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Effects of Isometric and Isotonic Squat Exercise in Post-Activation Performance Enhancement on Vertical Jump for Trained Male Athletes

Broery Alim Syah Md Daud¹, Raja Nurul Jannat Raja Hussain^{1*}, Noor Azila Azreen Md Radzi¹,
Muhamad Noor Mohamed¹, Muhamad Safiq Saiful Annur¹, Mohd Aizzat Adnan¹, Mardiana
Mazaulan¹, & Maisarah Shari²

¹Faculty of Sports Science and Recreation, Universiti Teknologi MARA Negeri Sembilan, Seremban Campus,
Malaysia

²Faculty of Sports Science and Recreation, Universiti Teknologi MARA Shah Alam, Malaysia

*Corresponding author: nuruljannat@uitm.edu.my

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I. INTRODUCTION

Explosive lower-body power is fundamental to many sports, with vertical jump height widely recognised as an indicator of neuromuscular readiness. Post-activation performance enhancement (PAPE) is a phenomenon whereby high-intensity muscular contractions acutely improve subsequent explosive performance through mechanisms including increased muscle temperature, motor unit recruitment, and phosphorylation of myosin regulatory light chains [1]. Squat exercises, performed isometrically (static hold) or isotonicly (dynamic movement), are commonly used PAPE conditioning activities. However, the optimal contraction mode for peak PAPE expression remains unclear. Mixed findings in the literature, methodological inconsistencies, and the absence of localised research among Malaysian collegiate athletes highlight the need for a controlled, time-sensitive investigation comparing these two squat modalities on vertical jump performance.

II. METHODS

A quantitative randomised controlled trial (RCT) with a repeated-measures design was employed. Twelve trained male collegiate athletes from UiTM Negeri Sembilan (mean age 19.5 ± 0.67 years; height 169.9 ± 4.78 cm; body mass 65.3 ± 10.09 kg; 1RM 86.1 ± 22.18 kg) were randomly assigned into three equal groups ($n = 4$): isometric squat, isotonic squat, and control (normal warm-up). Squat interventions were performed at 75% of one-repetition maximum (1RM). The isometric group performed a static squat hold at 90° knee flexion, the isotonic group performed three repetitions of full-range dynamic squats, and the control group completed a general warm-up with no resistance loading. Countermovement jump (CMJ) height was measured using a jump mat immediately, 3 minutes, and 6 minutes post-intervention. Pre-screening was conducted using the PAR-Q. Data were analysed in Jamovi (v2.6.44) using a two-way repeated-measures ANOVA ($\alpha = 0.05$). Sample size was calculated

using G*Power 3.1 (effect size $f = 0.72$, power = 0.80, minimum $n = 9$).

III. RESULTS AND DISCUSSION

The Shapiro-Wilk test confirmed normality of pre-test data ($W = 0.924$, $p = .316$). The two-way repeated-measures ANOVA revealed no significant main effect of time ($F(2,18) = 1.978$, $p = .167$), no significant group $\times$ time interaction ($F(4,18) = 0.443$, $p = .776$), and no significant between-subjects group effect ($F(2,9) = 2.91$, $p = .106$). Minor fluctuations in CMJ height were observed across time points but did not reach statistical significance. These findings are consistent with [2], who reported no significant differences between isometric and isotonic protocols on CMJ performance. The absence of a PAPE effect may be attributed to the fatigue-potential balance at moderate intensity, the short 6-minute post-activation window, and inter-individual neuromuscular variability. Previous study [3] similarly found that PAPE protocols do not consistently enhance jump performance beyond standard warm-up effects in trained individuals.

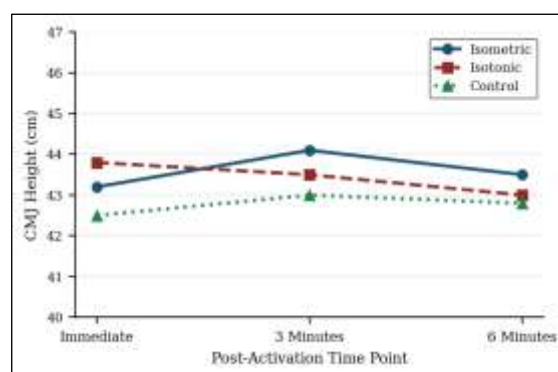


Fig. 1 Mean CMJ height (cm) across post-activation time points by group

IV. CONCLUSIONS

Moderate-intensity isometric and isotonic squat exercises at 75% 1RM did not elicit a significant PAPE effect on vertical jump performance among trained male collegiate athletes within a 6-minute post-activation window. All null hypotheses were accepted ($p > 0.05$). These findings indicate that contraction type alone is insufficient to determine acute performance enhancement. Training intensity, recovery duration, and individual athlete characteristics are critical determinants of effective PAPE protocols. Future research should investigate higher loading intensities, extended time courses, and individualised approaches to optimise pre-competition warm-up strategies for trained athletes.

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