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Effects of Squat Combined Barbell with Elastic Band on Muscle Strength, Body Composition, and Balance in Working Age Men

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ABSTRACT

Fungnumcharoensab K, Anek A. Effects of Squat Combined Barbell with Elastic Band on Muscle Strength, Body Composition, and Balance in Working Age Men. **JEPonline** 2023;26(5):1-10. This study investigated the effects of the squat exercise combined with using barbells and elastic bands on muscle strength, body composition, and balance in working age men. A total of 24 men in working age between 18 and 39 years were randomly selected into 3 Groups using systematic sampling: (a) Combined Training using Elastic Band Weight at 35% (n = 7); (b) Combined Training using Elastic Band Weight at 20% (n = 8); and (c) Control Group (n = 9). The 2 Treatment Groups trained twice per week for 8 weeks. For each training session, squats combined with using elastic band repetitions per set of 4 sets (80% one-repetition maximum [1RM]) were performed in 0-4 weeks and (85% 1RM) in 5-8 weeks. Before and after 8 weeks of training, the participants were tested using the 1RM squat (SQ), Balance Error Score System (BESS), Vertical Jump Reach Test (VJT), and Body Composition. An analysis of the paired *t*-test revealed that the SQ, BESS, and VJT scores were significantly higher after training in the 2 Treatment Groups ($P < 0.05$). An analysis of covariance revealed that the SQ and BESS scores were significantly higher than those of the Control Group ($P < 0.05$). No significant differences were detected between the 2 Treatment Groups. The results suggest that combining barbell and elastic band exercise increases strength, balance, and power, and combined training with using a band among those who never performed resistance exercise via an applied load of bands that can be used to replace other weights.

Key Words: Combined Training, Elastic Training, Resistance Training

INTRODUCTION

Variable resistance training involves lifting weights with constant and evenly distributed resistance throughout the range of motion. This type of resistance training is typically performed using free weights and various movement patterns. Currently, it is widely used among individuals interested in developing maximum muscular strength and power. This training method can increase the force during the initial (eccentric contraction) and final (concentric contraction) lifting phases (7,10,13,15,16). It is also used to enhance the strength and maximal power output of different muscle groups.

The principle of increasing resistance using elastic bands results in consistent force production throughout the range of motion. In addition, it recruits a higher number of motor units. It is recommended to u se elastic bands that represent 20 to 35% of the total weight lifted and reach a maximum load of 60 to 85% of the one-repetition maximum (1RM) (20). Notably, a 20% increase in resistance of the elastic band provided the greatest peak power; whereas, a 35% increase in resistance offered the highest peak force in the vertical direction. These studies on variable resistance training demonstrate that the use of elastic bands with weight lifting improves 1RM strength, peak power, and counter movement jump performance (2,17). Moreover, comparisons of muscle responses using elastic bands at different ratios of 30%, 20%, and 15% have shown variations in muscle force production.

Given the abovementioned findings, it is important to point out that research is limited on the long-term effects of variable resistance training lasting 6 to 8 weeks or longer. Therefore, we felt it was necessary to investigate the effects of combining barbell and elastic band training in a variable resistance training program for squat exercises (5). Specifically, the results of using a barbell weight of 65% and an elastic band weight of 35% versus a barbell weight of 80% and an elastic band weight of 20%, both with 80% of 1RM were compared to determine the effects on muscle strength, muscle mass, vertical jump-reach, and balance in individuals with no prior experience in resistance training.

The anticipated outcomes of this study included the improvement in muscle strength and the increase in muscle mass, vertical jumps, and balance in males who had not previously engaged in resistance training. It is anticipated that the findings will contribute to a better understanding of the impact of this training approach on muscle strength and recovery in individuals with no prior experience in resistance training. Also, it is hoped that the data will be beneficial for the development of sports training and muscle strengthening programs for individuals in need. On the long term, this research may be valuable for planning training programs as well as the customization of strength training programs for this specific population.

METHODS

Participants

The experimental research in this study focused on a group of working age men with no prior experience in resistance training and no musculoskeletal or muscular disorders. The study population comprised individuals working at Chulabhorn College who volunteered to participate. Prior to training, their health was assessed using the Physical Activity Readiness Questionnaire. The participants were selected using systematic sampling. They were assessed for their 1RM squat performance for categorizing the population into equal-size groups. The

study consisted of 3 Groups: (a) the Combined Training using Elastic Band Weight at 35% (Group 1; n = 7); (b) the Combined Training using Elastic Band Weight at 20% (Group 2; n = 8); and (c) the Control Group (Group 3; n = 9).

Group 1 performed squat exercises using a combination of barbell and elastic bands with a barbell weight of 65% and an elastic band weight of 35% (n = 7). Group 2 performed squat exercises using a combination of barbell and elastic bands with a barbell weight of 80% and an elastic band weight of 20% (n = 8). Group 3 was the Control Group (n = 9). A paired *t*-test was used with an error probability ratio (alpha) of 0.05 and a power of 0.8. The sample size for each Group was 9 participants.

The sample group that met the inclusion criteria for the study comprised participants who were 18 to 39 years of age with a body mass index (BMI) score ranging from 18.5 to 24.9 $kg \cdot m^{-2}$. They had no musculoskeletal disorders and had not engaged in resistance training with variable resistance during the past 6 months. Additionally, individuals who were unable to participate in the study because of certain circumstances or did not complete at least 80% of the training sessions, as well as those who were unwilling to participate were excluded from the study.

Measurement

Before conducting the study, the participants' body composition was determined using an InBody 770 machine. Then, the following tests were conducted: (a) 1RM squat (maximum weight lifted in one repetition); (b) Balance Error Scoring System (BESS) to measure balance ability; and (c) vertical jump test to assess vertical jump ability.

Exercise Program

The participants in Groups 1 and 2 followed a training program. Group 1 was trained using a combination of barbells (65%) and elastic bands (35%) for the squat exercise. Group 2 was trained using a combination of barbells (80%) and elastic bands (20%). Both Groups performed combined training twice weekly for 8 weeks. During each training session, the participants in Groups 1 and 2 performed 8 repetitions of squats per set with a total of 4 sets. The intensity was set at 80% of the 1RM for weeks 0 to 4 and increased to 85% for weeks 5 to 8. The Control Group continued to perform their normal daily activities.

Statistical Analyses

To compare the mean and standard deviation of the 1RM in the squat exercise, balance ability (BESS), vertical jump reach test, muscle mass, and fat mass before and after the 8-week training period, the paired *t*-tests and one-way ANOVA were used. The alpha level of 0.05 was used for statistical significance. A paired *t*-test was used to compare the means within each Group (Groups 1, 2, and 3) before and after the 8-week training period. This test determined whether there were significant differences in the variables before and after training within each Group. A one-way ANOVA was used to analyze the variance among the 3 Groups (Group 1 and 2 and the Control Group) after the 8-week training period. This test was used to determine whether there were significant differences in the variables among the Groups.

RESULTS

The baseline data for the 3 Groups showed no significant differences before training in terms of age, height, and BMI scores ($P > 0.05$). Refer to Table 1.

Table 1. Participants Characteristics.

Group	Group 65-35 N = 7	Group 80-20 N = 8	Control N = 9
Age (years)	27.28 ± 5.90	26.75 ± 4.23	29.00 ± 5.09
Weight (kg)	67.20 ± 10.51	68.75 ± 11.73	72.56 ± 8.14
Height (cm)	173.57 ± 0.02	174.00 ± 0.50	175.33 ± 0.42
BMI ($kg \cdot m^{-2}$)	22.31 ± 3.49	22.65 ± 3.46	23.51 ± 1.64

There were no significant differences in body composition data, including fat mass and percentage of fat, before and after training ($P > 0.05$). Similarly, there were no significant differences in thigh muscle mass before and after training ($P > 0.05$) (Table 2).

Table 2. Body Composition.

Group	Group 65-35 N = 7	Group 80-20 N = 8	Control N = 9
Fat (kg)			
Pre-Test	11.92 ± 6.12	11.79 ± 6.54	15.53 ± 5.55
Post-Test	11.66 ± 6.14	11.85 ± 5.97	15.78 ± 5.88
Fat (%)			
Pre-Test	16.96 ± 7.63	16.05 ± 7.47	21.02 ± 6.08
Post-Test	16.46 ± 8.12	16.23 ± 6.84	21.28 ± 5.71
Muscle Mass (kg)			
Pre-Test	26.52 ± 3.97	28.26 ± 4.15	28.39 ± 3.34
Post-Test	26.85 ± 3.39	28.42 ± 4.05	28.49 ± 3.23

Right Leg Muscle (kg)			
Pre-Test	5.60 ± 0.92	6.42 ± 1.64	6.73 ± 1.34
Post Test	5.67 ± 0.84	6.51 ± 1.64	6.73 ± 1.31
Left Leg Muscle (kg)			
Pre-Test	5.50 ± 0.83	6.32 ± 1.73	6.65 ± 1.42
Post-Test	5.56 ± 0.76	6.44 ± 1.73	6.64 ± 1.36

Regarding the 1RM squat, both Groups 1 and 2 showed a significant increase in 1RM squat after the 8-week training period when compared with the Control Group ($P < 0.05$), as shown in Table 3.

Table 3. One Repetition Maximum Squat (kg).

Group	Group 65-35 N = 7	Group 80-20 N = 8	Control N = 9
Pre-Test	104.89 ± 29.90	101.74 ± 16.85	97.80 ± 20.70
Post-Test	136.07 ± 21.90†*	125.36 ± 15.57†*	97.28 ± 18.25

The data are presented as mean ± SD. † Significant between Pre-Test and Post-Test ($P < 0.05$). *Significantly different from the Control Group ($P < 0.05$).

Regarding balance ability (BESS), both Groups 1 and 2 showed a significant increase after the 8-week training period when compared with the Control Group ($P < 0.05$) (Table 4).

Table 4. Balance Error Score System (BESS).

Group	Group 65-35 N = 7	Group 80-20 N = 8	Control N = 9
Pre-Test	5.14 ± 2.96	5.12 ± 1.88	7.55 ± 2.29
Post-Test	3.00 ± 1.15†*	2.50 ± 1.77†*	7.11 ± 2.14

The data are presented as mean ± SD. † Significant between Pre-Test and Post-Test ($P < 0.05$) * Significantly different from the Control Group ($P < 0.05$).

In terms of the vertical jump reach test, both Groups 1 and 2 showed significant improvement after the 8-week training period when compared to the Control Group ($P < 0.05$), as shown in

Table 5. However, there were no significant differences in vertical jump ability between both Groups 1 and 2 and the Control Group after training.

Table 5. Vertical Jump Reach Test (Peak Power) (W).

Group	Group 65-35 N = 7	Group 80-20 N = 8	Control N = 9
Pre-Test	3638.45 ± 706.04	3740.93 ± 495.84	3923.60 ± 518.88
Post-Test	3886.38 ± 658.79†	4050.88 ± 543.54†	3899.85 ± 554.93

The data are presented as mean ± SD. † Significant between Pre-Test and Post-Test ($P < 0.05$).

DISCUSSION

The research findings from these studies indicated that the combined barbell and resistance band training, specifically in the squat exercise, can effectively increase leg strength compared with that in the Control Group. The mixed training approach improved maximal muscle strength and power after the 8-week training period (1). Moreover, various studies analyzing mixed training have shown that it can be more beneficial in increasing strength than the traditional strength training approach. However, the effectiveness of mixed training depends on several factors, such as the program design, training duration, frequency, intensity, and lifting velocity. It was concluded that the “mixed training” has a slight advantage over traditional strength training in terms of strength gain (18), although the research design in the present study did not evaluate this point.

Comparing the results within each Group before and after the combined barbell and resistance band training for the squat exercise, we found that Group 1 using 35% resistance from the elastic band and 65% from the barbell and that Group 2 using 20% resistance from the elastic band and 80% from the barbell showed significant improvements in maximal squatting ability (1RM squat) after 8 weeks of training. This is consistent with the findings of Shoepe et al. (17), who studied the effects of a 24-week combined free weight and resistance band training program and of Kashiani et al. (11), who studied the effects of a 12-week mixed training program with 65% resistance from the elastic band and 35% resistance from the barbell on squat performance.

Another study by Marin and colleagues (12) showed the acute effects of mixed free-weight and resistance band training with 65% resistance from the band and 35% resistance from the barbells on vertical jump performance and reported significant improvements. Based on these studies and the findings in the present study, it can be concluded that combining barbell and resistance band training has a positive effect on strength, balance, and vertical jump ability for men in the working age range (4,8,9). The advantages of variable resistance training using resistance bands include convenience and accessibility as individuals can easily incorporate resistance bands into their training without the need for heavy equipment.

Interestingly, the duration of the present study might have limited the ability to capture significant changes in body composition components and thigh circumference (3). Hypertrophy

or an increase in muscle size is influenced by such factors as protein intake and resistance training (19). Morton et al. (14), concluded that protein supplementation along with resistance training significantly increased 1RM and fat-free mass (FFM) while attenuating the decline of FFM in older individuals. The authors recommended a protein intake of 1.6 g per kg of body weight per day to support muscle growth.

It is noteworthy that the present study focused only on squatting exercises, which may be considered limited in terms of lower-body muscle development. A 9-week training study by Costa et al. (6) compared a group performing various exercises targeting leg muscles and a group performing a single exercise was conducted in which they found a greater increase in the size of the lateral thigh muscles. This finding suggests that training with varied angles and different muscle activations during each exercise can lead to muscle hypertrophy.

CONCLUSIONS

Our findings indicate that combining barbell and resistance (elastic) band training can improve strength, body balance, and vertical jump ability in working age men. However, it is still important to consider various factors, such as protein intake and exercise variety to optimize muscle hypertrophy and strength gain.

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REFERENCES

1. Andersen V, Prieske O, Stien N, et al. Comparing the effects of variable and traditional resistance training on maximal strength and muscle power in healthy adults: A systematic review and meta-analysis. ***J Sci Med Sport*.** 2022;25(12):1023-1032.

2. Anderson CE, Sforzo GA, Sigg JA. The effects of combining elastic and free weight resistance on strength and power in athletes. ***J Strength Cond Res*.** 2008;22(2):567-574.

3. Arazi H, Asadi A, Gentil P, et al. Effects of different resistance training frequencies on body composition and muscular performance adaptations in men. ***PeerJ*.** 2021;9: e10537.

4. Bellar DM, Muller MD, Barkley JE, et al. The effects of combined elastic- and free-weight tension vs. free-weight tension on one-repetition maximum strength in the bench press. ***J Strength Cond Res*****.** 2011;25(2):459-463.

5. Chelly MS, Fathloun M, Cherif N, Ben Amar M, Tabka Z, Van Praagh E. Effects of a back squat training program on leg power, jump, and sprint performances in junior soccer players. ***J Strength Cond Res*****.** 2009;23(8):2241-2249.

6. Costa BDV, Kassiano W, Nunes JP, et al. Does performing different resistance exercises for the same muscle group induce non-homogeneous hypertrophy? ***Int J Sports Med*****.** 2021;42(9):803-811.

7. Ebben WP, Jensen RL. Electromyographic and kinetic analysis of traditional, chain, and elastic band squats. ***J Strength Cond Res*****.** 2002;16(4):547-550.

8. Ghigiarelli JJ, Nagle EF, Gross FL, Robertson RJ, Irrgang JJ, Myslinski T. The effects of a 7-week heavy elastic band and weight chain program on upper-body strength and upper-body power in a sample of division 1-AA football players. ***J Strength Cond Res*****.** 2009;23(3):756-764.

9. Giboin LS, Gruber M, Kramer A. Six weeks of balance or power training induce no generalizable improvements in balance performance in healthy young adults. ***BMC Sports Sci Med Rehabil*****.** 2019;11:31.

10. Israetel MA, McBride JM, Nuzzo JL, Skinner JW, Dayne AM. Kinetic and kinematic differences between squats performed with and without elastic bands. ***J Strength Cond Res*****.** 2010;24(1):190-194.

11. Kashiani AB, Soh KG, Soh KL, et al. Effects of 12 weeks combined weight and chain versus combined weight and elastic band variable resistance training on upper and lower body muscular strength and endurance among untrained males in Iran. ***MoHE.*** 2020; 9(1):121.

12. Marin DP, Astorino TA, Serafim AIS, et al. Comparison between traditional resistance exercise and variable resistance with elastic bands in acute vertical jump performance. ***Human Movement.*** 2021;22(4):28-35.

13. McMaster DT, Cronin J, McGuigan M. Forms of variable resistance training. ***Strength Cond J.*** 2009;31(1):50-64.

14. Morton RW, Murphy KT, McKellar SR, et al. A systematic review, meta-analysis and meta-regression of the effect of protein supplementation on resistance training-induced gains in muscle mass and strength in healthy adults [published correction appears in Br J Sports Med. 2020 Oct;54(19):e7]. ***Br J Sports Med*****.** 2018;52(6):376-384.

15. Prejean S, Judge LW, Patrick TJ, et al. Acute effects of combined elastic and free-weight tension on power in the bench press lift. ***Sport J.*** 2012;15(1).

16. Ronca F, Spendiff O, Swann N. An electromyographic analysis of combining weights and elastic tubes as a method of resistance for exercise. ***Transl Sports Med.*** 2020; 3(2):164-170.

17. Shoepe T, Ramirez D, Rovetti R, et al. The effects of 24 weeks of resistance training with simultaneous elastic and free weight loading on muscular performance of novice lifters. ***J Hum Kinet.*** 2011;29(1):93-106.

18. Soria-Gila MA, Chirosa IJ, Bautista IJ, Baena S, Chirosa LJ. Effects of variable resistance training on maximal strength: A meta-analysis [retracted in: ***J Strength Cond Res.*** 2018 Nov;32(11):e56]. ***J Strength Cond Res*****.** 2015;29(11):3260-3270.

19. Spillane M, Emerson C, Willoughby DS. The effects of 8 weeks of heavy resistance training and branched-chain amino acid supplementation on body composition and muscle performance. ***Nutr Health.*** 2012;21(4):263-273.

20. Wallace BJ, Winchester JB, McGuigan, MR. Effects of elastic bands on force and power characteristics during the back squat exercise. ***J Strength Cond Res.*** 2006;20(2):268-272.