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Male Relative Muscle Strength Exceeds Females for Bench Press and Back Squat

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ABSTRACT

Monteiro ER, Brown AF, Bigio L, Palma A, Dos Santos LG, Cavanaugh MT, Behm DG, Correa Neto VG. Male Relative Muscle Strength Exceeds Females for Bench Press and Back Squat. **JEPonline** 2016;19(5):79-85. The purpose of this study was to examine gender based strength differences during one repetition maximum (1RM) back squat (BS) and chest press (CP) exercises. Fifteen females (age, 25.3 ± 5.3 yrs; height, 164.9 ± 6.8 cm; weight, 64.7 ± 10.0 kg) and 15 males (age, 28.1 ± 5.3 yrs; height, 178.0 ± 6.6 cm; weight, 85.9 ± 25.5 kg) performed 1RM BS and CP with 4 days rest between each session. Relative strength was calculated as load/fat free mass. Men had higher relative strength in BS ($P<0.001$) and CP ($P<0.001$) 1RM tests when compared to females. Females exhibited greater relative strength with BS versus the CP ($P<0.001$). In conclusion, male relative strength exceeded females for both the upper and lower tests employed in this study.

Key Words: Resistance Training, Performance, Sex, Men, Women

INTRODUCTION

Resistance training (RT) is commonly used to develop muscle strength and force (10), hypertrophy (21), and power (1) gains. Muscle force (MF) involves overcoming inertia through muscular contraction by combining concentric and eccentric actions (8). It can be categorized as: (a) absolute, when the total load lifted is taken into account; and (b) relative as when the total load lifted is associated with the body weight of the individual (9). In this context, the one repetition maximum test (1RM) is commonly used to measure absolute strength (3,5).

It is reported that men possess greater strength and muscle volume than women (7,9,14), with men's greater testosterone production being a predominant contributing factor (20). Studies (11,15) have shown that men have the ability to lift higher loads than women, and that women have higher MF in the lower body versus the upper body (9,19). Baechle and Earle (2) cited a 1976 article by Laubach (13) that stated women generally possess about two-thirds the strength of men. In fact, when testing absolute force, women have been found to be weaker in hip abduction (22).

However, Baechle and Earle (2) suggest the sex-based differences tend to be lower when the lower body is tested. Heavens et al. (11) analyzed back squat, bench press, and deadlift on muscular damage markers in RT starting with 10RM and lowering the set by one repetition each set. They observed that women were able to perform the protocol faster, and presented slight increases in intensity, which suggests higher muscular fatigue resistance even though the men demonstrated a greater workload. Lovell et al. (15) found that men had higher absolute strength and produced more power than women during a bench press. Whereas men can develop greater absolute strength, there is less agreement on gender based relative muscle force differences.

The relative strength literature remains conflicted. When expressed relative to body mass, lower body strength of women is reportedly similar to men (2). According to Holloway (12), when strength comparisons between sexes are made relative to body mass, differences in strength tend to disappear. Anthropometrically, women tend to have broader hips relative to their waist and shoulders compared to men who possess broader shoulders relative to their hips (2). Thus, women should be more disadvantaged with upper body versus lower body resistance exercises compared to men.

Chagas et al. (6) observed 15 men and 15 women and did not find gender-based differences at 40% and 80% of 1RM in leg and bench press exercises. Flanagan et al. (8) investigated muscular contraction type and the number of repetitions performed by both genders. Using an intensity of 85% of 1RM with eccentric, concentric, and combined (concentric + eccentric) contractions the authors reported no gender-based differences with the bench press. Contrary to the prior anthropometric rationale (i.e., relatively broader female hips permit greater lower body force outputs), the men had higher force outputs with the squat than the women (8). Given that there is limited information on gender based differences of relative muscle force parameters, the purpose of this study was to examine gender based strength differences during 1RM back squat (BS) and chest press (CP) exercises.

METHODS

Subjects

Thirty recreationally trained subjects, 15 females (age, 25.3 ± 5.3 yrs; height, 164.9 ± 6.8 cm; weight, 64.7 ± 10.0 kg) and 15 males (age, 28.1 ± 5.3 yrs; height, 178.0 ± 6.6 cm; weight, 85.9 ± 25.5 kg) participated in this study. The subjects were required to have no less than 12 months of RT experience (19.7 ± 8.05) with an average of 60 to 70 min·session^{-1}, 3 to 4 sessions·wk^{-1}, using loads with 6 to 12 repetitions maximum, and rest intervals between 1 and 3 min among sets and exercises (1). Subjects had previous experience performing the BS and CP exercises. The female subjects performed the procedures in the luteral phase of the menstrual cycle (16). Subjects were excluded from participation if they had an injury or a pre-existing medical condition. A Physical Activity Readiness Questionnaire (PAR-Q) was used as a screening mechanism.

Procedures

All subjects were required to participate in four separate sessions. Anthropometric data included height (Stadiometer ES 2030 Sanny, São Paulo, Brazil), body mass, and lean body mass (Bioimpedance tetrapolar balance Inbody 270, Rio de Janeiro, Brazil). Before the data collection, the subjects read and signed PAR-Q and consent documents in accordance with the Helsinki Declaration. On the first two visits, a load testing and retesting for 1RM was conducted for the CP exercise, with a 48-hr recovery between the visits. After 96 hrs, 1RM testing and retesting for the BS exercise was completed. For all procedures the same apparatus was used (Chest Press Selection Line and Multipower Selection Line, Technogym, Cesana, Italy).

One Repetition Maximum Testing

Subjects performed a brief warm up with 1 set of 10 repetitions at 40% of their estimated 1RM and 1 set of 3 to 5 repetitions at 60% of their estimated 1RM. The subjects were given a 1-min rest between warm up sets. Three minutes after the warm up, subjects began the 1 RM testing. They were allowed three attempts to obtain the 1RM load (3). Prior to testing, subjects were given instruction on proper form and execution of each lift. The subjects performed a retesting 48 hrs after the test to confirm the 1RM load. Consistent verbal encouragement was provided to motivate the subjects to enhance performance. Subjects were permitted to perform the lifts at their preferred cadence. For the 1RM load, the interclass correlation coefficient (ICC) was calculated using the equation: $ICC = [MS_b – MS_w] / [MS_b + \{k -1\} \cdot MS_w]$, where MS_b = mean-square between, MS_w = mean-square within, and k = average group size. The ICCs women values for the BS and CP exercises were 0.97 and 0.98, respectively. In the men group, the ICCs values for the BS and CP exercises were 0.99 and 0.99, respectively.

Statistical Analyses

Data are presented as means ± standard deviations. Initially, relative strength was calculated with the equation: Relative Strength = 1RM Load / Body Mass. A Shapiro-Wilk test was used to analyze normality and homoscedasticity of the data. Two separate Student's *t*-test were used to determine any between gender and between exercise interactions with a significance

level of 5% (P<0.05). All statistical analyses were performed using SPSS version 20.0 (SPSS Inc, Chicago, IL, USA).

RESULTS

Men were shown to have significantly greater relative force with both CP (P<0.001; 157.1%) and BS (P<0.001; 67.1%) when compared to women. Additionally, women were shown to have significantly greater relative force in the BS when compared to the CP (P<0.001; 73.8%).

Table 1. Relative Muscle Force in Women and Men (Mean ± SD).

	Chest Press	Back Squat
Women	0.41 ± 0.11	0.73 ± 0.13[#]
Men	1.08 ± 2.83[*]	1.22 ± 0.37[*]

[*]Significant difference compared to the women group; [#]Significant difference for the Chest Press.

DISCUSSION

The main finding of the present study was that men possessed greater relative force than women in both of the upper and lower body exercises. Additionally, women were found to have greater relative force with the BS when compared to the CP exercise. These results are in accordance with previous findings (4,19).

Similar to the findings in the present study, Bishop et al. (4) observed 24 males and 25 female collegiate amateur swimmers and found that men had higher absolute MF with the biceps curl, bench press, handgrip, leg press, and leg extension exercises compared to women. Furthermore, Morrow and Hosler (19) observed 180 women collegiate athletes and 80 untrained individuals reporting that men had higher absolute and relative MF compared to women athletes for both the upper (bench press) and the lower (leg press) limbs. Interestingly, all the male subjects were untrained, in contrast to the athletic women. The most accepted hypothesis regarding gender based differences in relative MF production is related to differences in both production and concentration of testosterone (15,20).

Women demonstrated greater relative (73.8%) lower versus upper body strength in the present study. Frontera et al. (9) measured the MF of the knee and elbow extensors and flexors in men and women. Similar to the present study, they observed that women produced higher MF in the lower body than in the upper body (knee extensor > knee flexors > elbow extension > elbow flexor). Furthermore, Morrow and Hosler (10) also observed that women had greater lower body MF compared to the upper body (leg press > bench press).

There is a positive relationship between the number of muscle groups and muscle size with MF production (17,18). Since women have broader hips relative to their shoulders, their lower body can mechanically support a greater muscle volume allowing them to provide greater lower body forces (14). Further support for this contention is evident with the relative

differences between men and women in the present study. While the men's force output exceeded the women by 157.1% with the upper body BP, the gender difference was substantially lower (67.1%) with the lower body (BS).

Limitations of the Study

Some factors may directly influence the responses to the test such as menstrual cycle phase and recuperation between the initial test and the retest (16). These factors may contribute to test variability and hence contribute to potential limitations. There were limitations in the present study. Bar velocity was not controlled during 1RM testing, which may have attributed to variation in workload intensity. Additionally, dietary and hormonal (i.e., testosterone, GH, and cortisol) influences were not controlled. With these variables under consideration, future studies should be performed in order to further clarify the relation between gender and relative muscle force variables.

CONCLUSIONS

The present results demonstrate that men exert greater relative forces with both the CP and the BS. However, the gender disparity is not consistent across the upper and lower body and, thus women can handle relatively greater forces when performing BS. Further research is needed to better understand the influence of gender on relative strength. The understanding of such responses can be applied in practice as they allow for more optimal targeted musculoskeletal training and rehabilitation.

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