International Journal of Sport Nutrition and Exercise Metabolism, 2015, 25, 559-565
http://dx.doi.org/10.1123/ijsnem.2015-0077

Human Kinetics
ORIGINAL RESEARCH

Effect of Two- Versus Three-Way Split Resistance Training Routines on Body Composition and Muscular Strength in Bodybuilders: A Pilot Study

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The purpose of this study was to compare different split resistance training routines on body composition and muscular strength in elite bodybuilders. Ten male bodybuilders (26.7 ± 2.7 years, 85.3 ± 10.4 kg) were randomly assigned into one of two resistance training groups: 4 and 6 times per week (G4× and G6×, respectively), in which the individuals trained for 4 weeks, 4 sets for each exercise performing 6–12 repetitions maximum (RM) in a pyramid fashion. Body composition was assessed by dual energy X-ray absorptiometry, muscle strength was evaluated by 1RM bench-press testing. The food intake was planned by nutritionists and offered individually throughout the duration of the experiment. Significant increases ($p < .05$) in fat-free mass (G4× = +4.2%, G6× = +3.5%) and muscular strength (G4× = +8.4%, G6× = +11.4%) with no group by time interaction were observed. We conclude that 4 and 6 weekly sessions frequencies of resistance training promote similar increases in fat-free mass and muscular strength in elite bodybuilders.

Keywords: strength training, hypertrophy, one repetition maximum

The sport of bodybuilding is an aesthetic pursuit whereby competitors aspire to achieve a combination of high levels of muscularity, complete symmetry between muscles, and very low levels of body fat (Cyrino et al., 2008; Hackett, Johnson, & Chow, 2013). Assuming similar muscular symmetry and definition, the competitor with the largest muscles necessarily has a decided advantage over his opponents. Thus, maximizing muscle hypertrophy is critical for success in the sport.

The ultimate magnitude of hypertrophic adaptations consequent to resistance training (RT) is predicated on the proper prescription of acute program variables (Kraemer & Ratamess, 2004). These variables include volume, load, rest intervals, and training frequency, operationally defined here as the number of training days per week. The vast majority of bodybuilders believe that high training frequencies are necessary to maximize muscular development. A recent survey of 127 competitive bodybuilders found that every respondent trained either 5 or 6 days a week (Hackett et al., 2013). Moreover, all respondents reported using a split-body routine to facilitate these high frequencies, with each muscle group worked either once or twice per week.

Limitations in current research make it difficult to draw conclusions as to whether a dose–response relationship does in fact exist between training frequency and gains in lean tissue mass. In a review of literature, Wernbom, Augustsson, and Thomee (2007) plotted the daily increase in muscle hypertrophy from all relevant studies on the topic and then calculated average values for different training frequencies. With respect to the elbow flexors, gains of 0.18% per day in muscle cross-sectional area (CSA) were seen regardless of whether participants trained 2 or 3 days a week; training 4 days per week produced an increase in CSA of 0.59% per day, but these results were specific to a single study. With respect to the knee extensors, no differences were seen between frequencies of 2 versus 3 training days a week (0.11% vs. 0.11%, respectively). As with the elbow flexors, only one study involved a 4-day-a-week program, and daily increases in CSA were in the order of 0.10%.

While the Wernbom et al. (2007) review provides interesting insight into the effects of different training frequencies on muscular adaptations, the implications of these findings are not clear when training frequency per muscle group is matched on a volume-equated basis.

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Conceivably, packing too much exercise into a given exercise session would cause cumulative fatigue that ultimately diminishes the quality of work performed later in the bout. A potential benefit of greater training frequencies, therefore, is that they allow for total training volume to be distributed over more sessions per week, preserving the quality of exercise performance and thus enhancing results. To the authors' knowledge, only one previous study has endeavored to investigate this topic in a controlled fashion. Calder, Chilibeck, Webber, and Sale (1994) randomized untrained young women to either a total-body (n = 10) or a split-body (n = 10) routine. The total-body group performed four upper body exercises and three lower body exercises twice a week while the split-body group performed the lower body exercises on separate days from the upper body exercises so that training was carried out over four weekly sessions. All participants performed five sets of 6–12 RM to concentric muscle failure. After 20 weeks, both groups significantly increased measures of maximal strength and lean tissue mass with no differences seen between conditions.

To date, no study has compared the effects of training frequency while holding the number of weekly sessions per muscle group constant in highly trained participants. Trained muscle not only differs structurally and functionally from untrained muscle in an untrained state but also shows differences in intracellular anabolic signaling and the acute protein synthetic response to intense RT (Schoenfeld, Peterson, Ogborn, Contreras, & Sonmez, 2015). It is therefore unknown whether there is a benefit to pack more exercise into each session while training fewer days per week versus having shorter RT sessions but training more frequently in this population. Therefore, the purpose of this study was to evaluate the effects of volume- and body part-equated RT protocols performed 4 versus 6 days a week on muscular adaptations in elite bodybuilders. Based on the findings of Wernbom et al. (2007), we chose to employ a split-body protocol whereby each muscle group was worked twice per week as the hypertrophic response to RT plateaus appears to plateau at this frequency. We hypothesized that the group training 6 days a week would realize greater gains in fat-free mass (FFM) and strength compared with the 4-day-a-week group.

Methods

Participants

Ten male professional bodybuilders volunteered to participate in the study; all athletes were elite competitors in Brazil affiliated with the national bodybuilding federation. The participants were randomly assigned to one of the two groups: a group that performed RT four times per week (G4×) (n = 5, 26.6 ± 2.7 years), and a group that performed RT six times per week (G6×) (n = 5, 26.8 ± 3.1 years). The inclusion criteria were that individuals have been professional bodybuilding competitors for at least 3 years, abstained from anabolic steroid use for at least the 6 months leading up to the study, were nonsmokers, and did not consume alcoholic beverages. All participants were in their off-season period, aiming to increase muscular hypertrophy, and all participants had been training six times per week with varied routines. The total testosterone means, standard deviation, and confidence interval of the participants at pre- and posttraining were 622.5 ± 47.7 ng/dl (572.4–672.2), and 558.1 ± 92.7 ng/dl (460.7–655.3), respectively. Written informed consent was obtained from all participants after a detailed description of study procedures. This study was performed in accordance with the declaration of Helsinki, and the experimental protocol was approved by the local University Ethics Committee.

Experimental Design

The study was carried out over a period of 6 weeks, with 4 weeks dedicated to the RT program and 2 weeks used for measurements and evaluations. Anthropometric and body compositions measurements were performed at Weeks 1 and 6 while the supervised RT program was performed during Weeks 2–5. All sessions were supervised by trained fitness personnel. Participants did not perform any other type of exercise during the entire study period.

Body Composition

Body mass (BM) was measured using a calibrated electronic scale (Filizola, Model ID 110, São Paulo, Brazil). The FFM and percentage of body fat (%fat) measurements were carried out using a dual energy X-ray absorptiometry (DXA) scan (Hologic, Waltham, MA). Before scanning, participants were instructed to remove all objects containing metal. Scans were performed with the participants lying in the supine position along the table's longitudinal centerline axis. Feet were secured by taping them together at the toes level to immobilize the legs while the hands were maintained in a prone position within the scanning region. Both calibration and analysis were carried out by a skilled laboratory technician. The equipment calibration followed the manufacturer's recommendations.

Muscular Strength

Maximal dynamic strength was evaluated using the 1RM test assessed on a free-weight bench press (BP). The exercise test was preceded by a warm-up set (6–10 repetitions), with approximately 50% of the estimated load to be used as the first attempt for each test. The regular testing procedure was initiated 2 min after warm-up. The grip for BP was such that the thumbs were at shoulder width when the bar was resting on the support props. Complete range of motion consisted of lowering the bar until it touched the chest and pressing it upward until locking the elbows at the top of the press. The participants were instructed to accomplish two repetitions with the imposed load in each of the three attempts for each exercise. If the participant was successful in the first attempt, weight was added (3–10% of the first-attempt load), a 3–5 min rest was given, and a second attempt was made. If this attempt was successful, a third attempt was given following a 3–5 min rest, with an increased load (3–10% of the second-attempt load). If not successful, weight was the weight that was used on the second attempt minus 3–10% and one other attempt was given. The 1RM was recorded as the last resistance lifted in which the participant was able to complete one single maximum execution. Execution technique and form for each exercise were standardized and continuously monitored to guarantee consistency in maximum strength assessment during the testing sessions.

Resistance Training Program

The RT was carried out during 4 weeks designed to promote muscular hypertrophy. All participants were personally supervised by physical education professionals throughout each training session to reduce deviations from the study protocol and to ensure participant safety.

The G4× performed four RT sessions per week divided in two routines (A and B), where program A was executed on Mondays and Thursdays and composed of exercises for the chest, shoulders, triceps, calf, and abdomen in the following order: BP, incline dumbbell fly, cable crossover, barbell military press, lateral raise, lying triceps French press, triceps pushdown, standing calf raise, seated calf raise, crunch, and cable crunch. Program B was conducted on Tuesdays and Fridays incorporating exercises for the back, biceps, forearm, thigh, and abdomen in the following order: v-bar pulldown, bent over barbell row, seated cable row, arm curl, alternate incline dumbbell curl, seated palm-up barbell wrist curl, seated palm-down barbell wrist curl, squat, leg extension, lying leg curl, oblique crunch, and seated leg tuck.

The G6× performed the same exercises parceled into three routines (A, B, and C). Program A was carried out on Mondays and Thursdays and included exercises for the chest, shoulders, triceps, and abdomen. Program B was performed on Tuesdays and Fridays and consisted of exercises for the back, biceps, and forearms. Program C was carried out on Wednesdays and Saturdays and was composed of exercises for the thigh, calf, and abdomen. Table 1 displays the RT program routines.

For all exercises, the participants performed four sets with the load increasing and number of repetitions simultaneously decreasing for each set (pyramid method). Thus, the number of repetitions used in each set was 12/10/8/6 repetition maximum, respectively, with variable resistance, except to calves (15–20 repetition maximum) and abdomen (150–300 repetition per session). The greater volume of repetitions for the calves and abdominals is based on the premise that these muscles are more endurance oriented and thus need a greater time under tension to maximize muscular development. The load was increased for each set by 2–4 kg for upper body exercises and 3–6 kg for lower body exercises. Participants were instructed to perform each repetition with a concentric-to-eccentric phase ratio of 1:2, respectively. The rest period between sets lasted 1–2 min, with a 2–3 min rest interval between each exercise. The four-times-a-week routine lasted approximately 90–100 min per session on average

Table 1 Exercises Performed by Each Group During a Standard Week

G4×		G6×		
Monday and Thursday	**Tuesday and Friday**	**Monday and Thursday**	**Tuesday and Friday**	**Wednesday and Saturday**
Bench press	V-bar pulldown	Bench press	V-bar pulldown	Squat
Incline dumbbell fly	Bent over barbell row	Incline dumbbell fly	Bent over barbell row	Leg extension
Cable crossover	Seated cable row	Cable crossover	Seated cable row	Lying leg curl
Barbell military press	Arm curl	Barbell military press	Arm curl	Standing calf raise
Lateral raise	Alternate incline dumbbell curl	Lateral raise	Alternate incline dumbbell curl	Seated calf raise
Lying triceps French press	Seated palm-up barbell wrist curl	Lying triceps French press	Seated palm-up barbell wrist curl	Oblique crunch
Triceps pushdown	Seated palm-down barbell wrist curl	Triceps pushdown	Seated palm-down barbell wrist curl	Seated leg tuck
Standing calf raise	Squat	Crunch		
Seated calf raise	Leg extension	Cable crunch		
Crunch	Lying leg curl			
Cable crunch	Oblique crunch			
	Seated leg tuck			

Note. G4× = group that performed resistance training four times a week; G6× = group that performed resistance training six times a week.

while the six-times-a-week routine lasted approximately 60–70 min per session on average.

Dietary Control

At the onset of the study participants were individually interviewed by dietary surveys (24-hr recall, 3-day food record, and general eating habits) to assess the daily nutritional habits of each athlete (means and standard deviations: energy = 54.9 ± 3.5 kcal/kg/d, carbohydrate = 10.4 ± 1,4 g/kg/d, protein = 1,53 ± 0.27 g/kg/d, and lipids = 0.82 ± 0.16 g/kg/d).). Thereafter, a nutritionist established a specific diet for each athlete. The diet was composed of 66 kcal/kg of BM. Dietary protein was fixed at 1.8 g/kg. The remaining calories were apportioned so that ~76% of total energy intake was from carbohydrates and ~13% was from lipids. All foods were selected, tempered, cooked, quantified, and individually delivered to athletes by the nutritionist. The meals were apportioned into six daily meals (breakfast, collation, lunch, snack, dinner, and supper). Total dietary energy, protein, carbohydrate, and fat content were calculated using nutrition analysis software (Avanutri Processor Nutrition Software, Rio de Janeiro, Brazil; Version 3.1.4).

Statistical Analysis

Normality was checked by Shapiro-Wilk's test. Two-way analysis of variance for repeated measures was used for intra- and intergroup comparisons, followed by Tukey's post hoc test. Baseline scores as well as the relative changes differences between groups were explored with an independent *t* test; for the variables that did not present normal distribution the baseline comparisons between groups were made using the Mann–Whitney *U* test. The effect size (ES) was calculated to verify the magnitude of the differences using Cohen's *d* (Cohen, 1988) and classified according to Rhea (2004). Significance was accepted at $p < .05$.

Results

Total macronutrients intakes of both groups are displayed in Table 2. There were no statistically significant differences between groups for carbohydrates, protein, and lipids.

Table 3 shows specific pre- and posttraining values for body composition components and maximal strength according to group. There was no statistical significance for the main effects of group and interaction for any variables. However, main effects of time were reached for FFM, %fat, BM, and 1RM BP, in which both groups increased similarly the values after the intervention. The ESs were considered small in both groups for FFM and BM while the %fat ES was considered trivial for G4× and small for G6×. For the 1RM BP the G6× had an ES of moderate magnitude while the ES for G4× was considered small.

Relative changes in FFM, BM, %fat, and 1RM BP are presented in Figure 1. There were no statistical differences ($p > .05$) between groups for the variables analyzed.

Table 2 Dietary Intake of Bodybuilders According to Training Frequency Groups

	G4× (*n* = 5)	G6× (*n* = 5)	
Nutrients	**Mean ± *SD* (95% CI)**	**Mean ± *SD* (95% CI)**	*p*
Carbohydrates			
Grams	1101.4 ± 144.2 (922.3–1280.3)	1113 ± 149.9 (927.5–1299.8)	.84*
g/kg	13.0 ± 0.4 (12.4–13.4)	13.0 ± 0.4 (12.5–13.4)	.97
Energy (Kcal)	4295.4 ± 562.3 (3597.2–4993.5)	4343.4 ± 584.7 (3617.4–5069.4)	.84*
Energy (%)	76.1 ± 1.2 (74.5–77.5)	76.1 ± 1.2 (74.6–77.6)	.99*
Proteins			
Grams	150.7 ± 25.6 (118.9–182.4)	152.7 ± 26.3 (119.9–185.3)	.90
g/kg	1.8 ± 0.2 (1.5–1.9)	1.8 ± 0.2 (1.5–2.0)	.95*
Energy (Kcal)	617.8 ± 104.8 (487.7–747.9)	626.0 ± 107.9 (491.9–759.9)	.90
Energy (%)	10.9 ± 1.0 (9.7–12.1)	11.0 ± 1.0 (9.7–12.1)	.84*
Lipids			
Grams	78.8 ± 10.2 (66.0–91.4)	78.9 ± 9.1 (67.6–90.2)	.97
g/kg	0.9 ± 0.04 (0.8–1.0)	0.9 ± 0.05 (0.8–1.0)	.85
Energy (Kcal)	732.4 ± 95.1 (614.3–850.4)	734.1 ± 84.6 (629.0–839.1)	.97
Energy (%)	13.0 ± 0.4 (12.4–13.5)	12.9 ± 0.5 (12.3–13.4)	.78

Note. G4× = group that performed resistance training four times a week; G6× = group that performed resistance training six times a week; CI = confidence interval. An asterisk represents nonparametric data.

Table 3 Body Composition Components and Maximal Strength in Bodybuilders (n = 10) According to Training Group at Pre- and Posttraining

	G4× (n = 5)	G6× (n = 5)		
Variables	**Mean ± *SD* (95% CI)**	**Mean ± *SD* (95% CI)**	**Effects**	***p***
Body mass (kg)				
Pre	84.6 ± 8.9 (73.5–95.7)	85.9 ± 12.8 (70.0–101.9)	Group	.84
Post	88.6 ± 8.9* (77.5–99.6)	90.2 ± 13.5* (73.3–107.0)	Time	< .001
Effect size	0.45	0.34	Interaction	.71
Relative body fat (%)				
Pre	14.6 ± 3.5 (10.2–19.0)	14.7 ± 3.1 (10.8–18.6)	Group	.85
Post	15.1 ± 2.6* (11.7–18.4)	15.8 ± 2.9* (12.1–19.5)	Time	< .05
Effect size	0.14	0.35	Interaction	.27
Fat-free mass (kg)				
Pre	72.1 ± 6.6 (63.8–80.3)	73.0 ± 9.1 (61.6–84.4)	Group	.88
Post	75.0 ± 6.4* (67.0–83.1)	75.6 ± 9.9* (63.3–87.9)	Time	< .001
Effect size	0.44	0.29	Interaction	.70
1RM bench press (kg)				
Pre	104.4 ± 19.3 (80.3–128.4)	105.6 ± 16.4 (85.1–126.0)	Group	.81
Post	113.2 ± 23.0* (84.5–141.8)	117.6 ± 16.3* (97.3–137.8)	Time	< .001
Effect size	0.46	0.73	Interaction	.44

Note. G4× = group that performed resistance training four times a week; G6× = group that performed resistance training six times a week; CI = confidence interval; RM = repetitions maximum. *$p < .05$ versus pre.

Discussion

To the authors' knowledge, this is the first study to compare the effects of high training frequencies on muscular adaptations when the number of sessions per muscle group was held constant. The novel and primary finding of this study was that RT performed 4 versus 6 days a week produced equal increases in FFM when training volume was equated between groups. We had hypothesized that an increased training frequency with lower per-session volume would lead to greater improvements in body composition. This hypothesis was refuted, with results indicating that when training muscle groups twice a week with an equated volume, training frequency does not influence body composition outcomes. Results also showed no significant differences in BP 1RM between G4× and G6×, suggesting upper body strength is similarly not enhanced by spreading out an equal volume of training over 6 versus 4 days per week. Based on our findings, it can be inferred that both doubly and triply parceled routines are effective strategies to increase FFM and muscular strength in elite bodybuilders. Therefore, highly experienced lifters can choose the strategy that best suits their preferences and training responses. For example, the higher intrasession volume of training associated with four versus six weekly training sessions may impair performance in some individuals because of general fatigue by the end of the session. Alternatively, the 6-day-a-week routine might not allow for enough recovery between training sessions, potentially hastening the onset of overtraining. These responses should therefore be taken into account on an individual basis to guide program design.

Our findings are consistent with those of Calder et al. (1994), who found similar increases in muscle strength and FFM when splitting the training load between 2 versus 4 days a week in a cohort of young, untrained women. The present study adds to the literature by showing that these results apply to elite bodybuilders using higher frequency routines (4 vs. 6 days per week) more customary of RT in this population. Given that competitive bodybuilders are able to generate extremely high intensities of effort during RT, we had speculated that cumulative fatigue from longer sessions in G4× would lead to performance decrements later in each session. If such decrements did in fact occur, they did not translate into impaired muscular adaptations. It should be noted, however, that these findings are specific to the training volume employed in our protocol, which may have been below the threshold where the quality of work was negatively affected by condensing it into a 4-day-per-week program. We thus cannot rule out the possibility that

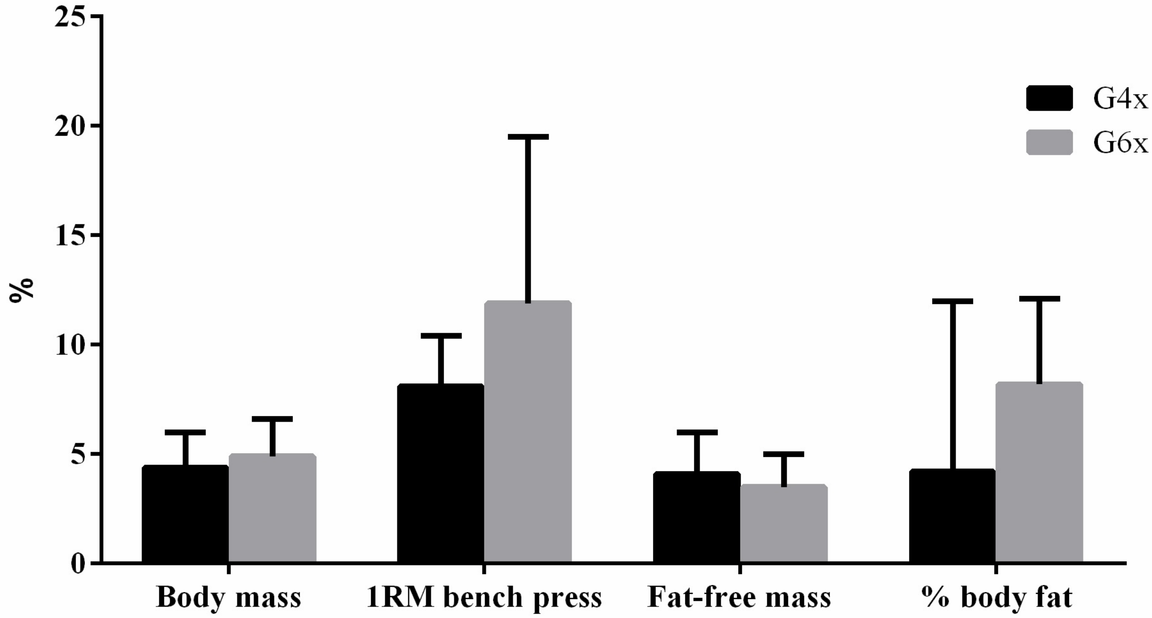

Figure 1 — Relative changes from pre- to posttraining on the body compositions components and maximal strength in bodybuilders. Data are presented as mean and standard deviation.

a greater training frequency may prove beneficial with performance of higher volumes of training. This prospect warrants further study.

A novel aspect of this study was the use of elite-level bodybuilders as participants. It could be hypothesized that because these individuals are able to train with very high intensities of effort over high volumes of RT, the ability to maintain such levels of effort would wane in a longer session and thus impair results. Interestingly, both groups significantly increased FFM over the course of the 4-week training period. Results were of a small to moderate magnitude of effect, which would be practically meaningful in a bodybuilding population. This indicates that even those approaching their genetic ceiling can make meaningful gains provided they follow a properly designed training and nutritional regimen.

A potential advantage of higher training frequencies is the ability to increase volume over and above what is possible when training at lower frequencies. Meta-analytic data shows a dose–response effect between volume and hypertrophy, with higher training volumes leading to greater muscle protein accretion (Krieger, 2010). This dose–response relationship appears to follow an inverted-U pattern where muscular gains peak at a certain volume threshold and negative effects from overtraining ultimately manifest if volume is excessive (Fry & Kraemer, 1997; Wernbom et al., 2007). It is conceivable that an increased training frequency may facilitate enhanced muscular adaptations by allowing for a higher volume of training. Whether the additional volume afforded by these higher frequencies would be optimal or excessive remains to be elucidated.

Although the primary focus of bodybuilding is on physical appearance as opposed to strength, increasing the ability to exert maximal force allows an individual to train with higher overload, thereby increasing the mechanical tension on muscles, a factor that has been shown to play an important role in muscular development (Schoenfeld, 2010). Given that increases in 1RM BP were similar between G4× and G6×, our results indicate that both frequencies are beneficial for improving upper body strength in this population.

Nutritional plans seeking to maximize muscular hypertrophy require achieving a positive nitrogen balance; the relationship between nitrogen and protein is that 1 g of nitrogen is equivalent to 6.25 g of protein, and for each 1 g of nitrogen 150 kcal is necessary to improve the fixation of nitrogen (Lemon, 1991, 1998; Lemon, Tarnopolsky, MacDougall, & Atkinson, 1992). Given this information, we provided participants a diet with approximately 1.8g/kg/day of protein, which results in approximately 30 kcal/g/protein to maintain a positive nitrogen balance. After setting the protein requirement, at a level consistent to achieve a positive nitrogen balance, the remaining nonprotein calories were completed by a high-carbohydrate intake with dietary fat comprising the balance of calories.

This study had several important strengths. First, the exclusive use of professional drug-free bodybuilders as participants provides unique insight into the response of these athletes to intensive RT. The authors are not aware of any previous study that has investigated body composition changes in this population during a mass-building phase. The homogeneous nature of the sample provides the ability to draw evidence-based conclusions on training frequency recommendations for highly advanced lifters seeking to maximize muscle mass. No other study to date affords such generalizability. Second, diet was strictly controlled. All meals were prepared and cooked by a nutritionist and then delivered to participants for consumption. This level of dietary control is rare in experimental research, especially research investigating muscular adaptations pursuant to resistance exercise. Most studies monitor nutritional intake via dietary recall or food diaries, which are notoriously imprecise as an assessment tool (Barrett-Connor, 1991).

The study was not without its limitations. First, the duration of the study was quite short, lasting only 4 weeks. Although both groups did show significant gains in FFM, it is not clear whether results would have changed had training been carried out over a longer term. Second, the sample size was small; thus, we cannot rule out the possibility of a type II error. It is extremely difficult to recruit professional bodybuilders to participate in an experimental study (Kistler, Fitschen, Ranadive, Fernhall, & Wilund, 2014), and we were fortunate to have been able to get 10 qualified participants. The decidedly homogeneous population, the similar absolute gains in FFM, and the low variance between subjects would suggest that the findings are valid. Third, the participants reported abstaining from anabolic steroid usage for the last 6 months via a questionnaire. These attestations were supported by the fact that their total testosterone scores at baseline and posttraining were in the normal range for young adult men. However, the possibility that previous use of performance-enhancing drugs may have affected results cannot be ruled out. Finally, while DXA is a very sensitive instrument for measuring body composition, we did not attempt to evaluate hypertrophy in specific muscles.

Conclusion

We conclude that four and six weekly sessions frequencies of RT promote similar increases in FFM and muscular strength in elite bodybuilders when the body part frequency is matched. Therefore, those seeking to maximize muscle mass can take a flexible approach to this aspect of program design and tailor training frequency to lifestyle preferences and individual response to the respective training programs. Specifically, an individual can either choose to spend more days training each week for less time per session or train for a longer duration each session with fewer total training days per week.

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