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ROUNDTABLE

METHODS OF WEIGHT GAIN IN ATHLETES

Participants:

Gail Butterfield, Ph.D.
Geriatric Research, Education, and Clinical Center
VA Medical Center
Palo Alto, California

Susan Kleiner, Ph.D., R.D.
High Performance Nutrition
Mercer Island, Washington

Peter Lemon, Ph.D.
Kent State University
Schools of Biomedical Sciences and Exercise, Leisure, and Sport
Kent, Ohio

Michael Stone, Ph.D., C.S.C.S.
Appalachian State University
School of Health, Leisure, and Exercise Science
Boone, North Carolina

Introduction

Gaining body weight is one of the last things that most non-athletic people want to do. For many athletes, however, gaining weight can provide a competitive advantage for sports in which speed, power, leverage, and mass are necessary attributes. Of course, most athletes would prefer that the majority of the weight that they gain be in the form of lean body tissue rather than as fat, which does little to promote the enhancement of power and strength.

The Gatorade Sports Science Institute discussed the issue of healthy weight gain with a panel of experts in the areas of nutrition, exercise training, and health. Their answers to our questions follow.

How much lean body mass can a person reasonably expect to gain in one year?

Lemon: This is an extremely difficult question to answer because it depends on a variety of factors including, but not limited to, prior heavy-resistance-training experience, genetic predisposition, body mass, gender, diet, training program used, motivation, and the use of anabolic agents (drugs). If one examines a group of individuals in whom most of these factors are maximized (except the drug use), e.g., 18-25-year-old male body builders or football players, it is possible to observe body mass increases of approximately 20% during the first year of regular heavy resistance training. Moreover, unless energy intake greatly exceeds expenditure, the majority of this weight gain will be lean mass. This is certainly impressive; however, it is important to re-emphasize that individual responses are quite variable. Finally, initial gains greatly exceed subsequent gains, probably because one tends to approach his or her genetic potential relatively early in the training program. After a few years of systematic training, gains may be only 1-3% per year.

Stone: In untrained young men, initiation of a weight training program can produce initial increases in lean body mass of approximately three pounds per month. This figure is reduced considerably after three months unless energy intake is substantially increased. High-intensity training (including weight training) coupled with increased energy and protein intake can produce gains of greater than 20 pounds of body mass per year, with as much as 18 pounds being lean body mass. This is a common scenario among freshman football linemen over a one-year period. In women, smaller gains (50-75% those seen in men) occur due, in part, to a smaller initial body mass and lean body mass.

As Dr. Lemon suggested, gains in well-trained athletes are much slower. In our work with elite weight lifters and throwers over the past 17 years, we have observed that increasing body mass is very difficult, if not impossible, without substantially increasing dietary energy. Coaches in other sports have reported similar findings.

Butterfield: In well-controlled studies there appears to be a maximum rate--2-3 gm/d--at which nitrogen can be incorporated into protein. At this rate of nitrogen accumulation, an estimated 18.75 g of protein or 93.75 g of lean tissue (protein constitutes about 20% of lean tissue) could theoretically be added to the body mass every day, resulting in a gain of 75.37 lb. of lean tissue in a year. However, for reasons we do not entirely understand, this maximal rate of tissue accretion cannot be sustained, and actual lean-mass gains are in line with those mentioned by Drs. Lemon and Stone. Also, because the relative stimulus of a program of weight training and increased dietary energy is greater in the early stages of the program than during later phases, larger gains in lean mass will occur at the initiation of a weight-gain program.

What is the single most-important nutritional factor affecting muscle gain?

Kleiner: Total dietary energy, specifically carbohydrate energy. Building muscle requires a rigorous strength-training program. It takes tremendous energy to fuel this type of exercise. A high-carbohydrate diet allows for the greatest recovery of muscle glycogen stores on a daily basis, enabling the muscle to work equally hard on successive days. Furthermore, studies done with strength-trained athletes such as wrestlers have shown that subjects who consume a hypoenergetic, high-carbohydrate diet are better able to maintain exercise performance than athletes consuming a hypoenergetic, moderate-carbohydrate diet.

Butterfield: Many people assume that protein is the most-important nutrient for the accrual of muscle mass. However, we often lose sight of the early data on protein utilization which suggested that the best way to accumulate protein was to simply increase energy intake. For any given protein intake, increasing total energy intake will improve nitrogen retention. When exercise is performed, the improvement in nitrogen retention accomplished by increasing energy intake may be magnified. Conversely, if energy is not supplied in adequate amounts, the protein consumed will be used as an energy source, and not as a means of increasing muscle mass.

Lemon: Adequate intakes of both protein and total energy are critical for the promotion of muscle mass gains. Moreover, energy and protein intake interact such that protein needs are greater when energy intake is reduced. In recent years, suggestions have been made that a variety of other foods or food components may have significant anabolic effects. The use of products such as creatine, free-form amino acids, vanadium, etc., are common among power athletes. Although there is usually some truth underlying the proposed mechanisms of action of the majority of these products, most have not been evaluated scientifically. Many of these products are costly, and some can have adverse effects on one's health. I recommend that anybody considering the use of a food supplement should obtain sufficient information about the potential dangers of the product before it is consumed.

How much protein is required for strength training alone or cross training -combining strength training with endurance exercise?

Stone: Although several studies suggest that consuming more dietary protein than the RDA value of 0.8 gm per kg body weight per day has little or no effect on lean body mass accretion or performance, there are data indicating that strength/power athletes engaged in heavy training require about 1.76 gm/kg-1/d-1, and that endurance athletes need about 1.5 gm/kg-1/d-1. Therefore, it appears that both strength and endurance-type athletes require protein above RDA levels. Regardless, several investigations have indicated that many athletes (particularly male weight lifters and throwers) consistently ingest 2.0-2.5 gm/kg-1 /d-1 in their normal diets without any protein supplements. Thus, protein requirements for these athletes may be a moot point. They seem to be ingesting protein in excess of any recommended daily value that can be derived from the majority of the literature.

Kleiner: My experiences with strength training and body building athletes indicate that excellent gains in strength and muscle mass can be achieved with protein intakes of 1.4-1.8 gm/kg-1/d-1, and infrequently up to 2.0 gm/kg-1/d-1. Very aggressive cross trainers generally do well with a similar intake of protein.

Lemon: Recent data from several laboratories suggest that the recommended protein intake for adult strength-training athletes should be approximately 1.4-1.8 gm/kg-1/d-1, and for endurance athletes approximately 1.2-1.4 gm/kg-1/d-1 . These intakes exceed the current RDA for sedentary individuals by 75-125% and 50-75% for strength and endurance athletes, respectively. We have not specifically studied cross trainers but my guess is that protein intake for this group would be adequate if they followed the strength-athlete recom-

mendations.

If individuals who have higher protein needs because they are growing, e.g., children, adolescents, and/or women who are pregnant, or those whose diets may be inadequate, e.g., dieters, vegetarians, and/or the elderly, begin a regular exercise program, an even greater intake of protein may be necessary. In addition to supporting muscle growth with strength training and providing a supplemental energy source for endurance exercisers, protein in excess of RDA levels could facilitate muscle growth/repair by altering the hormonal profile in the direction of anabolism. Although it is not routinely addressed, there may be other components of protein foods that benefit those with an active lifestyle. Further study is needed to clarify the role of the various factors associated with exercise that affect protein need.

Butterfield: Contrary to some of the studies cited by the other respondents, I have seen convincing evidence indicating that protein requirements for endurance athletes are somewhat higher than those of strength athletes. Work done by Carol Meredith suggests that the requirement for endurance athletes for maintenance of lean tissue is about 0.94 gm/kg-'/d-'. If this value is converted to a recommendation in the manner of the Food and Nutrition Board, the recommendation would be approximately 1.2 grn/kg-1/d-1. According to Meredith, elite body builders have a requirement of 0.6 gm/kg-1/-1 or a recommendation of about 1.0 gm/kg-1/d-1. Of course, the question of protein requirements for strength training athletes is confounded by the issue of whether or not the individual is trying to maintain or increase lean tissue. As is the case during the early stages of a strength-training program, protein needs are somewhat higher when lean tissue is increasing.

What is the most effective training pattern for muscle and strength gain?

Stone: This is a complex issue that is not easily addressed in a simple manner. However, based on the literature the following appears likely: a) Appropriate resistance training can result in an increase in lean body mass and muscle hypertrophy, as well as in strength/power gains; b) Gains in muscle hypertrophy appear to be best accomplished by multiple sets and higher repetitions per set (8-12); c) Gains in strength/power are better accomplished by using multiple sets with fewer repetitions per set (4-6). However, some research indicates that a "periodized" approach produces superior gains in strength/power. Briefly, this approach entails moving from higher repetitions to lower repetitions over a period of several months, with appropriate changes in exercise selection during this period; d) The number of training days depends upon several factors, including one's goals, and one's present training state. There is little doubt that more than three days of exercise per week are necessary to maximize the training effect, and multiple daily training sessions may also be appropriate periodically; e) Endurance training does not create a physiological environment compatible with gaining lean body mass or strength and power; f) Combined aerobic and resistance training can increase endurance, lean body mass, and strength/power. However, if maximizing gains in lean body mass, strength, and especially power, are goals, then aerobic training should be markedly reduced if not eliminated.

Lemon: Sometimes it seems that there are almost as many training programs as there are individuals engaged in strength training. However, if one evaluates a variety of programs, it becomes clear that a great many are very successful in terms of inducing significant gains in muscle size and strength. This suggests that most successful programs include the critical factors that Dr. Stone alluded to, e.g., overload, intensity, progression, and recovery between training sessions. In other words, I don't believe that there is one "most effective" training program.

I do believe that adequate recovery is critical to effective training. Based on recent data, we know that muscle protein synthesis follows a biphasic pattern. It decreases during and immediately following a strength training session, and it increases to a peak at about 24 hours after exercise. These observations clearly indicate that recovery between sessions must be greater than 24 hours to maximize gains. Future work will undoubtedly fine tune our understanding of the time course of these events. However, it is exciting to speculate that some nutritional manipulation during this period of time might make it possible to further enhance muscle growth.

Are there any dietary supplements that can effectively enhance lean muscle mass in athletes?

Butterfield: There are many potions that have been touted as alternatives to anabolic steroids. Protein is often considered the key anabolic nutrient, but as was discussed earlier it is probably the energy contribution of supplemental doses of protein that actually accounts for its apparent ability to stimulate lean muscle growth. There is no evidence to suggest that protein in and of itself can push the synthetic process beyond that which would normally occur.

Chromium picolinate has received a lot of attention recently. Research conducted a few years ago at Bemidji State University in Minnesota suggested that chromium supplementation might increase lean tissue and decrease fat tissue in active people who maintained body weight. However, more recent studies have refuted many of these claims. Presently, there does not appear to be a substitute for hard work and adequate nutrition.

Lemon: Unfortunately, there does not appear to be a safe, effective nutritional alternative to products like anabolic steroids, which clearly can increase muscle strength and size in some individuals. I am hopeful that a food component or combination of food components will ultimately be discovered. To date, none exists.

Stone: We have studied the efficacy of nutritional substitutes, including aspartate, chromium, carnitine, and gamma oryzanol. None of these products produced an ergogenic effect. Other laboratories have investigated claims for products such as boron and individual amino acids, but very little promising data exist. One substance that has shown promise in strength/power athletes has been creatine; additional research demonstrating consistent effects in well-trained athletes is necessary, but some of the data have been impressive.

Kleiner: I don't have too much to add that has not been said already. I don't believe in steroids; they are unsafe and illegal. The short-and long-term physical and competitive risks associated with steroid usage far outweigh the benefits. However, there are no magic nutrients that can enhance muscle and strength gains. By following the recommendations outlined by the panelists in this roundtable discussion, one can definitely achieve substantial gains in strength and muscle mass. There are obviously no easy ways to gain lean tissue via dietary means alone.

Selected Readings:

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The Sports Science Exchange Roundtable is moderated by Mitchell M. Kanter, Ph.D., Senior Research Scientist, Gatorade Exercise Physiology Laboratory & Director, Gatorade Sports Science Institute

The Gatorade Sports Science Institute® was created to provide current information on developments in exercise science, sports nutrition, and sports medicine and to support the advancement of sports science research.