Polarized Training Is Not Optimal for Endurance Athletes

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A so-called polarized endurance training program is understood to mean one in which training is performed predominantly at a "low" intensity, with some training also done at a "high" intensity and with relatively little training at an intermediate (or "threshold") intensity. It has been reported that polarized training is prevalent in elite endurance athletes (1–3), and a polarized training approach has been recommended as appropriate, or even optimal, for endurance athletes at all levels (4). Polarized training has gained traction with myriad magazine articles, blogs, podcasts, and websites presenting or promoting the concept, but has received surprisingly little scientific critique. In this article, we argue that polarized training is, in fact, rarely practiced by elite athletes, and there is limited to no evidence that it is more effective than other training models—on the contrary, there is evidence that contradicts the notion that polarized training is optimal. Hereinafter, we set out our key criticisms of the current fashion for polarized training.

Inadequate definition of polarized training. In the sports specialist press and websites, polarized training has been popularized as the "80/20 rule"; that is, 80% of endurance training should be easy, and the remaining 20% should be hard (3,5). The problems with this definition are immediately obvious: what exactly constitutes low-intensity or easy training, what exactly constitutes high-intensity or hard training, and where does the one stop and the other begin? It is clear that the *a priori* acceptance of this arbitrary and artificial dichotomy results in the inevitable conclusion that training must only occur at two intensities with nothing in between.

For the purpose of this discussion, let us define training intensity with reference to three "zones," each separated by well-defined metabolic (lactate or ventilatory) thresholds: zone 1 (below lactate threshold, LT), zone 2 (above LT but below the critical power/speed), and zone 3 (above critical power/speed). These zones are defensible because they correspond to the moderate, heavy, and severe exercise intensity domains that have been comprehensively characterized and that evoke discrete muscle metabolic, blood acid–base, and pulmonary gas exchange responses to exercise (6). The specific definition of a polarized training profile is zone 1 > zone 3 > zone 2 (7). In contrast, a "pyramidal" training intensity distribution is zone 1 > zone 2 > zone 3, whereas a "threshold" training distribution is zone 2 > zone 1 and zone 3 (7).

Elite endurance athletes rarely practice polarized training. Elite endurance athletes are highly committed, are often professional, and typically have more time for training and for deliberate recovery from training than do subelite athletes or recreational exercisers. Naturally, these athletes will complete a greater total volume of training in their programs. As a consequence of the training duration versus intensity relationship, a higher proportion of this greater total training volume will be at a lower intensity (zone 1). The extent of zone 1 training and its likely efficacy will be a function of 1) exercise modality, because the appropriate training intensity distribution is likely to be different for weight-bearing compared with non–weight-bearing activities (e.g., running vs cycling, swimming, or rowing); 2) event specialism, because the optimal training intensity distribution is related to the competition being trained for (e.g., 10 km compared with ultramarathon or 800 m running); and 3) the caliber of the athlete and number of training sessions they complete per week. However, although zone 1 training may be considered a cornerstone of any endurance training program, it is the proportion of zone 2 versus zone 3 training that is the nub of the polarized training debate.

Scientific interest in training intensity distribution began with retrospective analyses of elite athletes' training diaries (1). Establishing optimal training styles in this fashion is fraught with difficulty and subject to confirmation bias. Moreover, although examples of a genuine polarized approach to training may be found, this does not provide good evidence that the distribution is optimal; for example, this approach invites survivorship bias wherein recommendations are based on the practices of successful athletes while ignoring the many athletes that followed the same program without success.

The most serious indictment against the whole notion of polarized training is that, when training intensity is classified and quantified appropriately, it is evident that most elite endurance

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athletes practice pyramidal, not polarized, training. This is evident even in the original investigations in this area. For example, Seiler and Kjerland (2) classified the intensity of each individual training session according to the "session goal" and concluded that the elite athletes studied train in a polarized manner (75%, 8%, and 17% in zones 1, 2, and 3, respectively). However, when the actual time spent in each of the three training zones is quantified from the data presented, it is clear that the athletes actually performed pyramidal, not polarized, training (91%, 6%, and 3% in zones 1, 2, and 3, respectively). Indeed, when training intensity is classified according to the total time spent or distance covered in the three training zones, pyramidal training intensity distributions are almost exclusively reported across endurance sports (e.g., [2,8–14]; Fig. 1). The importance of using logical and consistent methods for assessment of training intensity distribution has recently been emphasized (8,12). We would also point out that, in several studies, methods used for the identification of the metabolic thresholds dividing the three training intensity zones have been flawed or imprecise, with the potential for lower zone 2 training to be misclassified as zone 1 and for upper zone 2 training to be misclassified as zone 3. For example, an athlete training close to LT (i.e., at the top end of zone 1 or at the lower end of zone 2) would invoke a similar motor unit recruitment pattern and experience a similar level of metabolic stress, which is likely to be beneficial for enhancing muscle oxidative capacity and fatigue resistance in both principal fiber types; yet, depending on the definition of "LT" applied, the training might be considered as contributing to either a polarized or a threshold model of endurance training. We contend that the distribution of endurance training by elite athletes has been mistakenly described as polarized as a consequence of the questionable approaches taken to classifying and quantifying exercise intensity.

"Threshold" training can be highly effective and is not contraindicated. A fundamental tenet of training theory is specificity, that is, training at an intensity that provides similar physiological, as well as biomechanical and psychological, demands to the event being trained for (15). For many events in many sports, avoiding threshold training, as has been implicitly advocated in the promotion of polarized training, conflicts with the concept of training specificity. As highlighted in the previous section, most elite endurance athletes do not avoid such training but rather view it as an essential component of their training programs as evidenced by the fact that they typically spend more training time in this zone than at higher intensities. On specificity grounds, regular training in zone 2 will be especially important for athletes whose races emphasize the heavy exercise intensity domain (i.e., competition duration between approximately 25 min and 3 h).

Zone 2 training might even be considered optimal for enhancing endurance capacity given that it creates a significant aerobic training stimulus without the loss of muscle metabolic homeostasis characteristic of zone 3; that is, it lies between the severe-intensity zone, which causes rapid fatigue and is associated with short training duration, and the moderate-intensity zone where training is prolonged but may not always be of sufficient intensity to stimulate significant improvements in physical condition (16).

To our knowledge, there are no studies that demonstrate that adherence to a polarized training program produces superior outcomes compared with the pyramidal training programs athletes typically practice (4,5,17,18) or, indeed, other possible training models (19–21). There is evidence that threshold training is highly effective in promoting beneficial physiological adaptations (22,23). Moreover, although many of the studies demonstrating positive mitochondrial adaptations to training have involved "moderate-intensity continuous training," closer scrutiny shows these studies involved training in zone 2 (24). Highly successful endurance athletes, including Olympic champions and world record holders, many of whom are known to the authors, intuitively appreciate this and have often incorporated significant

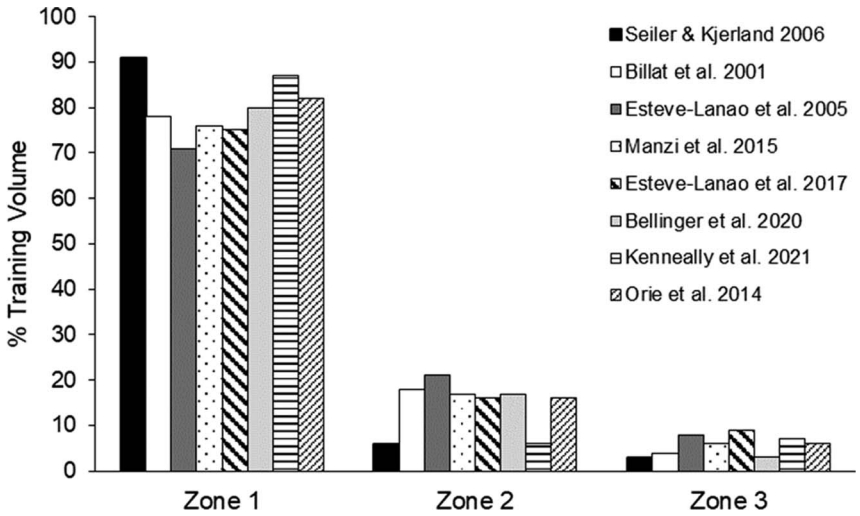

FIGURE 1—Endurance athletes structure their training by time and/or distance, and studies consistently show that endurance training programs follow a zone 1 > zone 2 > zone 3 (pyramidal) pattern for time and/or distance. Exemplar data from references (2,8–14). A polarized training distribution typically arises only when every training session receives a value count of 1 according to the "goal" or highest intensity reached during the session, regardless of the volume of training actually undertaken at each intensity within the session. This method of session counting has created widespread misunderstanding of the actual training intensity distribution (as a volume) completed by endurance athletes.

quantities of zone 2 training (colloquially known as "sweet spot" training, just below the critical power/speed) in their programs.

One perplexing aspect of polarized training is the inherent notion that so-called threshold intensity training sessions should be minimized or eliminated. The physiological rationale for such an omission (that exercise above LT might result in excessive sympathetic stress; (2)) is weak, because sympathetic outflow increases systematically at power outputs above LT (25). Hence, zone 3 training should theoretically be more damaging or debilitating than zone 2 training, and yet, the former is promoted over the latter in a polarized training program. Clearly, too much of *any* type of training may lead to overreaching and perhaps increased risk of injury or illness, but there is no scientific justification for the suggestion that zone 2 training is especially problematic.

CONCLUSIONS

We emphasize that an "optimal" endurance training program will 1) provide the necessary total training volume for the individual athlete in relation to the event being trained for and 2) appropriately balance training intensity distribution across the three zones. Polarized distributions of training volume have neither been shown to be more effective than other distributions, nor are they practiced commonly by endurance athletes; indeed pyramidal distributions are what highly successful athletes typically practice. To be clear, we are not advocating a model of endurance training that emphasizes threshold training over other training intensities but rather one that appreciates the strategic value of zone 2 training in a varied and balanced overall program. In summary, polarized training was initially misrepresented and has continued to be misconstrued, and adherence to its practice is, for the most part, misguided.

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