# Miles To Go Before I Sleep

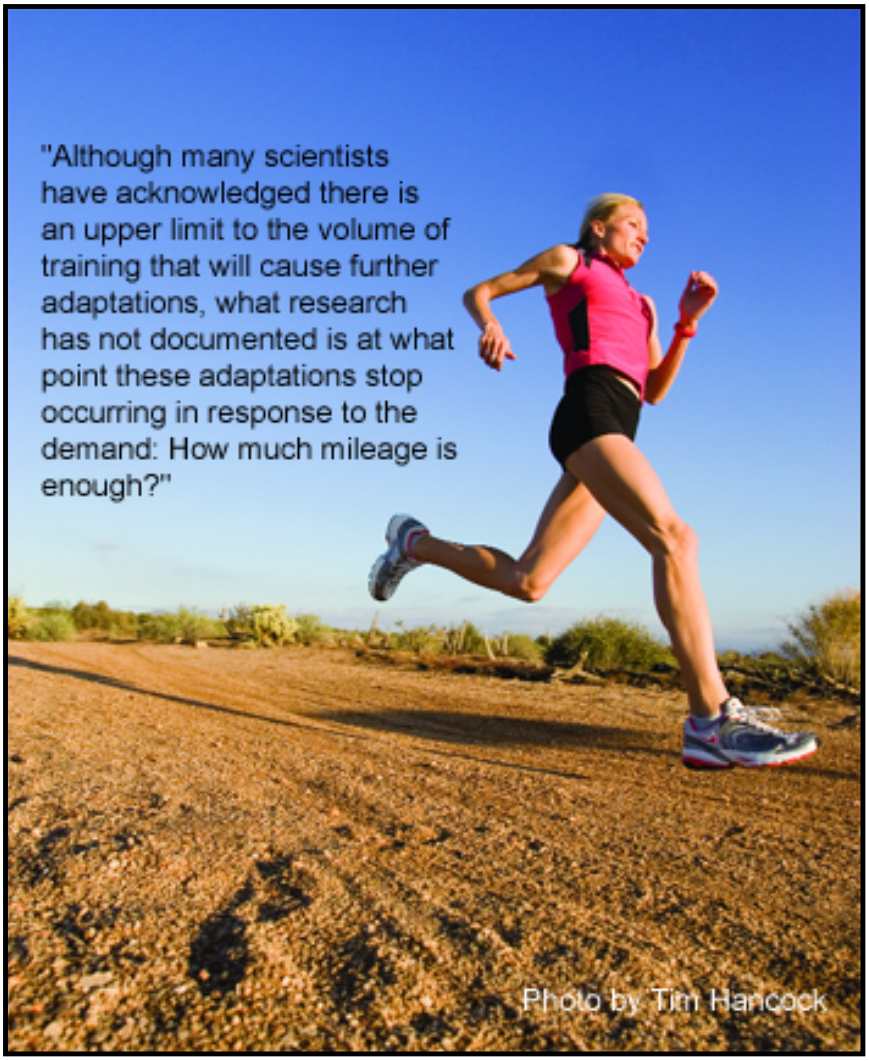
***How Much Mileage Is Enough?***

By Jason R. Karp, M.S.

As featured in the May 2007 issue of Running Times Magazine

I recently finished reading the book, How to Think Like Einstein. Its theme is that you have to break rules to solve problems and find answers to difficult questions. Einstein discovered the theory of relativity, according to the book, by breaking rules that other scientists were unable to break because their preconceived ideas got in the way. They saw things the way they were convinced things were, not the way things could be. Einstein imagined what would happen if the universe acted differently, and so he was able to break the rules.

One of the "rules" of distance running is that you must run lots of miles. Indeed, most runners link their fitness level to the number of miles they run, inevitably believing that more is better. A friend of mine who missed the 2004 U.S. Olympic Trials in the 1,500 meters by four seconds ran 100 miles per week. Frankly, I thought he was nuts. And I began to wonder, is it really necessary to run 100 miles per week to run a race that takes less than four minutes?




As legendary coach Arthur Lydiard so ardently claimed, lots of aerobic running forms the basis of any distance runner's training program. Whether you're training for the mile or the marathon, it all starts with mileage. That's because endurance training stimulates many physiological, biochemical, and molecular adaptations. All of these adaptations can be thought of as your body's attempt to cope with the demand placed on it by running every day.

For example, endurance training stimulates more fuel (glycogen) to be stored in your muscles, increases the use of intramuscular fat at the same speed to spare glycogen, improves your blood vessels' oxygen-carrying capability by increasing the number of red blood cells and hemoglobin, creates a greater capillary network for a more rapid diffusion of oxygen into the muscles, and, through the complex activation of gene expression, increases mitochondrial density and the number of aerobic enzymes, increasing your aerobic metabolic capacity. The link between an increase in mitochondrial enzyme activity and an increase in mitochondria's capacity to consume oxygen, first made in 1967 in the muscles of rats, has provided much insight into the adaptability of skeletal muscle. Generally, the greater the demand, the greater the adaptation. Although many scientists

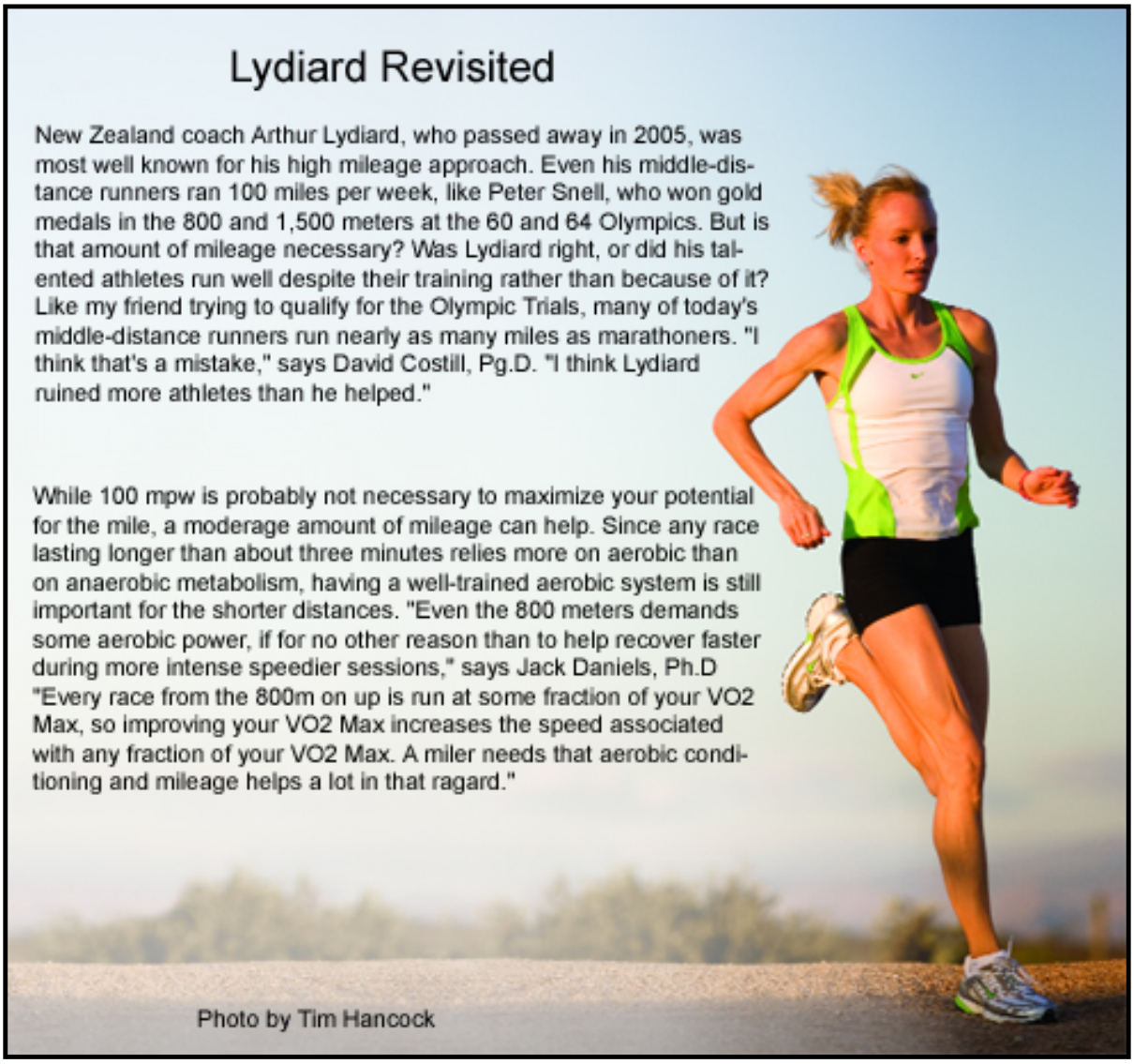
have acknowledged there is an upper limit to the volume of training that will cause further adaptations, what research has not documented is at what point these adaptations stop occurring in response to the demand. In other words, how much mileage is enough?

The answer depends on a number of factors, primary among them your genetically determined propensity to continually adapt to greater amounts of running, and the amount of running that you can physically and psychologically handle. "It's very hard to say how much mileage is ideal to maximize the various cellular adaptations that take place as a function of time spent running," says exercise physiologist and coach Jack Daniels, Ph.D., head distance coach at the Center for High Altitude Training at Northern Arizona University and author of Daniels' Running Formula. "The best answer might be to do as much as you can without losing interest or getting sick or injured."

While most runners and coaches believe that more running equals greater success, Daniels cautions about its potential to dissuade nascent distance runners. "We may be going overboard with the mileage thing in running, especially for youngsters. We may lose too many potential runners if we start off stressing mileage when they are middle school or even high school aged," he says.

**Effect of Training Volume on Physiology and Performance**

As runners, we all know that the better we get, the harder it is to improve. Sadly, none of the adaptations associated with training continue indefinitely. Unfortunately, much of the research on biochemical adaptations to endurance training has been done on animals. For example, the mitochondrial enzyme content of rats has been shown to reach its maximum adaptation with running 60 minutes per day five days per week.




A study published in The European Journal of Physiology in 1998 on horses training for 34 weeks found that increases in muscle fiber area and the number of capillaries per fiber plateaued after 16 weeks of training. After the first 16 weeks, the horses were divided into two groups: a control group that increased training stimulus from the plateau and an overload training group, which trained with even higher mileage. Both groups increased mitochondrial volume and VO2 max with the increased mileage over the next 18 weeks, but there was no difference in those variables or in muscle fiber area and capillarization after 34 weeks despite a two-fold difference in training volume between groups over the final 18 weeks. Clearly, there is a limit to muscles' adaptive response to training.

Obviously, the more untrained you are, the more you can expect to improve by increasing your mileage. For example, a study published in The Journal of Applied Physiology in 1992 found that weekly mileage ranging from five to 75 miles per week explained 86.5 percent of the difference in VO2 max between runners. Another study published in The European Journal of Applied Physiology and Occupational Physiology in 1986 found that

runners training more than 62 miles per week ran significantly faster in races from 10K to 90K compared to those who ran less than 62 miles per week. While it is likely, and even probable, that running more mileage leads to a higher VO2 max and faster race times due to all of the previously described adaptations, we cannot conclude cause and effect from cross-sectional studies comparing separate groups of runners. It's likely that genetically gifted runners who have high a VO2 max are capable of running more miles and faster races.

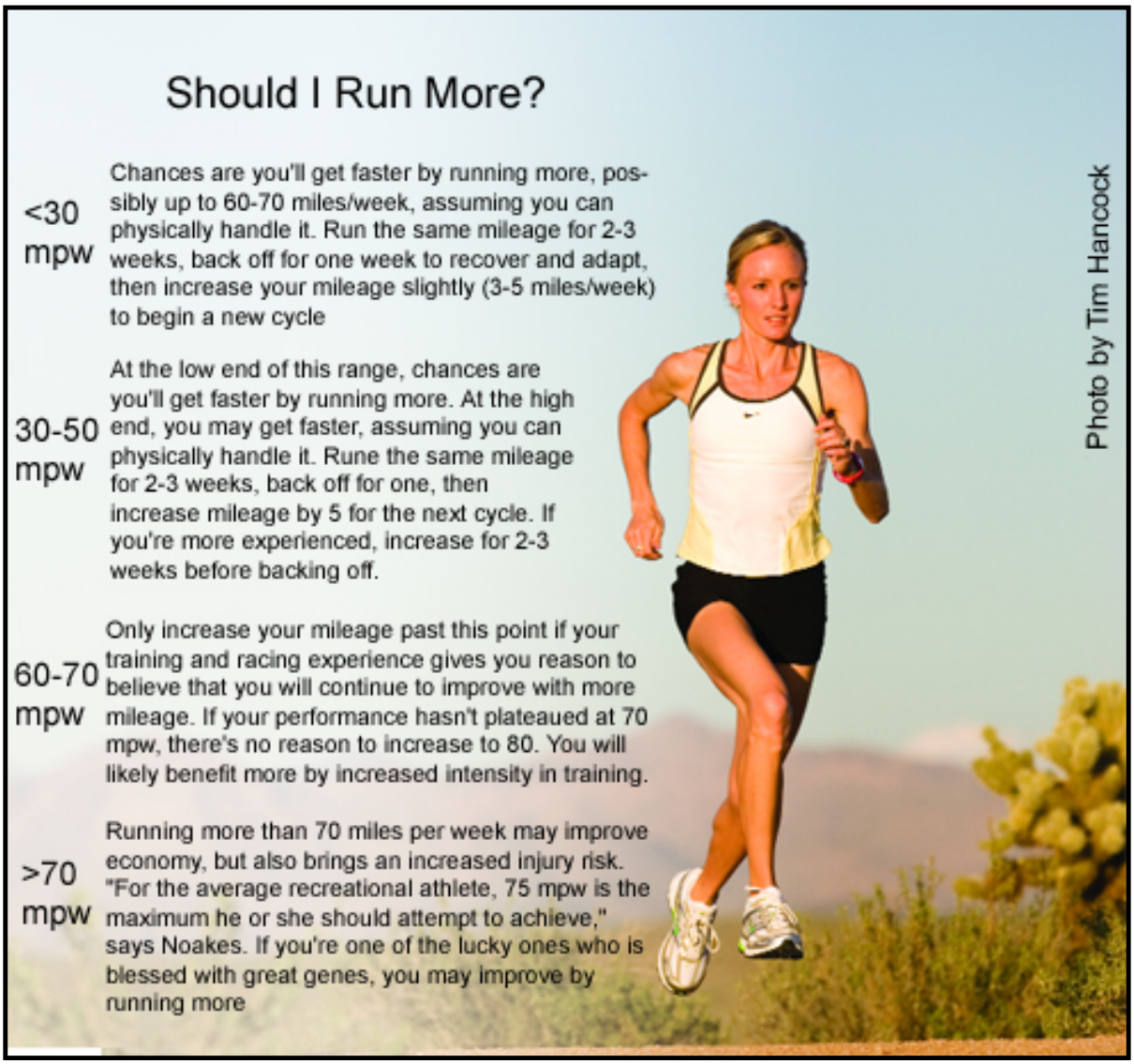

According to David Costill, Ph.D., professor emeritus of exercise science at Ball State University and former director of its Human Performance Laboratory, physiological changes plateau at a modest amount of mileage. "When you go from an untrained state to a trained state, running 30 to 40 miles per week, VO2 max and the measurements commonly taken from muscle biopsies increase, but as you move up to about 60 miles per week, things start to plateau," he says. "The exact mileage at which this plateau occurs depends on the individual, but beyond about 60 to 70 miles per week, there's not much change taking place." So, if VO2 max and muscle cellular adaptations plateau at about 70 miles per week, why do people run much more than that? "I really have no idea," says Costill. "People who run 5Ks and 10Ks still need a lot of speed, and when you run 120 or 130 miles per week, you can't do much quality."

**How Much Do Elite Athletes Run?**

In 2004, I conducted a study on the training characteristics of the U.S. Olympic Marathon Trials qualifiers. My findings, which were published in The International Journal of Sports Physiology and Performance in March, 2007, revealed that the men averaged 90 miles per week with a peak mileage of 120, while the women averaged 72 miles per week with a peak mileage of 95 for the year of training leading up to the Trials. However, the elite male marathoners (sub 2:15) didn't run statistically more than the national-class marathoners (2:15-2:22). The elite men averaged 97 miles per week with a peak mileage of 126, while their national-class counterparts averaged 90 miles per week with a peak mileage of 119. There was, however, a statistical difference in mileage between women's performance levels, likely due to their greater range in performance. The elite women (sub 2:40) averaged 84 miles per week with a peak mileage of 112, while their national-class counterparts (2:40-2:48) averaged 69 miles per week with a peak mileage of 91. While the faster female marathoners ran more, only a quarter of the difference in marathon performance between women could be explained by the amount of mileage they ran. Mileage accounted for even less of the difference among the men. Running more didn't necessarily make them faster. Regardless of how much you run, genetics plays a large role in your performance. A person with a lot of talent will almost always outperform a person with little talent and a lot of training.

"If you look at the training data of elite athletes, you find that the optimum training volume for the world's best athletes lies somewhere between 75 and 110 miles per week," says Timothy Noakes, M.D., Discovery

Health Professor of Exercise and Sports Science at the University of Cape Town in South Africa and author of The Lore of Running. "However, the time spent running may be more important than the mileage, since a fast runner will run that distance much quicker than a slow runner. Humans may have a maximum training volume they can undertake and I think it's close to 75 to 100 miles per week. Your body simply can't absorb any more training volume without breaking down."




**Beyond VO2 max and Metabolism**

If there is little or no improvement in VO2 max and the metabolic profile of muscles as one runs more than 70 miles per week, is there any benefit at all to running more? Maybe. Research has shown that runners who run high mileage tend to be more economical, which has led to the suggestion among scientists that running more than 70 miles per week improves running economy (the amount of oxygen used to maintain a given pace). It is possible that, just as repetition of the walking movement decreases the "jerkiness" of a toddler's walk to the point that it becomes smooth, repetition of the running movement has an under-recognized neural component. With countless repetitions, muscle fiber recruitment patterns and possibly even the relationship between breathing and stride rhythms are optimized to minimize the oxygen cost. In other words, practice makes perfect. Additionally, high mileage reduces body weight, which further reduces the oxygen cost. Because it is hard to prove cause and effect, it is not clear whether high mileage runners become more economical by running more miles or are innately more economical and can therefore handle higher mileage without getting injured.

Beyond the physiological adaptations to running lots of miles and their contribution to performance, the amount of mileage you run may ultimately depend on your brain. "The more important explanation, in my view, is that the brain is critically important in this process and is under-recognized," says Dr. Noakes. "The brain may optimally adapt to a certain volume of training and a lot of our training focus and adaptation may actually be to teach us that we can run the distance. The mental preparation starts long before you go training."

While most runners and coaches agree that training volume is important, training intensity is more important than volume for improving fitness and performance, especially in highly trained runners. Research has shown that a high training intensity is vital for maximizing cardiovascular improvement and that VO2 max and other physiological variables can continue to improve with the inclusion of high intensity training. For example, interval training performed at 95 to 100 percent of VO2 max is the most potent stimulus for its improvement, and is necessary for further improvement in highly trained runners. Given that training volume will impact training intensity, the better question may not be how much mileage is enough, but how much mileage is too much to sacrifice intensity.

So, as you prepare for your next 5K or marathon, how much mileage should you run? If you've read this far, you know that the answer is not an easy one (for some guidance, see "Should I Run More?"). The best way to determine your optimum miles per week is to slowly and systematically increase your mileage from month to month and year to year, taking care to note how you respond to the training stimulus. And remember that more is not always better. Like Einstein, sometimes you have to break the rules.

---

*Jason R. Karp is a Ph.D. candidate in exercise physiology at Indiana University, a professional running and sports performance coach, freelance writer, and competitive runner. He currently lives in Albuquerque, New Mexico. RunCoachJason.com.*