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The Post-Activation Performance Enhancement (PAPE) Effect of Plyometric Warm-Up on Agility Among University Rugby Players

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I. INTRODUCTION

Agility is a critical physical attribute in rugby, requiring rapid changes of direction during offensive and defensive play. Warm-up strategies may acutely influence performance through Post-Activation Performance Enhancement (PAPE), a neurophysiological phenomenon where a conditioning activity temporarily enhances subsequent explosive muscle contractions [1]. While general warm-ups are foundational for preparation, emerging evidence suggests plyometric stimuli may better capitalise on PAPE to improve change-of-direction speed [2]. Limited research has directly compared plyometric and general warm-up protocols on agility specifically among university rugby players, particularly within the Malaysian context. This study aimed to examine the acute effects of both warm-up protocols on agility performance measured at 1, 3, and 5 minutes post-activation and to compare their effectiveness.

II. METHODS

A randomised pre-post experimental design was employed with 18 male university rugby players from UiTM Seremban 3 (age: 18–25 years). Participants were randomly assigned to either a plyometric warm-up (PWU) or general warm-up (GWU) condition ($n = 9$ per group). The PWU consisted of 2 sets $\times$ 10 ankle hops, 3 sets $\times$ 5 hurdle hops, and 5 depth jumps [3]. The GWU comprised 10 bodyweight squats, 10 front lunges, and 3 minutes of dynamic stretching. Agility was assessed using the Illinois Agility Test (ICC = 0.85–0.98) [4] at baseline and at 1, 3, and 5 minutes post-warm-up. Anthropometric measurements were taken using a Seca 213 stadiometer and Seca 713 scale (both ICC = 0.99). Data were analysed using repeated-measures ANOVA with Bonferroni post-hoc corrections; significance was set at $p < 0.05$.

III. RESULTS AND DISCUSSION

Baseline agility scores were comparable between groups (GWU: 17.5 $\pm$ 2.22 s; PWU: 17.8 $\pm$ 1.85 s), and Shapiro-Wilk tests confirmed normal distribution for all variables ($p > .05$), justifying the use of parametric analysis. For the plyometric warm-up condition, repeated-measures ANOVA revealed no statistically significant change in agility across the three post-activation time points ($F = 1.10$, $df = 3$, $p = .367$). Similarly, the general warm-up condition produced no significant time effect ($F = 0.921$, $df = 3$, $p = .446$). These findings indicate that neither warm-up type induced measurable agility improvements across the 1, 3, and 5-minute recovery windows.

Between-group comparisons further revealed no significant difference in agility performance at any post-activation time point ($F = 0.00414$, $p = .950$), indicating that the plyometric warm-up did not confer superior benefits over the general warm-up. results are consistent with [5], who reported context-dependent potentiation effects in elite athletes, and with Behm et al., who noted that general warm-ups prepare the body but may not maximally prime neuromuscular pathways for explosive tasks [2].

Notably, contrast analysis within the PWU group revealed a statistically significant improvement at 5 minutes post-activation relative to earlier time points (estimate = -1.1567, $t = -3.0157$, $p = .017$). This delayed enhancement aligns with the PAPE concept, which suggests potentiation may emerge after sufficient recovery from the conditioning stimulus. Tobin and Delahunt similarly observed delayed performance improvements several minutes after plyometric stimulation in professional rugby players [3]. The absence of a significant main time effect despite this contrast finding may reflect individual variability and the small sample size limiting statistical power.

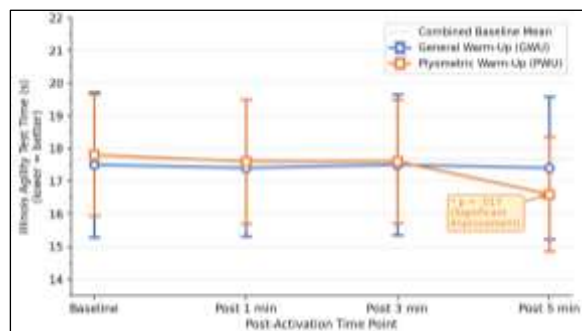


Fig. 1 Illinois Agility Test performance (Mean $\pm$ SD) for GWU and PWU groups across post-activation time points.

* Denotes significant improvement at 5 min post-PWU ($p = .017$).

IV. CONCLUSIONS

Neither plyometric nor general warm-up protocols produced statistically significant acute enhancements in agility performance under the tested conditions. However, the significant delayed improvement at 5 minutes post-PWU suggests a potential PAPE response. Future studies with larger samples and optimised recovery intervals (e. g., 5–10 minutes) are recommended to better understand the practical application of plyometric warm-ups for university rugby players.

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