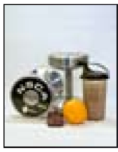
December 2007
Volume 6, Number 6
www.nsca-lift.org/perform

NSCA's Performance Training Journal

Nutrition

NSCA™ National Strength and Conditioning Association
bridging the gap between science and application

Contents



Nutrition

Departments

NSCA's Performance Training Journal

NSCA's Performance Training Journal is a publication of the National Strength and Conditioning Association (NSCA). Articles can be accessed online at… http://www.nsca-lift.org/perform.

NSCA Mission

As the worldwide authority on strength and conditioning, we support and disseminate research–based knowledge and its practical application, to improve athletic performance and fitness.

Talk to us…

Share your questions and comments. We want to hear from you. Write to *Performance Training* Editor, NSCA, 1885 Bob Johnson Drive, Colorado Springs, CO 80906, or send email to kcinea@nsca-lift.org.

The views stated in the NSCA's Performance Training Journal are those of the authors, and do not necessarily reflect the positions of the NSCA.

Editorial Office

1885 Bob Johnson Drive
Colorado Springs, Colorado 80906
Phone: +1 719-632-6722

Editor: Keith Cinea, MA, CSCS,*D, NSCA-CPT,*D
email: kcinea@nsca-lift.org

Assistant Editor: David Pollitt, CSCS,*D

Sponsorship Information: Richard Irwin
email: rirwin@nsca-lift.org

Editorial Review Panel

Does Consuming Whey Protein Before and After Resistance Training Alter Net Protein Synthesis?

It has been well documented that a combination of essential amino acids (EEA) and carbohydrates before a resistance training bout results in a significant elevation in muscle anabolism. Pre-exercise supplementation has also been shown to result in greater muscle protein anabolism when compared to supplementation immediately, one hour, and three hours post exercise. While this data appears to suggest that supplementation can result in a greater anabolic response to the training bout, little data exists looking at intact proteins such as whey protein.

Recently researchers from the University of Birmingham examined the effects of consuming whey protein before and after an acute bout of resistance training on muscle anabolism. Twenty grams of whey protein was consumed immediately prior to exercise and one hour after exercise based upon previous research which demonstrated positive anabolic effects in response to the combination of EAA and carbohydrates. The exercise bout consisted of 10 sets of eight repetitions of leg extensions at -80% of 1 RM. Muscle biopsies were taken from the vastus lateralis immediately before, one hour after, and five hours after the resistance training bout. Blood samples were taken at selected time points before, during, and after the training bout.

The first major finding was that the ingestion of 20 g of protein before and after the training session induced an anabolic response. However, there were no differences between the ingestion time points, which would suggest that the timing of ingestion of whey protein is not as important as it is when EEA and carbohydrates are ingested. The second major finding was that arterial amino acid concentration only increased by ~30% when whey protein was consumed prior to training. This increase was 70% less than that seen with the consumption of EAA and carbohydrates. Even though the net amino acid balance shifted from negative to positive for both ingestion time points, there was no significant increase in amino acid uptake. Based upon these data, the researchers concluded that the consumption of whey protein does not respond in the same manner as EAA and carbohydrate supplements. Instead, the timing of EAA and carbohydrate supplements is more crucial for inducing the anabolic response. The authors also suggested more research is needed to explore the effect of whey protein supplementation timing.

Tipton KD, Elliott TA, Cree MG, Aarsland AA, Sandford, AP, Wolfe RR. (2007). Stimulation of net muscle protein synthesis by whey protein ingestion before and after exercise. *American Journal of Physiology—Endocrinology and Metabolism*, 292:E71 – 76.

Hydroxy-Methylbutyrate (HMB) Supplementation Improves Aerobic Performance and Body Composition

Several studies have suggested that Hydroxy-Methylbutyrate (HMB) may improve lean body mass, strength, and lipid oxidation when combined with a resistance training program. Additionally, HMB has been demonstrated to reduce proteolysis (protein degradation) and acute damage to muscle structures as a result of eccentric running. As a whole, very few studies have looked at the effects of HMB supplementation on aerobic training adaptations. Recently, researchers from the University of Sherbrooke examined the effects of five weeks of HMB supplementation coupled with a three times a week interval training regime. The interval training program consisted of five intervals performed at the individual's maximal velocity for 50% of the time to exhaustion for that velocity. Recovery between each interval was performed at 60% of maximal. Each interval and its corresponding recovery summed to 100% of the time to exhaustion. Each session contained a five minute warm-up and recovery performed at 50% of the individual's maximal running velocity. Supplementation consisted of the consumption of three grams per day over the five weeks. Results of this investigation revealed that the combination of interval training and HMB supplementation resulted in significantly greater increases in maximal oxygen consumption. There were no differences in body composition changes between groups. Based upon these results it was concluded that the addition of an HMB supplement to an interval training program results in significant improvements to selected components of aerobic performance.

Lamboley CR, Royer D, Dionne IJ. (2007). Effects of beta-hydroxy-beta-methylbutyrate on aerobic-performance components and body composition in college students. *International Journal of Sport Nutrition and Exercise Metabolism*, 17:56 – 69.

Is Muscle Glycogen an Important Concern for Athlete's Who Want to Stimulate Muscle Hypertrophy?

It is generally accepted that a high carbohydrate diet is important for endurance athletes as it allows them to train at a higher level, thus resulting in greater physiological adaptations that potentially could lead to superior performances. Conversely, less attention has traditionally been focused on carbohydrate consumption in strength/power athletes. Recent research has suggested that low levels of muscle glycogen can result in a disruption of the mechanisms related to protein translation. This ultimately could result in impairments in the hypertrophic response to a resistance training regime. While preliminary data seems promising, further research is still warranted to strengthen this contention. Therefore, researchers from Australia recently explored the effects of muscle glycogen concentration and an acute bout of resistance training on the early response genes responsible for promoting muscle hypertrophy.

Seven highly trained athletes were recruited for this investigation. The subjects performed 1-legged cycling in order to deplete muscle glycogen in one leg (LOW). The other leg was utilized as the control condition (NORM). The following day the subjects performed unilateral resistance training. Muscle biopsies were taken at rest, immediately after the resistance training bout, and three hours after recovery.

When the two legs were compared the LOW leg exhibited significantly lower muscle glycogen levels when compared to the NORM leg. The resistance training program resulted in a significant reduction of muscle glycogen in both legs (NORM = -28.3%; LOW = -47.2%). When looking at genes related to carbohydrate metabolism the NORM leg exhibited higher levels than the LOW leg. Interestingly, the LOW leg exhibited lower levels of transcriptional activity of genes that promote muscle hypertrophy when compared to the NORM leg. Additionally, myogenic factors and insulin like growth factors were also suppressed in the LOW leg when compared to the NORM leg. In conclusion the authors suggested that performing resistance training with low muscle glycogen concentrations does not enhance the activity of genes related to muscle hypertrophy. This data may further suggest that low carbohydrate diets may actually result in reduced hypertrophic responses associated with resistance training. Therefore, strength/power athletes who are looking to increase muscle mass should consider the carbohydrate content of their diet to be very important.

Churchley, EG, Coffey VG, Pedersen DJ, Shield A, Carey KA, Cameron-Smith D, Hawley JA. (2007). Influence of preexercise muscle glycogen content on transcriptional activity of metabolic and myogenic genes in well-trained humans. *Journal of Applied Physiology*, 102:1604 – 1611.

Does the Combination of β-Alanine and Creatine Monohydrate Supplementation Improve Aerobic Power, Ventilatory Threshold, Lactate Threshold, and Time to Exhaustion?

Research exploring the effects of dietary supplements is prevalent in the scientific literature. One of the most studied supplements is creatine monohydrate. The ergogenic effects of creatine supplementation are well established. Recently, evidence has been presented to suggest that β-alanine supplementation improves high intensity performance. However, little research has been conducted to explore the effects of combining creatine and β-alanine supplementation on performance. Fifty-five men were recruited for this investigation. Four groups consisting of 1) a placebo treatment (34 g of dextrose), 2) creatine treatment (5.25 g creatine + 34 g dextrose), 3) β-alanine treatment (1.6 g β-alanine + 34 g dextrose), and 4) a creatine and β-alanine (5.25 g creatine + 1.6 g β-alanine + 34 g dextrose) treatment were established. All treatments were identical in taste and appearance. The supplements were consumed four times per day for six days and then twice per day for 22 days. Subjects underwent a graded exercise test on a cycle ergometer prior to and immediately after the 28 days of supplementation. There were no significant differences between the treatment groups for any of the markers of aerobic performance. However, the creatine + β-alanine group demonstrated significant increases post supplementation in the lactate threshold, power output at lactate threshold, oxygen consumption at lactate threshold, and percent VO_2 max at which lactate threshold occurred when compared to the pre-supplementation values. Based upon these finding the authors concluded that the combination of creatine and β-alanine supplements may offer some promise. The author's conclusions should be examined with caution as it is important to reiterate that no statistical significance was noted between the treatment groups. Therefore at this time more research is warranted in order to determine the efficacy of the use of β-alanine or creatine and β-alanine.

Zoeller RF, Stout JR, O'Kroy J, Torok DJ, Mielke M. (2007). Effects of 28 days of beta-alanine and creatine monohydrate supplementation on aerobic power, ventilatory and lactate thresholds, and time to exhaustion. *Amino Acids*, 33: 505 – 510.

About the Author

G. Gregory Haff is an assistant professor in the Division of Exercise Physiology at the Medical School at West Virginia University in Morgantown, WV. He is a member of the National Strength and Conditioning Association's Research Committee and the USA Weightlifting Sports Medicine Committee. Dr. Haff received the National Strength and Conditioning Association's Young Investigator Award in 2001.

Single Versus Multiple Set Training: What Does the Research Say?

Joseph M. Warpeha, MA, CSCS,*D, NSCA-CPT,*D

In the world of strength and conditioning there are many debates regarding optimal training. The question as to the effectiveness of performing a single set of an exercise as opposed to numerous sets is one such debate. The proponents of the single set theory claim that performing one set is just as effective as doing multiple sets if the goal is strength enhancement. The consensus of many sport scientists, researchers, and practitioners is that multiple sets are superior for strength development for strength athletes as well as for beginners beyond the first month or two of training. However, a consensus alone is not enough in the absence of research to support such a claim. While the vast majority of evidence in the form of peer reviewed original research articles, review papers, and meta-analyses do support the notion that multiple set training is superior, there is not a complete lack of support in the scientific literature for the single set side of the debate. Additionally, the lay literature occasionally reports that multiple set training is no more effective than single set training for optimal strength development. This is an important point since many in the general public regard the information in these lay publications as truth when often it simply is not the case. The purpose of this article is to briefly review what the research says related to the single versus multiple set debate.

The consensus within the scientific community today is that beyond the first month or two of training, multiple sets are superior to single sets in eliciting strength gains. The disparity is especially pronounced in well-trained strength athletes. The few scientific studies that advocate single set training generally have similar flaws which makes it difficult to apply the conclusions. The biggest problems with the designs of many of these studies are that: 1) the subjects were untrained, and 2) the duration of the training was not longer than one or two months. The conclusions, therefore, can only be applied to beginners within the first month or two of training. It is not surprising that there were no major differences in the amount of strength gained between the single set groups and the multiple set groups when they trained for one or two months. As a beginner, it does not take too much of a stimulus to elicit strength gains and it does not take a complex designed program that yields positive results for those just starting out. The real trick in strength training program design is constructing a program for people who are no longer beginners and still want to see improvements. According to the American College of Sports Medicine's most recent position stand on this topic (entitled Progression Models in Resistance Training for Healthy Adults), "In resistance trained individuals, though, multiple set programs have been shown to be superior for strength enhancement. No study has shown single-set training to be superior to multiple-set training in either trained or untrained individuals." It goes on to say "Long-term progression-oriented studies support the contention that higher training volume is needed for further improvement." While this position stand (1) was written in 2002 and is five years old at the time of this writing, no new abundance of evidence to the contrary has come to light. Not surprisingly, the NSCA's position statement on the Basic Guidelines for the Resistance Training of Athletes states: "Multiple-set periodized resistance-training programs are superior to single-set, nonperiodized programs for physical development over long-term training programs." (5)

An example of the perpetuation of false information based on misinterpreted research in the lay literature (i.e. meant for the general public) can be found within the pages of a publication (2) which came out in 2004. It was stated within a chapter of the book that "…a recent review [from 1998] of the scientific literature that examined the effectiveness of multiple-set and single-set training programs found that performing multiple sets aren't more effective for the development of muscular size (hypertrophy) and strength."

In a constantly growing field of research like that of strength and conditioning, a recent review of literature implies within the past few years (five years maximum). It is difficult to believe that a single review paper published in 1998 (4) represents either the "recent scientific literature" (even by 2004 standards) or the "preponderance of scientific research". However, let us say for a moment that it does. This is important because this particular scientific paper (4) which is cited typically makes up the bulk of the argument for those of the single-set mentality.

What is not mentioned by the single-set proponents is that a letter-to-the-editor was written (3) in response to this review paper and published less than a year later in the same journal which critically reviewed and subsequently dismantled the validity of the article and its conclusions. It is interesting that this letter-to-the-editor was authored by 17 of the world's leading exercise science researchers who have between them hundreds of years of practical experience as well as thousands of truly peer-reviewed original research articles among them. Keep in mind that official position stands or consensus papers put out by professional organizations like the American Medical Association or the American Heart Association frequently have fewer than 17 leading scholars as the authors who have disseminated the research. Now why would 17 of the world's leading scientists, practitioners, and researchers take the time to write such a letter-to-the-editor? The answer should be pretty clear.

This article is not intended to convey the notion that there is no place for single set training, even in the program of an experienced strength athlete. There is obviously a huge advantage in terms of time and efficiency with single set training. Additionally, if a person's goal is general health and not maximizing their strength potential (this is the case for many people), single set training offers the benefit of efficiency as well as the possibility for a reduced risk of injury (although this has never been proven) simply because the overall volume and number of repetitions is lower than multiple set training. For the well-trained recreational lifter or strength athlete, this type of training also offers variety, a different kind of training stimulus, and may very well have a place in a yearly training cycle. It could certainly be argued that single set training may be one way to maintain strength levels during the competitive season (e.g. football) when time and energy are at a premium. However, at this point in time it seems clear that the long-term (i.e. years) foundation of any serious strength training program should be comprised mainly of multiple set training if maximal effectiveness is the goal.

This article also brings up an important point when reading research and trying to make conclusions. These days there are so many millions of research articles on every topic imaginable. If more than a few research articles exist on a single topic, it is very likely that conflicting results will exist. If one wants to present a fair and balanced summary of the scientific literature, then all of the research must be presented, not just the research that was cherry picked because it happens to support the argument.

References

1. American College of Sports Medicine. (2002). Position Stand on Progressive Models in Resistance Training for Healthy Adults. *Medicine and Science in Sports and Exercise*, 34(2):364 – 380.

2. Bradley M, Brzycki M, Carlson L, Harrison C, Picone R, Wakeham T. (2004). *The Female Athlete: Train for Success*. Page 42. Terre Haute, IN: Wish Publishing.

3. Byrd R, Chandler TJ, Conley MS, Fry AC, Haff GG, Koch A, Hatfield F, Kirksey KB, McBride J, McBride T, Newton H, O'Bryant HS, Stone MH, Pierce KC, Plisk S, Ritchie-Stone M, Wathen D. (1999). Letter-to-the-Editor Regarding "Strength Training: Single Versus Multiple Sets." *Sports Medicine*, 27(6):409 – 416.

4. Carpinelli RN, Otto RM. (1998). Strength Training: Single Versus Multiple Sets. *Sports Medicine*, 26(2):73 –84.

5. Pearson D, Faigenbaum A, Conley M, Kraemer WJ. (2000). The National Strength and Conditioning Association's Basic Guidelines for the Resistance Training of Athletes. *Strength and Conditioning Journal*, 22(4):14 – 27.

About the Author

Joe Warpeha is an exercise physiologist and strength coach and is currently working on his PhD in exercise physiology at the University of Minnesota-Minneapolis. His current work focuses on NASA-funded research related to the application of innovative technology to manipulate thermoregulatory physiology in humans working, living, and performing in extreme hot and cold environments. Joe teaches several courses at UM including "Advanced Weight Training and Conditioning", "Measurement, Evaluation, and Research in Kinesiology", "Strength Training Program Design" and "Introduction to Kinesiology". He has a master's degree in exercise physiology and certifications through the NSCA, ACSM, USAW, USAPL, USATF, ASEP, and YMCA. He has over 15 years of resistance and aerobic training experience and has been a competitive powerlifter since 1997. Joe is a two-time national bench press champion and holds multiple state and national records in the bench press while competing in the 148, 165, and 181-pound weight classes.

▲

Iron Deficiency in the Endurance Athlete: Tips for Prevention and Recognition

Jason Brumitt, MSPT, SCS, ATC, CSCS,*D

Some endurance athletes experience bouts of exhaustion, fatigue, and poor performance as they prepare for competition. While these symptoms can often be attributed to overtraining, there may be other underlying physiological causes for these issues . If you have been experiencing any of these symptoms, you may be suffering from a condition known as iron deficiency.

Table 1. Recommended Food Sources of Iron (2,7)

Red Meats	Eggs
Lentils	Nuts
Dark Green Leafy Vegetables	Fortified Breakfast Cereals
Legumes	Dried Beans
Soy Foods	

What is Iron Deficiency?

Iron is a mineral found within all of our cells and serves several vital physiological functions within the body. Athletes, especially females, who participate in endurance sports are at risk for iron deficiency (3,4). One epidemiological study reported up to 45% of adolescent female cross-country runners suffering from iron deficiency by the end of their cross-country season (3).

Athletes who are iron deficient have an impaired ability to deliver oxygen to the body's tissues. Several factors may contribute to the onset of this condition including a diet low in red meat (or other sources of dietary iron), consumption of medications that impair iron absorption, drinking caffeinated and carbonated beverages, gastrointestinal tract disorders, abnormal menstrual bleeding, exercise, and iron loss via sweat (1,2,3,5).

The main symptoms athletes with iron deficiencies experience include fatigue, weakness, poor performance, and pale skin color (2). The iron deficient athlete who continues to train will not be able to perform at an optimal level and is at an increased risk of developing musculoskeletal injuries (6). If an injury occurs, many anemic athletes may find it very difficult if not impossible to fully recover until the iron deficiency is recognized and has been effectively treated.

When to Seek Medical Attention

It is important for any athlete experiencing these symptoms to schedule an appointment with their medical provider as soon as possible. The medical provider will typically order a complete blood count test (4). If an athlete presents with low values on these tests, his or her physician will likely conduct monthly follow-up tests until appropriate levels are established (4).

Simple Steps You Can Take

Not all athletes are at risk for iron deficiency anemia, but for those who are there are several simple measures that may be taken to help prevent this condition. First and foremost, one must eat a healthy, nutrient balanced diet that includes foods rich in iron (table 1). This will help boost the amount of iron stored in the body. It is also recommended that one should eat foods rich in vitamin-C (tomatoes, citrus fruits, broccoli) (2,7). Vitamin C enables the body to convert iron into a bio-usable form (2,7). Second, avoid food and drinks, such as coffee or pure bran, that may impair the body's ability to appropriately utilize iron (7). Finally, schedule an appointment with your physician prior to the start of your sports season to discuss your individual risk factors.

References

1. Balaban EP, Snell P, Stray-Gundersen JS, Frenkel EP. (1995). The effect of running on serum and red cell ferritin: a longitudinal comparison. *International Journal of Sports Medicine*, 16: 278 – 282.

2. Landry GL, Bernhardt DT. (2003). *Essentials of Primary Care Sports Medicine*. Champaign, IL: Human Kinetics.

3. Rowland TW, Stagg L, Kelleher JF. (1991). Iron deficiency in adolescent girls. Are athletes at increased risk? *Journal of Adolescent Health*, 12(1): 22 – 25.

4. Schnirring L. (2002). Screening athletes for low iron: questions surface about ferritin. *The Physician and Sportsmedicine*, 30(9): 5 – 6.

5. Schumacher YO, Schmid A, Konig D, Berg A. (2002). Effects of exercise on soluble transferring receptor and other variables of the iron status. *British Journal of Sports Medicine*, 36: 195 – 200.

6. Strakowski JA, Jamil T. (2006). Management of common running injuries. *Physical Medicine and Rehabilitation Clinics of North America*, 17: 537 – 552.

7. Venderley AM, Campbell WW. (2006). Vegetarian diets; nutritional considerations for athletes. *Sports Medicine*, 36(4): 293 – 305.

About the Author

Jason Brumitt is a board-certified sports physical therapist residing and practicing in the Portland, OR area. He serves as adjunct faculty for Pacific University's school of physical therapy. He is currently pursuing his Doctor of Science degree at Rocky Mountain University of Health Professions. To contact the author email him at jbrumitt72@hotmail.com.

▲

Every Day Nutrition VS Game Day Nutrition

Dawn Weatherwax-Fall, RD, CSSD, LD, ATC, CSCS

Many athletes, parents, and coaches ask what is best to eat before, during, and after competition. However, another very important question is "What food and beverages are needed every day to maximize performance and is there a difference between the two?" Some experts say that sports nutrition can enhance performance up to 15%. I can tell you from personal experience we get amazing results when the athlete puts every day nutrition, competition nutrition, and training all together.

Before

- Male, 16yo, 5'11, 195 lb
- Linebacker
- 12.8% body fat
- 3500kcal/day—Eating too much saturated and trans fats, not enough healthy fats/calories/protein/fluids and nutrient timing off on every day eating and game day for maximum performance

Goals

- Decrease 40 yd dash from 4.87 – 4.6 seconds
- Gain 20 lbs of lean mass
- Get a Football Scholarship

4 Month Follow-Up

- Body Fat 12.2%
- 5800kcals/day—Correct nutrient breakdown and timing for body type and activity
- Outcome
  - Gained 15lb Lean Mass
  - Decreased 40yd dash from 4.9 – 4.47 seconds

Whatever your goal, the following EVERY DAY nutritional guidelines are the basics for helping you get there.

1. Eat and drink within an hour after you wake up. Whether you get up at 6am or 11am, it is important to replace the water and carbohydrates you lost while you slept. Both these nutrients are important for energy, metabolism, and optimizing performance (1,5).
2. Get the right amount of calories and nutrients for your body type and sport. Usually an athlete that has a lower body fat burns more calories (energy) and utilizes more carbohydrates. I highly recommend you get your resting metabolic rate measured for accuracy. We have found the amount of calories you burn at rest varies greatly from one athlete to the next. This is important so you maximize recovery and your performance goals.
3. Eat enough protein to optimize repair, building, and maintenance of muscle tissue. The minimum amount of protein an athlete needs is 1.4g of protein per kg of body wt (3). Please spread this amount evenly throughout the day so the muscle always has protein at its disposal.
4. Watch the empty calories. In my office we call them "Freebies". Chips, candy, soda, sweets, fast food, fried food, sugary cereals and bars, high saturated fat items, and processed food are generally high in calories and/or fat, and low in nutrients. Most athletes consume 3-5 freebies a day, if not more. These types of calories do not assist in muscle building, recovery, immune system; wound healing and low body fat.

5. Proper hydration. Hydrating has been proven to aid in protein synthesis, fat burning, strength, speed, power, and fatigue resistance (2,4). A quick method to determine how much water you should be drinking is take half your weight and that is how many fluid ounces you should drink a day, not including workouts.
6. Eat within 30min after weight lifting or a hard workout. For maximum recovery of carbohydrate storage (muscle glycogen) and to promote muscle recovery and building, you should eat a minimum of 6-10g of protein and 30-60g of carbohydrates. It is highly suggested you work with a dietitian who has an emphasis in sports nutrition to get more exact numbers.

Game Day Nutrition

Game day nutrition has three significant changes.

1. Game day nutrition starts the day before. When it comes to sports nutrition, hydration and carbohydrates are the two most important factors that affect performance. Both have limited storage capacity and the body is constantly losing both throughout the day. It is very important that your body is full of both before you go to bed the night before. Think of it like a gas meter.
2. Eat enough calories. If you are an athlete who needs 4000kcals in a day, then you will need 4000kcals the day of the competition. However it does not help to get the majority after the event. The goal is to eat every two to four hours and to have two thirds of your calories before 4-5pm.
3. Fuel mixture is different. The day of the event you will get more of your calories from carbohydrates and liquids than proteins and fats. Proteins and fats have minimal needs especially before and during the event.

Bonus

Never try anything new the day of competition. You never know how your body is going to react. You worked to hard to take the risk.

Where do you begin?

Sports nutrition can impact performance if utilized correctly. The problem is very few people seek out a professional to calculate their individual needs. If you are serious about adding the nutrition component please seek assistance from a dietitian with an emphasis in sports nutrition.

References

1. Berning J. Nelson Steen S. (1998). *Nutrition for Sport & Exercise* 2nd Edition. Aspen Publishers: Gaithersburg, MD.

2. Burge CM, Carey MF, Payne WR. (1993). Rowing performance, fluid balance, and metabolic function following dehydration and rehydration. *Medicine & Science in Sports and Exercise*, 25 (12):1358 – 1364, 1993.

3. Campbell, B Kreider RB, Ziegenfuss T, La Bounty P, Roberts M, Burke D, Landis J, Lopez H, Antonio J. (2007). International Society of Sports Nutrition position stand: Protein and exercise. *Journal of the International Society of Sports Nutrition*, 4(1):8.

4. José González-Alonso J, Calbet JAL, Nielsen B. (1999). Metabolic and thermodynamic response to dehydration-induced reductions in muscle blood flow in exercising humans. *The Journal of Physiology*, 520(2):577 – 589.

5. Weatherwax D, Weiss S. The Complete *Idiot's Guide to Sports Nutrition*. Penguin Group: New York.

About the Author

Dawn Weatherwax-Fall is a Registered/Licensed Dietitian with a specialty in Sports Nutrition and Founder of Sports Nutrition 2Go. She is also an Athletic Trainer with a Certification in Strength and Conditioning from The National Strength and Conditioning Association. Therefore, she brings a comprehensive and unique understanding of the athlete's body, and its nutritional needs, to those interested in achieving specific performance goals and optimal health. Weatherwax-Fall is also the author of The Official Snack Guide for Beleaguered Sports Parents and The Complete Idiot's Guide to Sports Nutrition. She is an Official Speaker for the Gatorade Sports Science Institute and on the approval speaker list for the NCAA.

▲

Protein Update: How Much Protein is Enough?

Debra Wein, MS, RD, LDN, NSCA-CPT,*D

This is the first of a three-part series on research updates surrounding the macronutrients.

Athletes routinely focus on protein as the primary macronutrient that will help them to gain size, improve body composition, and promote optimal performance. Unfortunately, research to date has not shown protein to do all that. While the functions of protein remain clear (see table 1), the question of optimal intake remains controversial – if not still unknown.

The Dietary Reference Intakes (DRI) specifies that the requirement for dietary protein for all individuals aged 19 years and older is 0.8 g protein per kg. This Recommended Dietary Allowance is cited as adequate for all persons, yet this amount of protein would be considered by many athletes as the amount to be consumed in a single meal, particularly for strength-training athletes (6). In their defense, published data does suggest that individuals habitually performing resistance and or endurance exercise require more protein than people who are sedentary (6).

How Much Protein is Appropriate is Dependent on Many Factors

First off, the training and competition goals of the individual athlete (i.e. weight loss or muscle mass gain) will likely mean a different endpoint. For example, an endurance athlete, such as a marathoner, would likely focus on taking in enough protein to perform optimally, to maintain lean body mass, and to meet increased energy demands. On the other hand, a strength athlete, such as a weightlifter, might consider his protein requirement to be that which will increase muscle mass, strength, or power.

Secondly, the usual recommendations athletes hear from health professionals is to consume 1.2 – 1.8 g/kg body weight. These have been determined largely based on nitrogen balance studies (which is largely used to establish the RDA's as well) (6). According to researchers, this is not the only method available for evaluating protein needs, but in fact it may not be the best method to determine an athlete's needs. In addition to nitrogen balance studies, researchers have evaluated the question of optimal intake using another method involving tracer-derived estimations.

When researchers took into account both methods of analysis, they concluded that novices (those most likely to have an increased protein requirement) retain more protein from the exercise stimulus and therefore do not need any additional protein (due to a protein conserving mechanism). Furthermore, according to the research involving these orally consumed tracers, which estimate protein turnover, exercise seems to lower —not raise—protein requirements (6) for all athletes.

In addition to the amount of protein ingested, factors such as the composition of the protein and amino acids, timing of ingestion, and other nutrients ingested along with the protein all influence the utilization of ingested protein and amino acids. Thus, for any given protein intake, factors important to an athlete's performance may vary depending on what is ingested and when it is ingested (9).

The Right Balance

Protein supplements, although convenient, are not necessary for most resistance athletes (5,7,9). Landmark studies have clearly demonstrated that energy intake may be as, if not more, important than protein intake in determining nitrogen balance. What these early studies show is that even when no protein is consumed, increasing energy intake improves nitrogen balance. Conversely, even when consuming relatively high protein intakes, positive nitrogen balance is not possible until energy balance is positive. However, it is important to note that exercise seems to serve as a modifier and can actually increase nitrogen balance, even in the face of a low energy intake (7).

Too Much Protein

There is no evidence to suggest that protein supplements are more effective than consumption of high-quality protein from standard dietary sources (7). A suggested maximum protein intake based on bodily needs, weight control evidence, and avoiding protein toxicity is approximately 25% of energy requirements at approximately 2 to 2.5 g per kg, corresponding to 176g protein per day for an 80kg individual on a 12,000kJ/diet (2). This is well below the theoretical maximum safe intake range for an 80kg person (285 g/d) (2). See Table 2 for potential risks of excessive protein consumption.

Any such diet with an elevated protein intake should also contain a wide range of whole grain cereals, fresh vegetables, and fruits, rich in micronutrients and potassium alkali salts. These are needed to reduce the potential renal acid load and subsequent urinary calcium loss that can occur due to the acidic nature of protein-rich diets (2).

Table 1. Functions of protein (1,3)

- Supporting Growth and Maintenance
- Building enzymes, hormones, and other compounds
- Building antibodies
- Maintaining fluid and electrolyte balance
- Maintaining acid-base balance
- Clotting of blood
- Providing energy and glucose

Functions specific to athletes

- Repair exercise induced microdamage to muscle fibers
- Serve as an energy source during exercise
- Support gains in lean tissue mass

Table 2. Potential consequences of excessive protein (2)

(defined as when protein constitutes > 35% of total energy intake)

- hyperaminoacidema,
- hyperammonemia,
- hyperinsulinemia,
- nausea,
- diarrhea,
- and even death

Bottom line: What is the right amount?

To date, the best guide is still the joint position statement from the ACSM and the Dietitians of Canada. This position statement suggests 12% to 15% of energy from protein or 1.2 to 1.4g/kg for endurance athletes and 1.4 – 1.8 g/kg for strength athletes (1) as illustrated in various research studies (4).

What research currently points to is this: given sufficient intake, lean body mass (and optimal performance) can be maintained within a wide range of protein intakes (9). Remember that 35% of calories (or too much protein) could result in the displacement of dietary carbohydrates (well below the 6 – 10 grams per kg recommended), which could result in suboptimal athletic performance (6). First determine regular intake and then compare with individual requirements before adding additional protein from food (see table 3) or supplements.

References

1. American Dietetic Association. (2000). Position of the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. *Journal of the American Dietetic Association*, 100 (12):1543 – 1556.

2. Bilsborough S. Mann N. (2006). A review of issues of dietary protein intake in humans. *International Journal of Sport Nutrition and Exercise Metabolism*. 16:129 – 152.

3. Dunford M. (2006). *Sports Nutrition: A Practical Manual for Professionals* (4th ed.). Chicago: American Dietetic Association.

4. Lemon PWR. (1998). Effects of exercise on dietary protein requirements. *International Journal of Sport Nutrition*, 8:426 – 447.

5. Millward DJ, Botwell JL, Pacy, P, Rennie MJ, (1994). Physical activity, protein metabolism and protein requirements. *The Proceedings of the Nutrition Society*, 53:223.

6. Phillips S. (2006). Dietary protein for athletes: from requirements to metabolic advantage. *Applied Physiology, Nutrition and Metabolism*, 31: 647 – 654.

7. Phillips S. (2004). Protein requirements and supplementation in strength sports. *Nutrition*, 20, 7 – 8:689 – 695.

8. Smolin LA, Grover MB. (2007). *Nutrition: Science and Applications, Nutrient Composition of Foods Booklet.* Hoboken, NJ: John Wiley and Sons Lts.

9. Tipton K, Wolfe, R. (2004). Protein and amino acids for Athletes. *Journal of Sports Sciences*, 22:65 – 79.

Table 3. Protein content of selected foods (8)

Food	Protein (grams)
½ cup black beans	8
1 cup skim milk	8
1 ounce cheese	7
3 ounces chicken	26
3 ounces fish	12
1 slice bread	5
1 egg	6
2 Tbsp hummus	6
2Tbsp peanut butter	8
¼ cup almonds	8
½ cup whole wheat pasta	4
½ cup broccoli	1.5

About the Author

Debra Wein, MS, RD, LDN, CSSD, NSCA-CPT is a faculty member at the University of Massachusetts Boston and adjunct lecturer at Simmons College. Debra is the President and Co-founder of Sensible Nutrition, Inc. (www.sensiblenutrition.com), a consulting firm established in 1994 that provides nutrition services to athletes, individuals, universities, corporate wellness programs and nonprofit groups. Debra is one of only 60 RDs across the country Certified as a Specialist in Sports Dietetics (CSSD) through The American Dietetic Association. Her reproducible sport nutrition handouts and free weekly email newsletter are available online at www.sensiblenutrition.com.

The Glycemic Index and Recovery

Thomas W. Nesser, PhD, CSCS

The weight loss industry has classified carbohydrates as "good carbs" and "bad carbs". However, when it comes to athletic performance, there are no "bad carbs". All carbohydrates are equally important; the trick is understanding when one carbohydrate is better than another in relation to training.

Even though carbohydrates are the body's primary energy source, they are not the body's only source of energy. The body can also use fats and proteins for energy, though neither are as efficient as carbohydrates. Fats are a rich energy source, however it takes the body more time to breakdown fats to be used as an energy. In addition, the conversion of fat into energy requires a great amount of oxygen. Therefore fats are predominantly used during aerobic (endurance) exercise. While proteins can be used as an energy source, they are not the preferred source because it takes a lot of time for the body to break them down into a useable form. Besides, the protein used as an energy source comes from muscle breakdown. As an athlete, the breakdown of muscle mass is not desired.

When carbohydrates are consumed they are broken down to glucose and released into the blood stream. Carbohydrate sources include grains, fruits, vegetables, and sugar. Glycemic index (GI) is a measure of the rate at which specific carbohydrates are broken down to glucose and released into the blood stream. The ranking used is relative to pure glucose which has a ranking of 100. Carbohydrates with a high GI (e.g. corn flakes = GI value of 80) are rapidly broken down and released into the blood while those with a low GI (e.g. kidney beans = GI value of 29) are slower to break down and released into the blood. See table 1 for a list of carbohydrates and their glycemic score.

As blood sugar (glucose) levels increase, the pancreas releases insulin to move the glucose from the blood into the tissue where it is used as energy or stored as glycogen. It is important to note insulin also inhibits fat metabolism and protein breakdown. Foods with a high glycemic index are often accompanied by a spike of insulin. The excessive insulin pulls too much glucose from the blood causing fatigue, hunger, and usually additional sugar cravings. This cycle continues throughout the day impeding the use of fats as a fuel and ultimately leading to weight gain. This does not mean all high GI carbohydrates are bad and should be avoided.

High glycemic index foods are very beneficial when consumed prior to, during, and following exercise. During exercise, glycogen is broken down into glucose and released into the blood where it is carried to the working muscles to be used as energy. When an athlete eats a high GI food prior to or during exercise, the absorbed glucose is used as an immediate energy source to fuel the working muscles. Another benefit of consuming carbohydrates during exercise is to spare the use of stored carbohydrate (glycogen), allowing an individual to exercise longer without the risk of depleting glycogen stores.

Following exercise, high glycemic carbohydrates are recommended for quickly replenishing glycogen stores. Upon cessation of exercise there is a 45 minute window in which the body's capacity to replenish glycogen stores is greatest (2). After this optimal window, replenishing glycogen stores will take longer and may not be entirely complete by the next exercise bout which could hinder performance. Not having glycogen stores at full capacity could hinder performance during subsequent training or competition.

Strength and power athletes can also benefit from high glycemic carbohydrates. As previously mentioned insulin moves glucose from the blood to the tissue, inhibits the breakdown of fats to be used as a fuel source, and most importantly, blocks the degradation of proteins (muscle). This is beneficial to the resistance trained athlete by limiting muscle damage during exercise leading to improved recovery following training (1).

Even greater benefit is observed in both the endurance and the strength athlete when protein is added to the carbohydrate in a 3:1 - 4:1 carbohydrate/protein ratio (20 – 24 g carbohydrate to 5 – 6 g protein). It appears the consumption of protein with carbohydrate further reduces muscle damage during training leading to faster recovery following training, and further enhances glycogen replacement following exercise (1,4).

For maximum benefit, it is advised to begin consuming carbohydrate 10 minutes prior to the start of exercise and throughout the exercise session. Endurance athletes should consume a carbohydrate/protein supplement in a 4:1 ratio within the 45 minute window following exercise. Resistance trained athletes should consume 40 g of carbohydrates with 15 g of protein within the same 45 minute window (2). Of the protein supplements available, whey protein is recommended since it empties from the stomach faster than other protein supplements.

Table 1. Glycemic index of Common Foods

Food	GI Rank
Peanuts	13
Kidney beans	29
Apple	39
Orange	40
Whole wheat pasta	42
Sweet potatoes	48
Peas	51
Corn	59
Banana	62
Raisins	64
Brown rice	66
White bread	69
White rice	72
Corn flakes	80
Honey	87
Carrots	92

Note: Differences exist in GI ranking due to the exact type of food tested.[3]

When consuming a carbohydrate supplement prior to and during exercise, it is important that the carbohydrate is both high glycemic and a liquid, such as a sports drink. However, sports drinks made with the sugar fructose should be avoided since fructose is slower to move from the stomach. Most sports drinks will provide the carbohydrates necessary for the desired insulin response, though only a few drinks are commercially available that provide both the carbohydrate and protein necessary for glycogen replacement and muscle recovery. Of course you can get carbohydrates and proteins from solid foods, but solids may not be practical and they take a lot of time to pass from the stomach, which could lead to gastrointestinal distress during exercise.

Continual carbohydrate and protein consumption is vital beyond the initial 45-minute post exercise period so the body has the proper nutrients to continue to repair and recover from training. High glycemic carbohydrates can still be consumed up to four hours following exercise, though it should be combined with a quality lean protein source. At this point a meal may be more beneficial at meeting the nutritional needs rather than supplement bars and drinks. For the remainder of the day any carbohydrates consumed should be low glycemic to maintain a constant and controlled rate of insulin release. An insulin spike is no longer desirable and should be avoided.

Keep in mind the glycemic index is not a rating of nutritional value. Some foods can be high glycemic and low in calories, (e.g. beets) while some foods are low glycemic but high in calories (e.g. peanut M&M's). Choose wisely.

References

1. Baty JJ, Hwang H, Ding Z, Bernard JR, Wang B, Kwon B, Ivy JL.(2007). The effect of a carbohydrate and protein supplement on resistance exercise performance, hormonal response, and muscle damage. *Journal of Strength and Conditioning Research*, 21(2):321 – 329.

2. Ivy J, Portman R. (2004). *Nutrient Timing: The Future of Sports Nutrition*. Basic Health. North Bergen, NJ.

3. McArdle WD, Katch FI, Katch VL. (1999). *Sports & Exercise Nutrition*. Lippincott, Williams & Wilkins. Baltimore, MD.

4. Saunders MJ, Luden ND, Herrick JE. (2007). Consumption of an oral carbohydrate-protein gel improves cycling endurance and prevents postexercise muscle damage. *Journal of Strength and Conditioning Research*, 21(3):678 – 684.

About the Author

Dr. Thomas W. Nesser is an assistant professor in the Department of Physical Education at Indiana State University where he develops and teaches advanced courses in strength and conditioning. He has been a member of the National Strength and Conditioning Association (NSCA) for the past 17 years and has been a certified strength and conditioning specialist (CSCS) for 14 years. Dr. Nesser is the NSCA state director for Indiana and serves on the NSCA Education Committee. Dr. Nesser is also a certified health fitness instructor through the American College of Sports Medicine (ACSM). He holds a master's degree in exercise science from the University of Nebraska at Omaha and a PhD in Kinesiology from the University of Minnesota. Dr. Nesser's research interests include the effects of training and the factors related to athletic performance.

▲

Expect Something Different

Suzie Tuffey Riewald, PhD, NSCA-CPT,*D

Think about the way you approach your training, do you follow the same strength and conditioning program you have always done or maintain a similar diet? If your training and preparation stays the same, more likely than not, you will find your performances are going to be the same.

Why try to achieve different or better results but continue to do all the same things? Athletes often scratch their heads in frustration wondering why performance did not improve or why similar problems occurred but yet they did not do anything different to achieve different results. An athlete recently spoke to me as he was frustrated about not achieving a specific score in a time trial after multiple opportunities during the preseason. He said he got so anxious that he did not sleep well the night before and was tight and tired prior to the time trial. Yet, when asked what he was doing to address this challenge, he had no answer. He was attacking the time trail the same way each opportunity. He did not change anything, be it using relaxation strategies, warming up longer, or altering his mental approach.

In working with elite athletes and their coaches it is interesting to see how they approach practice and competition. They do several things that differ from most athletes. First, they often anticipate that their competitors are training just as hard as they are and hard work alone will not suffice. At the next Olympic games, athletes will be stronger and more powerful than they are today. It is also likely that many current world records will fall by the wayside. Elite athletes anticipate the future and use this knowledge to prepare themselves for upcoming challenges. Secondly, they realize that while their old way of training has taken them this far, in many instances, it will take doing something different to reach a new level in performance. Let us use strength training as an example. Someone new to strength and conditioning will spend a period of time to develop a foundation of strength throughout the body. In doing this, strength and athletic performance will likely improve, but only to a point. To achieve subsequent gains it is necessary to do something new, possibly adding a power development component to the training sessions, or periodizing the strength and conditioning program. Without change, performance stagnation can result.

So, the question becomes, do you want the same or do you want better? If you are not comfortable where you are, it is insane to approach your training and preparation in the same ways. My guess is that like most athletes, you are probably looking to enhance your performance. You need to do something different to expect different (improved) results.

Look at the Big Picture

Each year it is important to assess yourself on the factors that affect athletic performance. Evaluate yourself on factors and skills that affect performance, think beyond physical. Physical factors / skills are often the most obvious in terms of their impact on performance but there are also a multitude of other skills that directly and indirectly impact your training and performance. In addition to physical skills, assess mental skills, technical skills, nutritional habits, and other lifestyle factors. In areas where you note a weakness begin to make changes to better develop the skill and enhance performance.

Practice and Competition Evaluation

In addition to evaluation, it is beneficial to assess or evaluate practice performance and competition performance to determine what you can do different (better). For example, in reflecting on the past several weeks of training, you may note that you seem to struggle in your morning workouts. Do you need to get more sleep? Do you need to eat better the night before a match or a race? Would it help to get up earlier to allow more time to wake up and warm up before you train? Try something different to help performance.

Similarly, after every competition, it should become standard practice to assess performance. Athletes often just look at the outcome and determine whether or not they achieved their goal. Do not stop there. Evaluate yourself on the multitude of factors that affect your performance. Determine what you can try to do different or better to positively impact the outcome.

About the Author

Suzie Tuffey Riewald received her degrees in Sport Psychology/Exercise Science from the University of North Carolina—Greensboro. She has worked for USA Swimming as the Sport Psychology and Sport Science Director, and most recently as the Associate Director of Coaching with the USOC where she worked with various sport national governing bodies (NGBs) to develop and enhance coaching education and training. Suzie currently works as a sport psychology consultant to several NGBs.

▲