questions and enriching the analysis with professional perspectives.

Data Analysis

We synthesized data from selected studies and expert consultations, employing qualitative and quantitative methods to identify patterns and draw conclusions, ensuring consistency and accuracy in the results.

Results

In research by Campos et al., performing lower-intensity resistance training with high repetitions (15+ reps per set) was shown to improve muscular endurance in a way that somewhat mirrors aerobic endurance training. This approach helps your muscles handle lower levels of force for longer periods without getting as tired, which is crucial for endurance athletes who must maintain consistent intensity performance for long periods of time. It can also help improve how your muscles use oxygen and manage energy, enhancing your ability to keep going in endurance events like marathons, triathlons, or long cycling races. This also increases an athletes' ability to perform consistently at a high and intense level without fatigue during competition, improving their chances of success.

Building on these findings, work by Neal et al. and Esteve-Lanao et al. shows that using heavier weights at lower repetitions (1-6 reps per set) can boost muscular strength and power in a similar way that high-intensity interval training (HIIT) improves your cardiovascular power. Adding this type of strength training to the 10–20% high-intensity portion of a balanced training program can help develop your fast-twitch muscle fibers. This can be particularly helpful for endurance athletes who might need bursts of speed or power during a race, such as breaking away from a group or surging at crucial moments.

The moderate-intensity, moderate-repetition training zone identified by Campos et al. (typically 8–12 reps per set) encourages overall muscular hypertrophy—an increase in muscle size. This method yields substantial gains in pure power or long-lasting endurance. This type of training can build functional muscle mass, which is also crucial for endurance athletes, as stronger muscles can improve force production during prolonged efforts. However, this hypertrophy does not necessarily target or enhance the endurance capacity

of slow-twitch muscle fibers in a way that improves aerobic performance. In other words, while you may increase muscle size, you may not be increasing the efficiency or fatigue-resistance that slow-twitch fibers are known for. Moreover, just as studies caution against spending too much time in moderate-intensity cardiovascular zones due to fatigue and plateauing adaptations, Campos et al.'s findings suggest that repeatedly training in this mid-range for resistance work can also lead to excessive muscle fatigue without proportional improvements in your ability to sustain intensity. This can interfere with recovery, limit functional performance gains, and ultimately detract from the balanced approach needed to excel in endurance sports.

Discussion

For endurance athletes, a balanced "polarized" training approach is optimal. About 80% of endurance training time is spent at low intensity (Zones 1 and 2), which helps strengthen your aerobic base and build muscular endurance. The remaining 10–20% is spent on high-intensity work (Zones 4 and 5) and can be paired with heavy, low-rep resistance training sessions to develop the power and speed you need for tougher race situations. Avoiding too much training in the moderate-intensity "middle" zone helps you recover better, make steady gains, and avoid plateaus.

By mixing these strategies, focusing mostly on low-intensity, power and endurance work, adding a small but purposeful amount of high-intensity training, and carefully using strength training designed for either endurance or power, you can achieve the best possible physiological adaptations. This leads to improved fuel usage, more energy-producing mitochondria in your muscles, stronger and more fatigue-resistant muscle fibers, and a higher tolerance for consistent and intense efforts in competition. All these factors contribute to becoming a more robust, well-rounded athlete who can excel in a variety of chaotic conditions.

At Crusade, our goal is to help student-athletes reach their full potential by providing clear, science-based guidance. By studying and understanding the purpose behind different intensity zones, learning how to target specific muscle fibers, and knowing how to properly push limits, athletes can become a stronger, faster, and more resilient competitor. We believe that optimizing mental resilience, enhancing physical training strategies, and prioritizing recovery will empower student-athletes to achieve sustained excellence and long-term success in their athletic and academic careers.

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