Nutrition and Exercise for Natural Physique Athletes: A Review of The Literature For Evidence-Based Strategies to Maximize Hypertrophy as Well as Reduce Body Fat For Contest Preparation

Abstract

Despite the growing popularity of bodybuilding and physique competitions, there is a lack of evidence regarding much of the "bro science-based" diet, supplement and exercise recommendations and strategies used to achieve body composition goals. This paper provides a summary of some of the scientific literature relevant to bodybuilding/physique competition preparation with respect to nutrition, exercise and supplement recommendations.

Nutrition strategies have focused on energy, macronutrients, micronutrients, nutrient timing and supplements:

1. Energy intake for body weight losses should be approximately 0.5 to 1%/wk in order to retain muscle
2. Macronutrient guidelines include:

Protein: 2.3-3.1 g/kg of lean body mass/ day
Fat: 15-30% of calories
Carbohydrate: The reminder of calories from carbohydrate

3. Micronutrient Recommendations: Consume a predominantly whole foods balanced diet (e.g. colorful fruits and vegetables, whole grains and lean meats).
4. Nutrient Timing Considerations: Eat three to six meals per day consisting of 0.4-0.5 g/kg body weight of protein before and after resistance training to potentially maximize the benefits of nutrient timing.
5. Supplements: Beta-alanine, bicarbonate, creatine monohydrate, caffeine, beetroot juice, fish oil and whey protein powder appear to have ergogenic effects relevant to physique athletes Exercise strategies used by physique athletes combine resistance and cardiovascular training in order to maximize

hypertrophic adaptations while at the same time reducing body fat.

Exercise strategies maximizing hypertrophy consider the principles of specificity, overload, adaptation and reversibility. The Principle of Specificity states that adaptations are specific to the stimuli provided. The Principle of Overload is that in order for a tissue to adapt to a demand, it must be progressively overloaded. The Principle of Adaptation is that the body will adapt physiologically to the demands we place on it. Lastly, the Principle of Reversibility is that any gains are progressively lost when training is stopped. Muscular hypertrophy is characterized by an increase in the cross-sectional diameter of muscle fibers that occurs as a response to those fibers being recruited to create increased levels of tension. It is a function of protein balance and consists of three mechanisms: muscle tension (motor unit recruitment), muscle damage (Inflammation), and metabolic stress. A hypertrophy training routine utilizes low to intermediate repetition ranges with progressive overload, e.g. 3-5 sets of 6-12 repetitions at 75-85% of the one repetition maximum with a rest period of 1-2 minutes.

In conclusion, evidence-based nutrition and exercise strategies for physique athletes combine specific diet, supplement and exercise manipulation to create physiological adaptations that result in hypertrophic adaptations and lower levels of body fat.

Keywords: Physique athletes, calories, macronutrients, micronutrients, nutrient timing, ergogenic supplement, exercise, hypertrophy

Introduction

The popularity of Physique and bodybuilding contests has increased over the past decade. Contest preparation involves increasing lean body mass (hypertrophy) concurrently with

drastic reductions in body fat. These adaptations are achieved by strength and cardiovascular training and through specific nutritional and supplement manipulation. Physique athletes follow numerous exercises, dietary and supplementation strategies to prepare for a contest. While some of these strategies are founded by science, many are based on "bro-science". The purpose of this article is to review the scientific literature with respect to exercise, nutrition and supplementation for physique competitors in order to make evidence-based recommendations that can maximize the desired adaptations.

Methods

PubMed and Google Scholar databases were searched online. Searches were performed using the keywords: Physique athletes, Energy, Calories, Macronutrients, Micronutrients, Nutrient Timing, Nutritional Supplements, Ergogenic aids, Exercise, Hypertrophy. Studies were screened to include healthy humans as well as populations commensurate with the intent of this paper. Due to the paucity of research, a date range was not specified, but studies less than ten years old were preferentially used. Lastly, author names and citation lists were used to expand the search for pertinent papers and related references. Given that this paper is intended as a review of evidence-based guidelines it was written in the style of a narrative review.

Nutrition

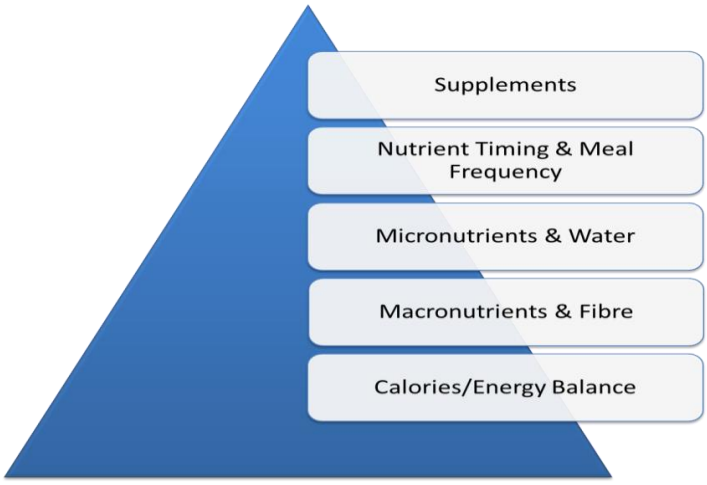
Nutrition for physique athletes should be prioritized as follows:

- Energy intake should be increased to fuel training and stimulate adaptations during the bulking phase and

decreased for two-four months prior to a competition, in order to achieve the desired leanness.

- Macronutrient combinations and considerations to fuel training and adaptations as well as maintaining lean body mass during calorie restriction
- Micronutrients, preferably through whole foods, to ensure normal metabolism, growth and physical well-being
- Nutrient timing/periodization
- Supplements

Figure 1



(Helms, E. R., et al., 2014)

Energy Considerations

During the bulking phase, an energy surplus is necessary as part of the stimulus for strength and hypertrophy adaptations. Conversely, creating an energy deficit is needed during the cutting phase. Time and size are key factors that need to be considered. For example, it is generally recognized that a pound of body fat yields 3500 Kcals and that by either creating a daily surplus or deficit of 500 Kcal, one will either gain or lose approximately one pound per week. While this static model

provides a guideline, one must also consider that dynamic physiological adaptations occur as athletes gain fat and lean body mass or lose fat and maintain lean body mass. During contest preparation, calories will need to be adjusted through the process as body mass decreases and metabolic adaptations occurs.

(Hall, K. D. 2008) (MacLean, P. S. et al.,2011) (Trexler, E. T. et al., 2014).

Since maintaining lean body mass is essential for physique athletes, a rate of 0.5 kg/body weight or approximately 0.5 to 1%/body weight wk over 2-4 months is advised in order to preserve lean body mass, support training performance and optimal anabolic hormones, such as testosterone. This gradual approach is important especially in later stages where the availability of adipose tissue declines and the likelihood of the loss of lean body mass increases.

(Garthe, I. et al., 2011) (Mero, A. A. et al., 2010)

Diets and Body Composition

Based on the current literature, the consensus is that while there is an abundance of diet types and eating styles, the long-term success of a diet depends upon compliance and suppression of mitigating factors such as adaptive thermogenesis. Ultimately, regardless of macronutrient composition, diets focused on fat loss are driven by a sustained caloric deficit. The higher the baseline body fat level, the more aggressively the caloric deficit needed. Slower rates of weight loss in leaner athletes is necessary to preserve lean body mass. The training status can also influence the nature of the gains of losses. Low-fat or low carbohydrate are similarly effective for improving body composition, however the consequences on training, i.e. glycogen levels, should be a

consideration when adopting a specific macronutrient calorie restricted diet.

Higher protein intakes (2.3–3.1 g/kg Fat Free Mass) may be required to maximize muscle retention in lean, resistance-trained athletes under hypocaloric conditions. Very high protein intakes (>3 g/kg) has demonstrated thermic, satiating, and lean mass-preserving effects of dietary protein, which might be amplified in resistance-training subjects.

(Aragon, A. A., et al., 2017)

Macronutrient Guidelines

There are three macronutrients: Proteins, carbohydrates and fats. These nutrients are both energy substrates and signaling molecules. As with other athletes, physique competitors need to play close attention to the three T's when dosing and periodizing these nutrients:

1. **Total**- Match caloric intake with training/activity requirements and goals.
2. **Type-** Focus on carbohydrates for energy, adequate protein for repair and healthy fats to minimize inflammation and support heart health.
3. **Timing**- Time your meals for optimum energy before training sessions and competitions and to refuel, repair. rehydrate and revitalize after

Protein

Adequate protein is important for muscle accretion and maintaining lean body mass during dieting for contest preparation. The consensus for optimal protein intake is between 1.2-2.4 g/kg. This dose appears to support training adaptations and meet the needs of concurrent resistance training and cardiovascular training while restricting energy intake. Some authors suggest that even higher intakes, 2.3-3.1 g/kg is more optimal when training in a hypocaloric state.

(Slater, G., & Phillips, S. M. 2011) (Hector, A. J., & Phillips, S. M., 2018) (Phillips, S. M., & Van Loon, L. J., 2011) (Helms, E. R. et al., 2014) (Bandegan, A., et al., 2017) (Helms, E. R., et al., 2014) (Morton, R. W., et al., 2018)

Carbohydrates

Carbohydrate dosing in sports is based on weight and intensity. According to the IOC, optimal dosing is as follows:

- Low-intensity or skill-based activities 3-5 g/kg BW/day
- Moderate exercise programme, ~ 1 hour/day 5-7 g/kg BW/day
- Endurance programme, moderate to high intensity, 1-3 hours/day 6-10 g/kg BW/day
- Strength-trained athletes 4-7 g/kg BW/day
- Extreme commitment, moderate to high intensity, > 4-5 hours/day 8-12 g/kg BW/day

(Potgieter, S., 2013)

Physique athletes need to balance consuming adequate carbohydrates to maintain the glycogen needed to train and achieve hypertrophy adaptations, while at the same time carefully periodizing carbohydrates as they enter into the contest preparation phase. In contest preparation, calorie restriction and carbohydrates reduction are balanced by higher protein intakes to maximize fat oxidation and preserve lean body mass. Ultimately, the optimum macronutrient combination will be determined by the individual.

(Phillips, S. M., & Van Loon, L. J. , 2011)

A decrease in key anabolic hormones: growth hormone, IGF-I, IGF binding protein-3, insulin and testosterone and an increase in the catabolic hormone cortisol can be affected by prolonged energy and carbohydrate restriction, that is commonly seen during contest preparation. Increasing carbohydrates during the final weeks of dieting may help mitigate the adverse metabolic and hormonal responses associated with reductions in lean body mass.

(Mäestu, J., et al.2010)

Fats

Typically, the focus on macronutrients in sports nutrition is on carbohydrates for fuel, protein for muscle building and repair and fat ingestion to make up the balance energetically.

The role of fat should not be downplayed, as dietary fat influences anabolic hormones and as such are important in maintaining lean body mass. Diets too low in fat and or too high in protein can impair the hormonal response to training

(Sallinen, J., et al., 2004)

It is recommended that fats comprise 15–30% of the bodybuilders' off-season and pre-contest diets.

(Lambert, C. P., et al., 2004) (Bird, S. 2010)

Macronutrient and energy recommendations summary

The total caloric intake should take into consideration the timeframe before the competition and current body composition of the athlete. As with other athletes, physiques athletes will benefit from a balanced macronutrient intake tailored to the demands of their sport and with consideration of individual responses. Table 1 summarizes an overview of the current recommendations.

Table 1 Summary of the dietary recommendations for bodybuilding contest preparation

Macronutrient	**Recommendation**
Protein (g/kg of Lean Body Mass)	2.3-3.1
Fat (% of total calories)	15-30

Carbohydrates (g/kg BW/day)	4-7
Weekly weight loss (% of body weight)	0.5-1%

Micronutrients

Micronutrients include vitamins and minerals. They are required in small quantities to ensure normal metabolism, growth and physical well-being. Adequate vitamin and mineral status is necessary for optimal metabolism, recovery, adaptation and performance. The combination of intense exercise and hypocaloric diets may increase the requirements for some nutrients, putting physique athletes at risk of inadequate micronutrient intake or nutritional deficiencies. Supplementation in the form of a multiple vitamin mineral, may be required as a 'safety net' against deficiency and screening, e.g. Nutrient assessment tools, a nutritional physical exam, and/or blood test, may be indicated in this population.

(Burke, L. M., & Read, R. S., 1993) (Larson-Meyer, D. E., et al., 2017)

In a Comparison of selected micronutrient intakes between flexible dieting and strict dieting bodybuilders, Participants completed a food frequency questionnaire. The analysis revealed that males consumed less than the RDA of vitamin A, vitamin D, vitamin E, potassium, and dietary fiber and females consumed less than the RDA for vitamin A, vitamin D, vitamin E, potassium, dietary fiber, and iron. Competitive bodybuilders should be advised to take their micronutrition into greater consideration.

(Ismaeel, A., 2017)

Nutrient Timing

Nutrient timing is the methodical planning and eating of whole foods, fortified foods and nutritional supplements. Strategically timing energy, macronutrients and nutritional supplements may enhance recovery and repair, augment muscle protein synthesis and improve energy and mood states following high-volume or intense exercise.

(Kerksick, C. M., et al., 2017)

To date, there is some disparity regarding the outcomes in acute and chronic studies, specifically regarding an anabolic response. What was once considered a "narrow window", is more likely a "garage door", (increased rates of muscle protein synthesis (MPS) that are sustained for ~48 h) with totals more of a consideration than temporal factors. Other factors affecting temporal responses include training status, gender, age and the type and dosage of nutrient(s).

(Aragon, A. A., & Schoenfeld, B. J., 2013) (Kerksick, C. M., et al., 2017)

Another consideration regarding nutrient timing is that consuming nutrients such as protein sources high in leucine and carbohydrates, for the insulin response, soon after a training session may take advantage of the increased sensitivity in muscles to nutrient availability and as such augment muscle protein synthesis and anabolism more readily. Immediate post-exercise amino acid provision is an effective nutrition-based strategy to enhance MPS above rates observed with exercise alone. Early post-exercise protein ingestion takes advantage of the exercise-mediated increases in rates of MPS which are greatest immediately after exercise (~100 – 150% above basal rates). The synergistic effects of exercise and feeding on MPS are likely greatest during this time-period.

(Churchward-Venne, T. A., et al, 2012)

Table 2 Continuum of nutrient timing and supplement timing importance.

Nutrient	**Minimal Importance**	**Variable Importance**	**Maximal Importance**
Carbohydrate	-Non-fasted, low-moderate intensity resistance training </= 1 hour.	-Training soon after overnight fast. -Exhaustive continuous training 1-2 hours.	-Multiple glycogen depleting training sessions in a day. - Training 2-3 hours.
Protein	-Timing in relation to aerobic training sessions.	-Timing in relation to resistance training in a fed state (after protein rich meal)	-Timing in relation to resistance training in a fasted state (>3 than hours postprandial)
Supplements	-Timing of creatine and beta-alanine for chronic muscular adaptations vs ergogenic effects		-Timing of ergogenic supplements such as CHO/Electrolyte drink, caffeine, bicarbonate etc

(Helms, E. R., et al., 2014)

Meal Frequency

Extreme lows or highs in meal frequency should be avoided as this type of eating pattern can adversely affect lean mass preservation and hunger control. Physique athletes should focus on sound training programs and properly targeted total daily macronutrients, while keeping meal frequency at moderate ranges (e.g., 3–6 meals per day containing a minimum of 20 g protein each).

(Helms, E. R., et al, 2014)

Nutritional supplements for physique athletes

Athletes typically choose supplements for:

1. Lean Body Mass
2. Strength & Power
3. Immune Health
4. Cardiovascular Performance Enhancement
5. Hydration
6. Injury Recovery and Repair

This review will focus on supplementation that augments lean body mass, strength, anaerobic training capacity and repair.

Beetroot juice

Beetroot juice contains high levels of inorganic nitrate (NO_3^-) and its intake has proved effective at increasing blood nitric oxide (NO) concentrations. NO promotes vasodilation and increased blood flow which enhances muscle contractile function. Ergogenic effects have been reported with supplementation on exercise efforts that have high oxidative energy metabolism demands.

A single dose of beetroot juice or over a few days may improve performance in intermittent, high-intensity efforts with short rest periods. These improvements are attributed to faster phosphocreatine resynthesis which could delay its depletion during repetitive exercise efforts. In addition, beetroot juice supplementation could improve muscle power output by promoting faster muscle shortening velocity, improving indicators of muscular fatigue, enhancing strength, improving endurance performance and reducing muscle damage after eccentric exercise.

(Domínguez, R., et al., 2018) (Clifford, T. et al., 2016)

Beta-alanine

Beta-alanine supplementation (4–6 g daily) significantly augments muscle carnosine concentrations, which act as an intracellular pH buffer. Daily supplementation for at least 2 to 4 weeks has been shown to improve exercise performance, during events lasting 1 to 4 min. Beta-alanine attenuates neuromuscular fatigue and may improve tactical performance. Creatine plus β-alanine supplementation has a synergistic effect on lean tissue accruement and body fat composition.

(Trexler, E. T., et al., 2015) (Hoffman, J., Ratamess, et al., 2006)

Caffeine

Caffeine is one of the most common pre-workout stimulants consumed by bodybuilders. A number of studies support the use of caffeine to

improve performance during endurance training, sprinting, and strength training at doses ranging from 3–6 mg/kg.

The proposed benefits of caffeine include increased secretion of catecholamines (epinephrine and norepinephrine), greater use of fats as an energy source and sparing of muscle glycogen and increased motor unit recruitment and firing rates.

(Hendrix, C. R., et al., 2010)

Collagen Peptides/Gelatin

Musculoskeletal injuries are the most common complaint in active populations, with more than 50% of all injuries in sports classified as sprains, strains, ruptures, or breaks of musculoskeletal tissues. Nutritional and/or exercise interventions that increase collagen synthesis and strengthen these tissues could have an important effect on injury rates. Adding 15g of gelatin to an intermittent exercise program improves collagen synthesis and could play a beneficial role in injury prevention and tissue repair.

(Baar, K., 2017) (Shaw, G., et al., 2016)

Creatine monohydrate

Creatine monohydrate (CM) is one of the most ergogenic and safe supplements legally available. Numerous studies have found significantly increased muscle size and strength when CM was used in conjunction with a strength training program.

Table 3 Potential ergogenic benefits of creatine supplementation

• Increased single and repetitive sprint performance

- Increased work performed during sets of maximal effort muscle contractions
- Increased muscle mass & strength adaptations during training
- Enhanced glycogen synthesis
- Increased anaerobic threshold
- Possible enhancement of aerobic capacity via greater shuttling of ATP from mitochondria
- Increased work capacity
- Enhanced recovery
- Greater training tolerance

(Kreider, R. B.,et al., 2017)

Fish Oil

Omega-3 PUFAs modulate molecular signaling that is responsible for growth and hypertrophy as well as muscle stem cell activity. Muscle stem cells (satellite cells) are primarily responsible for promoting the skeletal muscle repair process to potentially damaging stimuli, such as the mechanical stress from exercise.

(Tachtsis, B., et al., 2018)

Six weeks of fish oil supplementation has been shown to significantly increase lean mass and decrease fat mass. These changes were correlated with a reduction in salivary cortisol.

(Noreen, E. E., et al., 2010)

Fish oil doses vary depending on the goal of supplementation. For general health, 250mg of combined EPA and DHA is the minimum dose and can be obtained via fish intake. The American Heart Association recommends 1g daily. If the goal of supplementation is to reduce soreness, a 6g dose, spread over the course of a day, will be effective.

https://examine.com/supplements/fish-oil/

Table 4 Effects of Fish oil

Controlled Inflammatory Response • Pain • Tissue Remodeling • Repair and Recovery	**Multi-Organ System Support** • Cardio/Vasoprotective • Brain-Mood Support • Neuroprotective • Orthopedic
Anti-Catabolic • Proteolytic Modulation **Anabolic** • Maintain mTOR pathway	**Metabolic Wellness** • Insulin sensitivity • Body composition

(Smith-Ryan, A., & Antonio, J., 2013)

Sodium bicarbonate
Sodium bicarbonate (SB) can neutralize the acidity of lactic acid that is produced during intense exercise by increasing

intramuscular pH levels. Supplementation of SB prior to resistance training could enhance performance.

(Indorato, D., 2016)

Tart cherry juice

Consumption of tart cherry juice can increase subsequent resistance exercise performance by reducing inflammation and oxidative stress that cause secondary muscle damage following resistance exercise.

Short-term supplementation of Montmorency powdered tart cherries surrounding a single bout of resistance exercise, appears to be an effective dietary supplement to attenuate muscle soreness, strength decrement during recovery, and markers of muscle catabolism in resistance trained individuals.

(Levers, K., et al., 2015) (Levers, K., et al., 2015)

Whey protein powder (BCAA)

Whey protein is a high-quality protein given its amino acid content, specifically the BCAA- Leucine) and rapid digestibility. Consumption of whey protein has a powerful ability to stimulate muscle protein synthesis as well as regulate muscle mass and body composition in response to resistance training. In addition, whey protein can helpful in the maintenance of lean body mass during hypocaloric dieting.

(Devries, M. C., & Phillips, S. M., 2015)

In younger adults, muscle protein synthesis rates after resistance-type exercise respond in a dose-dependent manner to ingested protein and are maximally stimulated following ingestion of ~20 g of protein, whereas older adults appear to respond to the ingestion of greater around ~40 g.

(Churchward-Venne, T. A., et al., 2016)

Table 5 Summary of common supplements used by physique athletes.

Supplement	Mechanism	Protocol/Dose*	Purpose
Beetroot Juice (Nitrate)	Enhances nitric oxide (NO) bioavailability via the NO3. Enhanced function of type II muscle fibres; a reduced ATP cost of muscle force production; an increased efficiency of mitochondrial respiration; an increased blood flow to the muscle; and a decrease in blood flow to VO2.	Acute performance benefits within 2–3 hours following an NO3 bolus of 5–9 mmol (310–560 mg). Prolonged periods of NO3 intake (>3 days) also appear beneficial to performance. About 500 ml of beet juice as a general guideline.	Cardiovascular Performance Enhancement.
Beta-Alanine	Intracellular buffering capacity, through increased carnosine, having potential beneficial effects on sustained high-intensity exercise performance.	Daily consumption of ~65mg/kg BM, ingested via a split-dose regimen (ie, 0.8–1.6 g every 3–4 hours) over an extended supplement time frame of	Cardiovascular Performance Enhancement.

		10–12 weeks.	
Sodium Bicarbonate	Extracellular buffer regulating pH	Single acute dose of 0.2-0.4 g/kg BW 60-150 minutes prior to exercise. Consider smaller dosing per GI tolerance. Or Serial loading with 3-4 smaller doses per day for 2-3 consecutive days prior to the event.	Cardiovascular Performance Enhancement. Strength & Power.
Caffeine	Adenosine receptor antagonist; Increased endorphins; Improved neuromuscular function; Improved vigilance and alertness; Reduced perceived perception of exertion during exercise.	3-6 mg/Kg BW of anhydrous caffeine about 60 minutes prior to exercise. Can also consume about 200 mg before and during exercise with some CHO.	Strength & Power. Cardiovascular Performance Enhancement.
Creatine Monohydrate	Increased creatine stores, aug,enting PCr resynthesis, thereby enhancing short-term high intensity exercise and the ability to perform repeated bouts of high intensity exercise effort. Has also led to increases in lean body mass, strength and power.	Loading: 20 g/day divided into 4 equal doses 4x/day for 5-7 days. Maintenance: 3-5g/day for the duration of supplementation.	Cardiovascular Performance Enhancement. Strength & Power.

Collagen Peptides	Increased circulating glycine, proline, hydroxyproline, and hydroxylysine promoting collagen synthesis.	15 g gelatin 1 h before exercise	Injury Recovery and Repair.
Fish Oil	Anti Inflammatory; Anabolic; Anti-catabolic; Insulin Sensitivity.	250 mg-6g depending on goals.	Lean Body Mass. Injury Recovery and Repair. Strength & Power.
Tart Cherry Juice	Anti-inflammatory; Reduces oxidative stress.	12 ounces of a tart cherry juice blend twice per day.	Injury Recovery and Repair. Strength & Power.
Whey Protein Powder (BCAA)	Increases muscle mTOR activation	20-40 depending on age	Lean Body Mass. Strength & Power.

(Kreider, R. B.,et al., 2017) (Maughan, R. J., et al., 2018)

*Dosing and results can be influenced by training status, acute/chronic ingestion for some athletes/supplements and variable individual responses.

Supplement timing considerations

Consumption of supplements are usually suggested into 5 specific times:

1. **Pre-exercise**: nitrate, caffeine, sodium bicarbonate, carbohydrate and protein.
2. **During exercise**: carbohydrate.
3. **Post-exercise**: creatine, carbohydrate, protein.
4. **Mealtime**: β-alanine, creatine, sodium bicarbonate, nitrate, carbohydrate and protein
5. **Before sleep**: protein

The recommended dosing protocol for the supplements nitrate and β-alanine are fixed amounts irrespective of body weight. Dosing protocol for sodium bicarbonate, caffeine and creatine supplements are related to corrected body weight (mg/kg bw).

Intake duration is suggested for creatine and β-alanine, being effective in chronic daily time < 2 weeks, while caffeine, sodium bicarbonate are effective in acute daily time (1-3 hours). Ingestion of nitrate supplement is required in both chronic daily time < 28 days and acute daily time (2- 2.5 h) prior exercise.

Supplement Timing Summary

Beta-alanine: 3-6 g along with each meal containing carbohydrate and protein plus a dose of 1.2 g as a maintenance dose following acute β-alanine supplementation.

Sodium Bicarbonate: 300-500 mg/Kg bw, 60-180 min prior to exercise, 1-3 days.

Caffeine: 3-6 mg/(kg bw), 30- 60 min prior to exercise.

Creatine monohydrate: Daily intakes of 3-5 g, or for optimal absorption, 20 g divided into 4 daily intakes of 5 g in combination with carbohydrate and protein

Nitrate-rich beetroot juice: 140 ml (8.4 mmol) containing nitrate, 2-3 h prior to middle distance and endurance exercise.

(Naderi, A. et al., 2016)

Peak Week Strategies- Are Extreme Measures Needed or Safe?

During the period when physique athletes' peek prior to competing, they often employ strategies to manipulate fluid, electrolytes and carbohydrates, in an attempt to enhance size and definition.

Commonly used techniques to improve physique during the preparation phase before competitions include dehydration, prolonged fasting, severe caloric restriction, excessive cardiovascular exercise and inappropriate use of diuretics and anabolic steroids. These strategies, notwithstanding the illegal use of anabolic steroids, offer little if any appreciable difference and could in fact have adverse health effects.

In a case study by Robinson et al., a structured nutrition and conditioning intervention was used to improve body composition, resting and exercise fat oxidation, and muscular strength. Over a 14-week period, the athlete was provided with a scientifically designed nutrition and conditioning plan that encouraged him to (i) consume a variety of foods; (ii) not neglect any macronutrient groups; (iii) exercise regularly but not excessively and; (iv) incorporate rest days into his conditioning regime. The athlete was able to reduce body fat whilst improving physiological parameters of health, maintaining a favourable mood state and positively influencing strength.

In contrast to popular myths, it is not necessary to skip meals, neglect specific macronutrient groups, dehydrate or consume a large variety of supplements to adequately prepare for a physique competition.

(Robinson, S. L., et al., 2015) (Trexler, E. T., et al., 2017)

Disordered Eating, Muscle Dysmorphia and Body Dysmorphic Disorder in Physique Athletes

There is growing recognition of the prevalence of disordered eating (DE), muscle dysmorphia (MD) and body dysmorphic disorder (BDD) in physique athletes. Strength and conditioning professional and sports nutritionist should be aware of the prevalence of these relationships as they can serve as a portal of entry into the appropriate referral network for early intervention.

(Chapman, J., & Woodman, T., 2016) (Nieuwoudt, J. E., et al., 2015)

Exercise and Hypertrophy

According to the National Academy of Sports Medicine (NASM), there are five primary adaptations to exercise:

1. Stabilization endurance
2. Stabilization strength
3. Hypertrophy
4. Maximum strength
5. Power

Hypertrophy and leanness are are the primary goals of athletes involved in physique/figure events.

The specific adaptations to exercise are a result of:

1. Metabolic stress
2. Motor unit recruitment (Mechanical tension)
3. Inflammation (Tissue damage)

It is the manipulation of the acute exercise variables: Sets (volume), repetitions, tempo, intensity, rest periods and exercise selection (both multi joint and single-joint exercises), that determines the specific adaptations from the imposed demands (SAID Principle).

A hypertrophy programing should use a repetition range of 6-12 reps per set with rest intervals of 60-90 seconds between sets. Exercises should be varied, multiplanar, multi-joint, single joint, and multi angled, to ensure maximal stimulation of all muscle fibers. Multiple sets should be employed as a split training routine, emphasizing full range of motion and proper form. Some of the sets should be carried out to failure. Concentric repetitions should be performed at fast to moderate speeds (1-3 seconds). Eccentric repetitions should be performed at slightly slower speeds (2-4 seconds). Training should be periodized with brief period of higher-volume overreaching followed by a taper to allow for optimal compensation and adaptations. Cardiovascular

training can be used to enhance fat loss, however since interference with strength training adaptations increases concomitantly with frequency and duration of cardiovascular training, the lowest frequency and duration possible while achieving sufficient fat loss should be used. Full-body modalities or cycling may reduce interference. High intensities may as well; however, require more recovery.

(Clark MA, et al., 2018) (Schoenfeld, B. J., 2010) (Helms, E.R., et al., 2015) (Schoenfeld, B., & Grgic, J. 2017)

Table 6 Hypertrophy training program variables

Sets/ Volume	Reps	Tempo	Rest	Intensity	Frequency
6-9 per session (per muscle group) 12-18 sets per week (total volume)	6-12 40-70 reps per muscle group	Concentric (1-3 s) Eccentric (2-4 s) Isometric (1-2 s) E.g. 3/2/1	60-90 s between sets	70-80% of 1 repetition max	Train muscle groups 2x/week

Practical Strategies

Table 7 Summary of practical nutrition guidelines for natural physique Athletes to Support Training and Contest Preparation

Variable	Recommendation
Energy	**Training for Strength and Hypertrophy-** Meet energy requirements and add approximately 500 Kcal to increase 1 lb per week. **Contest Preparation-** Weekly weight loss (% of body weight)- 0.5-1%.
Macronutrients	**Carbohydrates:** 4-7 g/kg BW/day. **Proteins:** 2.3-3.1 g/kg BW/day. **Fats:** 15-30%.
Micronutrients	Consume a predominantly whole foods balanced diet (e.g. colorful fruits and vegetables, whole grains and lean meats). Supplement based on risk factor assessment, e.g. Multiple vitamin/mineral, iron, calcium essential fats.
Timing and meal frequency considerations	**Carbohydrates** -Multiple glycogen depleting training sessions in a day. - Training 2-3 hours. **Protein** **-**Timing in relation to resistance training in a fasted state (>3 than hours postprandial). **Meal frequency**

	• 3–6 meals per day.
Supplements	**Choose supplements to augment sounds training and dietary practices:** **Lean Body Mass** • Creatine monohydrate • Fish oil • Whey protein **Strength & Power** • Bicarbonate • Caffeine • Creatine Monohydrate • Fish Oil • Whey Protein (BCAA) **Cardiovascular Performance Enhancement** • Beetroot Juice • Beta Alanine • Creatine Monohydrate **Injury Recovery and Repair** • Collagen Peptides • Fish Oil • Tart Cherry Juice

Table 8 Summary of hypertrophy exercise recommendations

- Repetition range of 6-12 reps per set.
- Rest intervals of 60-90 seconds between sets.
- Varied, multiplanar, multi-joint, single joint, and multi angled exercises.
- Multiple sets employed as a split training routine.
- Full range of motion and proper form.
- Some of the sets carried out to failure.
- Concentric repetitions (1-3 seconds).
- Eccentric repetitions (2-4 seconds).
- Training should be periodized with brief period of higher-volume overreaching followed by a taper
- Low frequency and duration/ High intensities. cardiovascular training to avoid interference effect.

Future Considerations

Physique athletes employ a combination of resistance training, cardiovascular exercise, calorie reduction, macronutrient manipulation, nutrient timing and supplementation in order to lose fat mass and maintain lean body mass. While recommendations exist for contest preparation, research is limited to case studies or small cohorts. In addition, the influence of different nutritional strategies on competitive outcomes is uncertain.

Future studies are warranted to better understand the ramifications of the dietary practises employed by this specific population, both in the context of being able to make evidence-based recommendations, as well as maintaining optimum physiological and mental health.

References

Aragon, A. A., Schoenfeld, B. J., Wildman, R., Kleiner, S., VanDusseldorp, T., Taylor, L., ... & Stout, J. R. (2017). International society of sports nutrition position stand: diets and body composition. *Journal of the International Society of Sports Nutrition*, *14*(1), 16.

Aragon, A. A., & Schoenfeld, B. J. (2013). Nutrient timing revisited: is there a post-exercise anabolic window?. *Journal of the international society of sports nutrition*, *10*(1), 5.

Baar, K. (2017). Minimizing Injury and Maximizing Return to Play: Lessons from Engineered Ligaments. *Sports Medicine*, *47*(1), 5-11.

Bandegan, A., Courtney-Martin, G., Rafii, M., Pencharz, P. B., & Lemon, P. W. (2017). Indicator Amino Acid–Derived Estimate of Dietary Protein Requirement for Male Bodybuilders on a Nontraining Day Is Several-Fold Greater than the Current Recommended Dietary Allowance, 2. *The Journal of nutrition*, *147*(5), 850-857.

Bird, S. (2010). Strength nutrition: maximizing your anabolic potential. *Strength & Conditioning Journal*, *32*(4), 80-86.Burke, L. M., & Read, R. S. (1993). Dietary supplements in sport. *Sports Medicine*, *15*(1), 43-65.

Chapman, J., & Woodman, T. (2016). Disordered eating in male athletes: a meta-analysis. *Journal of Sports Sciences*, *34*(2), 101-109.

Churchward-Venne, T. A., Burd, N. A., & Phillips, S. M. (2012). Nutritional regulation of muscle protein synthesis with resistance exercise: strategies to enhance anabolism. *Nutrition & metabolism*, *9*(1), 40.

Churchward-Venne, T. A., Holwerda, A. M., Phillips, S. M., & van Loon, L. J. (2016). What is the optimal amount of protein to

support post-exercise skeletal muscle reconditioning in the older adult? *Sports Medicine*, *46*(9), 1205-1212

Clifford, T., Bell, O., West, D. J., Howatson, G., & Stevenson, E. J. (2016). The effects of beetroot juice supplementation on indices of muscle damage following eccentric exercise. *European journal of applied physiology*, *116*(2), 353-362.

Devries, M. C., & Phillips, S. M. (2015). Supplemental protein in support of muscle mass and health: advantage whey. *Journal of food science*, *80*(S1).

Domínguez, R., Maté-Muñoz, J. L., Cuenca, E., García-Fernández, P., Mata-Ordoñez, F., Lozano-Estevan, M. C., … Garnacho-Castaño, M. V. (2018). Effects of beetroot juice supplementation on intermittent high-intensity exercise efforts. *Journal of the International Society of Sports Nutrition*, *15*, 2. http://doi.org/10.1186/s12970-017-0204-9

Garthe, I., Raastad, T., Refsnes, P. E., Koivisto, A., & Sundgot-Borgen, J. (2011). Effect of two different weight-loss rates on body composition and strength and power-related performance in elite athletes. *International journal of sport nutrition and exercise metabolism*, *21*(2), 97-104.

Hall, K. D. (2008). What is the required energy deficit per unit weight loss? *International journal of obesity*, *32*(3), 573.

Hector, A. J., & Phillips, S. M. (2018). Protein recommendations for weight loss in elite athletes: A focus on body composition and performance. *International journal of sport nutrition and exercise metabolism*, *28*(2), 170-177.

Helms, E. R., Aragon, A. A., & Fitschen, P. J. (2014). Evidence-based recommendations for natural bodybuilding contest

preparation: nutrition and supplementation. *Journal of the International Society of Sports Nutrition*, *11*(1), 20.

Helms, E.R., Fitschen, P.J., Aragon, A.A., Cronin, J., & Schoenfeld, B.J. (2015). The Journal of Sports Medicine and Physical Fitness, 55, 164-178

Helms, E. R., Zinn, C., Rowlands, D. S., & Brown, S. R. (2014). A systematic review of dietary protein during caloric restriction in resistance trained lean athletes: a case for higher intakes.

Hendrix, C. R., Housh, T. J., Mielke, M., Zuniga, J. M., Camic, C. L., Johnson, G. O., ... & Housh, D. J. (2010). Acute effects of a caffeine-containing supplement on bench press and leg extension strength and time to exhaustion during cycle ergometry. *The Journal of Strength & Conditioning Research*, *24*(3), 859-865.

Indorato, D. (2016). Enhanced Resistance Training Performance via the Neutralization of Lactic Acid with Sodium Bicarbonate. *Inquiries Journal*, *8*(03).

Ismaeel, A. (2017). *Comparison of selected micronutrient intakes between flexible dieting and strict dieting body builders* (Doctoral dissertation).

Kerksick, C. M., Arent, S., Schoenfeld, B. J., Stout, J. R., Campbell, B., Wilborn, C. D., ... & Willoughby, D. (2017). International society of sports nutrition position stand: nutrient timing. *Journal of the International Society of Sports Nutrition*, *14*(1), 33.

Kreider, R. B., Kalman, D. S., Antonio, J., Ziegenfuss, T. N., Wildman, R., Collins, R., ... & Lopez, H. L. (2017). International Society of Sports Nutrition position stand: safety and efficacy of creatine supplementation in exercise, sport, and medicine. *Journal of the International Society of Sports Nutrition*, *14*(1), 18.

Lambert, C. P., Frank, L. L., & Evans, W. J. (2004). Macronutrient considerations for the sport of bodybuilding. *Sports Medicine*, *34*(5), 317-327.

Larson-Meyer, D. E., Woolf, K., & Burke, L. M. (2017). Assessment of Nutrient Status in Athletes and the Need for Supplementation. International journal of sport nutrition and exercise metabolism, 1-52.

Levers, K., Dalton, R., Galvan, E., Goodenough, C., O'Connor, A., Simbo, S., ... & Riechman, S. (2015). Effects of powdered Montmorency tart cherry supplementation on an acute bout of intense lower body strength exercise in resistance trained males. *Journal of the International Society of Sports Nutrition*, *12*(1), 41.

Levers, K., Dalton, R., Galvan, E., Goodenough, C., O'Connor, A., Simbo, S., ... & Kreider, R. (2015). Powdered tart cherry supplementation surrounding a single bout of intense resistance exercise demonstrates potential attenuation of recovery strength decrement with no definitive oxidative or inflammatory effect. *Journal of the International Society of Sports Nutrition*, *12*(1), P25.

MacLean, P. S., Bergouignan, A., Cornier, M. A., & Jackman, M. R. (2011). Biology's response to dieting: the impetus for weight regain. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, *301*(3), R581-R600.

Mäestu, J., Eliakim, A., Jürimäe, J., Valter, I., & Jürimäe, T. (2010). Anabolic and catabolic hormones and energy balance of the male bodybuilders during the preparation for the competition. *The Journal of Strength & Conditioning Research*, *24*(4), 1074-1081.

Maughan, R. J., Burke, L. M., Dvorak, J., Larson-Meyer, D. E., Peeling, P., Phillips, S. M., ... & Meeusen, R. (2018). IOC

consensus statement: dietary supplements and the high-performance athlete. *Br J Sports Med*, *52*(7), 439-455.

Mero, A. A., Huovinen, H., Matintupa, O., Hulmi, J. J., Puurtinen, R., Hohtari, H., & Karila, T. A. (2010). Moderate energy restriction with high protein diet results in healthier outcome in women. *Journal of the International Society of Sports Nutrition*, *7*(1), 4.

Morton, R. W., Murphy, K. T., McKellar, S. R., Schoenfeld, B. J., Henselmans, M., Helms, E., ... & Phillips, S. M. (2018). A systematic review, meta-analysis and meta-regression of the effect of protein supplementation on resistance training-induced gains in muscle mass and strength in healthy adults. *Br J Sports Med*, bjsports-2017.

Naderi, A., de Oliviera, E. P., Ziegenfuss, T. N., & Willems, M. E. (2016). Timing, optimal dose and intake duration of dietary supplements with evidence-based uses in sports nutrition. *Journal of Exercise Nutrition & Biochemistry*.

Nieuwoudt, J. E., Zhou, S., Coutts, R. A., & Booker, R. (2015). Symptoms of muscle dysmorphia, body dysmorphic disorder, and eating disorders in a nonclinical population of adult male weightlifters in Australia. *The Journal of Strength & Conditioning Research*, *29*(5), 1406-1414

Noreen, E. E., Sass, M. J., Crowe, M. L., Pabon, V. A., Brandauer, J., & Averill, L. K. (2010). Effects of supplemental fish oil on resting metabolic rate, body composition, and salivary cortisol in healthy adults. *Journal of the International Society of Sports Nutrition*, *7*(1), 31.

Phillips, S. M., & Van Loon, L. J. (2011). Dietary protein for athletes: from requirements to optimum adaptation. *Journal of sports sciences*, *29*(sup1), S29-S38.

Potgieter, S. (2013). Sport nutrition: A review of the latest guidelines for exercise and sport nutrition from the American College of Sport Nutrition, the International Olympic Committee and the International Society for Sports Nutrition. *South African journal of clinical nutrition*, *26*(1), 6-16.

Robinson, S. L., Lambeth-Mansell, A., Gillibrand, G., Smith-Ryan, A., & Bannock, L. (2015). A nutrition and conditioning intervention for natural bodybuilding contest preparation: case study. *Journal of the International Society of Sports Nutrition*, *12*(1), 20.

Sallinen, J., Pakarinen, A., Ahtiainen, J., Kraemer, W. J., Volek, J. S., & Häkkinen, K. (2004). Relationship between diet and serum anabolic hormone responses to heavy-resistance exercise in men. *International journal of sports medicine*, *25*(08), 627-633.

Schoenfeld, B. J. (2010). The mechanisms of muscle hypertrophy and their application to resistance training. *The Journal of Strength & Conditioning Research*, *24*(10), 2857-2872.

Schoenfeld, B., & Grgic, J. (2017). Evidence-based guidelines for resistance training volume to maximize muscle hypertrophy. *Strength Cond*

Shaw, G., Lee-Barthel, A., Ross, M. L., Wang, B., & Baar, K. (2016). Vitamin C–enriched gelatin supplementation before intermittent activity augments collagen synthesis. *The American journal of clinical nutrition*, *105*(1), 136-143.

Slater, G., & Phillips, S. M. (2011). Nutrition guidelines for strength sports: sprinting, weightlifting, throwing events, and bodybuilding. *Journal of sports sciences*, *29*(sup1), S67-S77.

Smith-Ryan, A., & Antonio, J. (Eds.). (2013). Sports Nutrition & Performance Enhancing Supplements. Linus Learning.

Tachtsis, B., Camera, D., & Lacham-Kaplan, O. (2018). Potential Roles of n-3 PUFAs during Skeletal Muscle Growth and Regeneration. *Nutrients*, *10*(3), 309.

Trexler, E. T., Smith-Ryan, A. E., & Norton, L. E. (2014). Metabolic adaptation to weight loss: implications for the athlete. *Journal of the International Society of Sports Nutrition*, *11*(1), 7.

Trexler, E. T., Smith-Ryan, A. E., Stout, J. R., Hoffman, J. R., Wilborn, C. D., Sale, C., ... & Campbell, B. (2015). International society of sports nutrition position stand: Beta-Alanine. *Journal of the International Society of Sports Nutrition*, *12*(1), 30.

Trexler, E. T., Hirsch, K. R., Campbell, B. I., & Smith-Ryan, A. E. (2017). Physiological Changes Following Competition in Male and Female Physique Athletes: A Pilot Study. *International journal of sport nutrition and exercise metabolism*, *27*(5), 458-466.

Appendix I- Sample Exercise Program: Cutting Phase

Day (time)	Weeks 1-7	Weeks 8-10	Weeks 11-14
Monday (AM)	Rest	Sprints	Sprints
		10 × 10–15 sec	10 × 10–15 sec
Monday (PM)	RT	RT	RT
	Chest and back	Chest and back	Chest and back
Tuesday (AM)	Rest	Rest	Incline walk on treadmill
			40 minutes
Tuesday (PM)	RT	RT	RT

	Legs	Legs	Legs
Wednesday (AM)	Rest	Incline treadmill walk	Incline treadmill walk
		40 minutes	40 minutes
Wednesday (PM)	Rest	Rest	RT
			Shoulders and Arms
Thursday (AM)	Rest	Rest	Incline treadmill walk
			40 minutes
Thursday (PM)	RT	RT	RT

	Shoulders and arms	Shoulders and arms	Shoulders and arms
Friday (AM)	Rest	Incline treadmill walk	Incline treadmill walk
		40 minutes	40 minutes
Friday (PM)	Circuit training	RT	RT
	30 minutes	Legs	Legs
Saturday (AM)	Rest	Rest	Incline treadmill walk
			40 minutes

Saturday (PM)	Rest	Rest	Rest
Sunday (AM)	Rest	Rest	Rest
Sunday (PM)	Rest	Rest	Rest

RT = Resistance Training (the mean duration of each session was 30 minutes).

Adjustments to the quantity of exercise performed should be set to accommodate the target energy deficit and the rate of body composition change as determined by each individual through a metabolic assessment and anthropometric measurements.

(Robinson, S. L., et al., 2015)

Appendix II- Sample Diet Plan: Cutting Phase

Menu 1: Training day		**Menu 2: Rest day**	
Item/description	***Amount (g)**	**Item/description**	***Amount (g)**
Meal 1		**Meal 1**	
Venison burger	150	Poached egg	150

Poached egg	150	Oats	50 (dry)
Spinach	50	Whey protein powder	30
Meal 2		**Meal 2**	
Whey protein powder	60	Tuna (tinned)	130
Creatine	5	Asparagus	100
Brazil nuts	20	Macadamia nuts	30
Meal 3		**Meal 3**	
Mackerel	150	Chicken breast	150
Brown rice	100	Sweet potato	150
Salad leaves	50	Almonds	20

Avocado	50		
Apple cider vinegar	12		
Meal 4		**Meal 4**	
Turkey breast	155	Salmon fillet	140
White Basmati rice	100 (dry)	White Basmati rice	50
Mushrooms	100	Broccoli	100
Coconut oil	12	**Snack**	
Snack		Chocolate flavored mousse	50
Full-fat cottage cheese	225	Coconut Oil	12

Totals		**Totals**	
Energy (kcal/d)	2413	Energy (kcal/d)	2246
Carbohydrate (g)	137	Carbohydrate (g)	143
Fat (g)	119	Fat (g)	96
Protein (g)	207	Protein (g)	212

*Quantities to vary depending on individual anthropometric measurements

Adjustments to nutritional intake should be set to accommodate the target energy deficit and the rate of body composition change as determined by each individual through a metabolic assessment and anthropometric measurements.

(Robinson, S. L., et al., 2015)