THE IMPACT OF LOAD ON THE FORCE-TIME CHARACTERISTICS OF THE SQUAT JUMP IN RESISTANCE-TRAINED MEN

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Introduction

The development of rapid force production in the lower extremities is critical for the success of many athletes as power is considered one of the most important factors influencing sport performance (2). Squat jump (SJ) training was found to significantly improve leg strength and power (4), and the static SJ was shown to be positively connected to sprinting, change of direction speed, and jumping abilities (3).

While the SJ may benefit an athlete's performance characteristics, the load and method of loading has not been determined for improving impulse and force. Swinton et al. (5) advised that weighted jumps are one of the most effective exercises for developing lower extremity power, but Dayne et al. (1) found that body mass was the best load for optimizing power in the SJ. However, Dayne et al. (1) compared loads between a percent of a one repetition max, not body mass (BM). Because of the discrepancies and lack of research on static SJ loading, the purpose of this study was to examine the impact that load prescribed off BM percentage had on the force-time characteristics of the SJ.

Practical Applications

- The Dur is specific to the load being moved, but when training for faster propulsive actions, 20 and 40% BM can provide similar results to 0% BM.
- Training with 0% BM can produce similar NetRelMF to 80 and 100% BM loads.
  - When the goal of training is to reduce stress on the body or improve SJ Dur, 0% BW may be used.
  - If the goal is to maximize NetRelMF and NetIMP, heavier loads during the SJ should be prescribed.
- Practitioners should recognize however that individuals may respond differently to the prescribed BM loads as their relative strength may have a significant impact on their performance.

Methods

- Twenty resistance-trained men (age: 23.5 ± 3.0 years, height: 175.1 ± 8.7 cm, body mass (BM): 79.6 ± 11.8 kg, relative 1RM back squat: 1.90 ± 0.28 kg/kg) participated in two separate testing sessions.
  - Session one: 1RM back squat followed by SJ familiarization.
  - Session two: subjects performed unloaded SJ repetitions as well as repetitions with loads corresponding to 20, 40, 60, 80, and 100% of their BM.
- Subjects squatted under barbell to assume a knee angle of 90° ± 5° and held a quiet standing period of at least one second before receiving a countdown prior to each jump trial.
  - Added load rested on boxes adjusted to each subject's height.
- Two jumps were performed at each load on a force platform and the force-time data were used to determine propulsion net relative mean force (NetRelMF), duration (Dur), and net impulse (NetIMP).
- Each variable was compared between the SJ loads using a series of one-way repeated measures ANOVA with Bonferroni post hoc tests.

Figure 1. SJ starting position (left) and flight phase (right).

Results

Table 1. Propulsion force-time characteristics during the squat jump performed with different percentages of body mass (BM).

Load (% BM)	Net Mean Force (N/kg)	Duration (s)	Net Impulse (Ns)
0	8.7 ± 1.2	0.32 ± 0.04	217.9 ± 32.1
20	10.0 ± 1.3[abcd]	0.30 ± 0.03	238.4 ± 37.5*
40	10.0 ± 1.4[abd]	0.33 ± 0.04[e]	257.8 ± 39.8*
60	9.6 ± 1.5[abd]	0.36 ± 0.04*	271.5 ± 42.0*
80	9.2 ± 1.6[a]	0.39 ± 0.06*	278.7 ± 41.2*
100	8.5 ± 1.6	0.43 ± 0.07*	284.0 ± 40.8[cdef]

a = significantly greater than 100%; b = significantly greater than 80%;
c = significantly greater than 60%; d = significantly greater than 0%;
e = significantly greater than 20%; f = significantly greater than 40%;
* = significantly greater than all lighter loads

Conclusions

- The external load used during SJ significantly altered NetRelMF, Dur, and NetIMP.
- Greater NetRelMF magnitudes were produced during the SJ with light-moderate loads (20-60% BM) while shorter propulsion Dur and larger NetIMP magnitudes were produced using lighter and heavier loads, respectively.

References

1) Dayne AM, McBride JM, Nuzzo JL, Triplett NT, Skinner J, Burr A. Power output in the jump squat in adolescent male athletes. J Strength Cond Res 25: 585–589, 2011.
2) Endab JP. Effectiveness of squat and countermovement jumps in improving vertical jump performance. Br J Multidiscip Adv Stud, 5: 69–95, 2024.
3) Loturco I, Kobal R, Maldonado T, Piazzi A, Bottino A, Kitamura K, Abad C, Pereira L, Nakamura F. Jump Squat is more related to sprinting and jumping abilities than olympic push press. Int J Sports Med 38: 604–612, 2015.
4) Ramesh KP. Effect of squat jump training on leg strength and explosive power among college men. AJMR 7: 921–926, 2018.
5) Swinton PA, Stewart AD, Lloyd R, Agouris I, Keogh JW. Effect of load positioning on the kinematics and kinetics of weighted vertical jumps. J Strength Cond Res 26: 906–913, 2012.

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