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Superimposed vibration in a flywheel squat. Acute effects on muscle activity in women during squatting in the eccentric phase.

Claudia Baraut [1], Bernat Buscà [1], Joan Aguilera-Castells[1], Jordi Arboix-Alió [1,2,3], Pol Huertas [1]

[1]Faculty of Psychology, Education Sciences and Sport Blanquerna, Ramon Llull University, Barcelona, Spain; [2]Faculty of Health Sciences Blanquerna, Ramon Llull University, Barcelona, Spain; [3]Sport Performance Area, FC Barcelona, Barcelona, Spain

INTRODUCTION:

Strength and conditioning coaches are increasingly seeking innovative strategies to boost athletic performance. One field of interest is combining different techniques, such as resistance training, whole-body vibration (WBV), and eccentric overload. Thus, whole-body vibration (WBV) is proposed as an alternative method to improve strength, power, and balance (1), primarily through the tonic vibration reflex (TVR) and muscle tuning mechanisms (2). Likewise, the vibratory stimuli may enhance motor unit activation and neuromuscular function (3), producing acute benefits when integrated into training (4). On the other hand, flywheel eccentric training leads to specific adaptations such as an increase in muscle cross-sectional area, maximum fiber shortening velocity (5) and preferential recruitment of high-threshold motor units (6). Also, flywheel exercises provides dynamic resistance by storing rotational energy in the concentric phase and releasing it in the eccentric phase. To the best of our knowledge no previous research has studied the muscle activity of the prime squat movers when superimposing vibration in a flywheel. The purpose of this study was to examine the effects of superimposing vibration while executing a flywheel squat.

METHODS:

Design: A repeated measures design was carried out to compare lower limb muscle activity during Flywheel squats performed with and without vibration. Participants completed five repetitions of a half squat (knee flexion at 90º), with three of them performed as fast as possible.
Sample: Fifteen physically active women (n=15, mean age=24,61 ±3,68 years, height=1,70 ±0,075 cm, body mass=68 ±9,97 kg, years of experience=8,90± 4,24) were recruited to take part in the study. All participants signed the informed consent and the Ethics Committee Broad of the Ramon Llull University of Barcelona approved this study.
sEMG assessment: Electromyography module (Bionomadix EMG2-R BIOPAC) was used to measure the muscle activity in rectus femoris (RF), vastus medialis (VM), vastus lateralis (VL), biceps femoris (BF), gluteus maximus (GMAX), gastrocnemius medialis (GAS MED) and gastrocnemius lateralis (GAS LAT) . The electrodes were placed according to SENIAM(7) and before exercise trails, participants performed a MVIC trail for each analyzed muscle following Konrad (8). The muscle activity was expressed as a percentage of MVIC (%MVIC).
Statistical analyses: A one-way repeated-measures ANOVA was conducted to assess the effect of the exercise condition on muscle activity. Statistical significance was set at $p < 0.05$.

1) Electrodes placement

2) Standardized warm-up

3) MVIC Trials

4) Exercise Trials (1x5 reps)
- Flywheel half squat
- Flywheel half squat + vibro 30 Hz
- Flywheel half squat + vibro 40 Hz

5) Measurements
- sEMG signal (% MVIC) RF, VM, VL, BF, GMAX, GAS MED and GAS LAT

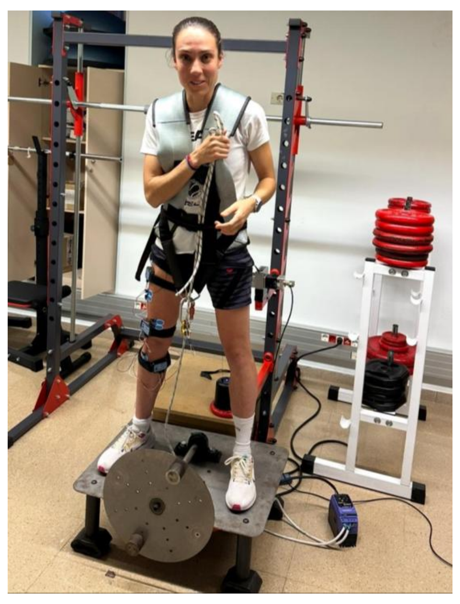

Figure 1:Flywheel squat setup

RESULTS:

A fixed effect of the exercise condition during the eccentric phase was found on the rectus femoris [F(2,28) = 7.19, p =0.003] and gastrocnemius lateralis [F(2,28) = 6.78, p =0.004], but not for vastus medialis [F(2,26.9) = 3.18, p = 0.0058], vastus lateralis [F(2,28) = 1.59, p = 0.222], biceps femoris [F(2,28) = 6.11, p= 0.006] gluteus maximus [F(2,26) = 6.23, p= 0.006] and gastrocnemius medialis [F(2,28) = 0.199, p= 0.821]. Flywheel squats with superimposed vibration (30 Hz and 40 Hz) showed a moderate effect and significantly higher activity on rectus femoris (40 Hz: p = 0.03, d = 0.64), gluteus maximus (40 Hz: p=0.003. d=0.76) and gastrocnemius lateralis (30Hz: p=0.004, d=0,91; 40Hz: p=0.042 d=0.82) compared to non-vibration condition.

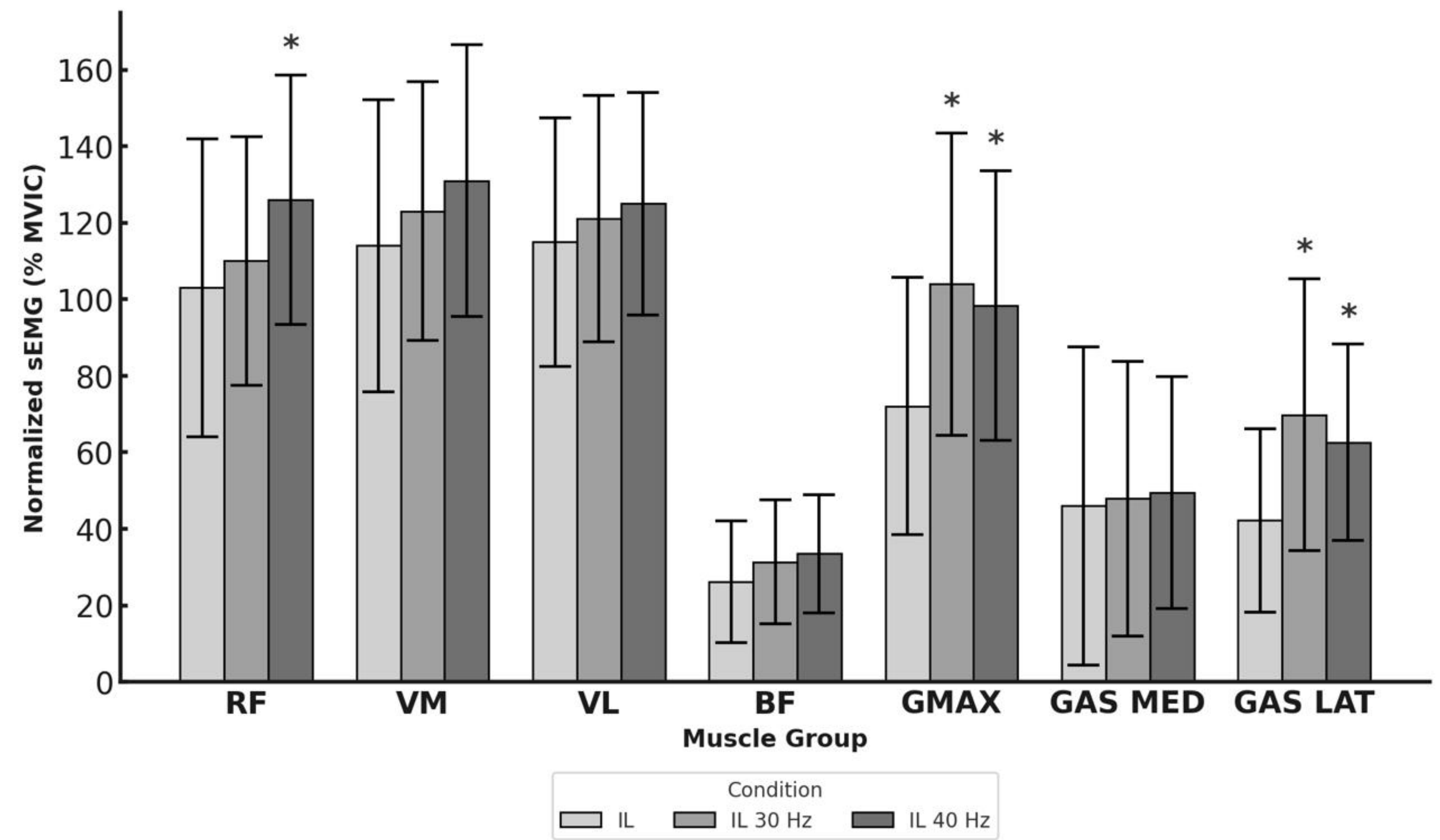

Figure 2. Normalized surface electromyography (sEMG) activity (%MVIC ±SD) across different muscle groups under three conditions: IL. IL 30 Hz, and IL 40 Hz. *Significantly different than IL (p < 0.05).

DISCUSSION AND CONCLUSION

The findings of the study indicate that the muscular response to vibratory stimuli is muscle-specific, thus exhibiting non-uniform activation patterns across different muscles. (conclusion).
RF Showed peak activation at 90º of knee flexion, corresponding to the transition point between the eccentric and concentric phases during the squat(9). Vibration enhanced its activation during submaximal contractions, likely due to reduced inhibitory compared to maximal efforts.
GMAX exhibited the greatest increase in activation under vibration, particularly during the eccentric phase at greater squat depths, where the muscle is lengthened and must activate maximally to initiate the concentric movement (9).
GAS LAT was affected by the vibration due to its proximity to the vibration platform (10). Vibration exacerbates the muscular response of one of the most important ankle stabilizers.

In conclusion, superimposing vibration enhances the muscle activity of rectus femoris, gluteus maximus and
gastrocnemius lateralis in the eccentric phase of the movement.

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claudiabg2@blanquerna.url.edu

Blanquerna Universitat Ramon Llull | Psicologia, Ciències de l'Educació i l'Esport

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