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Low-load bench press and push-up induce similar muscle hypertrophy and strength gain

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ABSTRACT

Aim: To investigate the effect of push-up training with a similar load of to 40% of 1- repetition maximal (1RM) bench press on muscle hypertrophy and strength gain in men.
Methods: Eighteen male participants (age, 20.2 ± 0.73 years, range: 19–22 years, height: 169.8 ± 4.4 cm, weight: 64.5 ± 4.7 kg) were randomly assigned to one of two experimental groups: bench press at 40% 1RM (bench-press group, n = 9) or push-ups with position adjusted (e.g. kneeling) to the same load of bench-press 40%1RM (push-up group, n = 9), performed twice per week for 8 weeks. Muscle thickness at three sites (biceps, triceps, and pectoralis major), bench-press 1RM, maximum repetition at 40%1RM, and power output (medicine ball throw) were measured before and after the training period.
Results: Significant increases in 1RM and muscle thickness (triceps and pectoralis major) were observed in bench-press group (1RM, from 60.0 ± 12.1 kg to 65.0 ± 12.1 kg, $p < 0.01$; triceps, from 26.3 ± 3.7 mm to 27.8 ± 3.8 mm, $p < 0.01$; pectoralis major, from 17.0 ± 2.8 mm to 20.8 ± 4.8 mm, $p < 0.01$) and in the push-up group (1RM, from 61.1 ± 12.2 kg to 64.2 ± 12.5 kg, $p < 0.01$; triceps, 27.7 ± 5.7 mm to 30.4 ± 6.6 mm, $p < 0.01$; pectoralis major, from 17.0 ± 2.8 mm to 20.8 ± 4.8 mm, $p < 0.01$). Biceps thickness significantly increased only in the bench-press group (28.4 ± 3.3 mm to 31.5 ± 3.7 mm, $p < 0.01$). Neither power output performance nor muscle endurance capacity changed in either group.
Conclusions: Push-up exercise with similar load to 40%1RM bench press is comparably effective for muscle hypertrophy and strength gain over an 8-week training period.

Introduction

The push-up is a very popular bodyweight-based strength training exercise for fitness in athletes and general populations.[1–4] The push-up can be performed without any additional tools, and its intensity can be altered with several variations, making it suitable for almost every level of fitness.[5,6] In addition, "bodyweight training" was selected the top 3 fitness trend in the past consecutive 3 years of the American College of Sports Medicine (ACSM) trend words in 2015 to 2017.[7] Although the push-up exercise is undoubtedly useful and important, chronic adaptations to push-ups, particularly muscle hypertrophy, remain unclear.

Strength training load is usually determined relative to one repetition maximum (1RM), and the training load for muscle hypertrophy is typically set to more than 70%1RM.[8] A recent study suggested that low-intensity strength training such as 30% 1RM induced muscle gain, if it was performed to failure.[9] A meta-analysis of randomized controlled studies to compare the effects of low-load versus high-load training for improving muscle strength and muscle development suggested that low-load resistance training led to similar muscle gain compared with high-load resistance training, but a lower tendency for strength gain was observed with low-load training.[10]

Bench press and push-up have been shown to elicit similar muscle activation patterns on electromyography.[1,11] Calatayud et al. reported that the elastic-resistance push-up exercise and bench press induced similar EMG values, as well as similar strength gains when both exercises were performed at the same intensity and speed of movement over 6 weeks, thus demonstrating a relationship between similar acute muscle activations and changes in

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muscle strength.[12] However, to our knowledge, no studies have investigated whether push-up training induces muscle gain similar to that of bench-press training.

Ebben et al.[5] investigated push-up variations including different levels of foot and hand elevation and bent-knee and normal position and observed ground reaction forces of approximately 64% and 49% of body weight in the regular and bent-knee push-up conditions, respectively. Other studies reported similar results.[13] These findings indicated that the intensity of push-up exercise can be adjusted to a suitable intensity for low-load training.

The purpose of this study was to investigate whether low-load bench-press and push-up exercise at similar intensity (40%1RM) performed to failure induced comparable muscle hypertrophy and strength gain in untrained men. We hypothesized that these exercises would lead to similar muscle hypertrophy and strength gain after an 8-week training program.

Methods

Study design

Subjects were randomly assigned to an experimental group: bench press and sprint push-up group. A supervised progressive RT program designed to induce muscular hypertrophy (40%1RM of bench press) was performed in 8-week with training carried out 2 times per week on nonconsecutive days. Muscle thickness at three sites (biceps brachii, triceps brachii, and pectoralis major), bench press 1RM, ball throwing, and maximum repetition were measured at 3 time points (two baseline tests and once after 8 weeks of training). Post measurements were performed at intervals of 48 hours from final training session. Test-retest reliability analyses revealed intra-class correlation coefficients of 0.703–0.986. Two-way ANOVA with repeated measures and Bonferroni post hoc tests were conducted to assess the effects. All testing and training were supervised by a National Strength and Conditioning Association, Certified Strength and Conditioning Specialist (NSCA–CSCS) and supervisors were blinded about the purpose of the study.

Subjects

Eighteen collegiate male students majoring physical education (age: 20.2 ± 0.7 years, age range: 19–22 years, height: 169.8 ± 4.4 cm, weight: 63.2 ± 6.3 kg) volunteered to participate in this study. The subjects were recreational noncompetitive exercisers with minimum resistance training experience of 1 year and were randomly assigned to bench-press group (n = 9 age: 20.1 ± 0.6 years, height: 171.4 ± 3.8 cm, weight: 63.3 ± 5.8 kg), push-up group (n = 9 age: 20.3 ± 0.8 years, height: 168.1 ± 4.5 cm, weight: 63.1 ± 7.2 kg). All participants were informed about the potential risks of the experiment and gave their written consent to participate. The study was approved by the ethics committee of our institution and was conducted in accordance with the Declaration of Helsinki for Human Research.

Training protocols

All training session was performed at training center in Nippon Sport Science University, Tokyo, Japan at noon (P.M. 0:00-1:00). Subjects were randomly assigned to the two experimental groups. One group performed 3 sets of bench press exercise at 40% 1RM (bench-press group, n = 9), and the other performed 3 sets of push-ups with their position adjusted to the same load, 40% 1RM, as the bench press (push-up group, n = 9) (Fig. 1). The intensity of push up group was fixed according to previous studies[5,6] and repetitions of each session. Both training groups performed the exercises to failure with 2-min rest intervals, twice per week for 8 weeks. Immediately after each training session, subjects consumed a source of high-quality protein (DNS Protein, 132 kcal, 24.4 g protein, 3.6 g carbohydrate, 2.3 g fat; DNS, Tokyo, Japan) in conjunction with 300 ml of water to standardize the post-exercise meal.

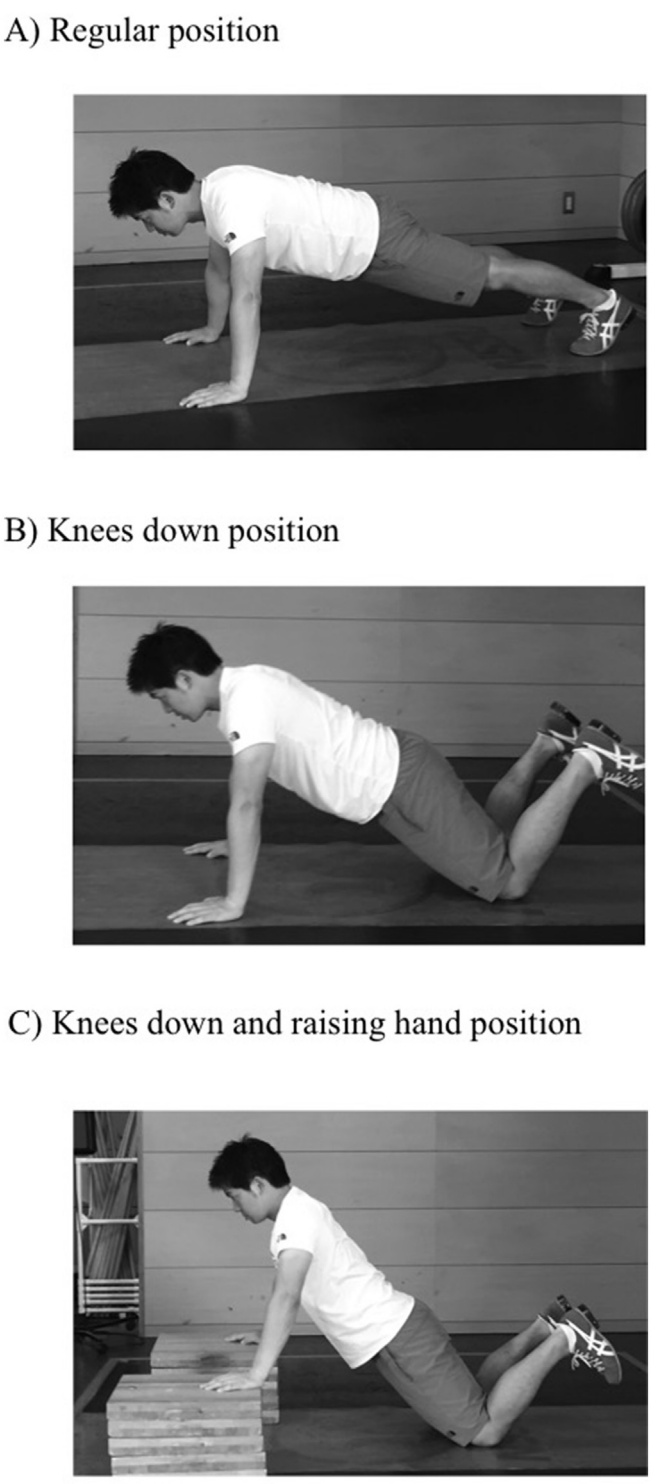

Fig. 1. Push-up exercise variations: regular position (A), knees bent position (B), and knees bent and hands elevated position (C). A previous study suggested that regular position and knees bent position represented 64% and 49% of body weight[5,6] (17).