

Difference between well-practiced high bar and low bar back squat is not in joint moment but in joint ROM and mechanical work of hip and knee

Hiroshi Arakawa^{1*}, Kairi Nasu², Michiya Tanimoto³

¹Physical Education, **International Budo University**, Chiba, Japan

²**NeuronNetwork Corp.** Yokohama, Kanagawa, Japan

³Graduate School of Health and Sports Science, **Juntendo University**, Inzai, Chiba Japan



INTRODUCTION

High-bar (HBSQ)

→ **Knee ext. dominant**

Low-bar (LBSQ)

→ **Hip ext. dominant**

(van den Tillaar et al., 2012)

What factor causes the difference in joint dominance between HBSQ and LBSQ ??

Joint moment ? Joint ROM ? Joint work ?

PURPOSE

To compare the biomechanical variables (net moment, ROM, and mechanical work) of the hip and knee joints between HBSQ and LBSQ performed by well-practiced participants at identical relative loads.

Hypothesis

	Knee ext.	Hip ext.
Moment	HBSQ = LBSQ	HBSQ = LBSQ
ROM	HBSQ > LBSQ	HBSQ < LBSQ
Work	HBSQ > LBSQ	HBSQ < LBSQ

METHODS

- ✓ Participants: Eleven male college students (20.4 ± 1.2 y; 1.69 ± 0.03 m; 66.9 ± 6.3 kg)
- ✓ Procedure:
 - Familiarization (3 months): 2 sets × 8 reps per week for both squats with progressively increasing 8RM loads
 - Exp. (1 day): 5 sets × 4 reps for both squats with respective 8RM loads (HBSQ: 86 ± 15kg, LBSQ: 98 ± 16kg)
- ✓ Tasks:
 - Depth: "parallel" for LBSQ and "full" for HBSQ.
 - Stance width: 40cm
 - Load: 8RM
- ✓ Experimental setups:
 - 3D motion capture system with 12 cameras (VICON)
 - Force platform (Kistler)
 - 27 reflective markers
 - Metronome for lifting speed (1.5 s up and 1.5 s down)
- ✓ Analysis:
 - Kinematic and kinetic variables were calculated using MATLAB
 - From the 20 trials of HBSQ and LBSQ, a pair with almost identical total mechanical work was picked up for comparison.
- ✓ Statistics: A paired two-tailed t-test (R software)

RESULTS

Time course of net joint moment (example)

Net joint moment

Joint	HBSQ [Nm]	LBSQ [Nm]
Knee ext.	221	241
Hip ext.	316	338

N.S. (Not Significant)

Joint ROM

Joint	HBSQ [deg]	LBSQ [deg]
Knee ext.	101	93
Hip ext.	93	98

* P < 0.05, ** P < 0.01

Joint work

Joint	HBSQ [J]	LBSQ [J]
Knee ext.	277	212
Hip ext.	303	354

** P < 0.01

CONCLUSIONS

In well-practiced participants, no significant differences were observed in net joint moment for both hip and knee joint between HBSQ and LBSQ. The joint dominance by changing the bar placement is due not to the net joint moment but to the joint ROM and the joint work in well-practiced participants whose loads temporarily reached a plateau.

PRACTICAL APPLICATION

When changing the bar placement for the purpose of focusing on either the knee or hip extensors, it is important to increase the ROM of the targeted joint as much as possible, which leads to the optimal joint work distribution.

REFERENCES

van den Tillaar, R., Knutti, T., and Larsen, S. (2020). The effects of barbell placement on kinematics and muscle activation around the sticking region in squats. *Front. Sports Act. Liv.* 2:172.