Influence of Supervision Ratio on Muscle Adaptations to Resistance Training in Nontrained Subjects

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Abstract

Gentil, P and Bottaro, M. Influence of supervision ratio on muscle adaptations to resistance training in nontrained subjects. *J Strength Cond Res* 23(x): 000–000, 2009–The purpose of the present study was to compare the changes in muscle strength in nontrained young males performing resistance training under different supervision ratios. One hundred twenty-four young men were randomly assigned to groups trained under a high (HS, 1:5 coach to athlete ratio) or low (LS, 1:25) supervision ratio. Both groups performed identical resistance training programs. Subjects were tested for maximum bench press 1 repetition maximum (1RM) and knee extensor torque before and after 11 weeks of training. According to the results, only HS lead to a significant increase (11.8%) in knee extensor torque. Both groups significantly increased bench press 1RM load; the increases were 10.22% for LS and 15.9% for HS. The results revealed significant differences between groups for changes in knee extensor torque and 1RM bench press, with higher values for the HS group. There were no differences between groups for the increases in bench press and leg press work volume or training attendance. The proportion of subjects training with maximum intensity was higher in HS for both bench press and leg press exercises. In addition, the distribution of subjects training with maximal intensity was higher for the bench press than for the leg press exercise in both groups. The primary findings of the present study are that the strength gains for both lower- and upper-body muscles are greater in subjects training under higher supervision ratios, and this is probably because of higher exercise intensity. These results confirm the importance of direct supervision during resistance training.

Key Words training intensity, maximum repetitions, strength, isokinetic, coach to athlete ratio

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Introduction

The adaptations to resistance training are largely dependent on the manipulation of many variables, including load, rest intervals, and movement velocity (9,11,20). Although the importance of correct design and prescription of a resistance training program is widely recognized, the supervision of the training sessions is also important, as shown by previous studies (4,12). Training supervision by specialized personnel may help to control important training variables such as load, rest intervals, and exercise technique and to provide motivation and psychological reinforcement. Although it is generally accepted that training supervision plays an important role in the results obtained with resistance training (2,7), there are only a few studies that directly measured the influence of supervision on strength gains.

Mazzetii et al. (12) were the first investigators to study the influence of a direct supervision of resistance training on strength gains. In their study, a group of moderately trained men exercised with personal trainer supervision, whereas the other group attended only 1 private consultation at the beginning of the study and subsequently performed all training sessions without direct supervision. Both groups performed the same training protocol; however, according to the results, the directly supervised training resulted in greater load increases and greater upper- and lower-body maximal strength gains.

Later, Coutts et al. (4) studied the effects of direct supervision in young rugby players. One group trained under the control of a team manager who was not trained in strength and conditioning whose function was to control training attendance and program administration. The supervised group completed the same program under the direct supervision of trained coaches, with a supervision ratio of 1:7 (coach to athlete ratio). Although the training protocols were the same for both groups, the supervised group showed greater strength gains than the unsupervised group. Recently, Ratamess et al. (15) reported that resistance training under the supervision of a personal trainer leads to greater initial 1 repetition maximum (1RM) strength values when compared with unsupervised training in resistance trained women.

It is important to note that the known studies regarding the effects of supervision on the adaptations to resistance training involved only trained subjects, and, therefore, the effects of supervision in nontrained subjects remains unknown. Because nontrained subjects are more prone to show gains in muscle size and strength than trained athletes (1), some coaches may neglect the effect of supervision in this group or may suppose that the importance of supervision is limited to improved safety and exercise technique. However, previous studies have shown that, when not supervised, novice lifters may not select a lifting intensity sufficient to induce muscle hypertrophy and strength gains (6) and that supervision leads to the selection of greater workout intensities (15). Therefore, adequate training supervision may be critical to nontrained subjects.

The appropriate supervision ratio suggested for novice lifters in gyms and health clubs is between 1:6 and 1:10 (2,7). Because previous studies have not compared supervised and nonsupervised groups, little is known about the effects of different supervision ratios. Thus, the purpose of the present study was to compare the changes in muscle strength in nontrained young males performing resistance training under a high (1:5) or a low (1:25) supervision ratio.

Methods

Experimental Approach to the Problem

Subjects were randomly assigned to 2 groups: a high (HS, 1:5) and low supervision ratio (LS, 1:25). The 2 groups undertook 11 weeks of whole-body resistance training. Training was conducted 2 days a week, with a minimum of 48 hours between sessions. Both groups performed the same exercises and were instructed to perform 8 to 12 repetitions until volitional fatigue at a speed of 4 seconds per repetition (2 seconds for the concentric phase and 2 seconds for the eccentric phase). This range of repetitions was chosen based on the recommendations of the American College of Sports Medicine (9).

Participants were initially required to attend 3 to 4 sessions to get familiarized with the resistance training program. Participants were then required to attend 1 additional session to test for 1RM in the bench press exercise and 1 session for measurement of maximal knee extensor torque in an isokinetic dynamometer. The tests were repeated at the end of the training period.

Subjects

Two hundred college-aged men volunteered to participate in the study. The men were selected at random from respondents to fliers distributed over the university and by word of mouth. The training classes were part of college activities, and, to be part of the study, the subjects should not have had any previous resistance training experience. To keep the supervision ratio constant, subjects who started resistance training outside the classes or changed their nutritional habits were not excluded from the classes, although they were excluded from the analysis. The criteria for entering the analysis included being at least 18 years of age, having no resistance training experience, and being free of clinical problems that could be aggravated by the protocol. To be included in the analyses, subjects had to attend more than 80% of the training sessions. Sixty-two subjects in the HS group (22.36 ± 2.62 yr of age; 71.61 ± 12.22 kg; 174.81 ± 6.45 cm) and 62 subjects in the LS group (21.38 ± 2.55 yr; 70.62 ± 12.62 kg; 175.13 ± 7.22 cm) were included in the analysis.

All participants were notified of the research procedures, requirements, benefits, and risks before providing informed consent. The institutional research ethics committee granted approval for the study.

Procedures

One Repetitions Maximum (1RM) Test. In the week before the experiment and 5 to 7 days after the last training session, the load for 1RM was determined for each subject in the bench press exercise using the protocol suggested by Kraemer and Fry (10). The initial tests were repeated in all subjects, and data were analyzed by Pearson product moment correlations to estimate day-to-day 1RM reliability ($r = 0.96$).

Measurement of Isokinetic Torque. Isokinetic peak torque was measured on the Biodex system 3 Isokinetic Dynamometer (Biodex Medical, Inc., Shirley, NY). Calibration of the dynamometer was performed according to the manufacturer's specifications before every testing session. The subjects sat upright with the axis of rotation of the dynamometer arm oriented with the lateral femoral condyle of the right knee. Belts were used to secure the thigh, pelvis, and trunk to the dynamometer chair to prevent additional body movement. The chair and dynamometer settings were recorded to ensure the same positioning for all tests. Gravity correction was obtained by measuring the torque exerted on the dynamometer resistance adapter with the knee in a relaxed, near-full extension. The tests comprised 2 sets of 5 repetitions at 60°/s. Subjects were instructed to fully extend and flex the knee and to work maximally during each set. Verbal encouragement was given throughout the test session. After each set, subjects were required to take 60 seconds of rest before the onset of the next set. The knee strap was released during each rest period to ensure unrestricted blood flow to the quadriceps. The procedures were administered to all subjects by the same investigator (3). Quadriceps peak torque baseline test and retest intraclass correlation coefficient and standard error of the mean were 0.98% and 2.3%, respectively.

Resistance Training Intervention. For both groups, a whole--body, multiple-set resistance training program was implemented using a combination of free weights and machines. The sessions consisted of 5 exercises, 2 for the upper body, 2 for the lower body, and 1 for the midsection (Table 1). The exercises chosen are very popular and are similar to exercises previously used to analyze the chronic (4,12) and acute effects (6,15) of exercise supervision during resistance training. To improve external validity and to follow the American College of Sports Medicine (9) recommendations,

TABLE 1. Resistance training programs (A–C)

A	B	C
Bench press (barbell)	Seated bench press (dual axis machine)	Seated bench press (machine)
Leg press 45°	Seated leg press	Knee extension
Lat pull down (supinated)	Seated row (dual axis machine)	Seated row (low pulley)
Stiff legged deadlift	Seated knee flexion	Knee flexion
Seat ups	Seat ups	Seat ups

subjects performed 2 sets of 8 to 12 repetitions. Subjects were instructed to adjust training loads carefully; if a subject could not perform 8 repetitions or could lift the load more than 12 times, he was instructed to adjust the load to ensure the completion of the required number of repetitions.

Training was conducted 2 days a week, with a minimum of 48 hours between sessions, for 11 weeks. The sets started every 3 minutes, leading to a rest interval of approximately 2 minutes. During the training sessions, music tracks with 120 beats per minute were played to facilitate control of movement speed.

One group trained under a low supervision ratio (LS, 1:25) and the other with a high ratio (HS, 1:5). Initially, subjects were divided into 8 classes of 25 subjects, 4 classes for LS and 4 for HS. LS classes were supervised by only 1 coach, whereas HS classes were supervised by 5 coaches. None of the coaches were aware of the purpose of the study, and all coaches were oriented to control attendance and technique, to keep the participants motivated, and to make them train with maximum intensity. Each subject kept a training log in which the loads used and the numbers of repetitions performed in each exercise were recorded. Training volume for the leg press and bench press exercises were calculated as the product of the number of repetitions by the load lifted. The number of subjects who trained with maximum intensity was calculated based on the training log.

Each class was divided into 3 subgroups. There were 3 different resistance training programs, as shown in Table 1. Each subgroup performed 1 of the 3 programs during a given class, and the subsequent program was performed in the next class, following the order A→B→C. Therefore, each program was repeated every 3 sessions.

Statistical Analyses

All values are reported as mean ± *SD*. Paired *t*-tests were used to compare pre- and postvalues within groups, and an independent *t*-test was used to compare pretraining values between groups. To compare differences in strength gains and changes in work volume between groups, final values of 1RM load, knee extensor torque, and work volume for LS and HS were compared with analysis of covariance (ANCOVA), using the initial values as covariates. When groups are assigned at random, ANCOVA is considered an adequate method for comparing changes between groups (8). Observed statistical power for 1RM bench press was 0.68 and for knee extensor peak torque was 0.99. Pearson chi-square was used to compare the distribution of subjects who trained with maximum intensity between groups. Statistical significance was set at $p \leq 0.05$.

RESULTS

The increases in bench press (813.44 ± 253.36 to 992.8 ± 289.4 for LS and 760.71 ± 232.18 to 886.4 ± 326.2 for HS) and leg press (2175.5 ± 763.9 to 3032.3 ± 945.8 for LS and 2251.1 ± 784.2 to 3290.3 ± 840.4) work volume were significant for both LS and HS ($p < 0.05$), but there were no differences between groups for any exercise ($p > 0.05$).

TABLE 2. Results of tests (mean ± *SD*)

	LS		HS	
Variable	Pre	Post	Pre	Post
Bench press 1RM (kg)	60.87 ± 14.18	67.09 ± 12.82†	56.6 ± 10.94	65.6 ± 11.11†‡
Knee extensor torque (N.m)	235.68 ± 31.34	238.46 ± 38.62	212.21 ± 41.13	236.96 ± 38.91†‡

*LS = low supervision ratio; HS = high supervision ratio; 1RM = 1 repetition maximum.
†$p < 0.05$ vs. Pre.
‡$p < 0.05$ vs. LS.

The results of the tests are shown in Table 2. HS lead to a significant increase (11.8%; $p < 0.05$) in knee extensor torque, whereas the 1.4% increase in the LS group was not significant ($p > 0.05$). The results of ANCOVA revealed significant differences between groups for changes in knee extensor torque, with higher values for the HS group ($p < 0.05$).

Both groups significantly increased bench press 1RM load; the increases were 10.22% for LS and 15.9% for HS ($p < 0.05$). The results of ANCOVA revealed that corrected post-training values for HS supervision were significantly higher than LS ($p < 0.05$), reflecting higher strength gains in this group.

Training attendance was 87% and 88% for LS and HS, respectively, with no difference between groups ($p > 0.05$). It was estimated that 74.19% of the subjects in the HS and 36.07% of the subjects in the LS groups trained with maximum intensity on the bench press exercise. In the leg press exercise, 17.74% of the subjects in the HS and 9.68% in the LS trained with maximum repetitions. According to the results of Pearson chi-square tests, the proportion of subjects training with maximum intensity was higher in HS for both exercises ($p < 0.05$). In addition, the distribution of subjects training with maximal intensity was higher for the bench press than for the leg press exercise in both groups ($p < 0.05$).

Dicussion

The purpose of the present study was to compare the changes in muscle strength in nontrained young males performing resistance training under a high (1:5) or a low (1:25) supervision ratio. The primary findings are that the changes in strength gains for both lower- and upper-body muscles are greater in subjects training under higher supervision ratios. These results confirm the importance of direct supervision reported by previous authors (4,12).

Coutts et al. (4) studied the effects of direct supervision in 42 young rugby players. The athletes were divided in 2 groups, 1 trained under the direct supervision of coaches, in a supervision ratio of 1:7, and the other unsupervised. Both groups followed the same periodized resistance training program for 12 weeks. According to the results, the absolute 3RM load increased more in the supervised group than in the unsupervised group for the bench press (29.9 vs. 15.3 %, respectively) and squat (40.1 vs. 15.8 %, respectively) exercises. In addition, the results revealed that the unsupervised group completed significantly fewer sessions than the supervised, and there was a significant correlation between training attendance and strength gains ($r = 0.35$). According to the authors, the increase in strength adaptation in the supervised groups appears to be related to an increased training attendance and, possibly, increased training intensity.

In a study involving 18 moderately trained young men, Mazzetii et al. (12) compared the changes in maximal strength after 12 weeks of a directly supervised training vs. an unsupervised training. The results revealed that the strength improvements in the supervised group for squat and bench press (33% and 22%, respectively) were greater than the increases in the unsupervised group (25% and 15%, respectively). The rates of increase in the squat and bench press work volume were greater in the supervised group, but there were no differences between groups for the number of training sessions performed. According to the authors, the more pronounced increases in training volume may explain the greater strength performance in the supervised group.

According to our results, the changes in training volume and training attendance were not different between groups. This lack of difference in the magnitude of volume increases may be a result of the fact that subjects in the HS were more prone to train to failure. It was observed that, because of fatigue, subjects in the HS groups tended to perform fewer repetitions in the last exercise sets, which could explain the lack of difference in the work performed in the end of the training period.

In the present study, the differences in strength gains between HS and LS could not be explained by a more pronounced increase in training volume nor by a higher training attendance. However, it is possible that the more frequent use of maximum repetitions led to more pronounced strength gains in the HS group. This is in agreement with the study of Drinkwater et al. (5), in which training that lead to failure induced greater strength gains than no-failure training in elite junior athletes. A rationale for these findings may be found in previous studies suggesting that processes associated with fatigue may contribute to the strength training stimulus (17–19).

It is interesting to note that subjects were less prone to work with maximum repetitions in the leg press than in the bench press exercise. This may be one of the possible reasons why lower-body muscles usually respond better to higher-volume training than upper-body muscles (13,14,16). In this regard, Paulsen et al. (14) and Ronnestad et al. (16) reported that the increases in 1RM in the lower-body exercises were significantly higher in the group that performed 3 sets of exercise in comparison with the group that performed only 1 set, whereas no difference existed in the upper-body exercises. The results of the current study may suggest that a lack of sufficient training intensity could be the reason why an increased training volume is necessary to increase lower-body strength gains.

In conclusion, the present study shows that a higher supervision ratio leads to greater changes in upper- and lower-body muscle strength in response to a resistance training program in young males. According to these results, this may be caused by greater motivation or psychological reinforcement, which leads the subjects to train closer to their maximal capacities. These results confirm the importance of an adequate supervision ratio, especially for lower-body training in untrained subjects.

Practical Applications

The present study demonstrated that strength gains caused by resistance training are improved with a higher supervision ratio, providing strong evidence that the supervision ratio is an important factor for adaptations to resistance training because it can help untrained persons to train with higher intensity. This information is important for weight room managers because it may help them to adjust the number of trainers according to the number of subjects training at their facilities. Moreover, it has important applications for the design of scientific studies because the results may be compromised by inadequate supervision. In addition, the information presented here may be important for exercise specialist distribution in a weight room given that supervision may be more critical for lower-body muscle strength gains. However, the results of the present study may not be applicable to strength coaches with athletes.

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