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Training Practices and Ergogenic Aids Used by Male Bodybuilders

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Abstract

Hackett, DA, Johnson, NA, and Chow, C-M. Training practices and ergogenic aids used by male bodybuilders. *J Strength Cond Res* 27(6): 1609–1617, 2013–Bodybuilding involves performing a series of poses on stage where the competitor is judged on aesthetic muscular appearance. The purpose of this study was to describe training practices and ergogenic aids used by competitive bodybuilders and to determine whether training practices comply with current recommendations for muscular hypertrophy. A web-based survey was completed by 127 competitive male bodybuilders. The results showed that during the off-season phase of training (OFF), the majority of respondents performed 3–6 sets per exercise (95.3%), 7–12 repetition maximum (RM) per set (77.0%), and 61- to 120-seconds recovery between sets and exercises (68.6%). However, training practices changed 6 weeks before competition (PRE), where there was an increased number of respondents who reported undertaking 3–4 sets per exercise at the expense of 5–6 sets per exercise ($p < 0.001$), an increase in the number reporting 10–15RM per set from 7–9RM per set ($p < 0.001$), and an increase in the number reporting 30–60 seconds vs. 61–180 seconds recovery between sets and exercises ($p < 0.001$). Anabolic steroid use was high among respondents competing in amateur competitions (56 of 73 respondents), whereas dietary supplementation was used by all respondents. The findings of this study demonstrate that competitive bodybuilders comply with current resistance exercise recommendations for muscular hypertrophy; however, these changed before competition during which there is a reduction resistance training volume and intensity. This alteration, in addition to an increase in aerobic exercise volume, is purportedly used to increase muscle definition. However, these practices may increase the risk of muscle mass loss in natural compared with amateur bodybuilders who reportedly use drugs known to preserve muscle mass.

Key Words muscular hypertrophy, resistance training, concurrent training, strength training

Introduction

Bodybuilding as a sport involves performing a series of poses on stage where judges rank each competitor on aesthetic appearance based on muscular mass, symmetry, and definition. The American College of Sports Medicine (ACSM) recommends that advanced trainers targeting muscular hypertrophy use multiple sets (3–6 sets) of moderate to heavy loads (i.e., majority of training devoted to 6–12 repetition maximum (RM) and less training devoted to 1–5RM), with rest periods between sets of 60–180 seconds depending on the loading used (27). Additionally, it is recommended that 1 or more of these program variables are altered over time (i.e., periodization) to allow for the training stimulus to remain challenging and effective (27). However, it is not known if current competitive bodybuilders follow training practices in agreement with these recommendations. Self-reported practices of competitive bodybuilders suggest that these athletes separate training into off-season (OFF) and pre-competition (PRE) phases (10,18). Within the OFF phase, bodybuilders are commonly cited as following high-volume (repetitions × sets × load) split training routines, which involve training muscle groups once (5-day split) or twice (3-day split) per week (15,39), and advanced overload techniques such as pyramids, negatives, supersets, and forced repetition sets (8).

It is well known that bodybuilders commonly use anabolic-androgenic steroids (AAS) to increase muscular hypertrophy (12,24). Supraphysiological administration of AAS can increase muscular strength and muscle mass (9); however, there are various health risks associated with excessive doses or long-term use (26). Bodybuilders are also known to use dietary supplementations to enhance training gains (12,24). In conjunction with resistance exercise, supplementing with protein, branched-chain amino acids, or creatine before and after a training session has been shown to increase muscle mass and strength (6,35,36). Currently, the prevalence rate of steroid use and dietary supplementation among competitive bodybuilders is unknown.

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The PRE phase generally commences 8–12 weeks before a bodybuilding competition, where training is focused toward reduction of body fat to very low levels while retaining muscle mass. Bodybuilders reportedly perform large volumes of aerobic exercise accompanied with caloric restriction during this phase to help increase the rate of fat loss (10,16,18). During this phase, bodybuilders using AAS reportedly modify their "stacks" (i.e., combination of drugs) to ensure minimal muscle mass loss (24). However, natural bodybuilders (i.e., do not use performance-enhancing drugs) are at risk of losing muscle mass during this phase if engaging in large volumes of aerobic exercise. Evidence suggests that large volumes of aerobic exercise performed concurrently with high-intensity resistance training may attenuate muscular hypertrophy, in part, as a consequence of elevated circulating cortisol associated with endurance exercise which promotes a catabolic environment (2,11,14). If large volumes of aerobic exercise are performed within a condensed period, this may be counterproductive for the natural bodybuilder.

The purpose of this study was to investigate the training practices and ergogenic aids used by competitive male bodybuilders. Self-reported survey responses were obtained to assess (1) whether training practices are in agreement with the ACSM recommendations for muscular hypertrophy, (2) whether there is a major shift in the self-reported training practices between the OFF and PRE phases, and (3) the use of drugs and supplements. The competitive bodybuilders' responses were also compared with those reported by 2 elite bodybuilders (natural bodybuilding world champions) to determine whether successful natural bodybuilders used similar training practices and ergogenic aids. It was hypothesized that within the OFF phase, the training practices of competitive bodybuilders would comply with the current ACSM guidelines for muscular hypertrophy but that aerobic exercise volumes would significantly increase in the PRE phase. It was also hypothesized that steroid use would be high among amateur bodybuilders and that a range of dietary supplements would be used. To our knowledge, no previous study has investigated the training practices of competitive male bodybuilders. Such information would be invaluable for future research in bodybuilders and may help identify areas of subsequent study.

Methods

Experimental Approach to the Problem

Although there is a wealth of information documenting the current training practices of competitive bodybuilders in textbooks, magazines, and internet sites, little evidence exists within research literature. Anecdotally, bodybuilders engage in numerous practices that have not been validated by research such as the use of advanced overload techniques to increase muscular hypertrophy; however, it is unknown whether training practices are generally in agreement with the ACSM recommendations. This is an exploratory descriptive study to establish the training practices and ergogenic aids currently used by competitive male bodybuilders and to assess the veracity of the anecdotal claims.

Subjects

The subjects of this study included 127 competitive male bodybuilders (mean ± *SD*, 28.7 ± 6.3 years, 177.5 ± 11.8 cm, 96.6 ± 7.7 kg) with 7.5 ± 1.3 years competitive experience (competed in approximately 8 bodybuilding competitions). Also included in this study were 2 elite male bodybuilders (natural bodybuilding world champions) (28.0 ± 2.1 years, 178.8 ± 4.7 cm, 96.0 ± 2.8 kg) with 11.5 ± 2.8 years competitive experience (competed in approximately 12 bodybuilding competitions). A web-based application (SurveyMonkey) was used to assess the training practices and ergogenic aids used by the bodybuilders. The URL (http://www.surveymonkey.com/) address of the survey was made available to potential subjects through links or postings placed on various bodybuilding websites, and these websites were identified through the use of internet search engines. The survey was available for a 6-month period from March through August 2010. Each subject read and signed (using a checkbox) an informed consent document approved by the University of Sydney Human Research Ethics Committee.

Research Instrument

The survey consisted of 24 questions and was sectioned into 4 areas including background information, resistance training practices, aerobic training practices, and ergogenic aids. The survey questions are shown in Table 1; however, these were both open-ended and fixed response when uploaded to the web-based application. In the survey, the PRE phase was described as the period 6 weeks before competition. Although 8–12 weeks is commonly reported as the time devoted to preparing for a bodybuilding competition, 6 weeks were chosen to capture the most extreme changes in training practices. Subjects were informed that only 1 survey could be submitted from a computer and IP addresses from computers were monitored to avoid duplication of surveys. All surveys were screened so that only respondents who indicated that they had competed in a bodybuilding competition within the previous 12 months were included to ensure accuracy of recall.

Statistical Analysis

Number of sets per exercise, RMs used per set, recovery time between sets, and weekly aerobic training volume for the OFF and PRE phases were compared to determine significant differences in responses. This was analyzed with the Wilcoxon signed rank test using the Statistical Package for the Social Sciences (SPSS version 12.0, Chicago, IL, USA). Statistical significance was accepted at $p < 0.05$. All values are expressed as mean ± *SD*.

Results

Of the 127 respondents, 73 reported competing in amateur competitions (drug testing not always implemented) and 54

Table 1. Survey questions.

1. Background information
   1.1. What is your age?
   1.2. What is your height?
   1.3. What is your average off-season body mass?
   1.4. How much mass do you lose in the last 6-weeks prior to a competition?
   1.5. How many years have you been competing in bodybuilding?
   1.6. What types of competitions do you competed in?
   1.7. How many competitions have you competed in and what is your best result?
   1.8. When did you last compete in a bodybuilding competition?
2. Resistance training practices
   2.1. Do you perform whole-body training sessions or split-routines?
   2.2. How many sessions do you perform per week and what is the average duration per session?
   2.3. How many times do you train each of the following muscle groups per week? (*chest, upper and lower back, shoulders, thighs, hamstrings, buttocks, arms, calves and abdominals*)
   2.4. Do you use any advanced overload techniques in your training? (e.g., drop sets, super-sets, negatives, forced repetitions, etc.)
   2.5. If yes, when do you perform them and for what exercises?
   2.6. What is the general training intensity you use during the off-season? i.e., the number of exercises per muscle group, number of sets per exercise, number of repetitions to failure (RM), and recovery between sets and exercises).
   2.7. Do you modify your training during the off-season by lifting heavier loads with lower repetitions (1–5RM)?
   2.8. What is the general training intensity you use during the 6-weeks prior to a competition? i.e., the number of exercises per muscle group, number of sets per exercise, number of repetitions to failure (RM), and recovery between sets and exercises)?
3. Aerobic training practices
   3.1. Do you perform any aerobic training in the off-season?
   3.2. If yes, what type of exercise (e.g., walking, running, cycling, etc.), number of sessions per week, duration per session, and perceived intensity of the exercise.
   3.3. Do you perform any aerobic exercise in the 6-weeks prior to a competition?
   3.4. If yes, what type of exercise (e.g., walking, running, cycling, etc.), number of sessions per week, duration per session, and perceived intensity of the exercise.
4. Ergogenic aids
   4.1. Do you use performance enhancing drugs?
   4.2. If yes, what drugs do you use during the off-season, and 6-weeks prior to a competition?
   4.3. Do you use supplements?
   4.4. If yes, what supplements do you use during the off-season, and 6-weeks prior to a competition?

respondents reported competing in natural competitions (stringent drug testing policy used). A top 5 placing at state-level championships was reported by 36 respondents (22 and 14 respondents in amateur and natural competitions, respectively) with the remaining respondents reporting similar best results at regional competitions (51 and 40 respondents in amateur and natural competitions, respectively). With the exception of the 2 elite bodybuilders, no respondents had placed in a major bodybuilding championship at the international level.

Resistance Training

Split routines were used by all competitive bodybuilders as opposed to training all the major muscle groups within each session (whole-body training sessions), with a frequency of 5–6 training sessions per week. Muscle groups trained in these sessions included the chest, upper and lower back, shoulders, thighs, hamstrings, buttocks, arms, calves, and abdominals. These muscle groups were trained either once (5-day split) (68.8% of respondents) or twice (3-day split) (31.2% of respondents) per week. Training session durations ranged between 40 and 90 minutes. The elite bodybuilders reported performing a 5-day split routine, averaging 60–70 minutes per session, and training no more than 2 muscle groups per session.

Off-Season Phase

Seventy-four percent of respondents reported performing 4–5 exercises per muscle group during the OFF phase, and 95.3% reported undertaking 3–6 sets per exercise. Seventy-seven percent reported performing 7–12 RM per set and 68.6% reported using 61- to 120-seconds recovery between sets and exercises during this phase (Table 2). Eighty-five percent of respondents reported occasionally modifying their training in the OFF phase with the lifting of heavier loads with low repetitions. Aerobic exercise was performed by 64.0% of respondents during the OFF phase. Of these

Table 2. Responses (%) of competitive bodybuilders describing training practices within the off-season (OFF) phase.

	Categories	Responses (%)
Resistance training		
Number of exercises per muscle group	2–3	1.6
	4–5	74.0
	6–7	24.4
Number of sets per exercise	1–2	4.7
	3–4	52.8
	5–6	42.5
Repetition maximums (RM) per set	4–6	23
	7–9	49.1
	10–12	27.9
Recovery between sets and exercises (s)	30–60	1.5
	61–120	68.6
	121–180	29.9
Aerobic exercise		
Weekly volume (min)	30–59	51.7
	60–89	10.6
	90–120	1.7

respondents, 44.3% performed 1–2 sessions per week at low to moderate perceived intensities. Running (68.8%), cross-trainer (elliptical trainer) (61.2%), walking (53.7%), and cycling (39.9%) were the most popular types of aerobic exercises used. The majority of respondents (51.7%) accrued between 30 and 60 minutes of aerobic exercise per week during this phase (Table 2).

The elite bodybuilders reported performing 4–5 exercises per muscle group, with 4–5 sets per exercise of 6–12RM during the OFF phase. Some sessions in the OFF phase involved lifting of heavier loads with lower repetitions (1–5RM). Recovery between sets and exercises ranged from 61 to 180 seconds, depending on the exercise and intensity used. No aerobic exercise was reportedly performed by the elite bodybuilders during the OFF phase.

The majority of respondents (83.2%) reported using advanced overload techniques for most but not all sessions and with only certain exercises. The most popular exercises used for advanced overload techniques were the biceps curl (84.2%), triceps push down (73.3%), chest fly (65.3%), lateral raise (62.8%), calf raise (61.8%), lat pull down (56.7%), leg extension (43.1%), and leg press (42.3%). The advanced overload techniques most commonly used among competitive bodybuilders were pyramids (i.e., progression from lighter loads with greater repetitions to heavier loads with fewer repetitions in subsequent sets) (64.6%), supersets (i.e., 2 exercises performed in succession without rest) (60.6%), forced repetitions (i.e., after reaching concentric failure, a spotter assists the lifter in performing additional repetitions) (50.4%), partial repetitions (i.e., repetitions performed over a portion of the full range of movement) (45.7%), and negatives (i.e., performance of eccentric contractions with a spotter assisting in the concentric phase) (41.7%). The elite bodybuilders reportedly performed pyramids, forced repetitions, and negatives toward the end of a workout during most sessions, using similar exercises to those reported by the competitive bodybuilders.

Pre-competition Phase

Seventy-six percent of respondents reported performing 4–5 exercises per muscle group during the PRE phase, which was similar to the OFF phase (74.0%). There was a significant difference in the reported number of sets per exercise between the OFF and PRE phases ($p < 0.001$, Figure 1). There was a reduction in the number of respondents who reported undertaking 5–6 sets per exercise in the OFF phase and an increase in the number reporting 3–4 sets in PRE phase. There was also a significant difference between the OFF and PRE phases in the reported number of repetitions (hence load) ($p < 0.001$, Figure 2) and recovery time between sets and exercises ($p < 0.001$, Figure 3). For the reported number of repetitions, there was a reduction in the number of respondents who reported undertaking 7–9RM and an increase in the number reporting 10–15RM in the PRE phase. For recovery time between sets and

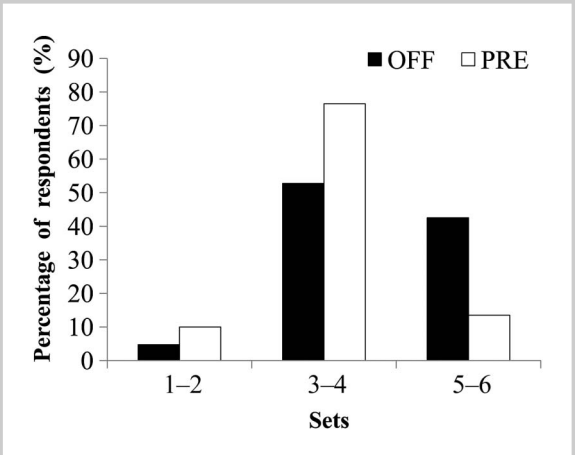

Figure 1. Number of sets per exercise during the off-season (OFF) and pre-competition (PRE) (6 weeks before) phases. OFF vs PRE phase is significantly different ($p < 0.001$).

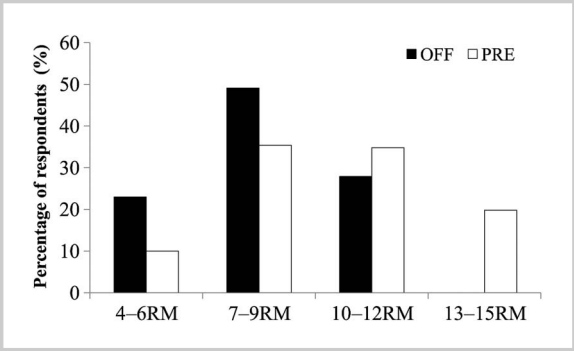

Figure 2. Repetition maximums (RM) used during the off-season (OFF) and pre-competition (PRE) (6 weeks before) phases. OFF vs PRE phase is significantly different ($p < 0.001$).

exercises, there was a reduction in the number of respondents who reported using 61–180 seconds and an increase in the number reporting 30–60 seconds in the PRE phase.

Aerobic exercise was performed by 85.0% of respondents during the PRE phase, with 59.2% performing ≥5 sessions per week (31.7% of respondents competing in natural competitions) and 37.9% performing 2–4 sessions per week (21.4% of respondents competing in natural competitions). There was a significant difference in the reported aerobic exercise volume between the OFF and PRE phases ($p < 0.001$, Figure 4). There was an increase in the number of respondents who reported undertaking 120 to 150+ minutes per week in the PRE phase. The intensity reported for aerobic exercise was most commonly perceived as low to moderate. Types of aerobic exercises used were jogging/running (74.6%), cross-trainer (elliptical trainer) (64.5%), walking (53.2%), and cycling (38.2%).

During the first half of the PRE phase, the elite bodybuilders used the same resistance training practices as in the OFF phase; however, during the last 2 weeks of the PRE phase, less

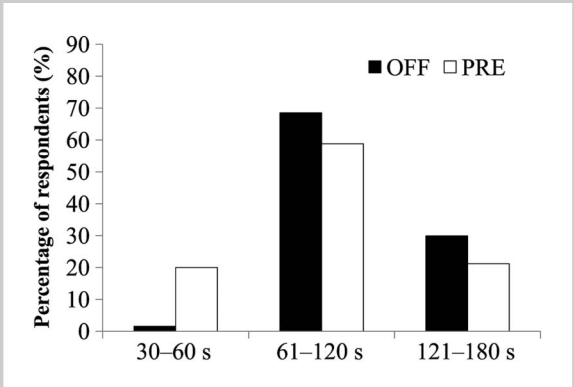

Figure 3. Recovery time between sets and exercises during the off-season (OFF) and pre-competition (PRE) (6 weeks before) phases. OFF vs PRE phase is significantly different ($p < 0.001$).

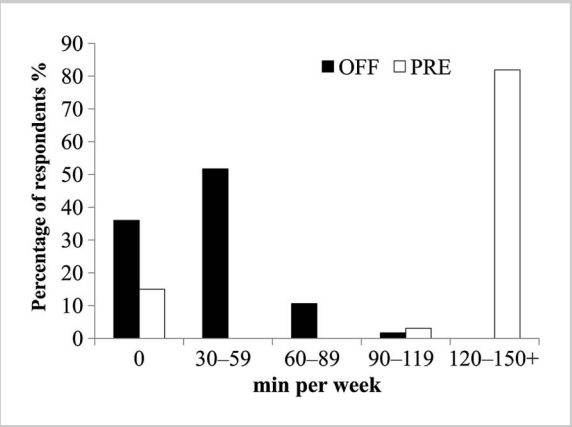

Figure 4. Weekly aerobic exercise volume during the off-season (OFF) and pre-competition (PRE) (6 weeks before) phases. OFF vs PRE phase is significantly different ($p < 0.001$).

sets and slightly more repetitions (lighter loads) per exercise were reported. Aerobic exercise totaling 120 to 150+ minutes per week at a perceived intensity of low-moderate was performed throughout the PRE phase by the elite bodybuilders, with similar types of exercise to the competitive bodybuilders. The competitive bodybuilders reported losing 8.3 ± 3.3 kg (9.1 ± 2.8% of body mass) within the PRE phase in preparation for competition (9.2 ± 2.2% of body mass reportedly lost by respondents competing in natural competitions), which was similar to the 8.0 ± 0.0 kg (9.3 ± 1.2% of body mass) reportedly lost by the elite bodybuilders.

Anabolic-androgenic steroids (AAS) were used by 76.7% of respondents who compete in amateur bodybuilding competitions (56 of 73 respondents), with no use reported among the respondents that compete in natural bodybuilding and among the elite bodybuilders. During the OFF phase, a mean of 3.6 ± 1.3 AAS agents were reportedly used, with the most common being nandrolone (48.1%), sustanon 250 (46.4%), boldenone (42.8%), and testosterone (36.5%). During the PRE phase, a mean of 3.3 ± 1.6 agents (a combination of AAS and nonsteroidal ergogenic agents) were reportedly used. The AAS agents most commonly used in the PRE phase were stanozolol (52.2%), boldenone (31.2%), and oxandrolone (18.2%). Nonsteroidal agents commonly used in the PRE phase were clenbuterol (54.9%), Liothyronine (45.7%), and Clomifene (33.5%).

Dietary supplements were used by all respondents of the survey. A mean of 3.4 ± 0.9 supplements were reportedly used during the OFF phase, with protein shakes (86.4%), creatine (68.3%), branch chain amino acids (66.9%), glutamine (42.3%), vitamins (39.8%), and fish oil (37.2%) the most popular. During the PRE phase, a mean of 3.7 ± 1.2 supplements were reportedly used with protein shakes (73.6%), branch chain amino acids (68.5%), glutamine (51.3%), vitamins (44.4%), fish oil (42.7%), and ephedrine-containing/caffeine-containing products (24.3%) the most popular. The elite bodybuilders reported

using protein, creatine, glutamine, branch chain amino acids, and vitamins during the OFF phase with the exclusion of creatine during the PRE phase.

Discussion

The aim of this study was to investigate the training practices of competitive male bodybuilders. We used a survey to examine whether training practices were in agreement with the ACSM recommendations for muscular hypertrophy and whether there was a major shift in the self-reported training practices between the OFF and PRE phases. Of the 127 male bodybuilders (73 amateur and 54 natural bodybuilders) who completed the survey and 2 elite bodybuilders (natural bodybuilding world champions), the group results showed that self-reported training practices were in general agreement with the ACSM recommendations for muscular hypertrophy during the OFF phase, confirming our original hypothesis. However, training practices significantly changed during the PRE phase, where there was an increase in the number of respondents who reported: undertaking 3–4 sets per exercise at the expense of 5–6 sets per exercise, an increase in the number reporting 10–15RM per set from 7 to 9RM per set, and an increase in the number reporting 30–60 seconds vs. >61 seconds recovery between sets and exercises. Before competition, there was a tendency for respondents to reduce training volume and intensity away from that which would maximize hypertrophy. Furthermore, aerobic exercise volume increased in the PRE vs. OFF phase with the majority of respondents undertaking 120–150+ minutes per week at this time, confirming our original hypothesis. During the OFF phase, the majority of respondents reported undertaking 30–59 minutes of aerobic exercise. Training practices reported during the OFF and PRE phases were generally similar between competitive bodybuilders and our subgroup of elite bodybuilders. Steroid use was high among the amateur bodybuilders, whereas dietary supplementation was used by all respondents (protein, creatine, and branch chain amino acids the most popular) in agreement with our original hypotheses.

Increases in muscle mass following a resistance training program are apparently accounted for by myofibrillar hypertrophy (i.e., increase of sarcomeres and myofibrils added in parallel) (22,31). Additionally, some researchers have suggested that increases in muscle mass may partly be the result of an increase in fiber number (1), although evidence in human subjects is lacking (17,19). Muscular hypertrophy is dependent on numerous hormones (e.g., testosterone, growth hormone, insulin-like growth factor, and cortisol) and cytokines (e.g., hepatocyte growth factor, interleukin (IL)-5, IL-6, fibroblast growth factor, and leukemia inhibitory factor) responses (30). The greatest acute elevations of anabolic hormones such as testosterone, growth hormone, and insulin-like growth factor tend to be produced following resistance exercise protocols high in volume and moderate to high in intensity (13,21), which is similar to the training practices reported from our survey.

The majority of respondents in our survey used training practices consisting of high volume (4–5 exercises per muscle group) and multiple sets (3–6 sets). The exercise volume needed for optimal gains in muscular hypertrophy is suggested to increase with training status, so that competitive bodybuilders may have to perform ≥10 sets per muscle group compared with novices (4–5 sets per muscle group) (25). From our data, the respondents performed 12–30 sets per muscle group which gives an indication of their high training status. Moderate to heavy loads (6–12RM) with periodic lifting of heavy loads (1–5RM) were used by the majority of respondents, which is in agreement with ACSM recommendations (27). Whether low RM (1–5RM) or moderate RM (6–12RM) is more effective for increasing muscle mass has been a matter of debate, although the consensus is that 6–12RM seems to optimize the muscular hypertrophic response (27). However, limiting resistance exercise prescription to load magnitude (i.e., RM), number of repetitions and sets, recovery between sets, and frequency of sessions per week may be insufficient to determine the resistance exercise stimulus. It has been suggested that the inclusion of other information such as time under tension, range of motion, and rest between repetitions should be identified when prescribing resistance exercise (32).

The majority of respondents self-reported using moderate (61–120 seconds) recovery between sets and exercises that complies with current recommendations for muscular hypertrophy (27). Recovery of this duration has been shown to induce greater hypoxia, which may lead to increased muscle growth (32). Additionally, moderate recovery between sets of resistance exercise is also associated with greater metabolic build-up resulting in large acute spikes in anabolic hormone concentration (4,13). However, Buresh et al. (5) found that short recoveries (60 seconds) between sets of resistance exercises elicited a greater anabolic growth hormone response compared with longer recoveries (150 seconds) within the first 5 weeks, but this difference disappeared following 10 weeks of training. This suggests that there may be a post-adaptive response by the muscles to the shorter recoveries, and therefore, variation of training may be required to elicit elevations in anabolic hormones over a longer period. This may be achieved through varying the types and/or order of resistance exercises during a training session (28).

There is currently little published information on the types of split routines used by bodybuilders. Evidence from our sample population showed that split routines involving training muscle groups either once (5-day split) or twice (3-day split) per week were commonly used. It is currently unknown which split routine is more effective for maximizing muscular hypertrophy, although it is interesting to note that the 2 elite bodybuilders reported using 5-day splits. Despite studies showing that training a muscle group once per week is effective for muscular hypertrophy (20,21), Vikne et al. (34) and Wirth et al. (37) found that muscle groups

trained 2 and 3 times per week yielded twice the increase in muscle cross-sectional area compared with once per week in strength-trained subjects and power athletes. These findings were supported by the data of McLester et al. (20) who showed superior muscular hypertrophy within strength-trained subjects from training muscle groups 3 times per week vs. once, despite equal weekly training volume. This suggests that stimulating a muscle group once per week may not be enough to maximize muscular hypertrophy; however, further research on training frequency in trained subjects is warranted.

Pyramids and supersets were the most commonly used advanced overload techniques, although it is not possible, with the current data, to know how often they were used within training sessions. Advanced overload techniques are thought to enhance the hypertrophic response to resistance exercise via targeting the 3 basic factors (i.e., mechanical tension, muscle damage, and metabolic stress) implicated in promoting exercise-induced muscle hypertrophy (29). Depending on the type of overload technique, these factors may work in tandem to produce a synergistic effect on the muscle.

In contrast to the OFF phase, an increased number of respondents in our sample population reported performing 10–15RM per set per exercise and 30–60 seconds recovery between sets and exercises. Higher repetitions and short recovery between sets and exercises are thought to improve muscle definition and increase the rate of metabolism to aid fat loss (3). In addition, higher repetitions are also used to deplete muscle glycogen stores, which when combined with manipulation of dietary carbohydrate intake for subsequent glycogen supercompensation may increase the "fullness" of a muscle (7,23). The major goal of the PRE phase is to reduce body fat while retaining muscle mass. This is more challenging for natural bodybuilders compared with amateur bodybuilders who reported using drugs known to preserve muscle mass (e.g., stanozolol, boldenone, oxandrolone) (24). Natural bodybuilders risk losing significant muscle mass if training is performed using lighter loads (>12RM) with short recovery between sets and exercises (30–60 seconds) for the duration of the PRE phase (15,27). This risk may be reduced in the elite natural bodybuilders who reportedly use lighter loads only during the last 2 weeks before a competition.

A notable training feature during the PRE phase among the respondents and the elite bodybuilders in our study was the increased volume of aerobic exercise. Aerobic exercise together with dietary restriction is commonly used by bodybuilders during the weeks leading up to a competition to improve muscular definition, with the amateur bodybuilders also using a combination of drugs to increase the rate of body fat loss (e.g., Clenbuterol and Liothyronine). Respondents reportedly lost approximately 9% (similar for natural and amateur bodybuilders) of body mass during the PRE phase, which was similar to the 9–16% of body mass loss reported in bodybuilders preparing for competition in other studies (33,38). Despite a similar loss of body mass for the natural and amateur bodybuilders during the PRE phase, it is speculated that greater muscle mass loss may occur in the natural bodybuilders performing high volumes of aerobic exercise. Studies have shown that concurrent resistance and high-volume aerobic exercise attenuate muscular hypertrophy and suppress muscular strength development (2,11,14). However, significant muscle mass and strength losses in amateur bodybuilders with concurrent training are unlikely because of the muscle-preserving drugs reportedly used in this phase.

Dietary supplementation and drug use among bodybuilders is well known and was confirmed by the results of our survey. Because of the extensive research showing performance and body composition improvements from training when supplementing with protein, branch chain amino acids, and creatine (6,35,36), it was unsurprising that these were the most reportedly used. Dietary supplements pose less of a threat to the health of a bodybuilder compared with AAS (26). Some associated health risks of AAS abuse include irreversible organ damage, hypertension and atherosclerosis, blood clotting, jaundice, hepatic neoplasms and carcinomas, tendon damage, and psychiatric and behavioral disorders. Anabolic-androgenic steroids use will likely result in greater increases in muscle strength and mass compared with dietary supplements (9), and it is unrealistic to expect amateur and professional athletes to cease AAS usage (especially if the drug testing policy is not stringent). Therefore, a greater emphasis should be placed on AAS education and encouraging the users to have regular medical check-ups to reduce these risks.

In conclusion, the results of this study provide evidence documenting the training practices and ergogenic aids currently used by competitive male bodybuilders. The data show that competitive male bodybuilders use numerous training practices and ergogenic aids when preparing for a competition. Competitive bodybuilders comply with current ACSM recommendations for muscular hypertrophy in the off-season; however, training practices changed before competition during which resistance exercise volume and intensity are reduced and aerobic exercise volume increases.

Practical Applications

The results of this study show the rigorous training practices used by bodybuilders preparing for competition. Despite the reported resistance training practices generally in agreement with the ACSM recommendations for increasing muscular hypertrophy, there is a lack of research evidence to support the use of advanced overload techniques. These techniques may be effective for enhancing muscular hypertrophy; however, confirmation is needed to create specific guidelines for their use. Another common resistance training practice unfounded is the use of higher repetitions with short recovery between sets for increasing muscular definition. Considering that muscle definition is a combination of muscle size and subcutaneous adipose tissue in that area, using lower loads to

enable a greater amount of repetitions may result in muscle mass loss, which would inevitably reduce muscular definition. However, this may not be applicable in the case of professional and amateur bodybuilders who reportedly use drugs in the pre-competition phase to reduce body fat and preserve muscle mass. Future research is needed to identify the most effective training strategies for natural bodybuilders during this phase. In the meantime, natural bodybuilders should follow similar resistance training practices to the elite natural bodybuilders (i.e., higher repetitions and shorter recovery between sets and exercises only during the final 2 weeks of the pre-competition phase). Additionally, natural bodybuilders should mainly rely on dietary manipulation strategies (e.g., reduced caloric intake) to lose body fat as opposed to high volumes of aerobic exercise because of the risk of losing muscle. However, if aerobic exercise is required to help accelerate the rate of fat loss, the increase in volume should be gradual with regular periodic anthropometry assessments used to monitor changes in body composition.

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