

Comparing Knee Kinetics and Muscular Activity between the Barbell Squat and Flywheel Squat in Recreationally Trained Females

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Category: Masters

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ABSTRACT

Previous literature has supported flywheel (FW) training with inducing muscular size and strength comparable to resistance training with free weights. However, it remains unclear how the biomechanical demands of these two training methods differ regarding reducing the risk of load-dependent injuries. **PURPOSE:** With the growing population of female astronauts, this study aimed to compare knee joint kinetics and muscle activation when squatting to full depth on the barbell back (BB) squat and a gravity-independent FW device utilizing technology to be deployed in future long-term space missions. **METHODS:** Twenty recreationally trained females (22.3 ± 2.7 yrs, 1.6 ± 0.1 m, 59.8 ± 6.8 kg) with at least two years of experience in BB squat training participated in this study. The first session involved one-repetition maximum (1RM) testing on the BB squat and familiarizing the participants with squatting on the FW device (YoYo™ Multigym). In session two, the participants conducted: 1) one set of seven repetitions at 83% of their 1 RM in the BB and 2) one set of seven maximal repetitions on the FW training device using an inertial load of $0.100 \text{ kg} \cdot \text{m}^2$. The order of the exercises in session two was randomized. Three-dimensional motion capture, force platforms, and electromyography assessed knee joint moments and muscle activation on the participants' dominant limb. Paired t-tests were conducted to compare these variables, with a significance set at $p \leq 0.05$. **RESULTS:** Analysis revealed peak knee extensor moments were greater in the BB squat (BB: $2.14 \pm 0.36 \text{ Nm/kg}$, $p = 0.004$; FW: $1.94 \pm 0.06 \text{ Nm/kg}$). The BB squat elicited greater mean muscle activity over the set compared to FW squats in the following: (vastus lateralis: +5.68%, $p = 0.015$; bicep femoris: +4.63%, $p < 0.001$; gluteus maximus: +4.67%, $p = 0.024$; gluteus medius: +2.75%, $p = 0.011$; gastrocnemius lateralis: +3.09%, $p = 0.028$; gastrocnemius medius: +2.48%, $p = 0.024$). However, FW squats attained greater tibialis anterior activity (+5.56%, $p = 0.04$). There was no significant difference in muscle activity observed in the rectus femoris and vastus medialis. **CONCLUSION:** Although FW training requires less mechanical demand on the knee extensors when squatting to similar depths, participants achieved greater muscular activation during the BB squat.