OPTIMIZING ATHLETIC PERFORMANCE—ARE CARBOHYDRATES NECESSARY?

DEBRA WEIN, MS, RD, LDN, NSCA-CPT,*D, AND NICOLE SCHULTZ, MS, MPH

Despite its poor performance in the United States News and World Report "Best Diets 2014" rankings, the Paleolithic diet has been growing in popularity among the general and athletic communities (10). Known as the Paleo Diet™, it recommends eating patterns similar to those of our Paleolithic ancestors, which included wild animals and plant-based foods. While the Paleo diet parallels the dietary guidelines with respect to lean protein, healthy fat, and fresh fruits and vegetables, it completely restricts dairy and grains, both of which have been integral components of athletes' eating regimens for decades. Yet proponents of the Paleo diet for athletes argue against the need for traditional "carbo-loading" for performance and claim that a low-carbohydrate eating regimen can be beneficial for athletes (2). Their argument is based on the body's ability to adapt to the altered macronutrient composition of the diet by enhancing reliance on fat oxidation for energy. The Paleo diet is just one example of recent diets that recommend specific eating patterns astray from traditionally accepted guidelines. Before sports nutritionists and coaches begin prescribing eating recommendations to athletes that are unconventional from traditional standards, it is important to consider the scientific evidence supporting a low-carbohydrate diet for boosting athletic performance.

THEORY—ORIGIN AND ARGUMENTS

A landmark study published in 1983 by Phinney et al. demonstrated the ability of well-trained cyclists to maintain endurance performance after adaptation to a four-week, low-carbohydrate diet, of which 83 – 85% of total calories came from fat (7). Surprisingly, the cyclists did not experience impaired endurance performance following the diet and, more importantly, data showed a dramatic shift in muscle substrate utilization, as demonstrated by a decreased respiratory quotient, reduction in muscle glycogen mobilization, and reduced blood glucose oxidation (7). This study serves as a foundation for modern day low-carbohydrate diet advocates. Adaptation to a low-carbohydrate diet should enable endurance athletes to use their abundant fat reserves for fuel, reducing reliance on endogenous carbohydrates and the need for exogenous sources of carbohydrates during prolonged endurance sports. Not only do they cite muscle glycogen sparing via enhanced fat oxidation, but proponents also argue that low-carbohydrate diets could aid in recovery due to the suppression of oxidative stress (6). Furthermore, observational and case studies have demonstrated associations between marathon running and coronary atherosclerosis—a topic that made headlines across the nation recently (5,8). Since marathon runners typically ingest large quantities of carbohydrates during training and competition, the recent observations called into question the long-term belief of high-carbohydrate diets as beneficial for athletic performance, further supporting the low-carbohydrate diet trend.

STATE OF THE EVIDENCE

While research has been suggestive, the evidence for following a low-carbohydrate diet to boost athletic performance remains weak. In 2005, researchers investigated the evidence for effects of high-fat (low-carbohydrate) versus high-carbohydrate diets on endurance performance. While they reported that endurance performance was moderately prolonged after a high-carbohydrate diet compared to a high-fat diet, they also noted that, due to the heterogeneity across trials, "a conclusive endorsement of a high-carbohydrate diet for improved athletic performance is difficult to make," (3). Contributing to the uncertainty, the small number of additional studies that examined low-carbohydrate diets on performance since then have produced conflicting and inconclusive results (all for varying reasons) (6). Low-carbohydrate proponents argue that these studies did not give subjects adequate time to adapt to the new eating regimen. Without time for adaptation, the experiments could be biased toward showing no performance advantage following a low-carbohydrate diet. While this may be true, strong evidence in favor of low-carbohydrate diets remains absent. Despite showing enhanced fat oxidation during exercise, some studies suggest low-carbohydrate diets may negatively impact chronic adaptations to training, carbohydrate utilization, and capacity for high-intensity exercise performance (1). Additionally, whether the metabolic differences in muscle following a low-carbohydrate diet translate into functional changes and improved athletic performance outcomes remains unknown (1). Although faster recovery has been anecdotally reported by athletes following low-carbohydrate regimens the hypothesized explanation for the suppressed oxidative stress and enhanced recovery has only been demonstrated in mice (6,9).

MOVING FORWARD

In 2003, Asker Jeukendrup stated in a research article examining high- versus low-carbohydrate diets that, "there is very little or no evidence to support the use of high-fat diets," (4). Limited evidence has surfaced to refute his statement, and a tremendous gap in the literature remains. Not only is the impact of a low-carbohydrate diet on performance inconclusive, but we lack research on its effect on weight control, training performance, recovery, immune function, injury risk, or capacity to concentrate (6).

Until robust studies emerge to clarify the uncertainty, it is important to keep three points in mind. First, there is a lot of variation among athletes, eliminating the possibility of a "one size fits all" approach. Secondly, an athlete's performance goals must be considered prior to exploring a low-carbohydrate diet. With a majority of the literature focusing on endurance performance, the ability to conserve carbohydrates might come at the expense of limited anaerobic capacity, potentially due to restricted substrate mobilization or fiber recruitment for high-intensity work (7). Therefore, low-carbohydrate experimentation might not be appropriate for some athletes. Lastly, regardless of metabolic adaptations to diet, carbohydrate availability remains the primary limiting factor for performance during prolonged submaximal or intermittent high-intensity exercise (1). In the midst of immense uncertainty, one thing is clear: there is a need for more research. Until then, the following recommendations can be made (1):

- Targets for daily carbohydrate intake can be estimated using body mass (as a proxy for muscle volume) and exercise load.
- Daily carbohydrate intakes should match the fuel needs of training and glycogen restoration.
- Carbohydrate intake should remain flexible, as an athlete's needs are not static; allow for variation in carbohydrate intake depending upon changes in daily, weekly, or seasonal goals, and training periodization.

REFERENCES

1. Burke, LM, Hawley, JA, Wong, SHS, and Jeukendrup, AE. Carbohydrates for training and competition. *J Sports Sc*i 29 Suppl 1: S17-27, 2011.

2. Cordain, L, and Friel, J. *The Paleo Diet for Athletes: The Ancient Nutritional Formula for Peak Athletic Performance*. New York, NY: Rodale; 2012.

3. Erlenbusch, M, Haub, M, Munoz, K, MacConnie, S, and Stillwell, B. Effect of high-fat or high-carbohydrate diets on endurance exercise: A meta-analysis. *Int J Sport Nutr Exerc Metab* 15: 1-14, 2005.

4. Jeukendrup, AE. High-carbohydrate versus high-fat diets in endurance sports. *Übersichtsartikel*:17-23, 2003.

5. Möhlenkamp, S, Böse, D, Mahabadi, AA, Heusch, G, and Erbel, R. On the paradox of exercise: Coronary atherosclerosis in an apparently healthy marathon runner. *Nat Clin Pract Cardiovasc Med* 4: 396-401, 2007.

6. Noakes, T, Volek, JS, and Phinney, SD. Low-carbohydrate diets for athletes: what evidence? *Br J Sports Med* 48: 1077-1078, 2014.

7. Phinney, SD, Bistrian, BR, Evans, WJ, Gervino, E, and Blackburn, GL. The human metabolic response to chronic ketosis without caloric restriction: Preservation of submaximal exercise capability with reduced carbohydrate oxidation. *Metabolism* 32: 769-776, 1983.

8. Schwartz, R, Kraus, S, Schwartz, J, Wickstrom, K, Peichel, G, Garberich, R, et al. Study finds that long-term participation in marathon training/racing is paradoxically associated with increased coronary plaque volume. *Missouri Med*; 2014.

9. Shimazu, T, Hirschey, MD, Newman, J, He, W, Shirakawa, K, Le Moan, N, Grueter, CA, Lim, H, Saunders, LR, Stevens, RD, Newgard, CB, Farese, RV Jr., de Cabo, R,Ulrich, S, Akassoglou, K, and Verdin, E. Suppression of oxidative stress by beta-hydroxybutyrate, an endogenous histone deacetylase inhibitor. *Science* 339: 211-214, 2013.

10. U.S. News and World Report. Best Diets, 2014. Retrieved 2014 from http://health.usnews.com/best-diet.

ABOUT THE AUTHOR

Debra Wein is a recognized expert on health and wellness and designed award-winning programs for both individuals and corporations around the United States. She is the President and Founder of Wellness Workdays, Inc., (www.wellnessworkdays.com) a leading provider of worksite wellness programs. In addition, she is the President and Founder of the partner company, Sensible Nutrition, Inc. (www.sensiblenutrition.com), a consulting firm of registered dietitians and personal trainers, established in 1994, that provides nutrition and wellness services to individuals. She has nearly 20 years of experience working in the health and wellness industry. Her sport nutrition handouts and free weekly email newsletters are available online at www.sensiblenutrition.com.

Nicole Schultz is a doctoral student in the Biochemical and Molecular Nutrition program at the Friedman School of Nutrition Science and Policy at Tufts University. Her research focuses on the impact of nutrition and physical activity on cardiometabolic health. She earned both of her Master's degrees at Tufts University, with emphases in Nutritional Biochemistry, Exercise Physiology, and Health Communication. She is also a Cooper Institute Certified Personal Trainer (CI-CPT). Prior to attending Tufts, Schultz worked in exercise physiology research and studied human energy expenditure and metabolism.