

Training, Supplementation, and Pharmacological Practices of Competitive Male Bodybuilders Across Training Phases

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Abstract

Hackett, DA. Training, supplementation, and pharmacological practices of competitive male bodybuilders across training phases. *J Strength Cond Res* 36(4): 963–970, 2022—Bodybuilding involves the pursuit of muscularity and leanness primarily through the use of progressive resistance training in combination with other practices such as manipulation of diet and use of ergogenic aids. This study aimed to compare the training practices and ergogenic aids used by competitive male bodybuilders across training phases. An online survey was completed by 235 competitive male bodybuilders with a median age of 26.0 (interquartile range 23.0–31.3) years. Results showed that most respondents performed split-routines (85.5%), 4–7 sessions per week (95.7%), trained major muscle groups twice a week (>50%), and session duration being 60–90 minutes (55.7%). Off-season resistance training sessions mostly comprised of targeting 2–3 muscle groups (56%), 2–3 exercises per muscle group (60.4%), 3–4 sets per exercise (73.2%), 7–12 repetition maximum (RM) per set (71.6%), and 61–180 seconds recovery between sets and exercises (80.5%). At the precompetition phase (6 weeks before competition), there was a decrease in the number of muscle groups trained per session ($p = 0.027$) and a greater number of repetitions performed per set ($p < 0.001$). A significant increase in the reported aerobic exercise volume was found during precompetition (<0.001). Performance enhancing drugs were used by 53.6% of respondents who did not compete in natural bodybuilding competitions. Dietary supplements were used by 95.7% of respondents with the most common being creatine monohydrate (80.4%) and whey protein (65.8%). Findings suggest that competitive bodybuilders follow resistance training practices consistent with the broad muscular hypertrophy recommendations but a notable shift in practices occur in the weeks before competition.

Key Words: muscular hypertrophy, resistance training, periodization, advanced training techniques, supplementation

Introduction

Bodybuilding is an activity of developing musculature primarily through the use of progressive resistance training and is complemented with diet-related changes. Popularity of bodybuilding has been increasing over the past 2 decades both as a recreation and competitive sport (11,16,41). For competitive bodybuilders, training and dietary practices are focused on achieving an “ideal” physique for contests where specific comparative poses are performed in front of a panel of judges (11). During contests, bodybuilders are ranked on muscle symmetry, definition, size, and posing (22). Preparation for a bodybuilding contest typically involves months of resistance training practices targeting muscle hypertrophy and strict dietary practices (i.e., adequate protein intake and caloric surplus) (27,41). The term for this phase of a bodybuilder’s preparation is the “off-season.” However, approximately 20–30 weeks before a contest, training and diet are focused on fat loss while minimizing muscle loss (4,5,23). This period is referred to as the “precompetition” phase and involves caloric restriction usually with the prioritization of protein intake compared with other macronutrients (4,27). Numerous studies to date have examined dietary practices and nutritional strategies of bodybuilders (3,4,18,39). In addition, there have been numerous case studies published on preparation for

bodybuilding contests (7,12,28) and adverse events associated with bodybuilding practices (17,20,26). However, less research has focused on the training practices of competitive bodybuilders, especially in large cohorts.

Resistance training recommendations for advanced trainers (such as bodybuilders) targeting muscle hypertrophy includes performing 3 to 6 sets of 1–12 repetitions using 70–100% 1 repetition maximum (1RM) with 1–3 minutes recovery between sets (25). Training is to be conducted in a periodized manner with loads of 6–12RM mainly used, but some training with loads of 1–6RM (25). These loads have been suggested to provide adequate mechanical tension (33), which is purported to be the primary driver of resistance training-induced muscle hypertrophy (31,44). Both metabolic stress and muscle damage also contribute to the hypertrophic process (albeit to a lesser extent) (31,44). However, there is evidence that similar muscle hypertrophy is achieved with lighter loads of 30–60% 1RM provided that sets are performed to volitional fatigue (30). Comparable levels of muscle activation and anabolic protein signaling has been found after sets with light (<60% 1RM) vs. heavier loads to failure (21). Potentially, lighter loads performed to failure increase metabolic stress (i.e., H^+ , P_i , ammonia, and lactate accumulation) within working muscle fibers that augment muscle activation and induce mechanical tension on larger proportion of muscle fibers (6). Although, there are numerous acute programming variables (e.g., load, volume [repetitions \times load], and recovery between sets) that can be manipulated to promote exercise-induced muscle hypertrophy. To

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further enhance muscle hypertrophy, the use of advanced training techniques such as drop sets, supersets, and forced repetition sets have been advocated (32) and are reportedly performed by bodybuilders (1,13). Bodybuilders also reportedly perform split-training routines, where muscle groups are trained either once (5-day split) or twice (3-day split) per week compared with whole-body sessions where all major muscles are trained in every session (7,29).

During the precompetition phase, bodybuilders reportedly make changes to their training practices to increase their physical leanness. In particular, a greater volume of aerobic exercise is performed in combination with caloric restriction to assist with fat loss (7,12,28). Because there is also an attempt to maintain muscle mass during the precompetition phase, it seems that resistance training practices do not change (19,28). In addition, it is well reported that supplements and performance enhancing drugs play an important role in enhancing the physique of a bodybuilder (18,39,40). Bodybuilders may compete in contests that are sanctioned as “natural” with these organizations and officials often being guided by drug-related policies and discourses from the more established sports, particularly the World Anti-Doping Agency (15). There can be a number of policy differences between the natural bodybuilding federations such as the time requirements for a drug-free status, substances banned, testing policies and methods, and sanctions for anyone identified as being “non-natural” (5,15). As an example, the British Natural Bodybuilding Federation uses a drug testing policy where every finalist is polygraphed and all class winners at every show are urine tested (15). This organization also performs random drug testing in the off-season. Therefore, practices of bodybuilders not competing in natural contests may differ compared with bodybuilders who do. Competitive bodybuilders often use anabolic-androgenic steroids (AASs) to enhance muscle mass during the off-season (40). In addition, to enhance body composition many other performance enhancing drugs are reportedly used by bodybuilders, such as hormones (e.g., human growth hormone, insulin, thyroid hormones, human chorionic gonadotrophin, and peptide hormones), drugs for losing fat (e.g., clenbuterol, ephedrine, and amphetamines), and other drugs (e.g., selective androgen receptor modulators and diuretics) (24). Bodybuilders also use additional drugs to reduce the side effects of AASs (e.g., gynecomastia) (24).

Because of social media, a greater amount of research can be disseminated that likely influences many of the practices used by current bodybuilders. Due to the rapid rate at which information is spreading, an up-to-date analysis of bodybuilding training practices, supplementation, and performance enhancing drug usage is needed. This study aimed to compare the training practices and ergogenic aids used by competitive male bodybuilders between the off-season and precompetition phases. It was hypothesized there would be no differences in resistance training practices during the off-season and precompetition phases. However, it was expected that an increase in aerobic exercise volume would be observed during the precompetition compared with the off-season phase. It was also hypothesized that steroid use would be prevalent among bodybuilders not competing in “natural” competitions and that a range of different dietary supplements would be used, influenced by the training phase.

Methods

Experimental Approach to the Problem

The practices of competitive bodybuilders seem to be constantly evolving because of advances in science and technology. Most studies exploring the practices of competitive bodybuilders have focused on dietary supplementation and pharmacological practices (18,39,40).

Little focus has been given to the scientific study of training practices of competitive bodybuilders despite the abundance of anecdotal reports in various communication channels, such as the internet, textbooks, and magazines. Because of the increasing popularity of competitive bodybuilding, it is imperative to conduct a comprehensive evaluation of training, supplementation, and pharmacological practices in a large cohort. This exploratory descriptive study will provide an up-to-date overview of the practices used by competitive male bodybuilders and primarily evaluate whether the training practices used are evidence based. Information was collected through an online survey. Training practices data were statistically analyzed to compare whether changes occurred between the off-season and precompetition phases. For all other data (e.g., supplementation and performance enhancing drug usage) descriptive statistics were used.

Subjects

Two hundred thirty-five competitive male bodybuilders (median age 26.0 (interquartile range [IQR] 23.0–31.3) years; height 177.0 (172.0–182.5) cm; body mass 88.0 (81.8–95.0) kg) participated in this study. An online survey was developed using REDCap (Research Electronic Data Capture) digital and was hosted on the University of Sydney’s REDCap server. The survey was titled “training practices used by male bodybuilders” and access was made available through a study webpage to potential subjects. Eligibility criteria included being men, aged ≥ 18 years, and having competed or currently in training to compete in a bodybuilding contest. However, it was later decided that respondents who were competing in their first competition would be excluded because of incomplete information surrounding the precompetition phase. The study was advertised on social media (Facebook, Instagram, and Twitter) and was available from April 2018 to February 2020. Each subject read and signed (using a checkbox) a written informed consent document. The study was approved by The University of Sydney Human Research Ethics Committee (approval number: 2018/158).

Procedures

Bodybuilding Survey. The survey was initially developed and then piloted over a couple of months on a group of approximately 20 bodybuilders. Feedback (both verbal and written) was provided from this group as well as a few academic staff to improve the tool, and these changes were then implemented. The revised survey was then piloted on another small group of bodybuilders with further feedback leading to minor changes. The final version of the survey consisted of 28 questions that were divided into 4 subgroups, including background information, resistance training practices, aerobic training practices, and ergogenic aids. Specific questions included in the survey are shown in Table 1; however, these were mostly fixed response (with some open-ended), when designed online. Questions asked related to both the off-season and precompetition phases. For this study, the precompetition phase pertained to the period 6 weeks before competition, to capture the most extreme changes in practices. Surveys were screened to determine potential duplicates and questionable responses (e.g., untruthful responses indicated by unrealistic respondent characteristics).

Statistical Analyses

Responses are reported as a percentage (i.e., the number of responses divided by the number that answered a survey item), and

Table 1
Survey questions.*

1. Background Information	2.10. Do you periodize your training during the off-season?
1.1. What is your age?	2.11. If yes, briefly describe
1.2. What is your height?	2.12. What exercises do you perform during your resistance training sessions (chest, back, shoulders, legs, arms, and abdominals)?
1.3. What is your average off-season body mass?	3. Aerobic Training Practices
1.4. How much body mass do you lose in the last 6 wk before a competition (precompetition)?	3.1 Do you perform any aerobic training in the off-season?
1.5. How many years have you been competing in bodybuilding?	3.2 If yes, what type of exercise (walking, running, cycling, etc.), number of sessions per week, duration per session, and perceived intensity of the exercise?
1.6. What types of competitions do you compete in?	3.3 Do you perform any aerobic exercise in the 6 wk before a competition?
1.7. How many competitions have you competed in and what is your best result?	3.4 If yes, what type of exercise (walking, running, cycling, etc.), number of sessions per week, duration per session, and perceived intensity of the exercise?
1.8. When did you last compete in a bodybuilding competition?	4 Ergogenic Aids
2. Resistance Training Practices	4.1 Do you use performance enhancing drugs?
2.1. Do you perform whole-body training sessions or split-routines?	4.2 If yes, what drugs do you use during the off-season and 6 wk before a competition?
2.2. How many sessions do you perform per week?	4.3 Do you use supplements?
2.3. What is the average duration per session?	4.4 If yes, what supplements do you use during the off-season, and 6 wk before a competition?
2.4. 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)	
2.5. Do you use any advanced training techniques in your training? (drop sets, supersets, negatives, forced repetitions, etc.)	
2.6. If yes, when do you perform them and for what exercises?	
2.7. What is the typical training prescription you use during the off-season? (i.e., number of muscle groups trained, exercises per muscle group, number of sets per exercise, number of repetitions to failure (RM), and recovery between sets and exercises)	
2.8. Do you modify your training during the off-season by lifting heavier loads with lower repetitions (1–5RM)?	
2.9. What is the typical training prescription you use during the 6 wk before a competition? (i.e., number of muscle groups trained, exercises per muscle group, number of sets per exercise, number of repetitions to failure (RM), and recovery between sets and exercises)	

*RM = repetition maximum.

respondent characteristics are presented as median with IQR. Muscle groups trained in sessions, exercises performed per muscle group, sets per exercise, RMs used per set, recovery time between sets, and the aerobic training prescription variables for the off-season and precompetition phases were compared, to determine significant differences in responses. The Wilcoxon signed-rank test was used for the resistance training data (because of equal sample sizes between phases), and the Mann-Whitney *U* test was used for aerobic training data (because of unequal sample sizes between phases). The SPSS (SPSS version 24.0, Chicago, IL) was used for all data analysis. Statistical significance was accepted at $p < 0.05$.

Results

Of the 235 respondents, there were 165 respondents who competed in natural competitions. Most respondents competed in amateur competitions, although 13 respondents reported competing at the professional level (including 2 respondents in natural competitions). There was a median of 3.0 (1.0–5.0) years' experience competing in bodybuilding with respondents having competed in a median of 3.0 (1.0–5.0) contests. A median of 303.3 (68.1–626.2) days had elapsed since the respondents' last bodybuilding contest.

Resistance Training

Split-routines were used by most respondents (85.5%) with training frequency being either 4–5 sessions (47.2%) or 6–7 sessions (48.5%) per week. The chest, upper back, lower back, thigh,

hamstring, and gluteal muscles were reportedly trained twice a week by >60% of respondents, with approximately 10–20% of respondents training these muscle groups once or 3 times per week. Most respondents also trained the shoulder, arm, and calf muscles twice per week (>50%), followed by approximately 20% of respondents training these muscle groups 3 times per week. The abdominals were directly trained either once (31.1%) or twice (34.5%) per week, followed by 16.6% of respondents training the abdominals 3 times per week. The most commonly reported session duration was 60–90 minutes (55.7%), followed by ≥90 minutes (23.8%).

Off-Season Phase

The reported resistance and aerobic training practices during the off-season are presented in Table 2. Fifty-six percent of respondents reported training 2–3 muscle groups in each resistance training session, with approximately 20% of respondents training 4–5 or ≥6 muscle groups. Most respondents (60.4%) performed 2–3 exercises per muscle group for 3–4 sets (73.2%). Forty percent of respondents reported performing 7–9RM per set, closely followed by 31.3% of respondents reportedly performing 10–12RM. Recovery between sets for 49.4% of respondents was 61–120 seconds, followed by 31.1% of respondents reportedly taking 121–180 seconds rest between sets. Modification of resistance training in the off-season through lifting of heavier loads with low repetitions was reportedly performed by 60.0% of respondents. Aerobic exercise was performed by 58.3% of respondents during the off-season. Of these respondents, 43.8% performed 3–4 sessions per week and 43.8% reportedly

Table 2
Subject responses for resistance and aerobic training during the off-season.

Survey item	Categories	Responses (%)
Typical resistance training session Muscle groups trained (<i>n</i> = 234)	1	2.1
	2–3	56.4
	4–5	21.4
	≥6	20.1
Exercises per muscle group (<i>n</i> = 235)	1	4.3
	2–3	60.4
	4–5	28.1
	≥6	7.2
Sets per exercise (<i>n</i> = 235)	1–2	5.1
	3–4	73.2
	5–6	18.7
	≥7	3.0
Repetition maximums (RM) per set (<i>n</i> = 233)	1–3	14.2
	4–6	7.7
	7–9	31.3
	10–12	40.3
	13–15	6.4
Recovery between sets (<i>s</i>) (<i>n</i> = 233)	30–60	9.8
	61–120	49.4
	121–180	31.1
	181–300	8.1
	≥301	1.7
Aerobic training		
Sessions per week (<i>n</i> = 137)	1–2	43.8
	3–4	43.8
	≥5	14.6
Session duration (min) (<i>n</i> = 137)	10–30	78.1
	31–45	14.6
	>45	11.7
Perceived intensity (<i>n</i> = 137)	Low-moderate	91.2
	Moderate-high	54.7

performed 1–2 sessions per week. Aerobic training session duration for most respondents (78.1%) was 10–30 minutes. Perceived intensities of aerobic exercises were mostly low-moderate (91.2%) intensities, although 54.7% also reported using moderate-high intensities. For the aerobic exercise questions, 67 of the 137 respondents selected more than one response that likely reflects changing of aerobic prescriptions within the off-season. Walking (75.2%), cycling (31.4%), jogging/running (23.4%), cross-trainer (elliptical trainer) (14.6%), rowing (8.0%), and swimming (5.1%) were the most popular types of aerobic exercises used.

Resistance exercises regularly performed by the respondents are shown in Figure 1. Greater than 80% of respondents regularly performed the following exercises: barbell flat bench press, lat pull-down (wide grip), dumbbell lateral raises, barbell back squat, leg curl, leg flexion, leg press, calf raises (standing), dumbbell curls, triceps push-down, and triceps extension. Eighty-nine percent of respondents reported using advanced training techniques during resistance training sessions. The most commonly reported advanced training techniques used were supersets (i.e., performing a set of one exercise followed by another exercise without rest) (85.2%), negatives (i.e., performing eccentric contractions with assistance during the concentric phase) (48.3%), pyramid sets (i.e., progress from lighter loads with higher repetitions, to heavier loads with less repetitions in subsequent sets) (47.8%), partial-repetitions (i.e., repetitions performed with a shortened range of movement) (37.3%), and forced repetitions (i.e., having assistance

to complete additional repetitions after reaching failure) (34.0%). Thirty percent of respondents reported when they would perform the advanced training techniques in training. Of these respondents, advanced training techniques were performed with single-joint exercises (64.1%) and multijoint exercises (37.5%), usually on the last sets (31.3%) and at the end of a session (31.3%).

Sixty-six percent of respondents reported periodizing their training during the off-season. Of these respondents, 116 of the 157 respondents (73.9%) briefly described how they periodized their training. Block periodization (i.e., longer phases concentrating on strength vs. hypertrophy) was performed by 69.0% of respondents. There were 19.8% of respondents who reportedly perform undulating periodization (e.g., alternating strength vs. hypertrophy focus daily or weekly). Resistance training volume increases throughout training cycles were emphasized by 19.8% of respondents, and there were 19.8% of respondents who also reportedly performed a de-loading week (i.e., reduction in volume and/or intensity).

Precompetition Phase

Overall, there were less muscle groups trained in sessions in the precompetition phase compared with the off-season phase ($p = 0.027$) (Figure 2A), with more respondents training ≤ 3 muscle groups ($\geq 60.9\%$). Also, there was an overall greater number of repetitions per set in the precompetition compared with the off-season phase ($p < 0.001$) (Figure 2B) with more respondents performing ≥ 10 repetitions per set. There were no differences between phases for exercises performed per muscle group, sets per exercise, and recovery between sets ($p > 0.05$). Aerobic exercise was reportedly performed by 89.8% of respondents during the precompetition phase. An overall greater number of aerobic exercise sessions were performed by respondents in the precompetition compared with the off-season phase with 57.3% of respondents performing ≥ 5 sessions per week ($p < 0.001$) (Figure 3A). Overall, there was a greater aerobic exercise session duration during the precompetition phase, with 39.8% of respondents performing ≥ 31 minutes per session ($p < 0.001$) (Figure 3B). There was no difference in perceived intensity used for aerobic exercise between training phases ($p > 0.05$). Walking (76.3%), cycling (40.8%) cross-trainer (elliptical trainer) (24.1%), jogging/running (20.9%), stair master (16.6%), and rowing (8.1%) were the most popular types of aerobic exercise during the precompetition phase. Respondents reported losing 4.0 (3.0–6.0) kg body mass within the precompetition phase.

Performance enhancing drugs were used by 53.6% of respondents competing in bodybuilding competitions not sanctioned as “natural” (37 of the 69 respondents), and by 2.4% of respondents who competed in natural bodybuilding competitions. A median of 6.0 (3.5–7.0) drugs was reportedly used by these respondents. The most common drugs reportedly used were testosterone (85.4%), drostanolone propionate (56.1%), stanozolol (46.3%), trenbolone acetate (46.3%), boldenone undecylenate (41.5%), oxandrolone (36.6%), clenbuterol (36.6%), and nandrolone decanoate (31.7%). Fifty-nine percent of respondents reported changing the type of drugs used in the precompetition phase. The drugs most commonly introduced in the precompetition phase were drostanolone propionate (66.7%), stanozolol (50.0%), clenbuterol (41.7%), trenbolone acetate (38.5%), and oxandrolone (33.3%).

Dietary supplements were used by 95.7% of respondents with a median of 5.0 (3.0–7.0) supplements used. The most common supplements reportedly used were creatine monohydrate (80.4%), whey protein (65.8%), multivitamins (31.6%), casein protein (26.2%), fish

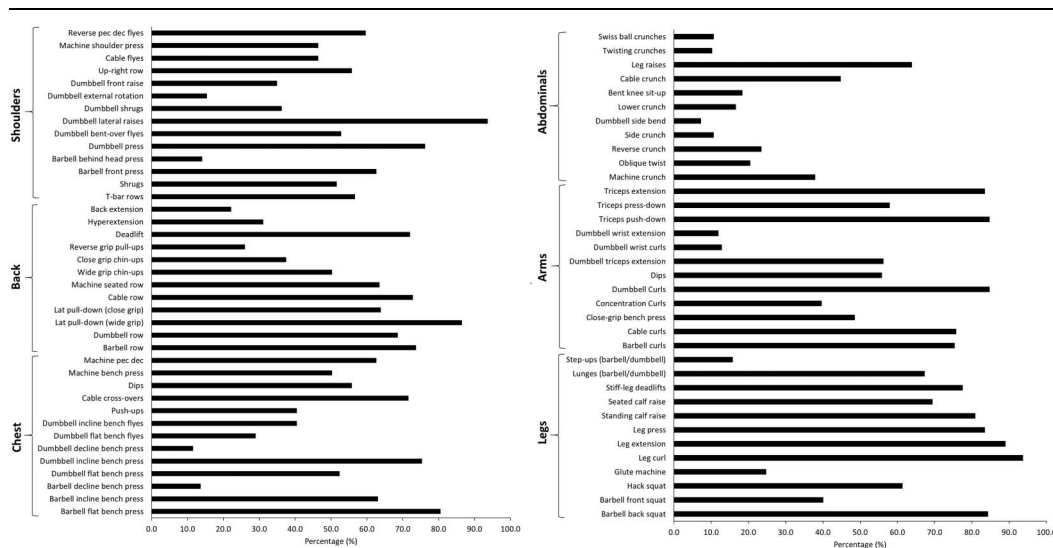


Figure 1. Resistance exercises performed by respondents during the off-season phase.

oil (26.2%), preworkout supplements (24.9%), and caffeine (20.0%). Only 12.9% indicated a change in supplements during the pre-competition phase. The supplements most commonly introduced in the precompetition phase were fat burners (27.6%), caffeine (24.1%), yohimbine (20.7%), and preworkout supplements (17.2%).

Discussion

The aim of this study was to investigate the training practices and ergogenic aids used by competitive male bodybuilders. Of the 235 respondents who completed the online survey, the majority (70%) competed in natural bodybuilding contests. The respondents had a

median of 3 years competition experience and a median of <1 year had elapsed since their previous contest. The resistance training reported during the off-season was generally in agreement with recommendations for muscular hypertrophy. Most respondents reportedly performed split-routines, trained major muscle groups twice a week, and performed 4–7 sessions per week. Moderate-to-high intensities were reportedly used as indicated by most respondents performing 7–12RM per set. In addition, moderate-to-high resistance training volumes were used as expressed by most respondents training 2–3 muscle groups per session, 2–3 exercises per muscle group, and 3–4 sets per exercise. During the off-season, most respondents included advanced training techniques and also periodized their

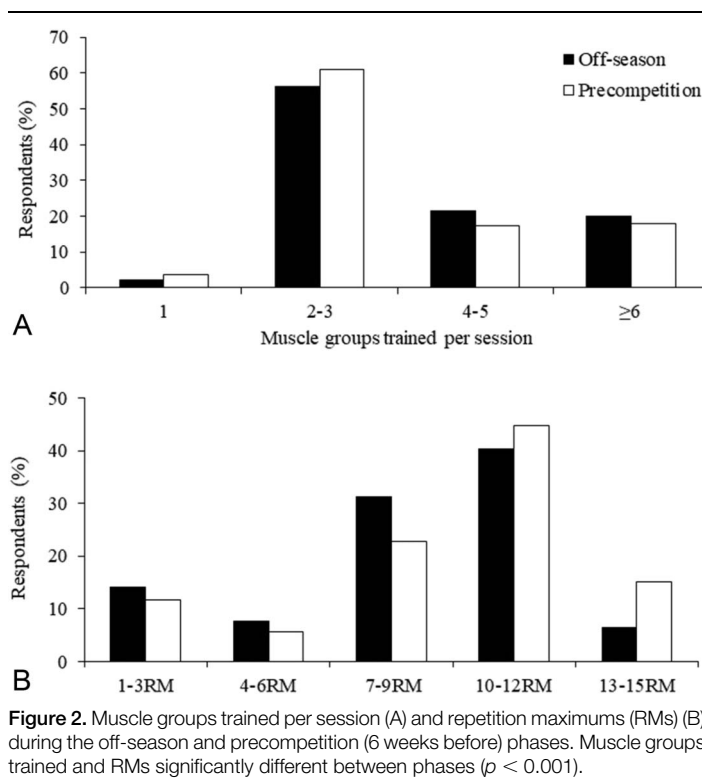


Figure 2. Muscle groups trained per session (A) and repetition maximums (RMs) (B) during the off-season and precompetition (6 weeks before) phases. Muscle groups trained and RMs significantly different between phases ($p < 0.001$).

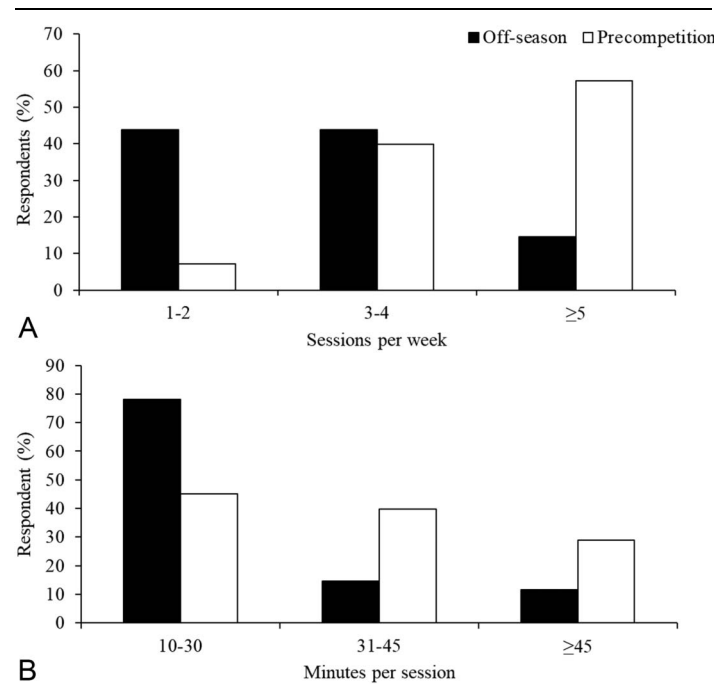


Figure 3. Sessions per week (A) and minutes per session (B) of aerobic exercise during the off-season and precompetition (6 weeks before) phases. Sessions per week and minutes per session significantly different between phases ($p < 0.001$).

resistance training. In the precompetition phase, there was a shift in the resistance training practices toward decreasing the number of muscle groups trained in sessions but an increase in the number of repetitions performed per set, although no other changes were found. Aerobic exercise volume reportedly increased during the precompetition phase, which was in agreement with the original hypothesis. In the pursuit of muscularity and leanness, most respondents who did not compete in bodybuilding contests sanctioned as “natural” reportedly used performance enhancing drugs. In addition, close to all respondents regularly used dietary supplements with the most common being creatine monohydrate and whey protein. Findings suggest that competitive bodybuilders follow resistance training practices consistent with the broad muscular hypertrophy recommendations but a notable shift in practices occur in the weeks before competition.

Muscle hypertrophy is maximized by the manipulation of resistance training variables, such as intensity (load and effort), sets per exercise, repetitions per set, rest between sets, and exercise selection. Of these variables, intensity and volume seem to be the most important for maximizing muscle hypertrophy (30,34). Most respondents reported using 7–12RM that closely aligns with the recommendations of 6–12 repetitions at 70–85% 1RM from the American College of Sport Medicine (ACSM) position stand for muscle hypertrophy (25). In addition, the results from the respondents mostly agree with the National Strength and Conditioning Association (NSCA) recommendations for muscle hypertrophy that includes 6–12 repetitions at 67–85% 1RM performed for 3–6 sets per exercise with 0.5–1.5 minutes rest period between sets (10). There was no option in the survey to allow respondents to indicate whether the sets were not performed to a RM, which is important when using lighter loads (<60%) or even slightly heavier loads for a small number of repetitions. Although RM is not considered to be momentary failure (42), it should be viewed as being close to failure and performing sets with lighter loads to a fatigued state is required to increase muscle activation that enhances the muscle hypertrophic effect (6,21). However, it is assumed that respondents would be performing sets either to RM or close to RM.

A dose-response relationship has been found between the total number of weekly sets and muscle hypertrophy (37). This supports the large volume of resistance training reported by most respondents with 6–12 sets targeting a major muscle group in a session and performed twice per week (12–24 sets per muscle group every week). It should be noted that the training volume could even be higher because exercises targeting the muscle groups listed in the survey might engage more than one of these muscle groups. For example, dips might have been listed by respondents as an exercise targeting the arm muscles (i.e., triceps brachii) but the chest muscles (i.e., pectoralis major) would also likely contribute to the performance (influenced by body position).

The respondents used a wide range of resistance exercises during their off-season training sessions with most performing 4–9 exercises in each session. A combination of both multijoint and single-joint exercises as well as free-weight and machine-weight exercises were reportedly performed. The ACSM recommends the prioritizing of multijoint compared with single-joint exercises when targeting muscle strength and hypertrophy (25). However, there is little evidence that muscle hypertrophy can be optimized through prioritizing either type of exercise (8). There was a trend toward prioritizing single-joint compared with multijoint exercises (64 vs. 37%, respectively) for performing of advanced training techniques. Because multijoint exercises would require more complex movement patterns compared with single-joint exercises, overloading the latter exercise may be a safer option but also enhance the hypertrophic stimulus for a targeted muscle group (35,43). The objective of advanced training techniques is to exploit the factors implicated in the promotion of exercise-induced muscle hypertrophy to a greater extent compared with traditional resistance training prescriptions. In particular, the combination of increasing the mechanical tension placed on a muscle group and accentuating the metabolic stress. The most popular advanced training techniques were supersets (85%), followed by negatives and pyramid sets (approximately 48%). Two reviews that have explored this topic have concluded that the evidence is

inconclusive on whether advanced training techniques are superior to traditional resistance training prescription for muscle strength and hypertrophy (1,13). However, the studies to date investigating this topic have been limited.

Split-routines were performed by greater than 80% of respondents and is commonly associated with the resistance training programs of bodybuilders (7,28,29). Compared with whole-body sessions, split-routines allows the accrual of increased training volumes on specific muscle groups leading to greater metabolic stress, followed by greater recovery between sessions that supposedly enhances the hypertrophic response (38). Sessions targeting specific muscle groups tend to be infrequent due to the large training volume performed during individual sessions, but will ultimately depend on the type of training split. For example, a 2-day split would mean training all major muscle groups in 2 sessions per week compared with a 3-day split where all major muscle groups are trained in 3 sessions per week. Because >50% of respondents reported training major muscle groups twice per week and approximately 96% of respondents reported performing 4–7 sessions per week, it seems that either 2-day or 3-day splits were used. Training muscle groups twice per week is well documented in competitive bodybuilders (7,28,29) and seems to promote greater muscle hypertrophy compared with once a week, but whether greater training frequencies enhance the hypertrophic effects are currently unclear (36). Most respondents (66%) also reported periodizing their off-season training, with block periodization being used by approximately 70% of these respondents. Periodization of training is commonly used to promote better recovery that may reduce the potential for overtraining and injury. The evidence surrounding periodization of resistance training programs on muscle hypertrophy is scarce (9). Furthermore, it seems that the decision on whether the resistance training program of competitive bodybuilders should be periodized and the type of periodization should be made on an individual basis.

The resistance training practices of most respondents showed some minor changes during the precompetition phase, which in this study represented the period 6 weeks before competition. Because of the number of muscle groups trained in each session decreasing during the precompetition phase, it suggests the emphasis of the resistance training was on the maintenance of muscle mass. It would be conceivable that sustaining high volumes of resistance training while undergoing caloric restriction and increased aerobic exercise volume during the precompetition phase may increase the risk of overtraining and injuries. However, Mitchell et al. (19) reported no change in resistance training volume between weeks 16, 8, and 1 before a contest despite an increase in aerobic training volume in the weeks closer to a contest in a cohort of natural male bodybuilders. Potentially, the resistance training volume reported by respondents in this study did not change between training phases because there was an increase in the number of RM in the final 6 weeks before a contest. An explanation for the increase in RM could be to elevate metabolism and increase fat loss that has been reported in competitive bodybuilders (7). Although increased aerobic exercise was performed during the precompetition phase by respondents in an attempt to reduce fat mass, there is evidence that if not adequately managed (through diet and recovery strategies) it may lead to a loss of muscle mass (45). The most common type of aerobic exercise performed was walking (76%), which was performed at least 5 times per week for approximately 30 minutes. However, greater fat loss has been shown after a higher intensity of exercise; where bouts are generally of a shorter duration (2).

A recent study showed that lifetime usage of performance enhancing drugs was high among competitive bodybuilders compared with recreational resistance trainers (63 vs. 10%, respectively) (40). It

was therefore not surprising to find most bodybuilders competing in contests not sanctioned as “natural” reporting the use of performance enhancing drugs. Generally, the respondents used “stacks” (i.e., combination of drugs) that promoted muscle hypertrophy in the off-season with 85% using testosterone plus other androgenic-anabolic steroids, such as drostanolone propionate, stanozolol, trenbolone acetate, and boldenone undecylenate. The type of drugs used during the precompetition phase included drostanolone propionate, stanozolol, and clenbuterol due to their fat loss effects, and testosterone usage stopped during this phase. Although these performance enhancing drugs taken in supraphysiological dosages are effective for achieving their purpose, there have been numerous associated adverse events reported among bodybuilder users (14,17,20). Supplement usage was also high among the respondents with a median of 5 different supplements used. This is in agreement with findings from Chappell et al. (4) where male bodybuilders reported consuming 5–7 supplements during contest preparation. Protein and creatine monohydrate were the most popular supplements used, which is consistent with recommendations for their use among bodybuilders to assist with building muscle size (11). During the precompetition phase, there was the introduction of a variety of stimulants including supplements labeled as fat burners, caffeine, preworkout supplements, and yohimbine (which is a medicinal preparation made from the bark of a tree species of this name). However, it has been previously stated that the efficacy of most of these stimulant supplements for promoting fat loss in bodybuilders is lacking (4,18).

In conclusion, competitive male bodybuilders mostly engage in resistance training practices that align with scientific evidence for the promotion of muscle hypertrophy, with the exception being the use of advanced training techniques. Training practices change during the precompetition phase in an attempt to reduce body fat, although there is also an effort to maintain lean body mass through supplementation with protein and following a similar resistance training prescription to the off-season. A variety of performance enhancing drugs are used by most bodybuilders not competing in “natural” contests, and there are questions concerning the efficacy of numerous supplements, especially for enhancing fat loss.

Practical Applications

The findings from this study show that competitive male bodybuilders are following resistance training practices during the off-season that are largely supported by scientific research for the promotion muscular hypertrophy. However, the use of advanced training techniques was very popular among the bodybuilders despite evidence to date being inconclusive about the effectiveness of this practice. If advanced training techniques are to be used during training sessions, it is well advised to not prioritize at the expense of the traditional resistance training prescription. Also, it is recommended that a strategic approach is used when implementing advanced training techniques, such as during the latter sets of single-joint exercises, so that overall training quality (i.e., load used and repetitions performed) is not negatively affected. During the precompetition phase, the findings from this study showed that male bodybuilders perform large volumes of aerobic exercise. Extra caution is warranted when focusing on fat mass reduction because large volumes of aerobic exercise may lead to a loss of lean mass (7). An alternative training approach could be to substitute with high-intensity interval training (HIIT) that has been reported to be more effective than continuous aerobic exercise for fat loss (2). However, if HIIT is performed, exercise modalities should be selected that reduce impact and

minimize eccentric contractions (e.g., cycling compared to running) in an attempt to avoid injury and any subsequent negative effects on lower-body training. Irrespective of the approach to lose fat mass any changes in training and diet should be gradual, and regular monitoring of body composition is suggested so that modifications can be made to suit individual needs. Finally, dietary supplements and pharmacological agents should be used cautiously, especially for the latter due to the increased risk of adverse health effects (14,17,20). It is advised that bodybuilders consult a medical practitioner before using dietary supplements and pharmacological agents. A medical assessment may identify an underlying health condition in which it would be contraindicated to use dietary supplements and pharmacological agents.

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