THE COMPARISON OF THREE TYPE OF EXERCISE SEQUENCE ON MAXIMUM STRENGTH IN UNTRAINED YOUNG MEN

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Annotation. *Aim:* The purpose of this study is comparison of three type of exercise sequence on maximum strength in untrained young men after 8 weeks of resistance training. *Methods*: Prior to the training program, participants were randomly assigned to three groups. One group began with upper to lower body (G1) while another performed lower to upper body (G2) or one exercise in upper body and one exercise in lower body order (G3). Training frequency was three sessions per week with at least 48 h of rest between sessions for a total of 24 sessions in the 8-week period. One repetition maximum (1RM) was assessed for all exercises at baseline and after 8 weeks of training. *Results*: The results indicate that the maximum strength increased after all sessions, but the increase was not significantly difference between groups ($p < 0.05$). These results indicate that performing exercises first in upper-body/lower-body or alternate in a bout of resistance exercise was not to leads difference in maximum strength. *Conclusions*: These results indicate that one exercise in upper body and one exercise in lower body order not provided greater strength gains than both muscle group upper and lower body exercises ($p < 0.05$).
Key words: muscle strength; exercise sequence; untrained men.

Introduction

When prescribed appropriately with other key prescriptive variables (i.e. load, volume, repetition velocity, failure versus or non-failure sets, rest interval between sets and exercises), the exercise order can influence the efficiency, safety and ultimate effectiveness of an resistance training programmed (Simao et al.,2012). It is generally recommended that exercises involving multiple joint exercises be placed at the beginning of a training session because this exercise sequence would result in the ability to resist higher loads. The rationale for performing multiple joint exercises in the beginning of a training session is that total work (repetitions × resistance) is greater when compared to performing single-joint exercises first, and may result in greater long term strength gains (Sforzo et al). However, Kraemer and Ratamess suggested the general recommendation for exercise order of performing multiple joint exercises first can be changed depending on the goals of the training program (Fleck SJ, Kraemer et al). Observed that performing multiple joint muscle group exercises at the early of an exercise sequence resulted in significantly larger repetitions compared to when the single joint were performed early in an exercise sequence (Sotoode et al). Showed exercise order can facilitate the power developed during an exercise placed at the end of a training session despite reductions in total work and number of repetitions performed in a set (Spreuwenberg et al). Finally, recommended if the strength and conditioning professional wants to maximize the Athlete's performance in one specific resistance exercise, this exercise should be placed at the beginning of the training session (Gentil et al.). To our knowledge, methodological training studies manipulating three type of exercise sequence and the investigation of the influence on strength have not been conducted. Therefore, the purpose of the present study was to examine the comparison of three type of exercise sequence on maximum strength during 8 weeks of training in untrained young men.

Methods and material

Thirty-six untrained young men from the Iran University of Guilan were randomly assigned to three groups. One group (23.7 ± 1.5 years, 74.5 ± 4.0 kg, 175.1 ± 2.0 cm, 24.4 ± 1.5 kg m^{-2}) trained with upper to lower body group exercises (G1) (n = 12). The second group (22.4 ± 1.4 years, 72.7 ± 4.4 kg, 172.2 ± 4.5 cm, 23.2 ± 1.9 kg m^{-2}) trained using lower to upper body muscle group (G2) (n = 12). The third group (24.8 ± 1.6 years, 75.9 ± 4.4 kg, 175.3 ± 3.0 cm, 24.2 ± 1.9 kg m^{-2}) trained with one exercise in upper body and one exercise in lower body order (G3) (n = 12) and continued performing the regular military physical activity component during the 8 week period, but not the resistance training program. There were no significant differences between groups in anthropometric parameters or one repetition maximum (1RM) prior to training. In addition, diet was the same for all participants throughout the course of the study. Inclusion criteria were the following characteristics for all participants: (a) were physically active, but had not taken part in resistance training for at least 6 months prior to the start of the study; (b) not performing any type of regular physical activity for the duration of the study other than the prescribed resistance training; (c) did not have any functional limitations for the resistance training program or the 1RM tests; (d) not presenting any medical condition that could influence the training program; and (e) did not use any nutritional supplements. All participants read and signed an informed consent document after being informed of the testing and training procedures to be performed during the study. The 1RM tests were performed on two nonconsecutive days for all exercises as described previously. Two weeks of familiarization took place prior to the 1RM tests (four sessions) (Simao et al). The 1RM tests were performed following the anthropometric measurements on the first day. After 48 h, the 1RM tests were repeated to determine test–retest reliability. The heaviest load achieved on either of the test days was considered the pretraining 1RM. No exercise was allowed in the 48 h between 1RM tests, so as not to interfere with the reliability results. The 1RM was determined

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in fewer than five Attempts with a rest interval of 5 min between 1RM attempts and 10 min were allowed before the start of the test for the next exercise. Following the 8 weeks of training, the 1RM test was performed similarly to the pre-training test in order to compare the strength changes in those exercises. Again, the highest load achieved in both days was considered as the 1RM. The exercise sequence for G1 was barbell bench press (BP), machine lat pull down (LPD), seated machine shoulder press (SP), leg press (LP), seated machine leg extension (LE), seated machine leg curl (LC). The exercise sequence for G2 was LP, LE, LC, BP, LPD and SP. The exercise sequence for G3 was BP, LP, LPD, LE, BS, and LC. All exercises for three groups were performed for three sets. In addition, an experienced strength and conditioning professional supervised all training sessions. Frequency of the training program was three sessions per week with at least 48 h of rest between sessions and 2 minute between sets and exercises. Twenty-four sessions were performed during the 8 weeks training period Prior to each training session, the participants performed a specific warm up, consisting of 20 repetitions with approximately 50% of the resistance used in the first exercise of the training session. During the exercise sessions, participants were verbally encouraged to perform all sets to concentric failure and the same definitions of a complete range of motion used during the 1RM testing were used to define completion of a successful repetition. Adherence to the program was 100% for all groups. The total work performed by G1, G2 and G3 were calculated by multiplying the number of sessions by the number of sets and resistance load (session × sets × load). Intra-class correlation coefficients (ICC) were used to determine 1RM test–retest reliability. The ICC method was used based on a repeat measurement of maximal strength. Coefficient of variation (CV) was used to calculate within-subject variation (CV% = [standard deviation/mean] × 100). All variables presented normal distribution and homoscedasticity. Following two-way (time) by three-way (groups) ANOVAs (time [baseline vs. 8-week training] × group [G1 vs. G2 vs. G3]) was used to analysis for differences among the groups in the 1RM and kilogram of body mass (1RM load/body mass). When appropriate, follow-up analyses were performed using Fisher post hoc tests. *T*- Tests were used to analysis for differences between 1RM test and retest, pre and post training, and between the total works in three training programs. An alpha level of $p \leq 0.05$ was considered statistically significant for all comparisons.

Table 1

Intra-class correlation coefficients (ICC) and range values in kg for each exercise, between 1RM tests and retests at baseline and after 8 weeks.

Group	Bench press		Lat pull down		Shoulder press		Leg press		Leg extension	
	Baseline	8 week	Baseline	8 week	Baseline	8 week	Baseline	8 week	Baseline	8 week
G1 (*n* =	*r* = 0.99, 58.7–	*r* = 82.1–	*r* = 0.94, 49.8–	*r* = 70.0–	*r* = 0.98, 34.8–	*r* = 51.7–	*r* = 0.96, 70.5–71	*r* = 83.0–	*r* = 0.99, 65.8–	*r* = 74.1–
G2 (*n* =	*r* = 0.99, 61.7–	*r* = 73.2–	*r* = 0.96, 54.3–	*r* = 65.5–	*r* = 0.98, 35.0–	*r* = 49.6–	*r* = 0.97, 70.5–	*r* = 87.2–	*r* = 0.99, 64.5–	*r* = 81.1–
C3 (*n* =	*r* = 0.98, 59.5–	*r* = 77.7–	*r* = 0.99, 49.6–	*r* = 69.8–	*r* = 0.98, 34.1–	*r* = 48.0–	*r* = 0.98, 70.7–	*r* = 85.6–	*r* = 0.98, 64.3–	*r* = 77.0–

r = ICC.

Group Leg curl

	Baseline	8 week
G1 (*n* =	*r* = 0.99, 63.7–	*r* = 0.99, 71.1–
G2 (*n* =	*r* = 0.99, 65.7–	*r* = 0.99, 80.2–
C3 (*n* =	*r* = 0.98, 6 4.5–	*r* = 0.99, 74.7–

r = ICC.

Results

The results indicate that the maximum strength increased after all sessions, but the increase was not significantly difference between groups ($p < 0.05$). These results indicate that performing exercises first in upper-body/lower-body or alternate in a bout of resistance exercise was not to leads difference in maximum strength.

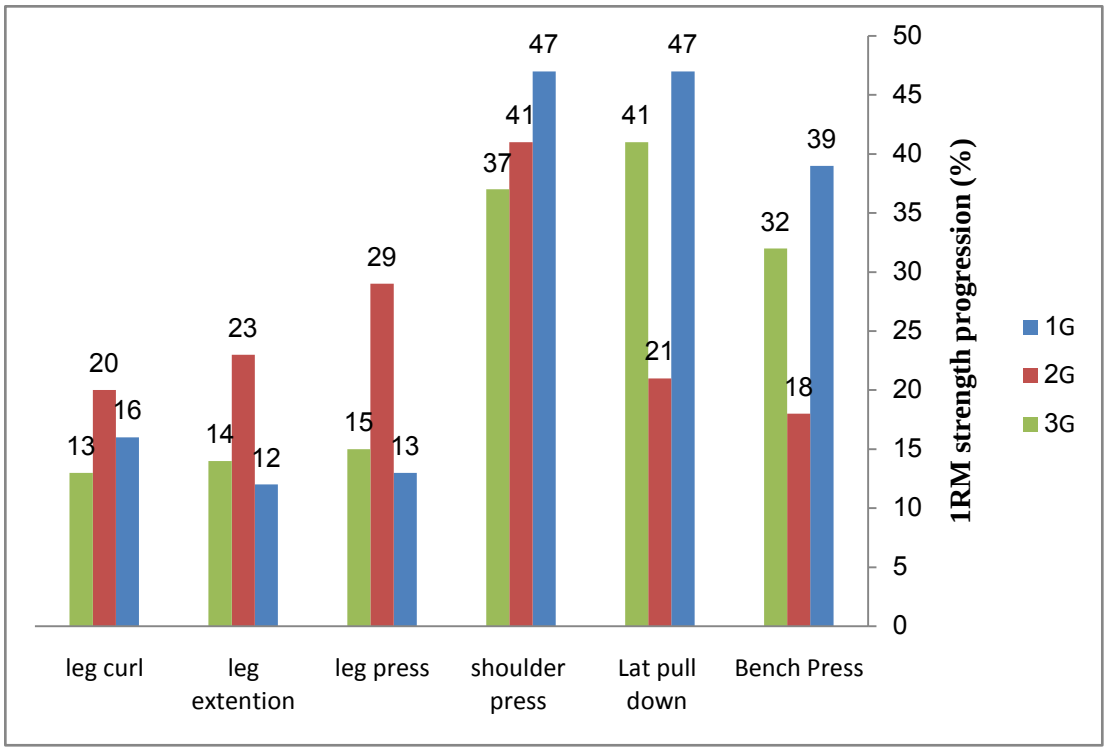

Fig. 1. 1RM strength progression (%) in each exercise of G1, G2 and G3 after 8 weeks of resistance training (mean).

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Discussion

The purpose of this study was to examine the comparison of three type of exercise sequence on maximum strength in untrained young men. To our knowledge, this was the first study to investigate the chronic effects the comparison of three type of different exercise sequence. The current results revealed not significant differences in strength gains in large muscle group (lower-body) than small muscle group (upper-body) exercises. Also, significant differences were not found in lower and upper-body muscle group exercises between the different exercise sequences, suggesting exercise order may be particularly important during the initial stages of resistance training in untrained men, mainly in large muscle group exercises. Generally, the length of the rest interval between sets is prescribed based on the training goal. The recommended rest interval increases when programs are designed for strength or power (e.g., 2–5 minutes) and decreases when programs are designed for hypertrophy (e.g., 30–90 seconds) or muscular endurance (e.g., less than or equal to 30 seconds) (rest inter val) (Willardson et al). compared two protocols; one using eight sets of 8–12 repetitions of arm exercises versus eight sets of 10RM of the leg press followed by the same arm training (Hansen et al). The authors of the study reported large muscle group exercises for the lower body performed early in a training session have a stimulatory effect on small muscle group exercises for the upper-body performed later in the same session (Hansen et al). In contrast to what was found by Hansen et al., our findings indicated arm exercises provided greater strength gains when performed early in the training session. This discrepancy can be associated to the fact that the sessions investigated in our study involved only exercises for the upper-body and had the same total work. This difference in total work might have influenced the results of the study by Hansen et al., as well as the fact the exercises used were for different parts of the body. It is very difficult to compare our results with previous similar studies, since none of these studies investigated chronic effects of exercise order on strength. In addition, all previous studies used trained participants. However, the current study investigated the influence of resistance training sessions in untrained men. The different exercise orders did increase strength differently in three muscle group lower and upper body or alternate exercises throughout the course of the study, but the increase was not significantly difference between groups. Nevertheless, it should be noted three training groups revealed significant increases in strength over the course (8 weeks) of the training period in all exercises. Another interesting point to observe was the strength progression in each exercise in three sequences (Fig. 1). The 1RM strength progression was higher for the exercises performed earlier in a training session for three training groups, but the increase was not significantly difference between groups. The current results are in agreement with previous studies (Sforza and Simao et al) and suggest whenever an exercise is performed last in an exercise sequence or training session, performance of that particular exercise may be negatively affected. This is true whether the exercise involves large or small muscle groups. This negative effect on exercises performed later in a training session needs to be considered when designing programs for both athletes and fitness enthusiasts. Simao et al. investigated the influence of different exercise sequences on the number of repetitions performed in a group composed of both men and women with at least 2 years of recreational resistance training experience. The exercise sessions,

consisted of performing three sets of each exercise with a resistance of 10RM and 2-min rest periods between sets and exercises. The results demonstrated performing either large or small group exercises for the upper-body at the end of an exercise sequence resulted in significantly fewer repetitions compared to when the same exercises were performed early in an exercise sequence (Simao et al). A more recent study suggested a similar phenomenon in trained women when both upper and lower body exercises are performed in the same exercise session (Simão et al). The previously mentioned studies demonstrated that an exercise performed last in a training session, is negatively affected in an acute manner whether the exercise involves large or small muscle groups (Sforzo et at). Our findings revealed those effects can influence the results also in a chronic manner. These results suggest the exercise most important for the training goals should be placed at the beginning of the training session for larger strength gains, independent of the size of the muscle groups involved. Early muscular strength gains (during the first few weeks of training) are predominantly mediated by the increase in motor unit firing rate (Gabriel et al). Thus, an increase in muscular strength without hypertrophy is commonly observed in the initial stages of resistance training. However, we are unaware if our results are associated with neuromuscular adaptations only, given that muscle volume and hypertrophy were not assessed. Therefore, additional investigations with longer interventions and using procedures to assess muscle volume and hypertrophy are necessary to promote further understanding of the chronic effects from the exercise order.

Conclusions

Our results indicate that performing exercises first in upper-body/lower-body or alternate in a bout of resistance exercise was not to leads difference in maximum strength. Results also suggest that whenever one exercise is the last of a sequence performed in a training session, its performance will be negatively affected. Applying the results to exercise prescription, a large to small muscle group order might be more beneficial for untrained men, when trying to improve health.

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