Current Scientific Evidence for a Polarized Cardiovascular Endurance Training Model

Jay R. Hydren and Bruce S. Cohen

U.S. Army Research Institute of Environmental Medicine, Military Performance Division, Natick, Massachusetts

Abstract

Hydren, JR and Cohen, BS. Current scientific evidence for a polarized cardiovascular endurance training model. *J Strength Cond Res* 29(12): 3523–3530, 2015—Recent publications have provided new scientific evidence for a modern aerobic or cardiovascular endurance exercise prescription that optimizes the periodization cycle and maximizes potential endurance performance gains in highly trained individuals. The traditional threshold, high volume, and high-intensity training models have displayed limited improvement in actual race pace in (highly) trained individuals while frequently resulting in overreaching or overtraining (physical injury and psychological burnout). A review of evidence for replacing these models with the proven polarized training model seems warranted. This review provides a short history of the training models, summarizes 5 key studies, and provides example training programs for both the pre- and in-season periods. A polarized training program is characterized by an undulating nonlinear periodization model with nearly all the training time spent at a "light" (≤13) and "very hard" (≥17) pace with very limited time at "hard" (14–16) or race pace (6–20 Rating of Perceived Exertion [RPE] scale). To accomplish this, the polarization training model has specific high-intensity workouts separated by one or more long slow distance workouts, with the exercise intensity remaining below ventilatory threshold (VT) 1 and/or blood lactate of less than 2 mM (A.K.A. below race pace). Effect sizes for increasing aerobic endurance performance for the polarized training model are consistently superior to that of the threshold training model. Performing a polarized training program may be best accomplished by: going easy on long slow distance workouts, avoiding "race pace" and getting after it during interval workouts.

Key Words threshold, high-intensity interval training, high volume training, $\dot{V}O_2max$, blood lactate, periodization

Address correspondence to Jay R. Hydren, jayhydren@gmail.com.

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Introduction

This article discusses recent scientific evidence and current coaching practice for optimizing the periodization of cardiovascular (CV) endurance training exercise prescription. Several common types of endurance training models will be introduced, a short history of a novel endurance training program will be provided, and a summary of several key experiments are discussed to reveal the efficacy behind these training models.

The traditional endurance training models have been: threshold, high volume, and high-intensity training. Threshold training is characterized by increasing intensity to a hard pace (14–16, 6–20 RPE scale, ~55% $\dot{V}O_2max$) and holding it for the entire workout, followed by a progressive increase in the pace of the workouts in a linear periodization model. High volume training (HVT) is characterized by long workouts at a very light intensity, whereas high-intensity interval training (HIIT) is characterized by interval workouts at a very hard (≥17) pace on consecutive days in a row with few to no long slow distance workouts. Novel endurance training programs (known as polarized training) are characterized by an undulating nonlinear periodization model with nearly all the training time spent at a light (≤13) and very hard (≥17) pace with little to no training at hard (14–16) or race pace (6–20 RPE scale) (3,18,22). Additionally, the polarized training model has specific high-intensity workouts separated by one or more long slow distance workouts, with the exercise intensity tightly controlled. What defines these different CV training models is not the linear or nonlinear layout of the microcycle, although programs with interval training typically have undulating nonlinear aspects, but the total percent time (microcycle and/or mesocycle) spent in each of 3 CV endurance exercise intensity zones defined by blood lactate levels and/or ventilatory thresholds.

There has been recent evidence of a growing trend in CV endurance exercise prescription indicating a switch from threshold to the polarized training model. Three studies have formally documented this (a) Orie et al. (18) reported a progressive change from a threshold periodized model in Olympic-level speed skaters in 1972 to polarized training in 2010. (b) Seiler et al. (22) in 2006 reported normative training volumes for 11 nationally competitive junior (17–18 years old) Norwegian cross country skiers in a tracking study that lasted 32 days and carefully collected data on 347 endurance training workouts. These elite populations, known for impressive CV endurance capacity, used a polarized distribution of training intensity across 3 zones–75% of training time in zone 1, 5–10% in zone 2, and 15–20% in zone 3 (Table 1 for definitions of exercise intensity zones). Unfortunately, changes in endurance performance and capacity were not reported. And (c) Fiskerstrand and Seiler 2004 (11) reported on 27 Norwegian international rowers from 1970 to 2001 and showed changes in training strategies that coincided with a 12% increase of relative maximal oxygen consumption. The study documented a 20% increase in training volume created by increasing zone 1 from 30 to 50 hours per month and reducing zone 2 and 3 time from 23 to 7 hours per month. Additionally, a review by Midgley et al. (15) in 2006 failed to find well-controlled studies to base specific recommendation for improving maximal oxygen uptake of highly trained distance runners. Copying training programs in elite sport does not provide scientific-based evidence for a polarized training program. A search in PubMed, Web of Science, and Google Scholar with the key words, polarized, threshold, interval, high intensity, and training zones, revealed 5 experimental studies since 2006 that do provide strong scientific evidence for a polarized training model (9,16,17,23,24).

It has also been suggested that a polarized training model may be a more enjoyable method of training while maintaining a lower potential of overreaching/overtraining (11,14,16). Specifically, poorly designed/implemented training programs have resulted in: decreased physical performance, general fatigue, loss of motivation, insomnia, change in appetite, irritability, restlessness, anxiety, body weight loss, loss of concentration, and feelings of depression (1). Studies have documented that reducing high-intensity exercise volume is linked to a lower overall injury rate (19). Owen et al. (19) in 2015 reported 23 elite professional male soccer players training volume showing a significant positive correlations between training volume at 85–90% of maximal heart rate (HR_{max}) and injury rate (0.57), and very high-intensity training volume (≥90% HR_{max}) and injury rate (0.568). An odds ratio analysis showed that being in the high volume of high-intensity training increases the risk of injury significantly (odds ratio = 1.87, 95% CI 1.12–3.12, $p = 0.02$) (19). Esteve-Lanao et al. (9) 2007 reported that in a pilot study, where spending 25–30% of training time at high intensity exercise (above the second VT) was too demanding, subjects suffered from overtraining symptoms within 2–3 weeks, but when high-intensity training volume was reduced to 8–9% of total training volume subjects tolerated the program and improved their CV performance.

If it is possible to decrease the intensity of training to reduce the risk of overreaching/overtraining while increasing the CV endurance performance gains over the preparatory and competitions season, like the polarized training model suggests, it is worth further investigation and review. Therefore, efforts to better understand the mechanisms behind the utilization of a polarized training model and investing in its application may be critical to optimize CV endurance training programs productivity for previously fit and athletic populations.

Cardiovascular Endurance Training Models

To define endurance training models, the ranges of possible exercise intensity levels have been broken up into 3 zones, Table 1. Rather than define endurance training zones by percent $\dot{V}O_2max$, like the traditional 5 zone system, the polarized training model zones are defined by physiological markers of ventilatory thresholds, blood lactate levels, ratings of perceived exertion, and some new work suggest heart rate variability might also be useful (6,7,21,22). These measures are used because more traditional means for defining exercise intensity, such as heart rate and percent $\dot{V}O_2max$,

Table 1. Definitions and parameters for the training models.*

	Zone 1	Zone 2	Zone 3
Definitions of each training zone			
Perceptual and physiological measures			
RPE scales (2)	≤Somewhat hard	Hard	≥Very hard
1–10 (5)	≤4	5–6	≥7
6–20 (2)	≤13	14–16	≥17
VT	≤VT1	VT1–VT2	≥VT2
Blood lactate (mM)	<2	2–4	>4
Percent time spent in each training zone			
Polarized training	75–80	0–10	15–20
Threshold training	50–60	40–60	0
HVT	100	0	0
HIIT	50	0	50

*VT = ventilatory threshold; HVT = high volume training; HIIT = high-intensity interval training; RPE = rating of perceived exertion.

adapt with training (move relative to %$\dot{V}O_2$max), whereas blood lactate and ventilator threshold are believed to stay relatively constant with respect to the CV stressors that result/stimulate meaningful training CV endurance performance adaptations (10,11,22). Therefore, these training models are defined by percent of total training time spent in each training zone during a microcycle and/or mesocycle; Table 1 reports these distributions for each CV endurance training model (16,17,22,23).

Table 2 reports data from studies where physiological measures were recorded for each zone and effect size for the improvement of endurance performances for polarized and threshold training.

Although this review primarily reports on comparisons between polarized and threshold training models, there are 2 other types of commonly used CV endurance training models that should be noted. High-intensity interval training is characterized by training approximately half the total minutes in zone 1 and 3 with no time in zone 2; functionally only performing interval workouts with 1:1 work rest cycles (23). High volume training, trains only in zone 1, frequently for long durations (23). These training models have been validated to improve health and fitness for untrained and weight-loss individuals (20) but may not be the best choice for optimizing training of previously fit/athletic populations with occupational fit for duty requirements or competitive sport goals.

Experiments Supporting Polarized Cardiovascular Endurance Training Model

Neal et al. (17) performed one of the first of several scientific experiments to explore polarized training for endurance performance enhancement. Twelve male club cyclists performed a crossover study design comparing 2 groups, threshold and polarized trained, with data collected during the winter month (November–March). Both groups improved in a variety of fitness measures previously been shown to be reliable (2,17): 40-km time trial, power output at 4 mM blood lactate, peak power output, and time to exhaustion at maximal work rate. Notably, the polarized training program effect size was consistently double that of the threshold training model. This polarized training model had no training in zone 2, and the threshold model had no training in zone 3. This experiment provides a comparison between both training in zone 1 and 2 to training in zones 1 and 3. (17).

Munoz et al. (16) in 2014 reported a study where 2 groups trained in zones 1, 2, and 3 but had different percentages of time in each zone (Table 2). This study reported 32 recreational runners who were randomly assigned to either polarized or threshold training groups who trained during the specific and competitive periods for 10 weeks. What makes this study so interesting is that both groups did an equal amount of time in zone 3. It was very difficult for runners to follow the polarized training model as only 6 of 15 subjects who finished this arm of the study were able to run slow enough to stay within zone 1, thus, 9 subjects spent too much time in zone 2 to qualify for a polarized training model. Despite this difficulty to resist training at higher intensities, the polarized training group ($n = 6$) improved their 10 km road race performance by 7.0 ± 3.6% after 10 weeks of training, whereas a matched sample group ($n = 6$) of threshold trained only increased 1.6 ± 4.0%, the reliability of this measure was not reported. The results indicate that by taking 80% of the time spent in zone 2 for the threshold training model and moving it to zone 1, while maintaining interval training in zone 3, increased training adaptations from potentially none to significant and meaningful improvements in CV endurance performance. (16).

Esteve-Lanao et al. (9) in 2007 performed one of the first well-controlled experiments on polarized training characterized by using 2 groups training in zone 1, 2, and 3 with different percentage of time spent in each zone (Table 2). Twelve competitive subelite runners (regional to national level) were randomly assigned to a polarized and threshold training groups for 5 months broken up into 3 periods (preparatory, specific, and competition). Training was individualized, but the experimental controls (% time in each zone) were highly controlled and recorded with a heart rate monitor to sum minutes in each zone. Both groups improved on a 10.4 km simulated race with the polarized group improving ~7.0% and the threshold group improving by ~5.3%, the effect size for the difference in improvement was 2.43, reliability of the measure was not reported. Both groups performed the same total volume of training during the 5 months while spending similar amounts of time in zone 3. Like the experiment by Munoz et al., the polarized training group reduced time spent in zone 2 and replaced it with training in zone 1. Interestingly, Esteve-Lanao et al. (9) reported that in a pilot study, they attempted to increase training in zone 3 to ~25–30% but found it to be too demanding because most subjects after 2–3 weeks suffered overtraining symptoms and had to withdraw.

Stoggl and Sperlich (23) compared 4 different training models all with differences in the time spent in each of the 3 training intensity zones. Forty-eight competitive endurance athletes 8–20 years of experience and more than 5 sessions per week participated and were randomly assigned to one of the 4 groups: HVT, threshold training, HIIT, and polarized training (for definitions see cardiovascular and Table 1) (23). The training cycle of the subjects was not reported and the intraclass correlation coefficient values for reliability of primary measures were above 0.96. The 12 athletes who completed the polarized training obtained the greatest improvements during the 9-week study, specifically: $\dot{V}O_2$peak, time to exhaustion during the ramp test, and peak power during a staged exercise test. The polarized training group improved power output at 4 mM blood lactate during the incremental test by 8.1 ± 4.6%, whereas HIIT improved 5.6 ± 4.8% and the other 2 groups had no significant increases (23). In all groups, these experienced athletes had no significant changes of work economy. Interestingly, body

TABLE 2. Studies investigating the effects of polarized training schemes.*

Type of study	Study (athlete level)	Training program	Zone 1	Zone 2	Zone 3	Total time (mean ± SD)	Effect size
Tracking of elite athlete training	Seiler et al. (22) (elite junior cross-country skiers)	Polarized (% time in zone)	75 ± 3	8 ± 3	17 ± 4	35 ± 4 workouts, 70–140 min each, for 32 d	Did not report
			In zone blood lactate concentrations (mM)				
			1.2 ± 0.4	2.7 ± 0.4	9.5 ± 2.8		
CV endurance	Esteve-Lanao et al. (9) (regional to national level Runners)	Polarized (% time in zone)	80 ± 2	12 ± 2	8 ± 1	452 ± 23 (TRIMPs per week for 5 mo)	2.80 (10.4 km simulated road race)
		Threshold (% time in zone)	67 ± 1	25 ± 2	9 ± 1	460 ± 26 (TRIMPs per week for 5 mo)	2.16 (10.4 km simulated road race)
	Neal et al. (17) (club cyclists)	Polarized (% time in zone)	80 ± 4	0 ± 0	20 ± 4	381 ± 85 (minutes per·week, for 6 wk)	2.44 (maximum time at 95% $\dot{V}O_2$max)
		Threshold (% time in zone)	57 ± 10	43 ± 10	0 ± 0	458 ± 120 (minutes per week, for 6 wk)	0.99 (maximum time at 95% $\dot{V}O_2$max)
	Munoz et al. (16) (recreational runners)	Polarized (% time in zone)	73 ± 6	14 ± 6	14 ± 4	39.1 ± 7.9 (hours over 9 wk)	1.29† (polarized group 10 km run time improvements over the threshold group)
		Threshold (% time in zone)	47 ± 15	37 ± 16	16 ± 4	36.3 ± 8.1 (hours over 9 wk)	
	Stoggl and Sperlich (23) (well-trained competitive endurance athletes)	Polarized (% time in zone)	68 ± 12	6 ± 8	6 ± 7	104 ± 20 (hours over 54 ± 3 workouts)	0.85 ($\dot{V}O_2$peak)
		Threshold (% time in zone)	46 ± 7	54 ± 7	0 ± 0	84 ± 7 (hours over 49 ± 3 workouts)	−0.42 ($\dot{V}O_2$peak)
Power/ sprinting	Yu et al. (24) (olympic speed skaters)	Polarized (% time in zone)	84 ± 5	5 ± 3	11 ± 2	146 ± 6 (hours over 102 workouts in a season)	1.00 (1,000 m skating time)
		Threshold (% time in zone)	41 ± 2	53 ± 3	6 ± 2	136 ± 4 (hours over 103 workouts in a season)	−0.11 (1,000 m skating time)

*A positive effect size indicates an increase in performance. Positive effect size comparing 2 groups indicates large performance gains for the polarized trained group. CV endurance is cardiovascular and/or aerobic endurance exercise.

†The sample size was a subset of the sample for each training group, these subjects followed the respective training models (% time zone $n = 15$, effect size $n = 6$, per group), percent time in each zone was not reported for the subset.

Table 3. Two example weeks of pre- and in-season polarized training programs.*

Week	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	%Zone training	%Zone week
Preseason									
1	LSD: 90 m	Intervals: W/C: 10 m; 5 s·2 m·3 r	Off	Intervals: W/C: 15 m; 8 s·2 m·3 r	LSD: 90 m	Intervals: W/C: 10 m; 5 s·3 m·3 r	LSD: 120 m	$Z_1 = 92$; $Z_2 = 0$; $Z_3 = 8$	$Z_1 = 92$; $Z_2 = 0$; $Z_3 = 8$
2	LSD: 90 m	Off	Intervals: W/C: 15 m; 8 s·3 m·3 r	Intervals: W/C: 10 m; 5 s·2 m·3 r	LSD: 90 m	Off	LSD: 165 m; w/intervals: 3 s·4 m·3 r	$Z_1 = 90$; $Z_2 = 0$; $Z_3 = 10$	$Z_1 = 90$; $Z_2 = 0$; $Z_3 = 10$
In-season									
1	Intervals: W/C: 10 m; 5 s·3 m·3 r	LSD: 180 m	Intervals: W/C: 15 m; 8 s·3 m·3 r	LSD: 90 m	Off	Off	Event/ competitions: $Z_1 = 60$ m; $Z_2 = 60$ m; $Z_3 = 15$ m	$Z_1 = 90$; $Z_2 = 0$; $Z_3 = 10$	$Z_1 = 76$; $Z_2 = 12$; $Z_3 = 9$
2	Event/ competitions: $Z_1 = 20$ m; $Z_2 = 90$ m; $Z_3 = 15$ m	Recovery (warm up & stretch); W/C: 20 m	LSD: 60 m; w/intervals: 5 s·3 m·3 r	LSD: 120 m	Off	Off	Event/ competitions: $Z_1 = 30$ m; $Z_2 = 60$ m; $Z_3 = 5$ m	$Z_1 = 93$; $Z_2 = 0$; $Z_3 = 7$	$Z_1 = 57$; $Z_2 = 34$; $Z_3 = 8$

*Time is in minutes (m). "W/C" indicates warm up and cool down. Long slow distance (LSD) workout intensities are in zone 1. Intervals are sets (s) by time in zone 3 (interval length in minutes, m) by rest interval time in zone 1 (r, rest length in minutes). Events and competitions are broken out by time in each zone ($Z_{\#}$). Percent time spend in each zone (%Zone) is calculated for each total exercise each week and during in-season %Zone is calculated for training only.

mass did decrease by 3.5% for the HIIT group. Because HIIT is functionally performing interval training workouts, the advantage is the shorter amount of total training time necessary to get meaningful endurance performance changes (HIIT, 66 hours; HVT, 102 hours). The polarized training group did perform a relatively high volume of training (104 hours) but spent about half the amount of time in zone 3 as compared with HIIT trained (14 vs. 27 hours) and each interval training session was followed by at least 2 days of low-intensity training. Scheduling the HIIT to reach 66 hours of training in 9 weeks required several weeks of back to back to back (3 days in a row) of HIIT workouts. Although participant injuries were not reported during this study, the fitness professional should be concerned that overreaching/overtraining could result from this volume of high intensity, especially during the competition period for sports with a high risk of overtraining (5,13). For these x-country skiers, middle and long distance runners, triathletes, and cyclists, the polarized training model was more optimal for improving CV endurance, as it contained fewer high-intensity workouts, longer session durations, and more days of low-intensity workouts between them as compared with the next best training model (HIIT) (23).

Experiment Supporting Polarized Training Model for Sprinting/Anaerobic Activity

Polarized training has also been shown to provide a means for improving the ability to sprint or work hard for short durations. Yu et al. (24) conducted a quasi-experimental study in which they prescribed a threshold training model with considerable training within zone 2 and 3 to Chinese men's and women's national speed-skating team for 1 year, then reduced the time spent in zone 2, redistributing it to both zone 1 and zone 3 in year 2. Remarkably, the polarized training model improved 500 m and 1000 m skating times by 2–4% in elite athletes, whereas the threshold training model actually had performance decrements of 0.10–0.4% for both sexes (24).

Optimizing Training in Zone 3

Within zone 3, there is a large range of possible intensities, which invokes the question, "*Is there an optimal intensity within zone 3?*" The response of peroxisome proliferator-activated receptor gamma, coactivator 1 alpha (PGC-1α) to training intensities may provide some insight. PGC-1α is the best known biomarker of upstream regulation (cellular signaling protein) known to improve endurance capacity of skeletal muscle. It is a master cellular regulator for increasing the volume of mitochondria within muscle fibers; akin to testosterone and growth hormone for strength and muscle mass gains.

Edgett et al. (8) in 2013 reported a randomized crossover experiment, where subjects worked out at 3 different intensities (73% $\dot{V}O_2max$, 100% $\dot{V}O_2max$, and 133% $\dot{V}O_2max$) on 3 separate visits, separated by 1–2 weeks. Edgett et al. controlled for total work performed on a bike at ~700 kJ, by changing the number of intervals performed on each visit (11, 9, and 6 1-minute intervals, respectively) in the 8 college-aged recreationally active men who participated. Interestingly, the relationship between training intensity and PGC-1α was not linear but an inverted "U:" at 73% $\dot{V}O_2max$ PGC-1α levels were ~4 ± 1 (AU), 100% it was ~9 ± 2, and at 133% it was ~4 ± 1 (data estimated from bar graphs) (8). Edgett et al. (8) showed that simply working out in zone 3 may not be precise enough to optimize training. Training specifically at 100% $\dot{V}O_2max$ may optimize the upstream signaling needed to increase mitochondrial volume within muscle fibers–a major factor to CV endurance performance. However, the link between the performance gains seen in polarized CV endurance training and the rate limiting physiological and metabolic adaptation(s) needed to make this occur, still need to be differentiated.

Example Training Program

Creating a program that fits the polarized training model requires more attention to interval intensity and total duration and summation of minutes spent in each training zone. Many of today's endurance exercise tracking technologies can do a fairly accurate job of continuously recording physiological and performance measures that can be used to estimate time in each zone. Specifically, heart rate, power output, or speed may be good options for defining intensity zones, when the gold standard of blood lactate analysis is not economically feasible. Ideally, these simple measures would be linked to blood lactate levels and/or cardiorespiratory measures from frequent (every 4–8 weeks) graded exercise testing, where heart rate, rating of perceived exertion, power output and/or speed is recorded at the end of each progressive stage such that a regression model can be generated to find the cut points between the 3 training zones. Although, these sophisticated tests are not available to everyone, simply linking rating of perceived exertion and ventilatory response to measures of heart rate, power output, and speed might be enough to help an individual to stay within prescribed training zones of 1 and 3.

Measures such as heart rate, power output, and/or speed should be collected during training and events and competitions for later analysis and summation of time spent in each training zone. This information can be used to help adjust in-season training programs for tapering and peaking an athlete for specific competitions. Table 3 provides 2 consecutive week examples of potential programs for the pre- and in-season periods. Please note that total training time of a typical workout should be individualized to fitness level, modality, and event/competition goals. In this example, it is easy to see how just by adding in competitions with an hour or more at race pace (zone 2) can quickly change the ratio of time spent in each intensity zone and that week of exercise may not qualify as meeting the standards for a polarized training model. Therefore, close monitoring and logging of exercise volume in each intensity zone are critical for evaluating expected vs. measured performance improvements during the competition season.

Future Research

Several studies have started to look at the ability of heart rate variability for application in a nonlinear functional periodization program for a 3 zone CV endurance training program. This line of research has 2 potential applications in the polarized training model: (a) finding the cut points between the 3 training zones (6,7,21) and (b) as a measure to monitor overreaching and overtraining (4,12). Because equipment to measure heart rate variability is much more economical and less invasive than other measures currently used (blood lactate, cardiorespiratory measures), and if these methods prove to be valid and reliable, it could make a polarized training program with more precision and with less risk of overtraining, accessible to nonelite athletes.

Conclusion

The 7 studies documenting the efficacy and utilization of a polarized endurance training model show both the wide spread implementation of these programs in elite sport and strong evidence for its efficacy. The effect size for changes in endurance performance on a wide range of measures was 0.85–2.80 which is considered to be very large. Where the traditional threshold training model range from −0.42 to 2.16 indicating that in some athletes it had a large positive affect, although inferior to that of a matched polarized training group, and in some cases decreased the performance of the athletes. In summary, the polarized training model has a small but promising body of literature reporting its efficacy. The reason for a blunting of physical performance adaptations from training in zone 2 in well-trained individuals remains a scientific mystery in need of further research. Further research and discussion for the implementation, tracking, and effects on performance are warranted for the already trained individual.

Practical Applications

A polarized training model is effective for men and women of any age or at any competition level. Avoiding zone 2 is challenging but warranted, as a well-controlled scientific study found that 60% of subjects spent too much time (>10%) in zone 2 to qualify as performing a polarized training model, often resulting in significantly diminished training gains (16). Individuals need to use both physiological and performance measures, such as heart rate monitors, speed, watts, or rate of perceived exertion scales, in relation to time to prevent the intensity from creeping from zone 1 to zone 2.

Principles of individualizing training on a daily basis to avoid injuries, overreaching, and overtraining should still be used by coaches when choosing weekly sequencing of different intensity workouts while maintaining a polarized distribution of training. Also planning mesocycles with loading and unloading weeks or using block periodization have been used by Esteve-Lanao et al. with good success in their 5-month training study. Coaches can help prevent overtraining injuries by monitoring their athletes training load index consisting of cumulative hours, intensity, and their history of injuries in the previous year.

Because zone 2 is race pace, when planning and evaluating training and competitions logs it is critical that consideration is given to how competition(s) contribute to total time spent in each intensity zone. If significant time is spent in zone 2 during a competition, the goal of training workouts during the in-season period should be primarily in zones 1 and 3. This ensures that the goal of a polarized training model is being met.

Despite only a handful of reported studies on polarized training model and a limited understanding of the key physiological changes, the polarized training model is promising for CV and muscular endurance exercise prescription. Optimizing endurance training may be best accomplished using a polarized training program, where the individual: enjoys zone 1, avoids zone 2, and gets after it in zone 3.

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