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Meal Frequency and Nutrient Distribution: What is Ideal for Body Composition?

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Abstract

This article explores the effects of meal frequency on protein synthesis, muscle mass and fat mass. Current research appears to indicate that manipulating meal frequency increases net protein balance and body composition when each meal provides an adequate supply of the amino acid leucine to optimize skeletal muscle anabolism. In contrast, research demonstrating no benefits to increased meal frequency generally employed small, inadequate boluses of protein per meal. The purpose of this paper will be to explore a variety of different strategies which individuals can employ when attempting to gain muscle and lose fat.

Keywords: Frequency; Protein synthesis; Body composition; Physical performance; Athletes

Background

Meal frequency and nutrient distribution are two of the most controversial topics in the sports nutrition field today [1]. Is there a perfect nutrient prescription for optimizing physiques and performance? Questions like these arise all the time, yet scientists vary on their opinions on what exactly is the ideal approach. One thing that is for sure is that there are varieties of different techniques such as very low meal frequency (1-2 meals), the typical American diet of 3 meals per day, or extremely high meal frequency (6+ meals). Research indicates a great deal of variability in the responses of humans to these dieting techniques. Thus, a question of immense importance is how can athletes optimally alter their meals so that they have the greatest affinity to alter their body composition in a positive manner. In this article, we will discuss what the current literature state is optimal for athletes looking to develop the most ideal body composition.

Athletes and Protein Distribution

Research indicates that most Americans unequally distribute their protein intake such that breakfast, lunch, and dinner consist of 10%, 20%, and 60% of their daily protein consumption respectively [2] (Figure 1). Thus, minimal protein is offered at breakfast, a moderate amount is consumed at lunch and a very large portion at dinner. If an athlete or individual trying to optimize their body composition is supposed to take in 120 grams of protein per day, does it matter how they distribute those 120 grams throughout the day's period?

Meal frequency is going to only be as good as your ability to reach the amount of protein necessary to maximize the anabolic response in muscle. This was clearly shown in a study by Areta et al. [3] who looked at the effects of 3 different whey protein combinations following a resistance exercise bout. These researchers took 80 grams of protein and spread it into 2, 4, or 8 meals with the protein divided equally between meals. For example if subjects had 2 meals, they would consume 40 grams of protein per meal, 4 meals would be 20 grams of protein per meal, and 8 meals would be 10 grams of protein per meal. These researchers found that the 4 servings of 20 grams of protein was optimal for maximally stimulating the anabolic response compared to the 8 servings of 10 grams of protein or the 2 servings of 40 grams of protein (Figure 2).

Timing and distribution of protein intake within meals may be very important for optimizing muscle-building adaptations over the course of an entire day. There seems to be a threshold for protein synthesis in which plasma leucine levels effectively need to double in the plasma to trigger a response. This threshold appears to fall between 20-30 grams of high quality protein or 2-3 grams of leucine [4-6]. Therefore, the 8 servings of 10 grams

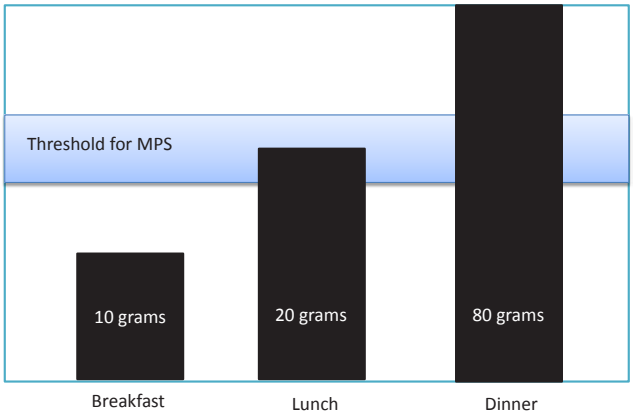

Figure 1: Typical distribution of protein.

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never reaches the threshold for protein synthesis; meanwhile, the 2 by 40 grams group reaches this threshold twice throughout the day with minimal added benefits (7%) to the larger servings of protein [3]. However, it is conceivable that had they had 4 by 40 grams the anabolic response may be slightly greater than the 4x20, which could be critical for the elite athlete [3,7,8]. Nevertheless, more research needs to be done on this area with a wide array of different populations.

Athletes Attempting to Lose Weight

A variety of different sports require athletes to maintain or even lose weight for competitions. To do this, coaches and trainers often attempt an extreme caloric restriction to achieve an energy deficit. Recently, Deutz et al. [9] examined gymnasts and runners, which are two of the sports that are known for their attempts in keeping athletes as light as possible. These researchers found that within-day energy deficits are associated with higher body fat percentage in both anaerobic and aerobic elite athletes, possibly from an adaptive reduction in the resting energy expenditure [9]. Therefore, athletes that are looking to optimize body composition should be aware that restrained or delayed eating patterns might drastically alter their desired body composition.

However, the aforementioned study only looked at body fat percentage. For a sport like wrestling or boxing, body fat percentage can be important, but muscle mass is essential in order to combat your opponent. Iwao et al. [10] examined boxers who were subjected to a low calorie diet while consuming either 2 or 6 meals per day. The individuals in the 6-meal group lost less muscle mass than the group consuming only 2 meals. It is important to remember that both groups consumed the same amount of calories so again this study seems to suggest that nutrient distribution can alter the amount of muscle mass you can gain or preserve, especially when dieting. We contend that the anabolic threshold model discussed previously can explain these results. The group consuming two meals only has the potential to initiate muscle protein synthesis (MPS) twice; meanwhile the 6 meal condition has the potential to stimulate MPS several times.

It is important to understand that anabolic processes are always coupled with catabolic processes. In the case of protein synthesis, several ATP molecules must be hydrolyzed, creating an energy strain in the cell [11]. As such, molecular pathways are

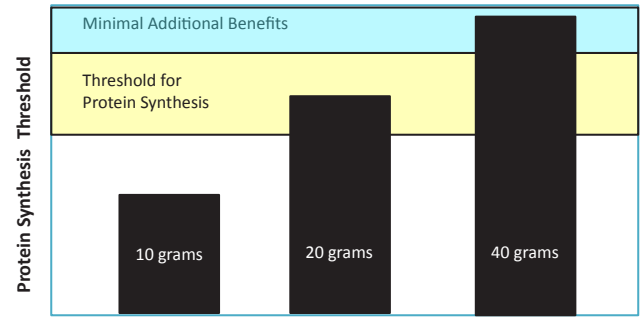

Figure 2: Theoretical model of protein synthesis threshold [1].

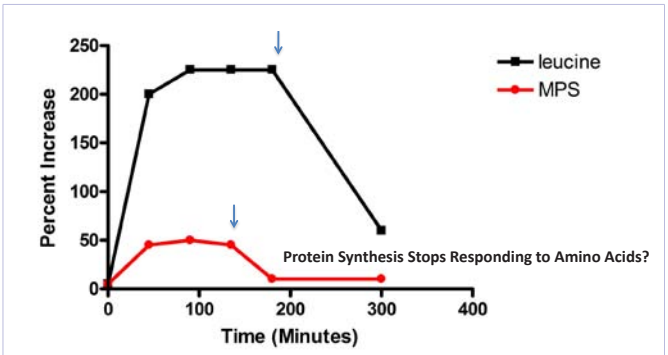

Figure 3a: Protein synthesis and amino acid concentration in the blood.

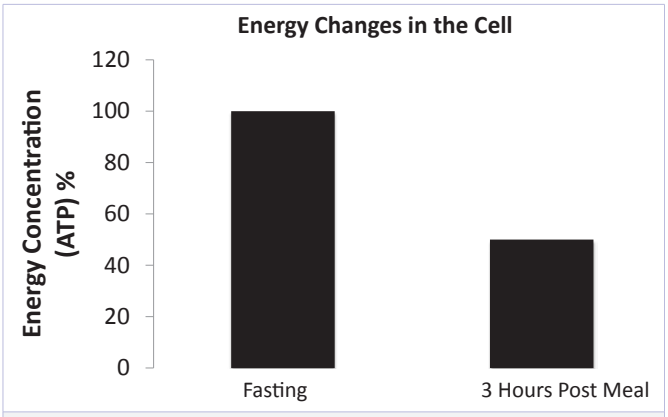

Figure 3b: Energy changes in cell [16].

activated which induce mitochondrial biogenesis and ultimately fat metabolism [12]. In support, Loenneke et al. [13] showed that there is an inverse relationship between the number of times an individual hits their threshold and central abdominal fat. These data indicate that the more times you reach the threshold, the smaller your central abdominal fat will be.

Optimizing Meal Frequency

How frequently you eat and what you eat depend on a number of different factors. These factors include how long protein synthesis lasts after a meal, why and what causes protein synthesis to stop, and what dietary modification can reinstate it? Research indicates that protein synthesis lowers to basal levels 3 hours after a meal or constant infusion of amino acids even though amino acids are still elevated in the blood (Figure 3a). The underlying mechanism for these effects was unknown until recently. Specifically, Wilson et al. [11] proposed the energy deficit theory of why protein synthesis becomes refractory. In support, Wilson et al. [11] found that ATP was significantly lower 3 hours after a meal, and ATP kinase, the negative regulator of translation was increased in activity (Figure 3b). Thus, we can conclude that data seems to suggest that it isn't the amino acids that are limiting protein synthesis 3 hours post feeding but rather a deficit in intracellular energy.

Further research from Wilson et al. [11] indicated that protein synthesis could be reinstated by consuming a large bolus of

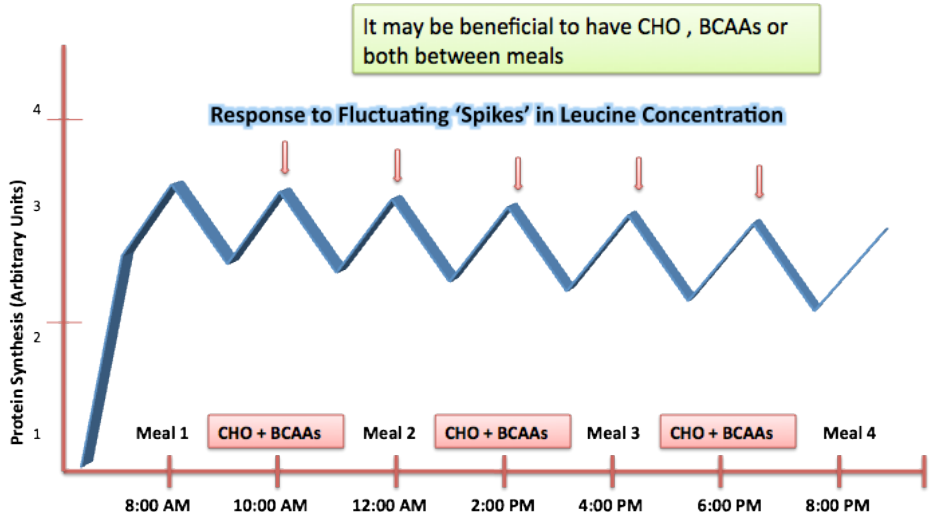

Figure 4: Possible suggestions for meal frequency.

branched chain amino acids, carbohydrates, or the combination of the two. The underlying mechanism for all three approaches was a reinstatement of ATP levels necessary to sustain protein synthesis. It appears that branched chain amino acids can be used for energy in the cell, but only sustain protein synthesis for 30-60 minutes, while the combination of fast digesting carbohydrates plus branched amino acids may sustain protein synthesis for 60 minutes. It is plausible that a slow digesting carbohydrate source could sustain energy longer and may sustain the anabolic response in muscle for possibly 90-120 minutes.

Regardless it appears that whole meals supplemented with low calorie snacks consisting of amino acids and carbohydrates may be the optimal approach for sustaining positive protein balance [1] (Figure 4). This contention is supported by research from Paddon-Jones et al. [14,15] these researchers compared three 850-calorie meals to three 850-calorie meals along with three 180-calorie amino acid carbohydrate stacks between meals. Results demonstrated that subjects who consumed the small snacks, but hit the anabolic threshold, had a far greater anabolic response than those who had three meals (23% greater protein synthesis). This simple addition could provide benefits for individuals looking to increase muscle mass and improve body composition in general.

Is Frequently Always Better?

In our opinion, there is never a cut and dried answer to anything, let alone meal frequency. For instance, for religious or maybe even work related reasons, some people may only be able to eat 1 or 2 meals a day. Advocates for low meal frequency generally cite a classic study by Cameron et al. [16], which indicated that 9 meals per day compared to just 1 meal per day did not enhance weight loss. It is important to remember however those subjects were already in a 700-calorie deficit and their protein was only 15% of their total calories. We interpret this data to indicate that individuals not able to consume a sufficient amount of protein or a large amount of calories may be better off with boluses for their protein and calories over a smaller number of meals. This contention is further supported by a recent study by Ohkawara et al. [17] who found that there were no differences in 24-h energy expenditure, 24-h respiratory quotient, or 24-h fat oxidation between 3 and 6 meals, respectively. These authors concluded that meal frequency may increase hunger and desire to eat as well. However, the diets of these individuals consisted of were again comprised of 15% protein, 55% carbohydrates, 30% fat and need to be interpreted with caution from athletes who have different macronutrient ratio distributions.

Conclusion

Further research needs to examine eating meal frequency for specific population groups with different physical activity (elite athletes, recreationally trained, sedentary, etc) as it relates to body composition and performance. For individuals that may only be able fit in 3 meals per day due to work and other responsibilities, it is recommended that they consume branched chain amino acids (BCAA's) and a carbohydrate source in between meals to reinstate protein synthesis. However for athletes looking to optimize body composition eating a high quality meal with at least 20-30 g of high quality protein every 4-5 hours is recommended. In between these meals consume carbohydrates and BCAAs to optimize protein balance throughout the day.

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