Position Stand on the Nutritional Requirements for Olympic Weightlifting

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1. Introduction

Olympic Weightlifting is a dynamic strength and power sport. During competition, maximum weight attempts of the snatch and clean and jerk are performed. These movements are multi-joint whole-body lifts at maximal intensities[1]. Typically, athletes have a high level of muscularity. Events are conducted in weight classes, thus absolute levels of lean body mass vary, but the goal is always a large amount of muscle mass and a low percentage of body fat[2]. Most athletes try to achieve the lowest possible body weight category and therefore try to optimize the power to weight ratio[3]. Concerning the physique, weightlifters competing at international level often have a higher sitting height to stature ratio with short limbs. Thus, they create a biomechanical advantage because they have a shorter distance when jumping under the barbell[4]. Weightlifters have a relatively high energy expenditure because they have a large amount of muscle mass. Training stimulus alone produced a total daily energy expenditure (TDEE) of around 3900 kcal in men. This is consistent with the values recommended for "intensive training" male athletes[1]. For females competing in strength and power sports TDEE of around 3200 kcal was measured[5], but further studies need to evaluate the energy expenditure for weightlifting athletes.

The training structure of competitive weightlifters is characterized by the frequent use of high-intensity resistance exercise movements. The snatch and clean and jerk form the basis of every weightlifting training program[1]. In addition, weightlifters perform complementary exercises with similar movement pattern and supplementary exercises that target synergistic muscle groups. International weightlifter perform 1 or 2 training sessions per day on 6 to 7 days per week, with intensities of often more than 80 percent of the 1-repetition-maximum[1]. During a weightlifting competition every attempt of the snatch and clean and jerk just takes a few seconds, followed by at least two minutes of rest period. During training maximal effort sets are performed in just a few seconds. In addition, complementary and supplementary exercise sets include more repetitions and can take up to half a minute[1]. Therefore, the anaerobic pathways, such as the phosphagen and later the glycolytic pathway are the major pathways during lifting to match the increased rates of adenosintriphosphat (ATP) depletion[6]. After the body's resting ATP stores are used up, the phosphagen system starts to support the ATP replenishment, using phosphocreatine (PCr) as a first substrate for loads up to 10 seconds[6]. Thus, a depletion of PCr is the first mechanism by which fatigue may occur. During training, over repeated sets and in sets with higher repetitions the availability of PCr decreases and glucose and muscle glycogen become important substrates[2]. The anaerobic glycolytic pathway rapidly metabolizes blood glucose and muscle glycogen through the glycolytic cascade. This can support high-intensity exercise lasting 10 seconds to 3 minutes[3]. Low Glycogen content has been shown to reduce strength and depletion can limit performance[2]. Thus, glycogen depletion is another mechanism by which fatigue may occur. To maximize training results, most athletes train with a bodyweight over their competition weight class[1]. Thus, the athletes try to lose weight shortly before competition. Doing so they often restrict water and dehydration can be a mechanism for fatigue during competition[7]. Additionally fatigue can also be neuromuscular, because the central nervous system has a huge involvement in exercises with high intensities[4].

Optimizing the nutrition for competitive weightlifters is a key factor of enhancing their performance. The nutrition should help the athletes to fuel for the training, to recover well and to optimize training adaptations concerning muscle size and strength[4]. The major nutritional challenges for the athletes occur during training phase and not during competition[2].

2. Nutritional Requirements in Training

2.1. Carbohydrates for Performance

For high intensity training like Olympic Weightlifting carbohydrates are the preferential energy substrate and also a key fuel for the brain and central nervous system[3]. A single bout of resistance training can result in a significant drop in muscle glycogen of up to 24 to 40 percent[4]. This amount alone does not limit performance, but according to Hokken[8], through resistance training type 2 muscle fibers deplete a lot of glycogen from intramyofibrillar storage, which is associated with fatigue. Therefore, special attention should be paid to ingest carbohydrates to improve weightlifting performance. To replenish muscle glycogen, 3 - 5 g/ kg/ day of carbohydrates are recommended for strength athletes and up to 4 - 7 g/ kg/ day when the strength athletes have lots of volume[2]. Due to frequent training sessions, national weightlifting athletes should aim for the higher end (4 - 7 g/ kg/ day) of these recommendations, when suitable for total daily caloric intake.

For optimal performance, special emphasis should also be placed on carbohydrate timing before, during and after training. According to Slater and Phillips[4], carbohydrate ingestion prior to strength training increases total work capacity and the amount of blood glucose, which can be used for glycolysis. Before and during training athletes should ingest carbohydrates with a high glycemic index to have a better absorption and higher insulin response, which increases the uptake of glucose in the tissues[9]. According to the literature 1 g/ kg of Carbohydrates before and 0.5 g/ kg during training are recommended for strength athletes[2,7].

As seen in endurance studies, through mouth rinsing of carbohydrates during exercise the oral receptor stimulates the brain and central nervous system, which can enhance perceptions of wellbeing and increase self-chosen work-output[10]. Due to its high intensity, weightlifting has a huge impact on the central nervous system. Thus, Carbohydrates during training could potentially improve performance in this sport too. Ingestion of carbohydrates in the first two hours after training could improve muscle glycogen resynthesis. Slater and Phillips[4] suggest 1 to 1.2 g/ kg of carbohydrates directly after training. Special emphasis should be paid on days with two training sessions, where glycogen resynthesis is important for performance in the second session[4].

2.2. Protein requirements

Protein consumption is of high importance for weightlifting athletes. To optimize gains in muscle mass and the repair of damaged tissues, athletes should spend more time in a state of muscle protein synthesis (MPS) than muscle protein breakdown (MPB) and have a positive protein balance[4,7]. Doing so, they need an exogenous source of amino acids for incorporation into new proteins[3]. Studies have shown that 1.6 g of protein/ kg/ day was necessary to maximize the gains in lean body mass during resistance training[7,9], which is an amount twice the current recommendations for protein of sedentary. Others suggest around 1.2 - 2 g/ kg/ day for all athletes[3], or 1.6 - 1.7 g/ kg/ day for strength and power athletes[2,7]. The acceptable macronutrient distribution range for proteins of 10 - 35 percent and the higher calorie intake due to more muscle mass and training also underline these amounts[7]. Taking this into consideration, it can be said, that international weightlifting athletes should consume around 1.6 - 1.7 g/ kg/ day, to make sure, they still stay in a positive net protein balance and recover well while having a huge training amount of up to 12 times a week. Additionally, adequate energy from Carbohydrates is important, so that amino acids can be used for protein synthesis and are not oxidized[3].

In addition, the timing of protein intake is important for weightlifters to maximize muscle protein synthesis. Special emphasis should be placed on protein after training and before bed, as well as on the whole distribution during the day. Increases in muscle mass and strength are shown to be greater with immediate post-exercise protein. A combination of carbohydrates and protein at this time point results in improvement in recovery, including restoration of muscle glycogen and elevated MPS[4]. Furthermore, protein feeding prior to sleep stimulates overnight MPS[9]. Every protein feeding stimulates protein synthesis for just a few hours, so athletes should ingest protein every 3 - 4 hours during the day, consuming around 0,3 g/ kg per meal or a total of 20 - 40 g of protein[9]. Over 40 g of protein per meal has not shown to further stimulate MPS[3].

Concerning the type of protein, athletes should consume a full complement of amino acids with a large leucine content. Leucine has shown to best activate the mammalian target of rapamycin (mTOR) and thus MPS[3,9].

2.3. Fat requirements

Due to the high intensity of weightlifting training the energy pathways used by the athletes do not use fat

metabolism. Although fat is not an important energy substrate for weightlifting, it is still important for hormone production and to ensure the absorption of fat-soluble vitamins (E,D,K,A)[3,7]. To make sure that all nutrients can be absorbed by the body the fat intake should not fall below 20 percent of the total daily caloric intake[3].

2.4. Hydration

Weightlifting is typically conducted in a climate-controlled indoor-arena, with exercise sets of only short duration. Thus, low sweat losses are anticipated[11]. Nevertheless athletes should take care of being well hydrated and staying in electrolyte balance, because dehydration and hyponatremia can negatively impact the athletes strength, speed and cognitive performance[12]. To ensure hydration out of training, athletes should drink mineral water every day during and between meals. During exercise the athletes should prevent body mass losses or gains of ± 2 percent of body mass, to not negatively impact their performance[13]. Special attention should be paid on restoring fluids when dehydrating for making weight. It might be difficult for athletes to consume enough fluids between weight in and competition, but athletes should try to replace lost body fluids, consuming 1.5 times mass loss. Besides, sodium consumed in pre-competition fluids and foods may help with fluid retention and electrolyte balance[3].

2.5. Micronutrients

Besides consuming macronutrients, athletes must consume vitamins and minerals to stay healthy.[2] In addition, Olympic weightlifting uses pathways in which micronutrients are required. Like in other sports the amount of micronutrients needed may increase with exercise[3]. Athletes should emphasize consuming a variety of food, including different vegetables and fruits to make sure they ingest all different vitamins and minerals. Supplementation of micronutrients should just be considered when athletes follow weight loss practices, where they cannot ingest sufficient amount of vitamins and minerals[3].

One micronutrient of key interest is Vitamin D, because it is mostly synthesized through radiation on the skin and food cannot supply it in sufficient amounts. Up to now there is no ideal serum concentration for athletes but studies recommend Vitamin D supplementation of 5000 IU/ day[14].

Moreover, weightlifting athletes should take care of ingesting enough iron, which is a component of hemoglobin and myoglobin and involved in ATP production[15]. Thus deficiency can negatively affect strength and weightlifting performance[16]. Especially female athletes should regularly control iron status, because lots of iron can be lost through menstrual blood loss[3].

Furthermore, Calcium and Magnesium are important micronutrients for weightlifting athletes. Calcium is involved in muscle contraction and the maintenance of bone tissues[3], whereas Magnesium plays a crucial role in glycolysis, protein synthesis and the production of ATP[17].

2.6. Supplementation

When training with high frequency and competing at international level, the use of supplements can be considered. Focus should still be on a food first approach.

Creatine

When considering the energy pathways during weightlifting training, it appears clear, that phosphocreatine is the substrate used first and foremost during training and competition. Thus, creatine supplementation might improve Olympic weightlifting performance. According to Slater and Phillips[4], creatine is the only supplement that has been shown to enhance skeletal muscle hypertrophy and functional capacity during resistance training. Additionally, Dempsey et al.[18] and Lanhers et al.[19] showed that oral creatine supplementation in combination with resistance training increases strength performance. Thus, creatine supplementation might increase the body´s phosphocreatine and therefore improve weightlifting performance. On the other hand, creatine supplementation draws water into muscle tissues and bodyweight can increase of 1 to 1.5 percent[7]. Because Olympic weightlifting athletes compete in weight classes the cost and benefit ratio of increased strength performance versus a higher bodyweight should be considered.

Caffeine

Caffeine supplementation has shown to improve various aspects of exercise performance, including muscular strength and concentration[20,21], which are important for weightlifting. Performance benefits are already seen with moderate amounts of 3 mg/ kg of body mass but recommendations range from 3 - 6 mg/ kg body mass[21]. For optimal strength performance athletes could ingest caffeine 60 minutes before exercise[20].

3. Nutritional Requirements in Competition

The competition demands of Olympic weightlifting are characterized by explosive single efforts with at least 2 minutes of recovery between each lift. Thus, muscle energy reserves are unlikely to be challenged. Therefore, when considering the nutrition for the competition the most important fact is reaching the appropriate weight for the weight class [4]. When making weight for competition, chronic weight making (body fat loss) and acute weight making ("making weight") can be distinguished.

For chronic weight making athletes can decrease their calories in the weeks or month before the competition. Smaller deficits (e.g., losing 0.5 percent of body mass per week) are more beneficial for maintaining lean body mass and performance compared to larger deficits (e.g., 1 percent of body mass per week) [7]. Emphasis should be on a high protein intake of around 1.6 to 2.4 g/ kg/ day because protein synthesis may decrease during the caloric deficit [7].

When thinking of acute weight making, athletes should consider benefits versus health danger of those strategies [22]. Common strategies are carbohydrate depletion, body water and gastrointestinal tract content manipulation.

Carbohydrate depletion works well in sports like Olympic weightlifting because of the greater reliance on phosphocreatine than glycogen during performance. Each gram of carbohydrates is stored with 3 to 4 grams of water and muscles can store 400 to 500 grams of glycogen. Thus, when fully depleted, the athlete could have up to 2.5 kilograms lower body mass. Because a full depletion is unlikely, athletes often lose 1 to 2 kilograms with the method of carbohydrate depletion [7].

Body water manipulation is another method for acute weight loss, which should be considered for a weightlifting competition. Doing so athletes should drink 100 ml/ kg of water per day for 3 days, followed by 15 ml/ kg of water for 1 day, to manipulate renal hormones [23]. According to Mota et al. [7] this could decrease body mass by up to 3.2 %.

Another method is the manipulation of gastrointestinal tract contents, which includes a restriction of food and fiber the day before the competition. This could easily be implemented in the athletes diet and like carbohydrate depletion and water manipulation, this method has almost no impact on weightlifting performance [22].

When considering the acute weight making strategies, refeeding between weight in and competition has greatest importance. Athletes should focus on restoring fluid losses and consuming sodium during this period to restore reduction in electrolytes. Furthermore, athletes should ingest mixed carbohydrate sources (glucose and fructose) to take advantageous of multiple gut transport mechanisms. Additionally, athletes should limit food rich in fiber because this can slow the absorption from other ingested nutrients [24].

4. Conclusion

Optimizing the nutrition for Olympic weightlifting athletes is a key factor in enhancing their performance. Focus during the training phase should stay on timing, type and amount of carbohydrates and proteins. Athletes should manipulate these macronutrients first, and fat should follow, but still not fall below 20 percent of total daily intake.

Carbohydrates:	
Per Day:	*4 - 7 g/kg*
Before Training:	*1 g/kg*
During Training:	*0.5 g/kg*
After Training:	*1 - 1.2 g/kg*

Proteins:	
Per Day:	*1.6 - 1.7 g/kg*
Per Meal:	*0.3 g/kg*
Meals/Day:	*4 - 6 x*

In addition to these macronutrients athletes should focus on a wide variety of food to ingest all different micronutrients and may consider creatine and caffeine supplementation to enhance their performance. For competition emphasize should be on making weight without impairing performance and refeeding between weighing in and the start of the competition.

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